Agriculture's contribution to rural viability: An approach to estimate regional economic impacts of agricultural policy in Swiss case study regions

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Abstract

This paper develops a thorough yet easily implementable approach to measuring agriculture's contribution to rural viability. The approach is based on input-output modelling. It adopts a number of concepts from input-output modelling such as determining the explicit geographical origin of input requirements and the geographical destination of farm household expenditures without formerly developing an input-output table.

The approach is applied to four case studies in the Swiss mountain regions and tested for three scenarios. Our results clarify the role that agriculture still plays in the context of rural viability. They demonstrate that agriculture's contribution to rural viability differs considerably between the case study regions and that future developments lead to a marked decline in this contribution. Rural development strategies have to take these specific regional characteristics and development perspectives into account.

Keywords: rural viability, employment, added value, agricultural production, input requirements, farm household expenditures, agricultural and rural policy

1 Introduction

Agricultural policy is experiencing a shift towards rural development. Since the reform of the Common Agricultural Policy, rural development has played an increasingly important role in the European Union. The Rural Development policy 2007-2013 consequently focuses on the following three areas: improving competitiveness for farming and forestry; environment and countryside; improving quality of life and diversification of the rural economy. In Switzerland, the shift towards rural development is reflected in the newly introduced possibility for agricultural policy to support rural development projects as long as agriculture plays a major role in such projects (article 93 1c in the Federal Law for Agriculture). Contrary to established instruments of agricultural policy such as area payments which are disbursed in all regions and to all farmers, rural development policies are assessed in the specific local context and investment decisions depend on the fulfilment of certain criteria. This paper develops a thorough yet easily implementable approach to measuring agriculture's contribution to rural viability. It takes into account that regions differ in their socioeconomic characteristics and that agriculture's contribution to a region's viability can only be derived when these characteristics are considered.

Viability refers to a region's ability to live and to develop (Sinabell, 2006). Development, in a narrow sense, equals economic development or economic growth, respectively and can be measured as a rise in output (GDP), a rise in GDP per capita or a rise in output per worker (Armstrong and Taylor, 2000). While economic growth clearly is not equivalent to development it is nevertheless an important component of it. Rural development in an economic analysis does not simply mean the nominal operation of the rural economy in a narrow or broad sense, but its structural and behavioral change (Thomson, 2001). Agriculture's contribution to rural viability and to rural development therefore has a static as well as a dynamic component. It also has effects via direct as well as via indirect channels (Sinabell, 2006). Effects via direct channels are directly visible in indicators of regional viability and development such as GDP. Effects via indirect channels cannot be tracked directly. However, they should be measurable through revealed indicators such as population growth, increase in productive local firms due to an attractive cultivated landscape or higher productivity due to social capital.

In this paper we focus on the static aspect and on the effects via direct channels. Our approach to assess these effects is based on input-output analysis. Input-output models are widely applied and useful tools for examining regional economic structure (Isard et al., 1998). They capture economic linkages between the economic sectors and the dependency of a regional economy on different categories of final demand such as private, public and export demand. When used for evaluating regional policies input-output models show the consequences of different policies on a given sector (agriculture) and its upstream (agricultural input suppliers) and downstream (e.g. food processors and retailers) industries, but also on all other sectors. Loveridge (2006) assesses different multi-sector regional impact models and concludes that input-output is a suitable approach in situations where decision makers want to know industry details. Miller and Blair (1985) and Schaffer (1999) provide comprehensive reviews of regional input-output modelling and of theoretical assumptions.

Regional economic impact assessment requires relevant regional multipliers. Figures derived from national input-output tables are often not applicable to the local or regional level. The share of farmers

on total employment as well as agriculture's input and demand structure on the regional level in rural areas are not comparable to the national average. In such a case, a number of approaches to create a regional input-output table can be applied. The best approach is to establish a regional input-output table based on a survey of local business establishments, which is a time-consuming, data-exhaustive process. A second possibility is to use national tables or national tables modified to reflect regional specializations. Regional purchase coefficients may be estimated through econometric techniques or ratio methods such as location quotients. Riddington *et al.* (2006) empirically demonstrate that such approach may produce misleading results. As an alternative they propagate a gravity model-based method for estimating local trade and input-output tables that produces similar results to the survey approach. Gravity model-based approaches are, however, overly complex in the context of this paper as we ignore trade between different regions.

The objective of this paper is to develop an approach to assess agriculture's contribution to rural viability based on the logic of input-output modelling. The data requirements for such an approach should be limited so that an assessment of agriculture's contribution to the viability of a specific region is feasible within a reasonable time frame from the perspective of agricultural decision makers. We test this approach in four case study regions in the Swiss mountain area that differ in their socio-economic characteristics and vary in size between 400 and 4500 inhabitants. For the case study regions we quantify agriculture's contribution to viability today and for two scenarios with different further developments in agricultural policy. We conclude the paper with reflections on the effectiveness of agricultural policy with respect to rural viability both from a static and a dynamic perspective.

2 Materials and methods

Our approach to assess agriculture's contribution to rural development is based on input-output modelling. It adopts a number of concepts from input-output modelling such as determining the explicit geographical origin of input requirements and the geographical destination of household expenditures without formerly developing an input-output table.

2.1 Input-output modelling and implications for assessing agriculture's contribution to rural viability

The input-output method and its applications are discussed in a number of books (Lahr and Dietzenbacher, 2001; Miller and Blair, 1985). A regional input-output model traces the interactions of local industries with each other, with industries outside the region, and with the final demand sector. The central element of the model is a regional transactions table. In this table, all economic activity is assigned to one of two sectors: production or consumption (Figure *1*).

All firms producing a specific product or service and households are allocated to the production sector.[1] Quadrant II in Figure *1* depicts the production relationships in the economy. These relationships describe the technology of production in the economy, that is, the ways that raw materials and intermediate goods are combined to produce outputs for sale to other industries, to households, and ultimate consumers. Quadrant III contains payments by the industry to holders of capital, to governments, and purchases from industries outside the region (imports). The final demand portion of the model includes government, tourism, and exports to other parts of the nation and the world. Quadrant I in Figure *1* is where the spending cycle in a regional economy begins. This is supported by the empirical observation that in open economies such as regional economies exports assume a high share of total GDP. Exports in Swiss mountain regions (Buser, 2005) amount to 60 to 70% of total GDP. The biggest regional economic impacts are therefore caused by changes in export demand.

Production	*Consumption*	
II Interindustry structure	I Final demands	**Total outputs**
III Final payments		
Total inputs		

Figure *1*: The transactions table as a snapshot picture of the regional economy (adapted from Schaffer, 1999: 15).

From such transaction table output multipliers can be calculated. An output multiplier is the sum of the direct, indirect and induced effect of a change in demand. The direct effect is the immediate result of a change in demand for the goods produced in industry *i*. This change in demand also leads to an increase in production in all the other industries (indirect effect). As a consequence of the change in production, employment and income increase which further raise consumption (induced effect).

Based on a transaction table and on output multipliers three determinants of agriculture's contribution to rural viability can be derived:

- *Structure of the regional economy,* that is the share of agriculture in total value added and total employment. The absolute size of the agricultural sector results practically directly from the utilised agricultural area available, in particular in mountain regions. The share held by agriculture in gross value added depends primarily on the socio-economic characteristics of the region and the other sectors. In agrarian regions with a predominant agricultural sector and a lack of non-

[1] Input-output models can either be constructed in open or in closed form depending on whether the household sector is counted as an industry or as a final demand sector. Schaffer (1999) makes a strong argument towards including the household sector in the interindustry structure in regions where households are a critical part of the economy. Households do not only buy goods and services they also sell their labour, skills and privately owned resources.

agricultural sectors, agriculture accounts for a considerably higher share in the gross regional value added than it does, for example, in tourist regions or in regions with a strong energy sector. In agrarian regions, the effect of agriculture on the regional economy is limited mainly to direct and induced effects. In spite of agriculture's relatively high input intensity, indirect effects are low. The reason for this is that inputs cannot be obtained regionally in these regions and must therefore be imported. The opposite can be observed in non-agrarian regions, where the direct effects of agriculture are lower due to the small volumes in the overall turnover of the regional economy. However, the indirect effects are greater than in agrarian regions since the other economic structures make it possible to obtain inputs locally. From an absolute point of view, the induced effects of agriculture are therefore also higher than in agrarian regions. From a relative point of view however, the induced effects in agrarian regions are more important since they account for a greater share in relation to the overall induced effects in the region.

- *Demand structure in agriculture* with the share of goods and services sold within the region and the share of exported goods and services. The values of output multipliers in agriculture are influenced by demand structure. On the one hand, agricultural demand structure is determined by the regional demand for its products and services and on the other hand by its competitiveness outside the region (exports). The latter depends on the competitiveness of the products and this, in turn, is influenced by the quality of the products, production costs and thus also by input structure and input costs. The amount of money which flows into the regional economic cycle through export activities results from demand structure taken together with the size of a sector. Due to direct payments and the concentration of processing at a few locations, agriculture exhibits a relatively high export share. In mountainous regions this share generally amounts to over 50% of turnover in the agricultural sector.
- *Input structure in agriculture* which is defined by the strength of the net value added (relationship between agriculture’s turnover and the costs of the purchased inputs), the wage share of the agricultural sector and the share of agricultural inputs purchased within the region. As opposed to exports which generate a flow of money into a region, the import of upstream services, products and services drain money out of the regional economic cycle. The latter is particularly applicable to agriculture, as in small agrarian regions only a low share of the inputs required for agricultural production and the goods needed by farming families can be obtained within the region. This means that a larger share of agricultural turnover flows out of the region without any additional value added, whereby even the potential of the exports is lost. On the other hand, in larger regions with more diversified economic structures agricultural upstream services are available within the region. This extends agriculture's regional value added chain and has a positive effect on the regional economy.

A fourth determinant, the size of the region in terms of population and gross domestic product, is implicit in and interdependent with the three other influencing factors on agriculture’s contribution to rural viability.

2.2 Framework for assessing agriculture's contribution to rural viability

Our approach to assess agriculture's contribution to rural viability consists in a detailed representation of the agricultural production process and in an explicit representation of the origin of production inputs. This approach allows collecting all the necessary data for quantifying the influencing factors of agriculture's contribution to rural viability as discussed above while at the same time data requirements are limited. An assessment of agriculture's contribution to the viability of a specific region is therefore feasible within a reasonable time frame.

Input requirements and output produced by the regional farms are derived from *regional agricultural accounting*. Regional agricultural accounting is based on the structural characteristics of the farms in a region (available at individual farm level from the Swiss Federal Office for Statistics) and on detailed individual farm accounts (available for representative test farms from Agroscope Reckenholz-Taenikon Research Station ART). Regression analysis of the individual mountain farm accounts is used to derive cost and revenue functions for structural characteristics of mountain farms (Flury *et al.*, 2007a and 2007b). These functions are combined with the information on the structural characteristics of the farms in a region. The regional agricultural accounting aggregates the results of all the individual farms in the region. An example of a regional agricultural accounting is given in Figure 2. The dotted lines in the figure indicate the share of inputs and investment goods purchased within the region (area of the columns below the line). Regional agricultural accounting estimated by such procedure disregards specific regional circumstances such as higher revenues from milk production due to regional processing or from meat production due to direct marketing. The accountings only consider agricultural activities in the narrow sense and ignore additional farm incomes from activities outside the agricultural sector. The advantage of the regional accountings with their standardised database is that they are comparable across regions.

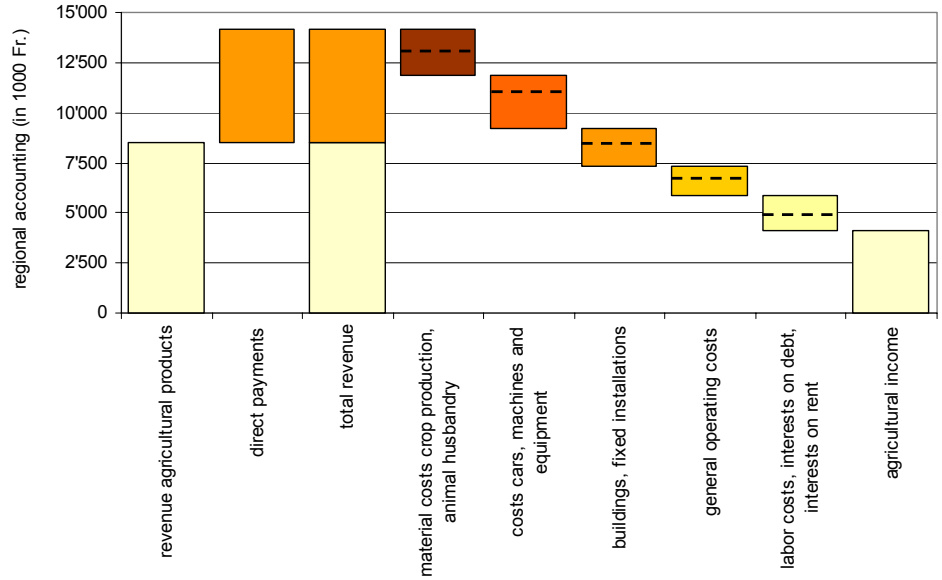

Figure 2: Regional agricultural accounting and origin of inputs and investment goods for the case study 'Puschlav'

The assessment of agriculture's contribution to rural viability is carried out in three stages:

- The direct employment and added value effects of agriculture can be quantified on the basis of the structure data and regional accounting.
- Recording of origin of input requirements as well as regional assignment of consumer expenditure of agriculture by interviews of local experts. The records of input and demand structures form the basis on which the cost-side relationships between agriculture and the rest of the economy can be quantified.
- The economic importance of agriculture is determined by comparing its direct effect and the effect of input requirements and farm household expenditures with total employment and added value.

2.3 Application

We quantify agriculture's contribution to rural viability in four lagging regions in the Swiss mountain area that differ in their socioeconomic characteristics (Figure 3 and Table 1). We calculate agriculture's contribution under current circumstances and for scenarios with different further developments in agricultural policy.

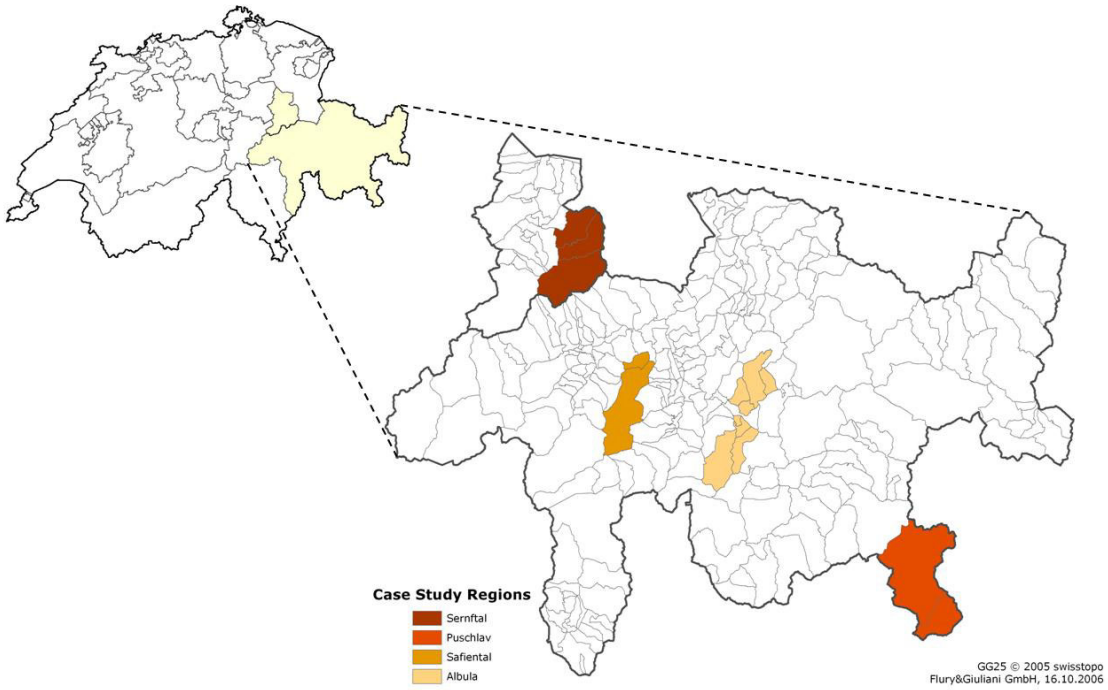

Figure 3: Case study regions

The regions differ in size and, in particular, in their socioeconomic characteristics:

- Sernftal region: mixed tourist and rural with industry;
- Puschlav region: mixed tourist and agrarian;
- Safiental region: agrarian;
- Albula region: mixed tourist, residence, rural with industry and agrarian.

Table 1: Socioeconomic characteristics of the case study regions, the corresponding cantons (in italics) and the Swiss average (bold) (data sources: census of enterprises 1991 and 2001, census of population 1990 and 2000)

	Employees (full time equivalents)			Change in employees		Population	Change in population
	1991	1998	2001	1991-2001	1998-2001	2000	1990-2000
Sernftal	789	683	643	-18%	-6%	1798	-5%
Canton of Glarus				*-12.8%*	*+2.1%*		*-0.8%*
Puschlav	2351	2006	2024	-14%	+1%	4427	+1%
Safiental	169	134	132	-22%	-1%	387	-12%
Albula	1100	964	830	-25%	-14%	2420	+5%
Canton of Grisons				*-9.4%*	*+0.2%*		*+7.6%*
Switzerland				**-4.3%**	**+4.8%**		**+6.7%**

We calculate agriculture's contribution to rural viability for three scenarios:

- Scenario 1: Current situation (agriculture 2002);
- Scenario 2: Agriculture at world market prices;
- Scenario 3: Agriculture at world market prices with area payments which ensure overall cultivation of productive land.

In the scenarios with world market conditions (Scenario 2 and Scenario 3), the regional economic importance of agriculture is estimated on the basis of model calculations. The calculations are carried out using SULAPS, the agricultural structure and land-use model developed at Agroscope Reckenholz-Tänikon ART (Meier et al., 2006), which covers the Albula case study region. This is an agent-based land-use model which is composed of single-farm linear optimisation models. The farms are linked together in the model by means of an area mobility module. The farm models represent the farms in the region, whereby real resource availability, infrastructures, education and some non-economic targets of the farm managers are integrated directly into the calculations. The results concerning agricultural structures in the Albula model region are applied to the three other case study regions.

3 Results

As an introduction to describing agriculture's contribution to rural viability in the four case study regions Table 2 summarises the empirical findings for the within-region purchases of agricultural production as well as of agricultural households. These findings provide the basis for determining the employment and added value effects that go beyond direct effects of the agricultural sector on the regional economy.

Table 2: Share of within-region purchases of the agricultural sector in the case study regions

	Sernftal	Puschlav	Safiental	Albula
Total external costs (%)	51	59	26	45
Material costs crop production and animal husbandry (%)	39	51	31	18
Costs cars, machines and equipment (%)	47	73	2	56
Buildings, fixed installations (%)	69	66	52	60
General operating costs (%)	50	60	21	44
Labour costs, interests on debt, interests on rent (%)	52	41	40	82
Total household expenditures including taxes and insurances (%)	45	70	32	44

3.1 Current situation

The evaluation of agriculture's contribution to rural viability focuses on employment and added value. In the four regions under investigation, we compare employment and added value generated by agriculture with that pertaining to the rest of the region's economy. The multiplication ratio of agriculture in the fields of employment and added value is derived from the relationship between the direct effect together with the effects caused by input requirements and farm household expenditures.

- Structure of the regional economy: As expected, agriculture contributes strongly to employment and added value most noticeably in regions with a marked agrarian nature. Due to the fact that the added value generated by agriculture is lower in comparison to other sectors, the share of employees is higher than the share in added value. The direct employment and added value effect of agriculture depends primarily on the area utilised, yield potential, farm structures and labour intensity. Given comparable area utilisation, the direct employment effect of agriculture is higher in regions with small farm structures and/or labour-intensive agriculture than in regions where large and labour-extensive farms are predominant.
- Demand structure in agriculture: The regional multiplication ratio results, on the one hand, from the size of agriculture as a sector and on the other hand from the regional grants for agriculture (export demand).
- Input structure in agriculture: Opportunities to obtain input requirements and consumer goods locally are limited in regions with a high share of agricultural employees. Consequently, the employment and added value effects caused by input requirements and purchasing of consumer goods is comparatively low in these regions. On the other hand in larger regions, there is a much stronger economic relationship between agriculture and the more widely diversified economic structure in these regions and this leads to a higher multiplication ratio.

In the four case study regions, the regional multiplication ratios for employment lie between 1.13 and 1.23 while the ratios for added value are between 1.21 and 1.52. The difference between the employment and added value multiplication ratios can be explained by the fact that agricultural input requirements are obtained from sectors with a higher added value per employee. The difference in added value per employee is also revealed by the share held by agriculture in the region's overall employ-

ment and total added value. On the whole, the share of employees dependent upon agriculture ranges from 14% to 72%. The shares in added value vary between 7% and 49%.

Table 3: Structures and importance of agriculture for the regional economy in the case study regions 2002

	Sernftal	Puschlav	Safiental	Albula
Structures of agriculture				
Number of farms	88	122	49	73
Agricultural land (in ha)	1279	1750	970	1355
Productive area per labour unit (ha)	8.1	7.6	11.6	12.2
Employment effect				
Full time equivalents agriculture	157	231	84	111
Total employment effect of agriculture	183	284	95	136
Employment effect of agriculture – multiplication ratio	1.17	1.23	1.13	1.22
Share of total agricultural employment effect in overall employment	28%	14%	72%	16%
Added value effect				
Added value of agriculture (in Mio. CHF)	5.0	8.5	3.9	5.2
Total added value effect of agriculture (in Mio. CHF)	7.0	12.9	4.7	7.2
Added value effect of agriculture – multiplication ratio	1.42	1.52	1.21	1.37
Share of total agricultural added value effect in overall added value	14%	7%	49%	12%

3.2 Alternative scenarios

The scenarios with world market prices exhibit noticeable changes in agricultural structures. In the scenario for agriculture at world market prices without any agricultural support, land-use would decline by about 70% compared to today and livestock numbers would go down by 60%. The numbers of the workforce employed in agriculture is roughly 55% lower than under current conditions. The added value generated by agriculture also sinks significantly as a result of the clearly limited agricultural activities and the discontinuation of agricultural support.

In the scenario for agriculture at world market prices with area payments, general area payments serve to remunerate agriculture for keeping land open. This is due to the fact that when it comes to keeping landscape open, agricultural suppliers are regarded as the most favourably priced alternative. In particular, since alternative methods of biomass disposal are extremely costly (Huber, 2006), the only realistic way of utilising the biomass resulting from mowing or from meadows is in the livestock sector. The granting of general area payments which ensure the cultivation of 95% of the productive land leads to noticeably higher numbers of animals as well as higher added value for agriculture. In addition, the workforce is also higher than in the scenario in which agriculture receives no support. In accordance with the specified target, 95% of the productive land is utilised. Given the specific structural and topographic basic conditions in the Albula region, an area payment of CHF 2200 per hectare is required to achieve this target. It is assumed that this sum is also sufficient to keep the landscape open

in the other regions as well. Depending on the region, the overall direct payments granted sink by 30% to 40% compared with today's situation.

Table 4: Structures and importance of agriculture for the regional economy in the case study regions in scenario 2 and 3

	Sernftal	Puschlav	Safiental	Albula
Agriculture at world market prices				
Agricultural land (in ha)	357	508	262	431
Change compared to 2002	-71%	-70%	-73%	-68%
Numbers of animals (in LUs)	521	676	300	605
Change compared to 2002	-59%	-58%	-61%	-54%
Agricultural workforce (in full-time equivalent)	70	103	37	50
Change compared to 2002	-55%	-55%	-55%	-55%
Direct payments (in Mio. CHF)	-	-	-	-
Change compared to 2002	-100%	-100%	-100%	-100%
Added value from agriculture (in Mio. CHF)	0.4	0.9	0.2	0.4
Change compared to 2002	-92%	-89%	-95%	-92%
Agriculture at world market prices with area payments				
Agricultural land (in ha)	1219	1667	926	1292
Change compared to 2002	-5%	-5%	-5%	-5%
Numbers of animals (in LUs)	930	1189	562	978
Change compared to 2002	-26%	-26%	-27%	-25%
Agricultural workforce (in full-time equivalent)	113	166	61	80
Change compared to 2002	-28%	-28%	-28%	-28%
Direct payments (in Mio. CHF)	2.7	3.7	2.0	2.8
Change compared to 2002	-31%	-35%	-39%	-30%
Added value from agriculture (in Mio. CHF)	2.8	4.1	2.1	3.1
Change compared to 2002	-46%	-52%	-46%	-40%

Source: The figures are based on the model calculations by Meier *et al.* (2006)

Given a comparable area utilisation, the comparison of the scenarios agriculture 2002 and agriculture at world market prices with area payments results in a noticeable difference in the numbers of employees and added value for agriculture as well as in agriculture's employment and added value effects. This difference corresponds to the differing costs of agricultural support in the two scenarios. Consequently, the direct comparison allows a quantitative estimation of the costs of agricultural employment and added value effects which overshoot the target of overall cultivation.

4 Discussion and conclusions

Our results clarify the role that agriculture still plays in the context of rural viability. In all case studies agriculture contributes to employment and GDP. It does so through direct effects as well as through effects caused by input requirements from other economic sectors and by farm household expenditures. The results demonstrate that agriculture's contribution to rural viability differs considerably

between the case study regions. Rural development strategies have to take these specific regional characteristics into account.

The employment effect of agriculture does not correlate with the absolute size of the sector. Agriculture's share in GDP does not play a great role either. For example, the energy sector in Safien generates a far greater added value than agriculture. However, this is not reflected in its employment effect as the added value is generated with a small staff (high productivity) and there are few linkages to the rest of the economy. Due to the low employment effect of this sector, agriculture is the most important source of employment in Safien; the lack of non-agricultural activities enhances the importance of agriculture for the regional economy and for decentralised settlement. This influences the relationship between the utilised agriculture area and population, whereby the utilised agricultural area can be interpreted as an indicator for the gross regional added value of agriculture. A comparison of the values between the regions shows that values are lower in those regions with non-agricultural activities, and thus where agriculture is relatively unimportant for the regional economy. The employment effect, on the other hand, increases with higher ratios. Since the monetary volumes of agriculture are defined by the utilised agricultural area, non-agricultural activities within a region are decisive for the degree of the employment and multiplier effects. Therefore, a high degree of dependency on agriculture is not a valid argument for adhering to today's agricultural structures. Rather, in many cases, a high degree of dependency on agriculture reveals a region's structural problems and thus indicates the need for the promotion of non-agricultural activities.

The literature about multifunctionality in agriculture (e.g. Anderson, 2000; Brunstad *et al.,* 2005; Zander *et al.,* 2007) is, among other, concerned with agriculture’s contribution to rural development in general and more specifically with evaluating the degree of jointness between rural development and agricultural production (Abler, 2001). Studies about agriculture’s contribution to rural development range from theoretical reflections on the different aspects of the contribution (Blekesaune, s.a.; Knickel and Renting, 2000) to rural development to quantitative studies that mainly consider the direct effects (Psaltopoulos *et al*., 2006). The conclusions drawn from these studies go in opposite directions. On the one hand, agriculture evidently has high multiplier values and in agrarian regions it is also responsible for high employment effects. On the other hand, technological change coupled with relatively stable consumption levels contribute to a further decline in agricultural employment and thus render the agricultural sector questionable for effective rural development strategies.

The results obtained in the four case study regions indicate that effective rural development strategies as well as rural development policy have to be adapted to the specific regional circumstances. In some cases, agriculture has indeed high leverage potential for development. Generally, though, it can be observed that, from a short-term point of view, there is a conflict of targets between employment and the regional GDP. Sector structures with low costs exhibit relatively high value added but, due to their input structures, have little effect on the overall regional economy or employment within the region. However, from a long-term point of view, sector structures which are competitive when compared to rivals from outside the region are essential as they ensure the long-term survival of the sector and, through direct effects, jobs within the region.

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