Regional income effects of producer support under the CAP

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Effets sur le revenu régional du soutien aux producteurs distribué par la PAC

Résumé – La politique agricole commune (PAC) de l'Union européenne est caractérisée par un large éventail de programmes et mesures mis en œuvre, qui diffèrent selon la catégorie d'instruments utilisés, en fonction des produits et dans le temps. En conséquence, l'impact net de cette combinaison d'instruments en terme d'incitation par les prix pour les producteurs et les consommateurs est opaque depuis des années. Notre étude utilise un concept régionalisé de l'estimation du soutien au producteur (ESP) pour évaluer les effets de la PAC pour les producteurs au niveau désagrégé des régions de type Nuts III. Une étude de cas portant sur 26 régions de l'état de Hesse en Allemagne a été réalisée pour la période 1986-1999. Il en ressort que la PAC appliquée de manière uniforme affecte ces régions de façon très différente. De plus, dans les régions étudiées, les réformes récentes de la PAC n'ont pas conduit à une réduction significative du niveau moyen du soutien aux producteurs. La tendance à la baisse, statistiquement significative, du niveau du soutien par les prix a en effet été compensée par l'accroissement tendanciel significatif du niveau du soutien par les paiements directs. Il est intéressant à noter que les indicateurs ESP en termes absolus, d'une part, et en termes relatifs, d'autre part, ne sont pas du tout corrélés. Si le transfert vers les producteurs, via la PAC, est déterminé sur la base d'un objectif de niveau absolu de soutien, alors il pourrait en résulter une distribution interrégionale arbitraire des ESP relatives, de l'ESP en pourcentage des recettes des producteurs, par exemple.

Mots-clés :
politique agricole commune, Union européenne, estimation du soutien au producteur (ESP), effets régionaux, Hesse

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Summary *– The Common Agricultural Policy (CAP) of the European Union (EU) is characterized by a wide array of individual policy measures, which differ by the category of instruments, across commodities and over time. Consequently, the net impact of the policy mix on price incentives for producers and consumers had been intransparent for years. This study utilizes a regionalized concept of producer support estimates (PSEs) to elaborate the primary effects of the CAP on producers at a disaggregate level of NUTS III regions. 26 regions in the federal state of Hesse, Germany, in the years 1986-1999 are utilized as a case study. One important result is that a uniform CAP does affect the regions very differently. Recent reforms of the CAP have not reduced significantly the average level of agricultural support in the region studied. Statistically significant downward trends in absolute producer support due to price support were associated with significant upward trends due to direct payments. Interestingly, absolute and relative PSE measures due to the CAP and price support are fully uncorrelated with each other. If transfers under the CAP are targeted in terms of absolute support, e.g., this may induce an arbitrary interregional distribution of PSEs in relation to farm revenues.*

Key-words:
common agriculture policy, European Union, producer support estimates (PSE), regional income effects, Hesse

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THE Common Agricultural Policy (CAP) of the European Union (EU) is characterized by a wide array of individual policy measures, which differ by the category of instruments, across commodities and over time. This situation is similar to many other industrialized countries. Consequently, the net impact of the policy mix on price incentives for producers and consumers had been intransparent for years. The existing level of agricultural protection, as a basis for agricultural trade liberalization, had also been unknown. Given this situation of the 1970s and 1980s, it was a major step forward that producer and consumer subsidy equivalents (*PSE*s and *CSE*s) have been introduced and computed by the OECD and the USDA as a continuing basis of information on agricultural support (OECD a; OECD b; OECD, 1987; Webb *et al.*, 1990).

Despite this progress, redistributive implications of the CAP remain hidden in several respects even with the aggregate computation of *PSE*s and *CSE*s for OECD countries:

1. *PSE*s are computed at one level of the marketing chain. Due to imperfect policy transmission (Colman, 1985), they may be different at other levels of the marketing channel.

2. Average *PSE*s are computed on the basis of the aggregate production structure within the EU. Due to varying production levels and structures at the farm level, *PSE*s for individual farm types may well be different from aggregate *PSE*s. Target groups of interest for farm policy may be large or small farms, family farms, part-time or full-time farmers or conventional *versus* organic farming.

3. *PSE*s are computed for the EU as a whole. As natural and economic determinants of production vary within Europe, regional protection levels will vary, too.

Accordingly, disaggregate information and analyses of support levels within the marketing channel, across farm types and regions are needed for a detailed assessment of policy impacts. Here, we will concentrate on the regional implications of the CAP. Theoretical and empirical evidence on regional redistributive effects of the CAP is still limited. A major and early study on the implications of the CAP for regional development exists with the RICAP study (Commission of the European Community, 1981). Regional specialization within agriculture was documented and linkages between the agricultural market orders and regional agricultural development were investigated. In the RICAP study a regional indicator of support was developed on the basis of nominal protection and computed for EU regions. In its summary, the authors of the RICAP study drew the conclusion that regional divergence in agriculture could not be mitigated with the CAP. A greater need to define regional policy goals as well as to measure regional impacts of the CAP was stressed.

Beyond the RICAP study, only a few publications examined the regional redistribution due to the CAP until the mid-1990s[1]. An exception is Brown (1990) who elaborated the uneven distribution of nominal protection under the CAP across farm types and regions. Since the mid-1990s, a number of studies on the regional impacts of the CAP has come up indicates, which, a regained interest in these distributional issues. Simulations of a policy change, with less price support and more direct income transfers, based on input-output analysis (Leon and Quinqu, 1995), and the modelling of multiplicator effects of a reduced price support on the basis of an agricultural sector model (Doyle *et al.*, 1997), capture regional effects for France and Scotland, respectively. In the European Commission's (2001) comprehensive study on the impacts of the CAP on economic and social cohesion, it is analyzed for the EU members and their federal states how transfers from the CAP are distributed across farm types and regions. Tarditi and Zanias (2001) analyze the impacts of agricultural price support on cohesion in Europe and distinguish the territorial effects of three scenarios: traditional CAP, 1992 reform and completion of the reform. Major results are that agricultural policy has favoured large farms and still does (European Commission, 2001, section 5.4) and that the CAP redistributes income from high- to low-income regions (Tarditi and Zanias, 2001). The European Commission and Tarditi and Zanias apply the *PSE* concepts; so does Zanias (2002) in an analysis of a partial re-nationalization of the CAP. Walkenhorst (2003) utilizes the *PSE* concept, too, and investigates the regional distribution of transfers to farmers in Switzerland.

Like in European Commission and Tarditi and Zanias, it is the objective of this study to gain a more detailed insight in the regional impacts of the CAP under the influence of the 1992 reform. Although these two studies go beyond ours in the sense that transfers to and from consumers are also incorporated and more European regions are covered, these studies do not deal with some other important issues:

1. Both relevant studies concentrate on selected years: the European Commission on the years 1989, 1994 and 1996, Tarditi and Zanias on 1991 and 1995. Our study covers for the NUTS III level of one federal state of Germany, Hesse, time series of agricultural protection from 1986 to 1999. This allows a broader analysis of policy effects beyond the 1992 reform as well as to concentrate more on the long-run trend and inequality of regional protection levels.

2. As we focus on producer support, we do not refer to statistical indicators of regional protection alone, but relate the interregional distribution of support and its changes over time to indicators of agricultural conditions.

[1] Various redistributive implications of the CAP are analyzed and further classical studies discussed in Buckwell *et al.* (1982).

We suggest a regionalized *PSE* approach and utilize it to measuring regional impacts of the CAP within one Federal State of Germany, *i.e.*, Hesse, over time. Hesse showed a very strong economic prosperity during the last five decades and is characterized by strong interregional disparities in economic development. Therefore, this state represents an interesting case study for measuring the spatial distribution of support.

We do not simulate alternative options of the CAP, as other authors did, but provide an *ex post* measurement and explanation of the distribution of support that incorporates all policy changes in the period 1986-1999. Data utilized are available over time (1986-99) and across commodities, so that regional support due to the CAP can be aggregated from support for the individual commodities.

We will address the following questions in detail:

(i) To which extent does European agricultural policy cause differential regional support levels for agriculture?

(ii) How did agricultural support due to the CAP vary over time?

(iii) How did policy changes affect the regional impacts of the CAP? More specifically, to which extent were lower transfers from decreasing price support compensated by increasing direct payments in the context of the 1992 agricultural reform or the Agenda 2000? Do these results differ by region?

(iv) From (i) to (iii), the question arises whether the CAP diminishes or raises income inequality within the farm community or across regions.

The paper is organized as follows. The methodological framework is presented first. Then, aggregate descriptive and inductive statistics are presented and analyzed in the empirical part in order to elaborate the regional implications of the CAP. Finally, conclusions for policy and future research are drawn.

REGIONALISATION OF THE *PSE* CONCEPT

To measure the level of agricultural protection at a regional level we adapt the OECD's (1999) producer support estimate (*PSE*) concept[2]. While the OECD derives several different *PSE* measures at an aggregated level of the EU, the goal of this study is to get comparable measures at a more disaggregated regional level.

[2] The producer support estimate is based on the original producer subsidy equivalent founded on work by Corden (1971) and introduced as a concept to measure agricultural support by Josling (1979).

The OECD's absolute *PSE* measure is defined as:

$$PSE = MPS + PP = (P_p - P_r)\,Q - L + PP, \qquad (1)$$

where *MPS* is the market price support, *Q* is the quantity supplied, P_p is the domestic price at the farm-gate level, P_r is the reference price representing the world market price, *L* are price levies, and *PP* are payments based on different criteria (output, area planted/animal numbers, historical entitlements, input use, input constraints, farming income, and miscellaneous).

In general, to derive more regional measures one could follow two alternative approaches: a bottom-up and a top-down approach. In a bottom-up approach one would collect data for P_p, P_r, Q, L, and PP at the regional level and utilize them to calculate the regional *PSE*. In the top-down approach utilized here we take the OECD's Unit *PSE* and multiply it by the quantity produced in a specific region. Certainly, the bottom-up approach would give more exact results of the regional level of support, but its application becomes more difficult the smaller the analyzed regions are. Necessary information might not be available at a very disaggregated level or be inconsistent across regions.

While the bottom-up approach has been utilized at the NUTS I (*e.g.* Zanias, 2002) and NUTS II (Tarditi and Zanias, 2001) level this study regionalizes the *PSE* at a NUTS III level where at least some of the necessary data for a bottom-up approach are not available. Therefore, we develop a top-down approach. In particular, we start from the OECD's Unit *PSE* (*UPSE*) which is defined for product *i* as

$$UPSE_i = PSE_i \,/\, Q_i \qquad (2)$$

to derive the *PSE* for a specific region *j* by

$$PSE^j = \sum_i UPSE_i\, Q_i \qquad (3)$$

with $i = 1, \ldots, 11$; $j = 1, \ldots, 26$. Utilizing equation (3) we calculate the *PSE*s for the 26 NUTS III regions of Hesse[3] including 11 different products[4] for which produced quantities at this regional level are available, representing about 70 % of total agricultural output of Hesse.

In accordance with the OECD we also calculate three additional *PSE* measures: *PSE* per single farm (*FPSE*), per hectare of land (*APSE*) and the so-called percentage *PSE* (*%PSE*):

[3] Since the OECD does not calculate the *PSE* for rye we use the Unit *PSE* and prices of common wheat to calculate the *PSE* of rye. For potatoes the OECD calculates only the *MPS* part of the *PSE* and we follow this procedure.

[4] The products chosen are: wheat, rye, barley, oats, rapeseeds, sugar, potatoes, milk, beef, pigmeat, sheepmeat.

$$FPSE^j = \frac{PSE^j}{F^j}, \tag{4}$$

$$APSE^j = \frac{PSE^j}{A^j}, \tag{5}$$

$$\%PSE^j = \frac{PSE^j}{\sum_i P_{pi} Q_i^j + PP}, \tag{6}$$

where F^j is the number of farms in region j, A^j is the area of cultivated land in hectares in region j and, again, $i = 1, \ldots, 11$; and $j = 1, \ldots, 26$. The *%PSE* gives the percentage of total revenues (including direct payments) implied by transfers from consumers and taxpayers.

Similarly, we construct absolute and relative measures for the market price support (*MPS*, *FMPS*, *AMPS*, *%MPS*) and the direct payments (*PP*, *FPP*, *APP*, *%PP*).

EMPIRICAL RESULTS

How did agricultural support vary across regions?

To calculate regional *PSE* measures for the 26 NUTS III regions, we utilize data for the period 1986-1999[5]. Table 1 presents mean values over time. The absolute *PSE* computations in the first column reveal that in the whole federal state of Hesse an average annual transfer to farmers of € 575 million (M) occurred as a consequence of the CAP. Around 70 % (€ 402 M) of this transfer was due to market price support and the remaining 30 % (€ 173 M) was due to direct payments[6].

[5] The names of the 26 regions analyzed in this study are: D–Darmstadt, FFM–Frankfurt/Main, OF–Offenbach, WI–Wiesbaden, BERG–Bergstraße, DADIE–Darmstadt-Dieburg, GG–Groß-Gerau, HTK–Hochtaunuskreis, MKK–Main-Kinzig-Kreis, MTK–Main-Taunus-Kreis, OD–Odenwald, OFL–Offenbach-Landkreis, RTK–Rheingau-Taunus-Kreis, WE–Wetterau, GI–Giessen, LDK–Lahn-Dill-Kreis, LM–Limburg-Weilburg, MB–Marburg-Biedenkopf, VB–Vogelsberg, KS–Kassel, FD–Fulda, HR–Hersfeld-Rotenburg, KSL–Kassel-Landkreis, SEK–Schwalm-Eder-Kreis, WF–Waldeck-Frankenberg and WM–Werra-Meißner-Kreis.

[6] Apparently, the share of support due to market price support and direct payments has changed over time most significantly with the CAP 1992 reform. The average share of market price support in the five years preceding the reform (1988-1992) was about 80 %, while it was only 52 % in the last five years of observation (1995-1999).

The relative *PSE* measures in columns 2-4 reveal that the impacts of the CAP differ widely across regions. This is especially true for the *PSE* per farm (*FPSE*) which is around € 12,696 on average, but varies between € 5,284 and € 19,772 implying an interregional coefficient of variation of 29.1 %. Apparently, the variation in the *FPSE* is driven by structural differences in farm sizes across regions. Average farm sizes vary between 12 and 28 hectares with a coefficient of variation of 23 %. The correlation coefficient (ρ) between the *FPSE* and average farm size is 0.8 as table 2 illustrates.

As expected, market price support (*FMPS*) as well as direct payments (*FPP*) per farm are significantly and positively correlated with average farm size.

Somewhat less variation is measured for the *PSE* per hectare (*APSE*) with an interregional coefficient of variation of 18.1 %. Nevertheless, the absolute differences in support per hectare are large, varying between € 443 and € 870 and an average value of € 670. The interregional variation is slightly higher for market price support (*AMPS)* with a coefficient of variation of 21.3 compared to 17.7 % for *APP*. None of the three measures per hectare (*APSE*, *AMPS*, *APP*) is correlated with the average farm size.

The lowest variation is calculated for the *%PSE*, which is 45.5 % on average (compared to 37.6 % for the whole EU), and varies between 38.2 and 51.1 % implying an interregional coefficient of variation of 6.7 %. The coefficient of variation is smaller for *%PSE* than for the two separate components *%MPS* (10.9 %) and *%PP* (16.8 %). This result is due to the fact that *%MPS* and *%PP* are significantly and negatively correlated (-0.48). *%PSE* and *%PP* are significantly negatively correlated with the average farm size. Therefore, looking at the correlations between our *PSE* measures and farm size one might conclude that large farms get higher transfers per farm, as they possess more land, but not per hectare. Moreover, the *%PSE* is larger for small farms, and, from an interregional perspective, for regions with low average farm sizes.

We have additionally examined whether the computed *PSE* measures are correlated with natural conditions (mean temperature, rainfall and soil quality), structural conditions (average size per farm) as well as socio-economic factors (population density, *per capita* income, rural or urban area) in the regions. Therefore, table 2 presents a correlation matrix with some interesting findings. The correlations with population density, available income *per capita*, and urban regions reveal that as a tendency agricultural support is transferred more to rural areas with lower income. This general finding is valid on a per-farm and per-hectare *PSE* basis for total support, price support as well as direct payments. The *%PSE* is not significantly correlated with either population density or *per capita* income. Favourable natural conditions like higher rainfall tend to imply higher producer support, especially market support, per farm and per hectare, but are associated with a lower *%PSE*.

Table 1. **Average regional producer support estimates, NUTS III level, federal state of Hesse, Germany, 1986-1999, in €**

	Total CAP				Market price support				Direct payments			
Regions	*PSE* M €	*FPSE* €	*APSE* €	*%PSE* %	*MPS* M €	*FMPS* €	*AMPS* €	*%MPS* %	*PP* M €	*FPP* €	*APP* €	*%PP* %
DA	0.8	13,037	492	38.2	0.6	9,412	362	27.4	0.2	3,625	130	10.8
FFM	2.7	10,461	632	43.7	1.9	7,063	445	30.3	0.8	3,398	187	13.4
OF	0.1	6,570	457	50.1	0.1	4,477	316	34.3	0.0	2,093	141	15.8
WI	2.9	9,132	607	41.8	2.0	6,053	418	28.4	0.9	3,079	189	13.5
BERG	16.6	12,520	676	46.2	12.6	9,264	512	34.7	4.0	3,256	165	11.5
DADIE	19.4	18,064	746	42.7	14.2	12,730	543	30.8	5.3	5,334	203	12.0
GG	10.6	16,228	584	39.6	7.6	11,122	417	28.1	3.0	5,106	167	11.5
HTK	6.3	11,507	580	48.2	4.3	7,526	395	32.6	2.0	3,981	185	15.6
MKK	33.8	13,360	747	49.3	24.3	9,369	537	35.3	9.5	3,991	210	14.0
MTK	4.1	9,866	579	46.3	2.8	6,377	390	30.9	1.4	3,488	189	15.4
OD	14.6	13,022	819	51.1	11.3	9,881	634	39.5	3.3	3,141	185	11.6
OFL	3.6	12,886	622	46.5	2.4	8,592	431	31.4	1.1	4,294	191	15.1
RTK	8.0	5,284	443	44.3	4.6	2,911	255	25.1	3.4	2,373	188	19.2
WE	41.5	18,112	797	45.6	29.7	12,382	569	32.3	11.9	5,730	228	13.3
GI	21.5	12,606	655	45.8	14.4	8,045	440	30.2	7.0	4,560	215	15.6
LDK	10.2	7,074	518	48.6	6.7	4,471	347	31.7	3.4	2,603	171	16.9
LM	22.5	19,772	716	48.3	15.3	12,979	489	32.8	7.2	6,793	227	15.5
MB	39.2	12,232	794	44.9	26.8	8,083	544	30.6	12.4	4,149	250	14.3
VB	51.3	15,126	780	47.5	37.5	10,720	569	34.7	13.8	4,405	210	12.8
KS	0.5	8,203	525	45.8	0.3	4,615	302	24.3	0.2	3,588	223	21.5
FD	49.8	12,065	770	47.3	36.7	8,680	568	34.9	13.1	3,385	203	12.4
HR	28.5	10,725	742	44.5	19.6	7,112	510	30.5	8.8	3,613	232	14.0
KSL	39.0	16,497	739	43.9	24.6	9,975	466	27.4	14.4	6,523	273	16.4
SEK	61.2	16,626	870	41.9	41.3	10,815	586	28.2	19.9	5,812	284	13.6
WF	58.8	14,340	811	46.9	41.7	9,949	574	33.3	17.1	4,390	237	13.6
WM	27.6	14,780	718	44.9	18.5	9,559	483	30.0	9.1	5,221	235	14.9
Hesse	575.1	13,635	743	45.6	401.8	9,219	519	31.7	173.3	4,415	224	13.9
Average of Regions[a]	22.1	12,696	670	45.5	15.5	8,545	465	31.1	6.7	4,151	205	14.4
Interregional *CV*[a]	87.1	29.1	18.1	6.7	87.8	30.9	21.3	10.9	87.2	29.3	17.7	16.8
Max.	61.2	19,772	870	51.1	41.7	12,979	634	39.5	19.9	6,793	284	21.5
Min.	0.1	5,284	443	38.2	0.1	2,911	255	24.3	0.0	2,093	130	10.8

[a]: average of regions and interregional CV are the arithmetic mean and the coefficient of variation for the 26 regions.
Source: authors' computations with data from OECD, various issues and Hessisches Statistisches Landesamt (a,b)

Table 2. **Correlation coefficients between relative *PSE* measures and region-specific variables** [a]

PSE measures	*A/F*	$RAINF_{05}$	$TEMP_{01}$	*POPDENS*	*PCI*	*URBAN*
FPSE	0.79***	0.24	-0.24	-0.48*	-0.31	-0.43*
APSE	0.13	0.40*	-0.49*	-0.57**	-0.55**	-0.52**
%PSE	-0.42*	0.10	-0.23	-0.06	-0.08	-0.26
FMPS	0.77***	0.32	-0.25	-0.47*	-0.30	-0.42*
AMPS	0.17	0.47*	-0.46*	-0.53**	-0.49*	-0.49*
%MPS	-0.10	0.37[*]	-0.28	-0.20	-0.13	-0.32
FPP	0.73***	0.04	-0.18	-0.43*	-0.28	-0.41*
APP	-0.01	0.03	-0.37[*]	-0.45*	-0.49*	-0.42*
%PP	-0.40*	-0.40*	0.11	0.21	0.09	0.12

***, (**, *, [*]): statistically significant at the 99.9%-, (99%-, 95%-, 90%-) level

[a]: ***A/F*** is the average size per farm in hectares, $RAINF_{05}$ is average rainfall in May, $TEMP_{01}$ is the mean temperature in Celsius in January, ***POPDENS*** stands for population density, ***PCI*** is *per capita* income and ***URBAN*** a dummy variable with unity for the urban centers WI, FFM, MTK and KS and zero in all other cases. Data for farm structure and the climatic variables are from Hessisches Landesamt (a), for *PCI* and *POPDENS* from Hessisches Landesamt (b). The indicators of soil quality (*SOIL*) and temperature in July ($TEMP_{07}$) showed no significant correlation and is excluded here. The *PSE* measures are defined and computed as explained in section 2. Average values were computed for 1986-1999.

Source: authors' computations

Natural conditions matter, too, for the regional distribution of transfers: income transfers per hectare tend to be larger for regions with a lower mean temperature in January, which is an indicator of climatic differences. Furthermore, rainfall in May is a major determinant of yields in crop production. Therefore, it is plausible that this variable is positively correlated with *APSE*, *AMPS*, and *FMPS*, whereas it is negatively correlated with *%PP*.

The correlation analysis among all *PSE* measures does uncover some further interesting findings. The correlation matrix is shown in the appendix. *PSE*, *FPSE* and *APSE* are positively correlated, but there is no statistically significant correlation among these absolute producer support estimates and *%PSE*. This is an interesting result with regard to regional policy goals. If price support or the total CAP, *e.g.*, is oriented at an *FPSE* or *APSE* target, this will lead to an untargeted and uncorrelated distribution of *%PSE* across regions.

It is noteable, too, that total producer support and market price support per farm and per hectare are negatively correlated with *%PP*. This suggests that favoured agricultural regions where support per farm or per hectare is high due to market price support, are less dependent of direct payments than disfavoured agricultural regions.

Summing up, a uniform CAP leads to very different regional protection levels according to all utilized indicators – *PSE*, *FPSE*, *APSE* and *%PSE*.

How stable was agricultural support over time?[7]

In table 3, the variation of regional support levels over the period 1986-1999 is measured on the basis of the coefficient of variation (*CV*). To account for possible trends in the time series, which would imply an overestimation of the *CV*, we utilize a method proposed by Cuddy and Della Valle (1978) and applied, *e.g.*, by Herrmann and Weiss (1995) and Aiello (1999). The Cuddy and Della Valle index (*I*) is given by:

$$I = CV\sqrt{1 - \overline{R}^2} \tag{7}$$

where $\overline{R}^2$ is the corrected goodness of fit of an exponential time trend:

$$\ln(PSE) = \alpha + \beta t. \tag{8}$$

The *CV* is replaced by the Cuddy and Della Valle index if the *F*-test (or the *t*-test for β) is significant at least at the 5 %-level. Since autocorrelation can modify the Cuddy and Della Valle index (Duggan, 1979) and many of our trend regressions have low Durbin Watson (*DW*) *d* statistics we proceed as follows: besides estimating the time trend as described in equation (8), we also use the Cochrane-Orcutt procedure, *i.e.* including an *AR*(1) term. If the *DW* statistic of the regression without the *AR*(1) term does not suggest to accept the null hypothesis of no serial correlation at the 10 % significance level ($d < 1.35$) and the *AR*(1) term is significant at the 10 % level, the time trend is estimated using the Cochrane-Orcutt procedure.

Table 3 reveals that the variation in the absolute *PSE*, *FPSE*, *APSE* and *%PSE* for most regions is moderate over time, in most cases lower than the variation across regions that had been shown in table 1. For total Hesse, the coefficients of variation for *PSE*, *APSE* and *%PSE* are 11.7, 10.0, 11.5 and 11.0 % respectively. Apparently, the CAP has led to a rather stable income support over time for total Hesse and at the NUTS III level.

With the exception of one single region, the values of *PSE* show rather similar levels of instability in the protection of agriculture, *i.e.* between 8.1 and 21.1 %. The interregional variation between the instabilities of *PSE* is, with 4.7 %, very low. The interregional variation of the instabilities of *APSE* and *%PSE* is moderate, too, with 7.5 and 10.2 % respectively. Somewhat higher is the interregional variation of the instabilities of *FPSE*. This is mainly due to differential rates of structural change across regions that enter into the denominator of *FPSE*. The findings suggest that the stabilization impacts of European agricultural policy is rather homogeneous across regions with regard to *PSE*, *APSE* and *%PSE*.

[7] We also tested for linear trend functions. However, in most cases the log-linear trend functions had a better fit.

Market price support and **direct payments** exhibit a very strong intertemporal variation driven by downward trends in market price support and upward trends in direct payments. In table 3, these variations are dampened substantially by trend-correcting the coefficient of variation. Despite this, the intertemporal variation in market price support as well as direct payments is clearly higher than for total CAP. Additionally, the interregional coefficient of variation indicates more variation of transfers across regions for market price support and direct payments than for total CAP. These results are consistently valid for all four measures of support with the only exemption that the interregional coefficients of variation are of similar magnitude for *FPSE* and *FMPS*.

It can be summarized that the intertemporal variation in producer support according to the CAP was modest in all regions. The limited variation of support over time affected the regions rather homogeneously. These findings are valid although the policy components price support and direct payments exhibited a clearly higher intertemporal variation in producer support as a consequence of structural policy changes in the 1990s.

How did the interregional pattern of agricultural protection under the CAP change over time?

Table 4 captures the average annual growth of producer support estimates and its statistical significance. For a better interpretation growth is estimated in absolute terms, e.g. in the case of *PSE* as the regression coefficient of the equation

$$PSE^j = \alpha + \beta t + \varepsilon. \qquad (9)$$

In the first column, annual growth of total protection under the CAP is presented. Apart from four regions with a negative trend, there is no significant increase or decline in *PSE* for all other 22 regions as well as for the federal state of Hesse. Therefore, the absolute *PSE*s remained rather constant over the period 1986-99 although the structure of agricultural policy changed crucially. Apparently, as a result of CAP reforms, a decline in *MPS* over time was compensated by an increase in direct payments of about the same amount. For the state of Hesse, e.g., the *MPS* decreased by about € 20.3 million per year while direct payments increased by about € 17.6 million.

A similar picture is identifiable for the support per hectare. While the overall support per hectare remained unchanged over time in Hesse and most of the 26 regions, there was a significant shift from *MPS* to *PP*. While, *e.g.*, for the whole region of Hesse the *AMPS* decreased by about € 26 per year, direct payments increased by about € 23 implying an insignificant change in the overall support per hectare.

For *%PSE*, *%MPS* and *%PP*, a coherent pattern across all 26 regions is again visible, which is similar to the development of support per

Table 3. **Instability of regional producer support estimates, NUTS III level, federal state of Hesse, Germany, 1986-1999 (%)** [a]

	Total CAP				Market price support				Direct payments			
Region	*PSE*	*FPSE*	*APSE*	*%PSE*	*MPS*	*FMPS*	*AMPS*	*%MPS*	*PP*	*FPP*	*APP*	*%PP*
DA	21.09	25.10	26.02	14.58	25.00	30.35	27.20	20.21	24.15	27.34	25.08	20.94
FFM	20.28	25.33	20.57	16.02	29.13	36.88	29.75	26.92	23.40	23.41	22.57	67.82
OF	15.46	41.51	16.51	12.33	22.97	46.09	23.38	20.98	25.21	41.91	26.23	15.71
WI	16.15	21.94	18.04	13.94	26.62	32.14	27.87	32.97	21.44	22.43	20.73	20.74
BERG	11.67	12.95	11.38	10.04	26.74	18.03	26.19	15.66	17.46	17.08	16.98	16.76
DADIE	11.67	12.57	13.18	11.92	32.10	19.31	31.34	19.09	18.76	18.61	18.71	17.68
GG	17.37	12.31	16.14	13.63	22.62	23.80	22.55	21.54	24.62	21.77	22.72	21.80
HTK	11.74	13.49	11.77	11.54	19.79	20.57	19.32	20.30	17.66	16.56	17.99	15.62
MKK	8.83	10.74	8.53	9.18	23.51	15.52	23.36	15.33	14.62	12.59	14.30	13.55
MTK	13.93	16.41	14.09	14.50	23.51	26.56	24.02	25.35	20.96	21.39	20.27	18.59
OD	8.12	9.41	8.27	8.29	16.92	12.89	17.66	12.29	14.26	12.05	13.40	50.35
OFL	10.73	14.08	11.31	8.95	31.60	24.92	37.56	17.23	16.52	17.05	15.14	15.18
RTK	11.65	16.43	11.70	12.73	26.49	27.69	26.52	28.84	17.27	18.13	17.10	15.08
WE	12.78	14.46	12.73	12.46	32.43	20.80	32.35	20.50	16.53	14.85	16.06	55.43
GI	11.99	15.23	11.69	10.71	37.39	22.13	36.72	19.32	12.88	11.39	12.57	47.00
LDK	12.19	8.47	11.78	9.22	32.55	19.33	37.67	25.41	14.08	12.00	13.01	44.95
LM	9.42	11.21	9.85	10.14	16.80	17.11	28.82	17.78	14.10	13.48	13.86	47.95
MB	9.92	11.94	9.96	10.38	16.66	17.60	27.27	17.64	15.62	13.42	15.08	13.74
VB	8.38	10.39	8.53	9.04	20.53	16.29	20.24	14.41	47.02	12.39	13.32	47.48
KS	34.95	30.79	37.79	19.80	54.99	52.68	56.16	32.96	25.27	23.55	21.10	29.88
FD	8.70	9.91	8.76	9.09	12.39	15.01	17.29	13.83	14.61	12.59	14.34	48.96
HR	9.15	12.17	8.65	10.25	25.97	18.54	24.65	16.87	14.91	11.90	14.55	46.59
KSL	12.29	12.82	12.02	11.45	21.12	22.82	21.32	22.67	16.98	15.70	16.66	14.90
SEK	11.07	14.75	11.18	12.05	19.27	21.79	19.48	20.53	15.74	13.94	15.47	14.67
WF	8.21	10.19	8.69	9.29	13.09	14.85	13.39	14.90	15.50	13.71	15.17	13.36
WM	10.22	12.26	10.52	10.52	17.90	18.81	18.19	18.87	15.81	14.36	15.26	14.24
Hesse	11.57	9.95	11.52	10.96	29.76	19.86	29.79	18.92	16.81	14.21	16.30	52.44
Average of Regions [b]	9.56	16.26	9.74	9.72	26.35	17.03	26.97	16.43	15.36	16.35	15.19	14.92
Interregional *CV* [c]	4.69	18.96	7.52	10.22	11.88	17.62	14.39	17.21	30.42	57.61	18.41	28.21

[a]: instability is measured with the trend-corrected and autocorrelation-corrected coefficient of variation as explained in the text,
[b]: average of regions represents the instability for the average region, *i.e.* the arithmetic means across regions for each year,
[c]: interregional *CV* indicates the instability for the coefficients of variation across regions for each year.

Source: authors' computations with data from OECD, various issues and Hessisches Statistisches Landesamt (a,b)

hectare. In the state of Hesse and all NUTS III regions, *%PSE* did not significantly alter in the period 1986-99 despite the policy changes that occurred under the CAP. *%PP* rose significantly, however, and *%MPS* fell significantly. Growth in *%PP* compensated for the decrease in *%MPS* thus leading to a basically unchanged *%PSE*.

A different picture is identified for the support levels per farm. In 22 out of 26 regions the support per farm increased. It is very clear from the definition of *FPSE* and a comparison between the columns for *PSE* and *FPSE* that the rising *FPSE* must be due to structural change. *FPSE* relates *PSE* to the number of farm and a declining number of farms led to the significant increases of *FPSE* given the fact that *PSE* did not significantly rise in any individual region.

A striking result refers to the average annual change in the interregional coefficient of variation as presented in the last line of table 4. These changes indicate whether the interregional disparities of producer support under the CAP diminished over time (with a negative trend in the interregional coefficient of variation), remained constant or even became larger. The interregional coefficients of variation for *PSE*, *FPSE* and *APSE* increased significantly by 0.41, 0.33 and 0.39 percentage points each year respectively. This suggests that the CAP induced a steady increase of interregional disparities in income support. It has to be borne in mind that an increasing variation in income support may positively or negatively affect the policy objective of cohesion. If transfers are increasingly concentrated, e.g., on poorer regions and the interregional coefficient of variation rises, this will enhance cohesion. Additional analyses show that this development did not take place in the period under consideration. Transfers per hectare under the CAP were higher for regions with a lower *per capita* income, but this redistribution did not increase over time.

There are opposite effects of market price support and direct payments behind the trends in the overall distribution of support. The interregional coefficient of variation increased significantly for *MPS*, *FMPS* and *AMPS*, by 0.89, 0.77 and 1.32 percentage points annually, but it declined – for *PP* and *APP* significantly – due to direct payments. Thus, it can be concluded that transfers via market price support became increasingly unequal across regions, whereas the interregional variation of transfers due to direct payments declined. Again, this does not necessarily mean that the regional distribution of transfers led to an increasing conflict with the objective of cohesion. The interregional coefficients of correlation between the annual growth of transfers and regional *per capita* income rather show a negative coefficient of correlation of producer support per farm and per hectare[8].

[8] The negative interregional coefficients of correlation between the average annual growth of support, as shown in table 4, and the regional *per capita* income were statistically significant at the 95 %- level for *FPSE* (-0.45) and *FMPS* (-0.48). Correlations with *per capita* income of *APSE* (-0.32), *AMPS* (-0.19), *FPP* (-0.23), and *APP* (-0.29) were also negative but not statistically significant at the 90 %-level.

Table 4. **Average annual growth of regional producer support estimates, federal state of Hesse, Germany, 1986-1999** [a]

Region	Total CAP				Market price support				Direct payments			
	PSE M €	***FPSE*** €	***APSE*** €	***%PSE*** % points	***MPS*** M €	***FMPS*** €	***AMPS*** €	***%MPS*** % points	***PP*** M €	***FPP*** €	***APP*** €	***%PP*** % points
DA	-0.01	-94.10	-16.00[*]	0.21	-0.04***	-514.09**	-28.60***	-1.13***	0.02***	419.99***	12.61***	1.34***
FFM	-0.04	221.47	-9.56	-0.03	-0.15***	-330.30**	-35.32***	-2.01***	0.11***	551.78***	25.75***	1.98***
OF	0.00	-87.68	-4.75	-0.11	-0.01**	-393.17**	-25.74***	-2.62***	0.01***	305.49***	21.00***	2.51***
WI	-0.03	220.14*	-10.12	-0.06	-0.13***	-196.50	-29.58***	-1.60***	0.10***	416.64***	19.46***	1.54***
BERG	-0.21	314.87**	-7.12	0.08	-0.66***	-146.87	-26.08***	-1.33***	0.46***	461.74***	18.96***	1.41***
DADIE	-0.36**	495.59***	-11.95[*]	-0.05	-0.92***	-248.90	-34.01***	-1.45***	0.56***	744.49***	22.05***	1.41***
GG	-0.19	585.08***	-6.62	-0.16	-0.56***	-228.24	-27.96***	-1.64***	0.37***	813.32***	21.34***	1.48***
HTK	-0.03	450.26***	-4.61	0.10	-0.26***	-126.82	-24.94***	-1.72***	0.23***	577.08***	20.33***	1.82***
MKK	-0.15	474.05***	-3.20	0.19	-1.11***	-58.00	-24.50***	-1.32***	0.96***	532.05***	21.30***	1.51***
MTK	-0.03	303.69**	-5.09	0.10	-0.19***	-202.93*	-27.20***	-1.81***	0.16***	506.62***	22.12***	1.91***
OD	0.03	528.77***	0.67	0.30	-0.34***	79.87	-20.21***	-1.04***	0.38***	448.91***	20.88***	1.34***
OFL	-0.03	217.58*	-15.40***	0.12	-0.16***	-348.62***	-34.20***	-1.68***	0.13***	566.19***	18.80***	1.80***
RTK	-0.09	103.40*	-5.35	0.08	-0.44***	-202.76***	-24.55***	-2.08***	0.35***	306.16***	19.19***	2.16***
WE	-0.53	770.46***	-9.55	-0.07	-1.91***	-125.16	-36.27***	-1.72***	1.38***	895.61***	26.72***	1.64***
GI	-0.49**	525.34***	-13.61**	0.06	-1.12***	-116.41	-33.24***	-1.61***	0.63***	641.75***	19.64***	1.67***
LDK	-0.11	322.61***	-13.49***	0.27	-0.43***	-31.14	-27.11***	-1.47***	0.32***	353.75***	13.61***	1.74***
LM	-0.04	854.13***	-4.28	0.10	-0.82***	-109.97	-27.95***	-1.60***	0.77***	964.10***	23.67***	1.70***
MB	-0.11	565.62***	-2.78	0.29	-1.38***	-19.01	-28.49***	-1.28***	1.28***	584.64***	25.71***	1.57***
VB	0.06	804.77***	2.02	0.20	-1.41***	161.75	-20.72***	-1.19***	1.48***	643.02***	22.75***	1.39***
KS	-0.04**	-159.62	-19.91	0.24	-0.04***	-432.29**	-33.13**	-1.31**	0.00***	272.66***	13.22***	1.56***
FD	0.45	610.72***	6.47	0.35	-1.05***	117.57	-16.64***	-1.04***	1.50***	493.15***	23.10***	1.39***
HR	-0.13	566.61***	-0.83	0.29	-1.01***	49.55	-24.33***	-1.21***	0.87***	517.06***	23.50***	1.50***
KSL	-0.57	607.31***	-9.64	0.01	-1.76***	-202.86	-32.58***	-1.54***	1.19***	810.18***	22.94***	1.55***
SEK	-0.12	847.70***	0.01	0.09	-2.08***	38.18	-28.40***	-1.29***	1.96***	809.53***	28.41***	1.38***
WF	0.17	638.98***	5.09	0.24	-1.38***	90.66	-17.08***	-1.02***	1.55***	548.32***	22.17***	1.26***
WM	-0.12	712.87***	-4.64	0.16	-0.95***	20.04	-25.91***	-1.29***	0.83***	692.83***	21.27***	1.45***
Hesse	-2.71	586.46***	-3.27	0.15	-20.30***	-24.60	-26.08***	-1.33***	17.58***	611.06***	22.81***	0.76***
Average of Regions [b]	-0.10	438.49***	-6.32	0.12	-0.78***	-133.71	-27.49***	-1.50***	0.68***	572.19***	21.17***	1.62***
Interregional *CV* [b]	0.41***	0.33**	0.39**	-0.06	0.89***	0.77***	1.32***	0.95***	-0.44***	-0.36	-1.15***	-1.55***

***, (**,*,[*]): statistically significant at the 99.9 %-, (99 %-,95 %-,90 %-) level

[a]: average annual growth is computed with equation (9) as explained in the text,

[b]: average of regions stands for the annual growth of support in the average region, *i.e.* the arithmetic means across regions for each year. Interregional *CV* represents annual growth of the coefficients of variation across regions for each year.

Source: authors' computations with data from OECD, various issues and Hessisches Statistisches Landesamt (a,b)

With regard to **relative support**, neither a significant increase nor fall of *%PSE* occurred due to the CAP in the period 1986-99. The interregional coefficient of variation of *%PP* was strongly reduced, *i.e.* by 1.55 percentage points annually. Hence, the trend towards direct payments made the distribution of income support more balanced across regions. However, the interregional coefficient of variation was raised for *%MPS* by 0.95 percentage points annually. This means that market price support was associated with a growing interregional inequality of income support. When the correlation with regional *per capita* income is taken into account, the changes in market support – but not the changes in direct transfers – were conform with the objective of cohesion[9].

CONCLUSION

The following major conclusions can be drawn from the presented analysis:

1. A uniform CAP does affect the regions very differently. This result is valid according to four measures of producer support – *PSE, FPSE*, *APSE* and *%PSE*. Some regions are clearly more favoured than others.

2. Recent reforms of the CAP have not reduced significantly the average level of agricultural support in the federal state of Hesse, Germany, and in 21 of 26 NUTS III regions of this state. Statistically significant downward trends in absolute producer support due to price support were associated with significant upward trends due to direct payments. In almost all regions, the effects of direct payments on *PSE* approximately compensated the opposite effect of price support.

3. The interregional variation in policy impacts of the CAP has increased, if we rely upon *PSE*, *FPSE* and *APSE*. Except for *FPP*, interregional variation of producer support has significantly increased due to price support and decreased due to direct payments. For relative support, a strongly declining trend of interregional variation for *%PP* compensated for the upward trend in *%MPS* so that the interregional variation of *%PSE* did not alter significantly.

If the CAP is targeted at producer support, it is important to define the measurement concept of support precisely. Absolute and relative support measures due to the CAP and price support are fully uncorrelated with each other. A targeted interregional distribution of *APSE*, *e.g.*, may induce an arbitrary interregional distribution of *%PSE*.

[9] The interregional correlation coefficient between the average annual growth of percentage producer support, as shown in table 4, and regional *per capita* income were negative and statistically significant at the 95 %-level for *%MPS* (-0.42). The respective value for *%PP* (0.38) was positive and statistically significant at the 90 %-level. Not statistically significant at that level was the correlation coefficient for *%PSE* (-0.32).

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APPENDIX

Correlation between *PSE* measures[a]

PSE Measure	*PSE*	*FPSE*	*APSE*	*%PSE*	*MPS*	*FMPS*	*AMPS*	*%MPS*	*PP*	*FPP*	*APP*	*%PP*
PSE	1.00											
FPSE	0.54**	1.00										
APSE	0.83***	0.69***	1.00									
%PSE	0.07	-0.19	0.13	1.00								
MPS	1.00	0.54**	0.84***	0.09	1.00							
FMPS	0.52**	0.98***	0.71***	-0.15	0.53**	1.00						
AMPS	0.75***	0.68***	0.97***	0.16	0.77***	0.74***	1.00					
%MPS	0.24	0.18	0.44*	0.72***	0.29	0.31	0.60**					
PP	0.99***	0.53**	0.80***	0.02	0.97***	0.49*	0.69***	0.14	1.00			
FPP	0.49*	0.91***	0.56**	-0.24	0.47*	0.80***	0.45*	-0.13	0.55**	1.00		
APP	0.72***	0.45*	0.70***	-0.02	0.69***	0.33[*]	0.49*	-0.17	0.79***	0.65***	1.00	
%PP	-0.25	-0.49*	-0.45*	0.25	-0.28	-0.63***	-0.63***	-0.48*	-0.17	-0.13	0.22	1.00

***, (**, *, [*]): statistically significant at the 99.9 %-, (99 %-, 95 %-, 90 %-) level

[a]: the *PSE* measures are defined and computed as explained in section 2. Each correlation is based on average values of the time period 1986-99 for each region, *i.e.* 26 observations.

Source: authors' computations