Price Changes, Policy Impacts and Instability in Farmers' Revenues

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1 Introduction

The paradigm of regional disparities is very prominent and relevant for the European Union. Over the last decades, disparities between the member states have decreased significantly which is appreciated as one of the main policy objectives of the EU (see, for instance, Geppert and Stephan 2008, or Crescenzi 2009). The same studies reveal that disparities persist at the regional level (Geppert and Stephan 2008, or Crescenzi 2009). However, some studies find evidence that fiscal decentralisation and resource allocation decreases regional disparities (Ezcurra and Pascual 2008, Gil, Pascual and Rapún 2004). Regarding the agricultural sector, existing studies have indicated that farmers depend strongly on regional production conditions which cause regionally differentiated levels of farm income (Hill 2000, OECD 2003, Shucksmith, Thomson and Roberts 2005). Concerning long term development, during the last ten years farmers faced very remarkable price variations on product markets (Headey and Fan 2008, Gilbert 2010). In recent years, significant price changes took place for several reasons such as business cycles in the world economy and correspondingly strong shifts in demand for raw materials and expansion as well as structural shifts in food demand (Dewbre et al. 2008, Schmitz, Furtan und Schmitz 2009). Moreover, the latest trends in agricultural commodity prices suggest another prices increase starting in May 2010 (AMI 2010). Beyond this, farmers also have to deal with fluctuations in factor costs such as wages and prices for fuel and fertilizers, respectively (Gilbert 2010). In addition, the adjustment and support of the policies of CAP has changed gradually as well (Brady et al. 2009). The latter is the attempt to bring the European agriculture closer to the market also resulting in an increasing volatility in agricultural commodity prices in the long run.

There is rich literature revealing the impact and the redistributional effects of the Common Agricultural Policy on European farmers (see, inter alia, Allanson 2007, Allanson and Rocchi 2008, Anders et al. 2007, Moro and Sckokai 1999, Rocchi, Romano and Stefani 2005). Most of the studies are focused on the effects of price support and direct payments (Anders et al. 2007, Moro and Sckokai 1999, Rocchi, Romano and Stefani 2005), while the analyses of Allanson (2007) and Allanson and Rocchi (2008) include all CAP support but do not determine effects of certain policies exclusively. Additionally, Latacz-Lohmann and Hodge (2001) as well as Glebe and Latacz-Lohmann (2007) have demonstrated that support programmes within the second pillar of the CAP, more precisely agri-environmental measures, also have an increasing relevant impact on farming and the agricultural trade regimes. Increasing attention is also paid to the multilayer issues and mechanism of rural development aspects (Dissart 2007). Therefore, the question which impact different support policies have on farmers in different locations is an ongoing research area.

Regarding these key facts, we focus on regional disparities in agricultural income, particularly in the context of agricultural price fluctuations and the impacts from agricultural policy. In order to illustrate regional disparities in farm income, we regard the communities in the German State of Hesse with its very strong regional disparities in terms of farming structure and landscape (Klausing 1987). Therefore, the term region corresponds in the underling analysis to the communities in the Federal State of Hesse. Our data set covers seven years for the period from 2000 to 2006. The time period includes the effect of the CAP reform 2003 and its implementation. Direct payments have become decoupled and increased in the period under study, while market price support continued to decrease and support from the programmes of the second pillar was expanded only slowly. Therefore, we consider different support policies under EU's CAP in our study.

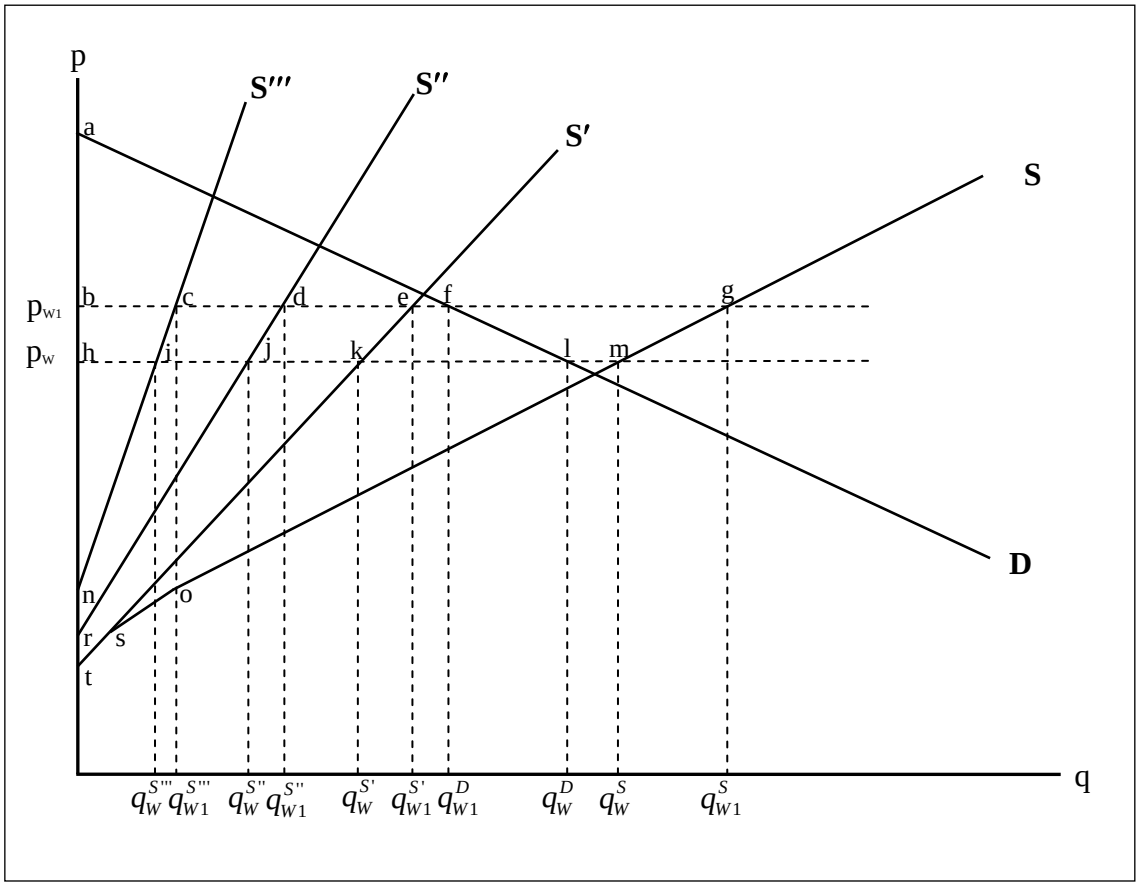
The remainder of this paper is organised as follows. In the next section, we present a theoretical model explaining regional disparities in farm revenues. Than, development of agricultural prices as well as farming revenues with and without support is illustrated. In the

fourth part we give an overview of regional disparities with regard to the instability of farm revenues arguing the issue of stabilization effects of the CAP. In the fifth section, we investigate regional disparities in farm revenues and analyse the differences for crop and animal production. Furthermore, we show what impact the changes in agricultural commodity prices have on farm revenues in the different regions. The last section concludes the major findings of this paper.

2 Theoretical background

The following section gives a short theoretical background for the underlying analysis. Consider three different regions that have a similar endowment of agricultural land: region one can be described by favourable production conditions, region two is enhanced by moderate production conditions and region three can be described by poor natural conditions. Figure 1 illustrates a market for an agricultural good.

Figure 1: Welfare effects of price change for structurally different regions



Source: Own illustration.

D is the demand curve for the total demand of all three regions. S′ is the supply of region one, two (S″) and three (S‴) that can be aggregated horizontally to the supply curve S that gives the supply of all three regions (Helmberger 1995).

The price of the world market is given by p_W. Demanded quantity is given by q_W^D. The production of region one is given by $q_W^{S'}$. $q_W^{S''}$ and $q_W^{S'''}$ give the quantity produced by region two and three. The differences in production are due to different cost curves, e.g. caused by different farm structures in the regions resulting in different supply curves. The total production of all three regions is indicated by q_W^S. The difference between production and

consumption is exported to the world market. The regions are assumed to have no impact on the world market.

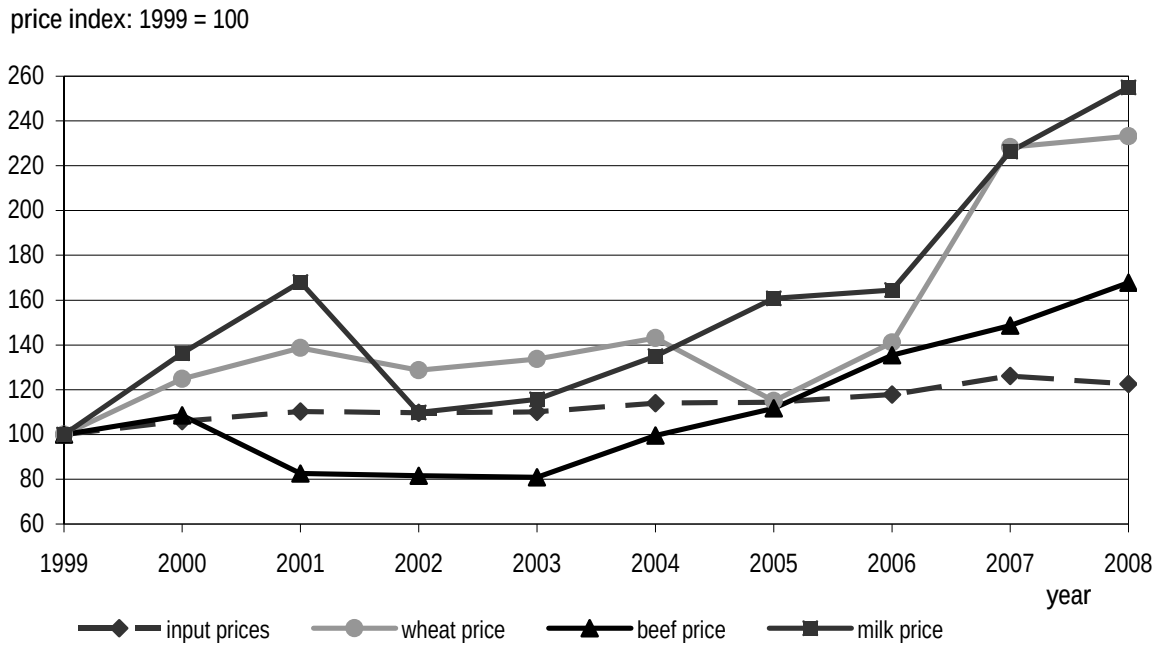
In this situation, the surplus of the consumers is given by the area *alh*. The surplus of the producers of all three regions is equal to *hmost*. However, the welfare effect is not the same for producers in the three regions. Given the different supply curves, the surplus of region one is equal to *hkt*. *hjr* and *hin* give the surplus for the producers in region two and region three, respectively. Now consider a change in world market prices from p_W to p_{W1}. The demand decreases to q^D_{W1}, the total supply increases to q^S_{W1} ($q^{S'}_{W1}$, $q^{S''}_{W1}$ and $q^{S'''}_{W1}$ for producers in region one, two and three) and the exports increases as well. In line with this, the surplus of the consumers is given by the area *afb* which goes along with a loss of *bflh*. The total surplus of the producers now equals *bgost*. However, the important point is that the increase in producer surplus is different in the regions: The surplus for region one is given by the area *bet* with an increase of *bekh*. The surplus of region two is equal to *bdr* (the increase equals *bdjh*). For producers in region three the surplus equals *bcn* being an increase by the area *bcih*. Thus, regions and farmers within different regions are not affected equally by an increasing commodity price.

The preceding theoretical considerations for three different regions have revealed that existing regional disparities may lead to regional different effects from price changes. Changes in agricultural policy can be assumed to have a similar result for the regions.

3 Developments in product prices and farmers revenues

Fluctuations in agricultural commodity prices have been moderate for a long time. However, this development has changed in recent years and is likely to change in the future. Agricultural commodity prices have increased dramatically in the years 2006 to 2009 (see Gilbert 2010, Schmitz, Furtan and Schmitz 2009).

Figure 2: Development of agricultural product and input prices 1999-2008[a)]



[a)] The agricultural commodity prices are the OECD reference prices, associated without any kind of support to agriculture, taken from the OECD data base on Producer and Consumer Support Estimates (2009). The price developments are given in percentage changes to the base year 1999. The input prices are reflected by a price index for agricultural inputs.

Source: Own illustration with data from OECD (2008) and Eurostat (2009).

Figure 2 gives an overview of the developments in agricultural commodity prices and agricultural input prices from 1999 to 2008. It is obvious that despite the significant changes in the years from 1999 to 2005 the changes in the following years are even more powerful. For instance, the wheat price increases by almost 40 % form the year 1999 to 2001. It falls by 18 percentage points from 2004 to 2005. After this, it almost doubled from the year 2005 to the year 2008. Admittedly, the prices for agricultural commodities decrease in the last month of the year 2008 and in 2009. Looking at the whole period, prices changes were dramatically.

The development of prices for milk and beef show that the price fluctuations were not only limited to grain products. In the case of milk, change seems to be even larger than for wheat. However, the example of beef also shows, for the period 2003 to 2008, an upward trend indicating fairly substantial price changes (also see Gilbert 2010, Headey and Fan 2008). In contrast to the agricultural commodity prices, the agricultural input prices show a moderate development. On average the input prices increased by almost 2.5 % from 1999 to 2008. In addition to this, a price index for agricultural inputs serves as an indicator in order to consider also the input side of farming. This index is taken from the Eurostat data base for prices and indices (Eurostat 2009).

Keeping the recent price changes in mind, a basic research question is whether these developments are similar for farms in structurally different regions. Our theoretical model presented in chapter 2 indicates that agricultural regions facing different production costs are also affected by different welfare effects resulting from price changes. Furthermore, the effect of agricultural policies may also have an impact on the farm revenues that is not the same for all regions. Firstly, in order to regard these questions, we separated the Hessian communities into three clusters to distinguish between different types of agricultural regions and to identify regional disparities in the State of Hesse. Following Bahrenberg et al. (2008) the approach to set threshold levels for the separation of the regions is applied. More precisely, we defined the average geographical height of a region as the indicator for the classification of the clusters and chose the threshold level to be 200 respectively 360 meters:

- Cluster I: regions with favourable conditions;
  120 regions with an average geographical height below 200 meters;
- Cluster II: regions with average natural conditions;
  192 regions with an average geographical height from 200 to 360 meters;
- Cluster III: regions with poor natural conditions;
  112 regions with an average geographical height above 360 meters.

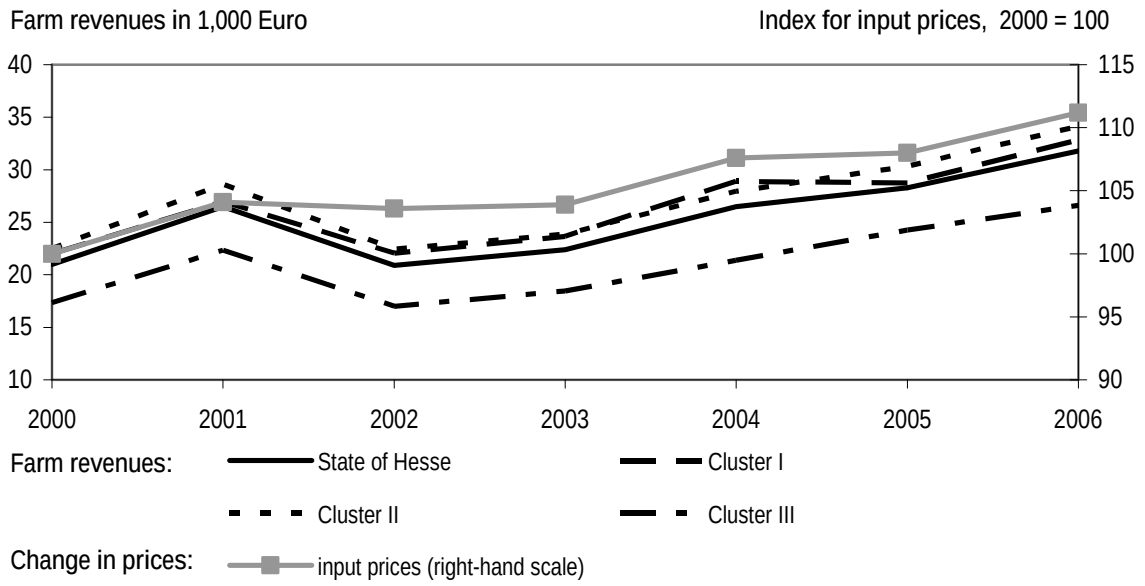
The classification of the clusters in regard to their average geographical height is applied to control for differences arising from the geographical location. Additionally, it has to be considered that the derived three clusters differ in several aspects of agricultural structure such as size of farms, parcel size, labour intensity and proportion of grassland. For instance, farms being located in cluster III are extraordinary small and show a high proportion of grassland in agricultural area. These farms are affected by heavy rainfall, low temperatures and mountainous regions (Klausing 1986). These conditions result in relatively high production costs (Robinson 2004). In contrast to this, farmers in cluster I operate under favoured conditions, namely with huge farms being endowed with relatively high proportions of cultivated land for crop production generating high yields.

Looking at Figure 3, we may conclude that all regional clusters are affected by strong fluctuations of farm revenues. Farm revenues are the revenues without support to agriculture. This is calculated by multiplying the regional production with the OECD reference price that is taken from the OECD dataset on *Producer Support Estimates* (PSE) (OECD 2008).[1]

[1] For more detailed information about this procedure see Anders et al. (2004) and (2007).

Among our three clusters, cluster III is characterized by the lowest average revenues.[2] An explanation for this finding may be that because of differentiated agricultural conditions farmers located in cluster III are strongly influenced by low yields resulting from unfavourable landscape and climate conditions.

Figure 3: Development of farm revenues and input costs 2000-2006 [a)]



[a)] The input prices are reflected by a price index for agricultural inputs (Eurostat 2009).
Source: Own illustration with data from OECD (2009), HSL (2008) and Eurostat (2009).

Contrary to this, farmers located in cluster I and cluster II are, by the majority, focussed on urban markets and show a wide range of products including several crops such as grain, sugar beets, vegetables and fruits as well as, in minor dimensions, livestock products. Therefore, these farmers have the potential to generate high yields and to compensate price fluctuations for single products by risk diversification. However, the general trend in farm revenues is the same in all three regions, which might indicate a strong effect of commodity prices that is equal for all regions. This would question the existence of regional disparities in Hesse. Furthermore, Figure 3 obviously indicates that farm revenues fluctuate stronger (more than 32 % in all regions from 2000 to 2006) than the input prices for the period under study (about 12 % in the same time).

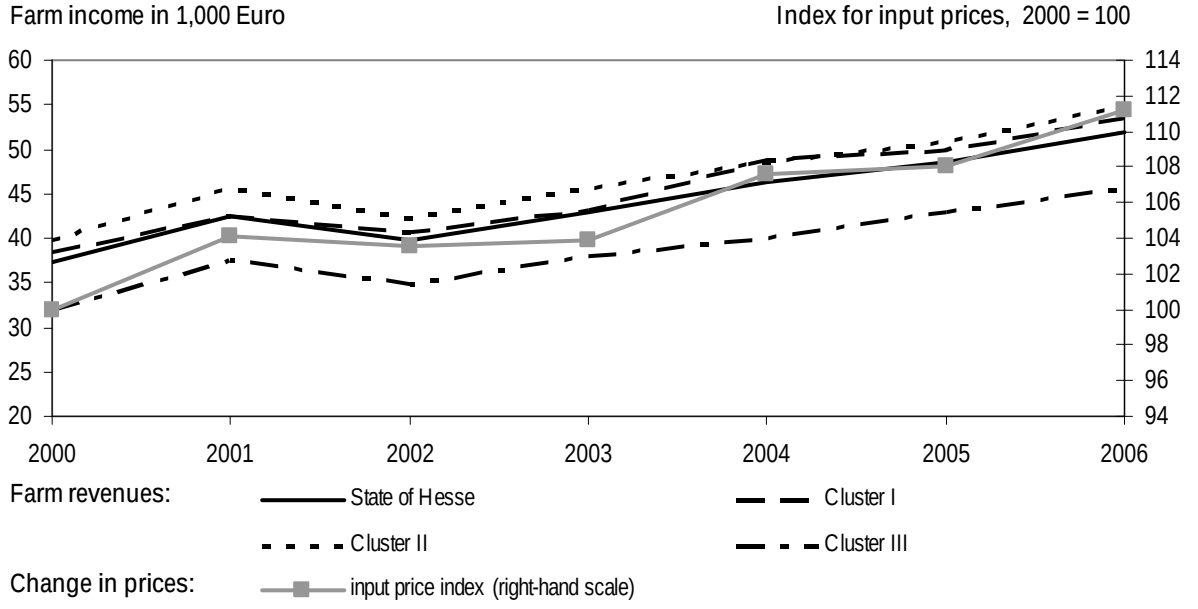
In a next step, in Figure 4 we illustrate temporal variations of farm income which include supplementary transfers induced by agricultural policy.[3] Particularly, we conclude that Common Agricultural Policy causes substantial income support to farmers. This is the case in all three types of agricultural regions in the State of Hesse. Developments illustrated in Figure 4 also lead to the statement that agricultural policy results in a stabilization of farm income, namely again in all three clusters of agricultural regions. We will test this hypothesis

[2] Moreover, the farm revenues are relatively small because of the high share of part time farmers in Hesse, as only the revenues of the farming activity are considered in this study.

[3] Farm income includes the farm revenues and the support to agriculture from the CAP. This is calculated by multiplying the regional production with the OECD reference price that is taken from the OECD dataset on *Producer Support Estimates* (PSE) and adding the regional sum of support from the different support schemes (OECD 2008). Region support from the market price policies is calculated by applying the per unit support taken from the OECD database. Regional support from direct payments and from the programmes of the second pillar was provided by the Hessian Ministry of Agriculture. For more detailed information about this procedure see Elsholz and Harsche (2008).

in the following chapter. In order to analyze the single effects from different policy instruments, several components of agricultural policy are separately considered.

Figure 4: Development of farm income and input costs 2000-2006 [a)]



[a)] The input prices are reflected by a price index for agricultural inputs (Eurostat 2009). Farm income is calculated by farm revenues plus the transfers from the different support policies.
Source: Own illustration with data from OECD (2009), HSL (2008) and Eurostat (2009).

4 Instability in farm revenues

As a result of remarkable business cycles, the past decade was characterized by strong variations in agricultural commodity prices (Gilbert 2010, Schmitz, Furtan and Schmitz 2009). In the same time there have been significant changes in the agricultural policy and support from agricultural policy (Brady et al. 2009, Dissart 2007, Rocchi, Romano and Stefani 2005). Therefore, the research question is how these different changes impact on farm revenues for farms in different locations. To answer this question we calculated the coefficient of variation for the different support policies and for farm revenues with and without support.

The methodology for the examination of the instability in farm revenues is to calculate the variation in the support measures and the farm revenues for the period 2000-2006 on the basis of the coefficient of variation (CV). To control for possible trends in time, the method proposed by Cuddy and Della Valle (1987) is applied as in several other studies (e.g. Anders et al. 2004, Aiello 1999). The Cuddy and Della Valle Index of instability (I) is:

$$I = CV\sqrt{1-\overline{R}^2}. \quad (1)$$

Where $\overline{R}^2$ is the corrected goodness of fit of a time trend regression:

$$y = \beta_0 + \beta_t t + \varepsilon \ . \quad (2)$$

The Cuddy and Della Valle index is used instead of the CV if the time trend is significant at the 5 % level. The trend (β_t) is calculated for a linear and a log-linear model. If both trends were significant the F-value for the models was used as criteria to choose.

Table 1: Coefficient of Variation (in percentage) / Instability index [a)]

Variation in time	Transfers per region(€)			
Measure	**DP**	**SPP**	**MPS**	**CAP**
Cluster I	**19.99**	**61.82**	**26.36**	14.91
Cluster II	**17.67**	**43.06**	**22.00**	13.18
Cluster III	**25.22**	**30.72**	**20.94**	12.29
Hesse	**20.39**	**45.27**	**22.97**	13.43

Variation in time	Farmers' Revenues per region (€)				
Measure	**without Support**	**supported by**			
		DP	**SPP**	**MPS**	**CAP**
Cluster I	11.65	11.75	15.10	8.34	10.87
Cluster II	11.92	**11.42**	**13.36**	7.45	8.75
Cluster III	13.51	**13.97**	**13.84**	7.81	9.03
Hesse	**12.17**	**12.18**	**14.75**	7.80	9.42

[a)] The bold figures give the instability index (for those measures with a significant trend in time). The normal figures show the coefficient of variation in percentages.
Source: Own Calculations.

Table 1 shows the instability index for the different support policies and farm revenues at the regional level with and without support. An alternative analysis of the instability of revenues and support per farm indicates significant time trends for all measures. However, it is rather complex to separate the time trend into a component of structural change and a component of the changes of the measures through price and yield changes, as shown by Harsche (2009). To avoid this issue we analysed the support and revenues per region.

The upper part of table 1 shows the instability of the support from policy. The different policies considered are direct payments (DP), second pillar payments (SPP)[4] and market price support (MPS). These policies are summed to the CAP. The DP shows an instability index of around 20 %. At the first glance this seems to be very high. However, keeping in mind that the period under study is limited to seven years and that there have been some important changes in DP might explain the values. The introduction of the DP for animal production in 2003 and 2004, e.g. the dairy premium, is one important aspect here, but also the introduction of direct payments for protein crops (EC 2003). Another is, of course, the increase in DP with introduction of the single payment scheme. The differences between the clusters are due to differences in the production mix. The SPP show the highest instability among all policy components. This can be explained by the fact that several programmes are aggregated to the second pillar including the support of investment for agricultural holdings which has a significant share (Elsholz, 2008). This programme has the character of a project based support programme.[5] Furthermore, this leads to very different results for the clusters. For instance, in regions in cluster I (cluster III) the investment programme has a higher (lower) share of SPP as in cluster II. The programme for the adaptation and the development of rural areas also contributes to this effect as it shows partly the same project based support mechanism (EC 1999).

[4] The SPP capture all transfers from the programmes of the second pillar with the exception of the programme for the improvement of processing and marketing of agricultural products for the years 2000 to 2002. The excluded transfers account for approximately 2.3 % of the total SPP for the period from 2000 to 2006 in Hesse.
[5] The support programme for investments in agricultural holdings leads to payments that are very high in two or even only one year and near zero for the other years. Additionally, the investments programme is relatively equal distributed between the different clusters, while most of the programmes from the second pillar allocate more funds to regions with poorer natural conditions. This results in very instable support of the SPP.

The support of the MPS was calculated by multiplying the regional production with MPS per unit. This was calculated for the OECD data set on *Producer* and *Consumer Support Estimates*. The MPS shows a moderate instability. This can be traced back to the fact that MPS is high in years when world market prices fall below the EU intervention level. The more significant world market prices fall, the higher the MPS becomes. In years when the prices are above the intervention level MPS becomes zero. In this case, the difference between the clusters can be explained by the yields per hectare. MPS is per unit support depending on the quantity produced. This leads to higher support in regions with higher yields and vice versa. A further component is the production mix in the regions. A remarkable result from the policy measures is that the sum of all policies, the CAP, shows the lowest instability for all three clusters and Hesse. This result shows that the policy mix leads to a relative stable income component for all different kinds of regions.

The lower part of table 1 indicates the instability of farmers' revenues without support and with support of different policies. On average, the revenues show an instability of 12.2 %. This seems to be rather small bearing in mind the substantial price changes discussed in the second part of our study. Indeed, for the different scenarios of support the findings are quite interesting. Farm revenues supported by DP illustrate almost no decrease in instability. For Hesse, instability increases by 0.01 percentage point. Instability decreases in cluster II but increases in cluster I and III. Farm revenues supported by SPP have a significant higher instability than without support. Interestingly, this result also has a strong link to the different types of regions. For regions in cluster III, we find an increase of only 0.33 percentage points, while the increase is 3.45 and 1.44 percentage points in cluster I and II. The MPS generates the highest reduction in instability for all regions and the clusters as well. This finding is certainly caused by the design of the MPS. On average the instability is reduced by 4.37 percentage points. For the farmers' revenues supported by CAP we illustrated a moderate reduction of instability. On average support of CAP decreases instability by 2.75 percentage points. Admittedly, the decrease is much smaller for regions in cluster I (0.78 percentage points) as for regions in cluster II (3.17 percentage points) and cluster III (4.48 percentage points). This finding may be a result of the fact that farms operating under poorer natural conditions, such as in low mountain ranges, depend very strongly on direct support payments. Our analysis also reveals that the instability of farmers' revenues has been moderate compared to the development of agricultural commodity prices. Furthermore, our findings indicate that the support from agricultural policy decreases instability. However, the latter result is more distinctive for regions with poorer natural conditions.

Unsurprisingly, we find significant time trends in all policy measures. For the DP and SPP the trends are positive for all regions, particularly the DP have increased from the year 2000 to 2006. The trend for MPS is negative indicating the reduction of the intervention prices and the increase in product prices. However, the sum of support shows no significant trend. This reveals that the reduction in MPS is compensated by the increase of DP and SPP. Interestingly, for farm revenues and farm revenues with support the findings are not so clear. Farm revenues supported by CAP or by MPS show no significant trend. Both, farm revenues supported by SPP or by DP show a positive trend but not for cluster I. The latter finding suggests that there are significant differences between the clusters regarding farm revenues. Thus, the question how changes in commodity prices impact on the different kind of regions is of central importance for the analysis in the next section.

5 Development of prices and regional disparities in farm revenues

In section 2 and 3, several aspects concerning development of farm income in the State of Hesse are considered. In order to get an explanation for the developments in structurally different regions, in this chapter a regression analysis is applied. Particularly, the agricultural production quantities and the commodity prices determine the regional farm revenues.

Therefore, a change of agricultural product prices leads to direct changes in farm revenues. In the following section we analyse the link between the development of agricultural commodity prices and regional farm revenues. Furthermore, we illustrate the regional disparities of farm revenues.

Table 2 contains the descriptive statistics for regional farm income, farm revenues, farm size and the price index of agricultural input prices. From the table, it is evident that there are considerable differences between the three clusters.

Table 2: Descriptive statistics for Hesse and the regional clusters

Variable	Unit	Min	Max	Mean	Std. dev.
Hesse					
Farm income	Euro	3,400.78	13,4275.9	41,512.58	21,433.75
Farm revenues	Euro	1,822.23	93,602.94	25,330.9	14,815.56
Farm size	Hectare	7.34	138.88	31.02	12.37
Price index	Annual (%) change	-0.48	5.93	2.39	2.20
Cluster I					
Farm income	Euro	4,128.54	12,4172.5	43,351.08	22,088.15
Farm revenues	Euro	2,227.35	90,569.42	26,450.07	14,707.03
Farm size	Hectare	9.17	75.63	34.37	12.28
Cluster II					
Farm income	Euro	4,031.57	13,4275.9	44,039.88	22,175.76
Farm revenues	Euro	2,086.82	93,602.94	27,125.34	15,523.04
Farm size	Hectare	7.87	85.14	31.28	11.85
Cluster III					
Farm income	Euro	3,400.78	98,775.72	35,210.26	17,894.17
Farm revenues	Euro	1,822.23	75,110.35	21,055.62	12,708.57
Farm size	Hectare	7.34	138.88	27.00	12.23

The price index for agricultural inputs is taken from the Eurostat database for price indices (Eurostat 2009).
Source: Own calculation.

For instance, farms located in cluster I generate the highest average income as well as revenues. These farms are also endowed with the largest size in terms of utilized agricultural area, in comparison to farms operating in the other regional clusters. In contrast to this, farms located in cluster III are characterized with the lowest income and revenues, respectively, as well as the smallest agricultural area per farm. All these indicators show that farms in cluster III may operate under rather unfavourable production conditions because of structural reasons.

Table 3 shows the results of three OLS regressions: Farm revenues are regressed on a price index for agricultural inputs, the farm size and two dummy variables according to the regional location of the regions. The price index for agricultural inputs is expected to have a positive impact on farm revenues, because in the long run a rising index indicates increasing production costs which leads to higher prices of agricultural products (Dewbre et al. 2008). The basis year for the index is 2000. The changes from year to year are measured in percent. The farm size measures the absolute size of the farm and is expected to have a positive impact on farm revenues (Hill 2000, OECD 2003).[6] The coefficient of the dummy for farms in cluster I is expected to have a positive sign as these farms are associated with the most favourable natural conditions. The coefficient of the dummy for farms in cluster III is expected to have a negative sign as these farms are associated with poor natural conditions for

[6] Farm size is measured in hectare.

farming. The reference for the dummy variables is cluster II. The dummy variables serve the purpose to identify regional disparities.

Table 3: Regression results for regional differences in farm revenues

revenues per farm (in €)	estimate I total	estimate II crop production	estimate III animal production
price index agri. inputs	540.16***	173.29***	366.87***
	(58.52)	(33.62)	(45.41)
farm size (ha)	780.51***	440.64***	339.88***
	(16.55)	(9.50)	(12.84)
cluster I	-3082.96***	2925.02***	-6007.98***
	(474.48)	(272.59)	(368.19)
cluster III	-2726.03***	-2810.79***	84.77
	(487.18)	(279.88)	(378.03)
constant	-54270.15	-20410.75	-33859.39
	(6114.37)	(3512.63)	(4744.55)
n	2968	2968	2968
F-value	0.000 (674.64)	0.000 (795.56)	0.000 (361.99)
Adj.R^2	0.4759	0.5172	0.3603

***, (**), (*) indicates statistical significance at the level of 99.9 %, (99 %), (95 %). Standard errors are given in parentheses.
Source: Own calculation.

In table 3, first estimate illustrates more than 47 % of the variation in total farm revenues are explained by the explanatory variables. The price index has a positive sign and is statistically significant at the level of 99.9 %. Farm size shows the expected positive sign and is significant. An increasing farm size leads to higher farm revenues. The dummy variable for farms in cluster I is significant but has a negative sign. This is unexpected and needs a further explanation that is given by the separation of revenues into crop and animal production. The dummy for farms in cluster III is negative and also significant. The latter two coefficients indicate that, on average farms in cluster II have higher farm revenues as those in cluster I and III controlled for farm size and price changes for agricultural inputs.

Estimates II and III in table 3 show the regression results for farm revenues generated by crop production and animal production respectively. For estimate II the dummy variables show the expected signs: Farms in cluster I have higher revenues than farms in cluster II and farms in cluster III have lower revenues than farms in cluster II. Both dummies are statistically significant. The results indicate that farms in cluster I generate more revenues by crop production than farms in cluster II. Farms in cluster III generate much less revenues by crop production than farms in the other two clusters. However, the picture differs for estimate III, namely the revenues generated by animal production.

While farm size and the price index are positive, the dummy for farms in cluster I is significantly negative and the dummy for farms in cluster III is not significant. On average farms in cluster I generate about 6,000 € less for animal production than farms in cluster II. This leads to the conclusion that the negative dummy for cluster I for total farm revenues in estimate I is caused by the high difference in animal production. Furthermore, the findings in table 3 indicate that there are distinctive regional disparities in farm revenues in Hesse. Moreover, the results reveal that farms in the different regions can be differentiated by certain farming strategies. Farms in cluster I (III) are focussed on crop (animal) production, while farms in cluster II follow a more balanced farming strategy.

Table 4 shows results of three OLS regressions to investigate the changes in farm revenues from 2000 to 2006. The absolute changes in farm revenues generated from crop production and animal production, respectively, are regressed on the change in farm size and the regional dummies. The change in farm size accounts for the structural change and is expected to have a positive impact on the development of farm revenues from 2000 to 2006 (Hill 2000). The dummy variables control for regional disparities in the development of farm revenues: It is expected for the development of total farm revenues that both dummy variables show a negative regression coefficient (estimate I). This is for the reason that farms in cluster II follow a more balanced farming strategy and therefore are expected to have the best capabilities to deal with price changes that cause the changes in farm revenues. The results from estimate I confirm this expectation and are also in line with the findings by Geppert and Stephan (2008) that disparities among regions within countries in the EU do not decrease. The change in farm size and the regional dummies explain more than 27 % of the variation of the changes in farm revenues from 2000 to 2006. An increase in farm size leads to an increase in farm revenues. This is a plausible effect and confirms former research findings (Hill 2000).

The results of estimate I show that farms in cluster II realize the highest increase in farm revenues for the period under study. For farms in cluster I and III, the increase in farm revenues is significantly lower. The findings for the change in revenues by crop and animal production reveal that farms in cluster I generate a higher increase in farm revenues from crop production but the lowest increase by animal production. For farms in cluster III, this picture is opposite. Namely, the increase in farm revenues generated by crop production is much lower than in farms in cluster I and II. For animal production, the findings indicate that the increase does not differ statistically from those of farms in cluster II.

Table 4: Regression results for regional changes (absolute) in farm revenues from 2000 to 2006

change in revenues per farm (in €)	estimate I total	estimate II crop production	estimate III animal production
change farm size	751.84***	392.94***	358.90***
(in ha)	(60.82)	(32.58)	(45.65)
cluster I	-1794.74*	920.30*	-2715.05***
	(786.27)	(421.13)	(590.17)
cluster III	-1985.56*	-2064.88***	79.32
	(799.22)	(32.58)	(599.89)
constant	6956.48	2656.69	4299.79
	(613.86)	(328.79)	(460.77)
n	424	424	424
F-value	0.000 (53.78)	0.000 (69.34)	0.000 (25.99)
Adj.R^2	0.2724	0.3264	0.1506

***, (**), (*) indicates statistical significance at the level of 99.9 %, (99 %), (95 %). Standard errors are given in parentheses.
Source: Own calculation.

The regional dummy variables indicate the same regional disparities for the development of farm revenues: Farms in cluster I focus mainly on crop production and realise the most significant increase of revenues generated by crop production. Farms in cluster III are the smallest and face the poorest natural conditions for agricultural production. However, we find no significant differences between cluster II and III for animal production. Furthermore, our results indicate that the increase in farm revenues is most remarkable for farms in cluster II. According to the findings, there are regional disparities in farm revenues between farms

located in the different clusters. This result is valid for farm revenues as well as for the changes in farm revenues controlled for farm size.

6 Conclusions

The development of the agricultural commodity prices shows an increase in price variations. For future, price and revenue variations are expected to increase (Gilbert 2010, Schmitz, Furtan and Schmitz 2009). The deregulation of the commodity markets, the reduction in market price support and the increasing demand for agricultural commodities are only parts of this process (Brady et al. 2009). However, our analysis shows that the evident changes in agricultural commodity prices have an impact on farm revenues without support. Support by the CAP tends to attenuate this impact on farm revenues. While some commodity prices have changed by more than 100 per cent in the last decade, farmers' revenues are more stable.

In a first step, a theoretical market model is presented in order to illustrate different welfare effects from price fluctuations for several farm production regions being endowed with different agricultural conditions. Our model reveals how price changes have an impact on structurally different regional and thus contributes to regional disparities.

The analysis of the instability of farm revenues without support and with support by different policies has revealed that there are remarkable differences between the measures. However, this effect appears plausible considering the design of the support policies (Anders et al 2004, Latacz-Lohmann and Hodge 2001). The instability of the support measures DP, SPP and MPS shows substantial variation in regard to the clusters. Interestingly, the sum of support, the CAP, shows the lowest instability of all support measures. Therefore, it might be argued that the underlying policy mix generates a relative stable component of farm income. Besides, the results show a stabilisation effect of the CAP. However, this effect varies in regard to the location. The stabilisation is smaller (more significant) for favoured (disfavoured) regions.

Furthermore, our results indicate that there are substantial disparities between farms located in geographically different types of regions. This finding is in line with results of studies on the economic development of structurally different regions in the EU (Geppert and Stephan 2008, Crescenzi 2009). Farms located in favoured agricultural regions obviously generate higher revenues than farms located in regions facing poor conditions. This finding is significant controlled for the size of the farm. In addition to this, our analysis reveals there are considerable differences regarding farming strategies. The better the natural conditions, the more revenues are generated by crop farming and vice versa. The poorer the natural conditions, the more farmers adopt animal production that can be combined with programmes of the second pillar (Dissart 2007). Investigating the regional changes in farm revenues from 2000 to 2006 we find farms with a more balanced farming strategy generating the highest increase in farm revenues. This result is valid controlled for structural change (e.g. farm size). Moreover, the findings indicate that the regional disparities are even more distinctive for the different production types and are significant for farm revenues and the change in farm revenues. The latter of the results leads to the conclusion that there has been no decline in the regional disparities. Thus, regional disparities in agriculture show an equivalent development than economic disparities (Geppert and Stephan 2008, Crescenzi 2009).

Concerning the presented results, we may discuss some aspects on the different objectives of agricultural policy such as the income support to farmers and the income stabilization. Depending on regional production conditions, the impacts from Common Agricultural Policy as well as those from national and regional policy packages are quite different. This is also confirmed by findings of Allanson and Rocchi (2008). Obviously, farms located in favoured regions are rather in need of more income stabilization whereas farmers operating under poor regional conditions are affected by relatively small incomes. As our results are based on data for the state of Hesse, the conclusion drawn from these results may be limited to regions with similar natural disparities or at least softened elsewhere. Indeed, the analysis provides some

insights into the existence and development of regional disparities at a disaggregated level. Moreover, our findings reveal that price changes in agricultural commodity prices and support from agricultural policy impact unequal on farms in different regions. This result has to be carefully considered for future policy reforms.

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