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REGIONAL IMPACT OF CAP ADJUSTMENT IN FRANCE AND GERMANY: A SIMULATION STUDY OF PRICE AND QUOTA CHANGES

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1 Introduction

The Common Agricultural Policy (CAP) of the European Economic Community (EEC) has been caught under increased pressure to curtail price support since the early eighties. Nevertheless, intervention schemes which do not disturb the vested interests but prevent increasing budgetary costs have become more important in European farm programmes: production quotas, land set-aside, i.e. more generally supply management policies. Furthermore, new internal political pressure for reform of the CAP appears in favour of an agricultural policy taking into account environmental objectives.

There is a growing literature on CAP reform. Most studies evaluate and compare the economic costs and benefits of different agricultural policies for the EEC agricultural sector (Buckwell et al., 1982) or for some specific crops, and especially for cereals (Blom, 1987; Munk, 1987; De Gorter and Meilke, 1989). Studies on production quotas deal with the evaluation of the rent or welfare loss, generally in a monooutput partial equilibrium framework (Barichello, 1984). Guyomard and Mahé (1989a) have analyzed milk quotas in the context of a multioutput sectoral model.
In this paper, regional impacts of different agricultural policies in the EEC (price support cuts, production quotas, fertilizer taxation) for France and Germany are estimated using also a static partial equilibrium approach but in a multioutput-multiinput framework. Effects of policies on output supplies and input demands, on shadow prices of milk and sugar beet and on value added are examined using adapted regional matrices of price elasticities taking into account explicitely production (and input) quotas. Furthermore, this paper is based on a theoretical framework, which takes into account new quantitative constraints both on inputs and on outputs (Guyomard and Mahé, 1989a, 1989b, 1990). This property will be illustrated by introducing a fertilizer taxation or a fertilizer quota.

2 Modeling supply behaviour with output and input quotas

When all outputs are free to adjust, we assume that the producer behaviour can be characterized by a value added function VA (p, w^1, x^0), where p is the vector of output prices, w^1 the vector of variable input prices (raw materials) and x^0 the vector of quasi-fixed input levels: capital, labour and land. The value added function is nondecreasing, convex, continuous and homogeneous of degree one in prices; nondecreasing, concave and continuous in input quantities. Furthermore, it is assumed that the value added function is continuously twice differentiable everywhere in p, w^1 and x^0. Differentiating VA (p, w^1, x^0) with respect to prices we obtain the complete system of output supply and variable input demand in unconstrained regime. In the same way, differentiating VA (p, w^1, x^0) with respect to quasi-fixed input levels we obtain the system of dual price response (Lau, 1976).

When some outputs are pegged at a given level y^0, for example by agricultural policy instruments (production quotas), the remaining variable netputs exhibit constrained response to exogenous variables in rationed regime. The new set of exogenous variables includes constrained output levels. Particularly, output quantities y^1 which can still be freely adjusted do not behave in the same way with respect to prices p^1 and w^1 since they are now also a function of quota levels y^0. Guyomard and Mahé (1989a, 1989b) have shown how the comparative statics of endogenous variables in a regime of effective rationing (i.e. variable output quantities, variable input quantities, quasi-fixed factor dual prices and rationed output dual prices) can be characterized from the knowledge of endogenous variable responses in unrationed regime, i.e. before the implementation of the constraints. Particularly, they have shown how the Le Chatelier-Samuelson principle holds, provided unrationed and rationed supply and demand functions are evaluated at the same point. The properties of the rationed supply, demand and dual price functions may be also derived directly from the producer optimization programme in constrained regime. The new behaviour is described by a restricted profit function πR (p^1, w^1, y^0, x^0) and the value added function corresponds to the sum of this restricted profit function and of the value of rationed outputs at observed market prices. In fact, we have two alternative representations of the same behaviour under rationing, which can be used indifferently depending on the available information. This analysis can be easily extended to the case where outputs and inputs are simultaneously rationed.

Given the new supply management policies introduced recently such a framework is particularly useful to analyse the situation of the agricultural sector. The unconstrained regime corresponds to a situation without supply management policies on sugar and milk, whereas the constrained regime takes into account these quota policies. The effects of changes in variable output and input prices and/or in quota levels on endogenous variables, i.e. variable netput quantities and rationed output dual prices, will be examined on a regional basis for France and Germany. For each region, the impact of the policy changes on value added will also be calculated. When new constraints on outputs or/and on inputs are introduced, it is necessary, to define the modified response functions of new endogenous variables.

3 Regional effects of price and quota changes

For the empirical application of the comparative static model the knowledge of the Hessian (noted VA_{vv} (p, w^1, x^0) where v represent an output or input price) is required for each region considered. Due to the fact that these matrices cannot be directly estimated because of a lack of an appropriate regional data base and because certain policies to be evaluated like fertilizer taxation or quotas to be implemented have not yet been tried out, it was necessary to make conjectures and to use available information for the construction of the Hessians VA_{vv} (p, w^1, x^0) for each country considered (France: Guyomard and Mahé, Federal Republic of Germany: Frenz and Manegold (1988), Grings (1985) and Becker and Frenz (1989))[1].

1) The derived matrices of price elasticities correspond to a restricted profit function or a value added function. The model applies to short run adjustments only: capital, labour and land are assumed to be fixed. Own price elasticities are in general inelastic.

These matrices have been used to calculate the restricted Hessian of πR (p^1, w^1, x^0, y^0) and the corresponding restricted matrice of variable netput price and rationed output quantity elasticities $\varepsilon^{\pi R}$. The constrained matrices are then utilized to simulate the effects of price/quota changes on regional variable output supply, on regional variable factor demand and on the shadow prices of outputs/inputs with quota restrictions. The data are taken from the 1984 Regio Databank of the Statistical Office of the European Community. The data of the year of the introduction of the milk quota have been used because we do not know the evolution of the milk shadow price over time. Nevertheless the presented model can be used to estimate shadow price change and to evaluate the rent, year after year.

This analytical framework was used for two major simulations: The first one imposes quotas on milk and sugar beets. The impact of quota reductions and price changes are shown on variable output supply for the following commodities: grains, potatoes, oilcrops, fruit and vegetables, other crops, beef and other livestock; on variable input demand: fertilizers, feed, energy and other variable inputs; and on the shadow price for milk and sugar beets. The second major simulation imposes in addition an input quota restriction on fertilizers which is compared with the fertilizer taxation. The introduction of new quantitative input constraints for example a fertilizer quota can be analyzed in the same framework as an output quota. Introducing this new input constraint modifies the comparative statics of supply and demand response as the implementation of the milk quota system in 1984 has modified the behaviour of supplies and derived demands. In particular, the quantity of fertilizers is now exogenous (fixed by the quota which is assumed to be binding) and the dual or virtual price of fertilizers is the new endogenous variable; the gap between market and dual prices of fertilizers is a "fixity loss", which corresponds to the quasi rent associated to an output quota (for more details, see Guyomard and Mahé, 1989a).

3.1 Regional impacts of price support/quota reduction[2]

For selected regions in France and in the Federal Republic of Germany the specification one is used to show the relative impact of the following options on shadow prices, on supply, on factor demand and on regional value added:

Option 1: Price reduction of 20 % for grains, oilcrops and beef, of 10 % for potatoes and other livestock and a decline of feed prices of 15 %.

Option 2: Quota cut for sugar beet and milk of 20 %.

In table 1 the relative effect on shadow prices is documented first. The indicated price reduction (option 1) results in shadow price decreases in the range from about 8 % (Ile-de-France) to 1 % (Nordrhein-Westfalen) for sugar beet, and from about 11 % to 5 % for milk. At the same time grain and oilseed production drop in the range from 13 % (Bretagne) to 4 % (Provence). Other variable output declines more moderately with the exeption of other livestock, which remains almost constant, as feed consumption does. Other livestock production might not decrease if prices are reduced: this is due to the fact that grain prices diminish more than livestock prices. There are two effects on other livestock production: a direct price effect (substitution) and an indirect effect due to the feed price

2) The complete regional data set is composed of 7 regions for the Federal Republic of Germany and of 22 regions for France, due to limited space results for only 4 German and 8 French regions are presented, further results can be obtained from the authors.

TABLE 1 REGIONAL IMPACT OF PRICE SUPPORT-QUOTA REDUCTION BASED ON SIMULATION MODEL I
- RELATIVE CHANGES -

OPTION 1 PRICE REDUCTIONS ONLY

	SHADOW PRICE CHANGES		SUPPLY CHANGES					DEMAND CHANGES				VALUE ADDED CHANGE
	SUGAR	MILK	GRAINS	POTATOES	OIL-CROPS	BEEF	OTHER LIVE-STOCK	FEED	FERTI-LIZERS	ENERGY	OTHER VARIABLE INPUTS	
BR DEUTSCHLAND	-0.025	-0.100	-0.078	-0.024	-0.079	-0.045	-0.002	0.012	-0.043	-0.027	-0.073	-0.115
SCHLESWIG-HOL./HAMB.	-0.035	-0.110	-0.086	-0.025	-0.087	-0.059	0.011	0.005	-0.068	-0.034	-0.097	-0.138
NORDRHEIN-WESTFALEN	-0.020	-0.099	-0.096	-0.030	-0.099	-0.051	0.000	0.023	-0.038	-0.031	-0.075	-0.111
RHEINL.-PFALZ/SAARL.	-0.028	-0.084	-0.053	-0.019	-0.053	-0.034	-0.007	0.002	-0.029	-0.014	-0.041	-0.079
BAYERN	-0.023	-0.100	-0.086	-0.027	-0.085	-0.054	-0.006	0.008	-0.053	-0.032	-0.091	-0.144
FRANCE	-0.050	-0.105	-0.072	-0.021	-0.073	-0.044	0.005	-0.001	-0.070	-0.027	-0.086	-0.160
ILE DE FRANCE	-0.081	-0.111	-0.060	-0.014	-0.057	-0.034	0.013	-0.008	-0.105	-0.023	-0.088	-0.196
PICARDIE	-0.069	-0.104	-0.080	-0.022	-0.071	-0.045	0.008	-0.009	-0.105	-0.029	-0.100	-0.188
HAUTE-NORMANDIE	-0.062	-0.109	-0.076	-0.021	-0.075	-0.048	0.006	-0.010	-0.098	-0.032	-0.111	-0.215
BOURGOGNE	-0.066	-0.114	-0.056	-0.015	-0.056	-0.035	0.004	-0.015	-0.092	-0.029	-0.102	-0.237
ALSACE	-0.065	-0.106	-0.045	-0.011	-0.046	-0.025	0.003	0.003	-0.054	-0.019	-0.064	-0.127
BRETAGNE	*	-0.114	-0.132	-0.035	-0.144	-0.074	0.032	0.048	-0.039	-0.049	-0.108	-0.059
LIMOUSIN	*	-0.102	-0.058	-0.023	-0.060	-0.038	-0.020	-0.023	-0.045	-0.031	-0.098	-0.237
LANGUEDOC-ROUSSILLON	*	-0.056	-0.037	-0.016	-0.037	-0.026	-0.008	-0.004	-0.014	-0.005	-0.016	-0.034
PRO.-AL.-COTE D'AZUR	*	-0.050	-0.042	-0.018	-0.043	-0.030	-0.010	-0.006	-0.014	-0.005	-0.016	-0.037

OPTION 2 QUOTA REDUCTIONS ONLY

BR DEUTSCHLAND	-0.699	-0.416	0.054	0.013	0.034	0.022	0.023	-0.091	-0.057	-0.028	-0.089	-0.034
SCHLESWIG-HOL./HAMB.	-0.547	-0.309	0.047	0.005	0.033	0.022	0.022	-0.088	-0.042	-0.024	-0.075	-0.051
NORDRHEIN-WESTFALEN	-0.617	-0.321	0.040	0.016	0.023	0.015	0.015	-0.061	-0.050	-0.022	-0.070	-0.036
RHEINL.-PFALZ/SAARL.	-0.859	-0.718	0.045	0.011	0.029	0.019	0.019	-0.077	-0.048	-0.024	-0.075	-0.008
BAYERN	-0.626	-0.392	0.069	0.012	0.047	0.031	0.031	-0.124	-0.067	-0.036	-0.111	-0.051
FRANCE	-0.532	-0.401	0.032	0.007	0.027	0.013	0.014	-0.062	-0.033	-0.016	-0.058	-0.023
ILE DE FRANCE	-0.436	-0.494	0.014	0.018	0.002	0.001	0.001	-0.005	-0.031	-0.007	-0.028	-0.009
PICARDIE	-0.396	-0.426	0.045	0.038	0.020	0.009	0.010	-0.045	-0.078	-0.023	-0.086	-0.033
HAUTE-NORMANDIE	-0.438	-0.389	0.041	0.012	0.033	0.016	0.016	-0.074	-0.044	-0.020	-0.073	-0.031
BOURGOGNE	-0.536	-0.463	0.014	0.003	0.012	0.006	0.006	-0.028	-0.014	-0.007	-0.025	-0.008
ALSACE	-0.800	-0.684	0.040	0.005	0.036	0.018	0.018	-0.082	-0.036	-0.020	-0.070	-0.009
BRETAGNE	*	-0.173	0.033	0.000	0.033	0.017	0.017	-0.075	-0.025	-0.017	-0.058	-0.080
LIMOUSIN	*	-0.469	0.017	0.000	0.017	0.008	0.008	-0.037	-0.012	-0.008	-0.029	-0.009
LANGUEDOC-ROUSSILLON	*	-1.070	0.008	0.000	0.008	0.004	0.004	-0.018	-0.006	-0.004	-0.014	0.000
PRO.-AL.-COTE D'AZUR	*	-0.941	0.003	0.000	0.003	0.001	0.001	-0.007	-0.002	-0.001	-0.005	-0.000

* no sugar beet production
Source: Own calculations

cut. Consequently livestock production might not decline (Bretagne, Schleswig-Holstein). The same applies to beef but with a smaller magnitude because beef uses proportionally less grains. Concerning input demand changes energy consumption declines slightly while other input demand drops in the range between 10 % and only 2 %. The same results with different regional distribution are obtained for fertilizer demand. Regional value added reduces most with 23 % in Bourgogne and lowest with only 3 % in Languedoc-Roussillon.

The results about quota changes are presented in part II of table 1. While value added in the first "price" option changes considerably, quota reduction imposes a reduction of value added which is rather small (less than five percent). This is due to the fact that within the initial year of quota introduction the milk quota had only a major quantity effect, compensated by increased supply of unconstrained products. Nevertheless, the effect would be more pronounced if the situation of 1990 would be analyzed since the rent imposed by quota has increased. Due to the incorporated cross-price effects production of all outputs with the exemption of fruit and vegetables and other crops increases, but due to the quota cut, input consumption declines in all regions. More pronounced are the effects on shadow prices and the quasi rents are increasing.[3]

3.2 Comparison of the impact of additional fertilizer taxes or fertilizer quotas

Table 2 presents the regional results of additional policy measures to regulate factor demand: mainly fertilizer consumption. With simulation model I a fertilizer tax of 50 % is considered (this is option 3). This is done in addition to price changes as indicated in option 1 (see table 1). Impact on shadow prices, output supply and factor demand are given. In option 4 simulation model II is used, and instead of a fertilizer tax of 50 %, a fertilizer quota is introduced, reducing the fertilizer availability by 20 % within all regions. While with option 3 fertilizer prices in all regions would increase by 50 %, the introduction of the fertilizer quota would increase the shadow price of fertilizers, depending on the regional production structure in the range of only 13 % (in the Ile-de-France) to more than 50 % in regions with low fertilizer application rates (like Limousin). The impact of a fertilizer tax of 50 % on value added is more pronounced than the fertilizer quota. This is due to the fact that fertilizer market prices are not changing while shadow prices are increasing. But in the first case fertilizer demand would decline in the range from over 40 % to at least 20 %. With a general fertilizer quota, fertilizer demand would decline by only 20 % (see table 2).

3) The relative decline in shadow prices indicates that the difference between the output price and the marginal cost increases and so do the unit rents.

TABLE 2 REGIONAL IMPACT OF FERTILIZER TAXES, FERTILIZER QUOTAS BASED ON SIMULATION MODELS I AND II
- RELATIVE CHANGES -

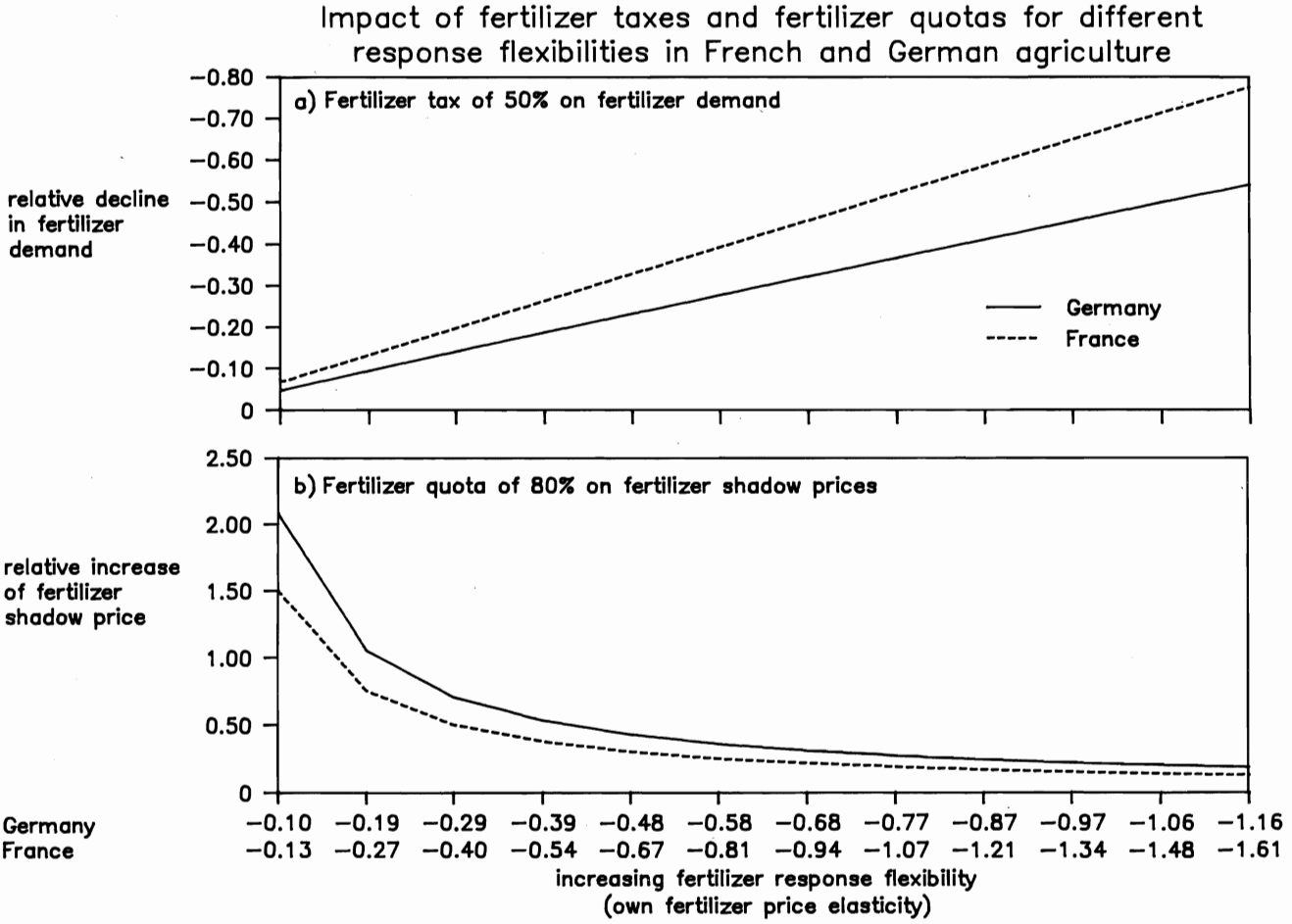
OPTION 3 FERTILIZER TAX OF 50 % + OPTION 1 (SIMULATION MODEL I)

	SHADOW PRICE CHANGES		SUPPLY CHANGES					DEMAND CHANGES				VALUE ADDED CHANGE
	SUGAR	MILK	GRAINS	POTATOES	OIL-CROPS	BEEF	OTHER LIVE-STOCK	FEED	FERTI-LIZERS	ENERGY	OTHER VARIABLE INPUTS	
BR DEUTSCHLAND	0.089	-0.076	-0.114	-0.058	-0.116	-0.058	-0.011	0.010	-0.230	-0.033	-0.074	-0.181
SCHLESWIG-HOL./HAMB.	0.082	-0.087	-0.133	-0.069	-0.136	-0.076	-0.001	0.001	-0.305	-0.042	-0.100	-0.220
NORDRHEIN-WESTFALEN	0.082	-0.081	-0.132	-0.065	-0.137	-0.064	-0.008	0.019	-0.231	-0.037	-0.077	-0.179
RHEINL.-PFALZ/SAARL.	0.079	-0.052	-0.080	-0.045	-0.081	-0.044	-0.013	-0.001	-0.249	-0.019	-0.043	-0.129
BAYERN	0.092	-0.074	-0.128	-0.066	-0.127	-0.069	-0.016	0.008	-0.223	-0.038	-0.090	-0.218
FRANCE	0.077	-0.076	-0.123	-0.066	-0.122	-0.059	-0.006	-0.006	-0.334	-0.035	-0.090	-0.236
ILE DE FRANCE	0.046	-0.068	-0.122	-0.071	-0.116	-0.052	0.001	-0.019	-0.466	-0.033	-0.092	-0.279
PICARDIE	0.059	-0.064	-0.155	-0.092	-0.137	-0.064	-0.006	-0.017	-0.436	-0.036	-0.093	-0.282
HAUTE-NORMANDIE	0.072	-0.073	-0.142	-0.079	-0.138	-0.067	-0.008	-0.015	-0.374	-0.041	-0.113	-0.307
BOURGOGNE	0.061	-0.082	-0.104	-0.058	-0.104	-0.050	-0.005	-0.022	-0.359	-0.037	-0.109	-0.310
ALSACE	0.041	-0.079	-0.073	-0.035	-0.073	-0.034	-0.003	0.001	-0.279	-0.024	-0.066	-0.171
BRETAGNE	*	-0.099	-0.191	-0.085	-0.202	-0.093	0.020	0.043	-0.206	-0.058	-0.114	-0.157
LIMOUSIN	*	-0.078	-0.093	-0.054	-0.095	-0.048	-0.027	-0.028	-0.184	-0.037	-0.103	-0.297
LANGUEDOC-ROUSSILLON	*	-0.024	-0.057	-0.034	-0.057	-0.032	-0.012	-0.008	-0.294	-0.009	-0.019	-0.068
PRO.-AL.-COTE D'AZUR	*	-0.021	-0.063	-0.037	-0.064	-0.036	-0.014	-0.010	-0.324	-0.010	-0.020	-0.071

OPTION 4 FERTILIZER QUOTA (-20 %) + OPTION 1 (SIMULATION MODEL II)

	SHADOW PRICE CHANGES			SUPPLY CHANGES					DEMAND CHANGES			VALUE ADDED CHANGE
	SUGAR	MILK	FERTI-LIZERS	GRAINS	POTATOES	OIL-CROPS	BEEF	OTHER LIVE-STOCK	FEED	ENERGY	OTHER VARIABLE INPUTS	
BR DEUTSCHLAND	0.071	-0.080	0.420	-0.109	-0.053	-0.110	-0.056	-0.009	0.010	-0.032	-0.074	-0.120
SCHLESWIG-HOL./HAMB.	0.031	-0.097	0.279	-0.112	-0.050	-0.115	-0.069	0.004	0.003	-0.039	-0.099	-0.141
NORDRHEIN-WESTFALEN	0.066	-0.084	0.420	-0.127	-0.059	-0.131	-0.062	-0.007	0.019	-0.036	-0.076	-0.116
RHEINL.-PFALZ/SAARL.	0.055	-0.059	0.388	-0.074	-0.039	-0.074	-0.041	-0.012	-0.000	-0.018	-0.042	-0.083
BAYERN	0.076	-0.078	0.432	-0.122	-0.060	-0.122	-0.067	-0.015	0.008	-0.037	-0.090	-0.149
FRANCE	0.013	-0.090	0.246	-0.097	-0.043	-0.097	-0.051	-0.000	-0.004	-0.031	-0.088	-0.163
ILE DE FRANCE	-0.047	-0.100	0.132	-0.077	-0.029	-0.073	-0.039	0.010	-0.011	-0.026	-0.089	-0.197
PICARDIE	-0.032	-0.093	0.144	-0.102	-0.042	-0.090	-0.050	0.004	-0.011	-0.031	-0.098	-0.190
HAUTE-NORMANDIE	-0.012	-0.096	0.185	-0.101	-0.043	-0.098	-0.055	0.001	-0.012	-0.035	-0.111	-0.217
BOURGOGNE	-0.014	-0.101	0.203	-0.076	-0.033	-0.076	-0.041	0.000	-0.018	-0.032	-0.105	-0.239
ALSACE	0.003	-0.088	0.324	-0.063	-0.027	-0.064	-0.030	-0.001	0.002	-0.022	-0.065	-0.129
BRETAGNE	*	-0.100	0.482	-0.189	-0.084	-0.200	-0.092	0.020	0.044	-0.058	-0.114	-0.067
LIMOUSIN	*	-0.076	0.559	-0.097	-0.057	-0.099	-0.050	-0.028	-0.029	-0.038	-0.104	-0.242
LANGUEDOC-ROUSSILLON	*	-0.035	0.332	-0.050	-0.028	-0.051	-0.030	-0.010	-0.007	-0.008	-0.018	-0.037
PRO.-AL.-COTE D'AZUR	*	-0.033	0.299	-0.055	-0.030	-0.055	-0.034	-0.012	-0.009	-0.008	-0.019	-0.039

* no sugar beet production
Source: Own calculations


Impact of fertilizer taxes and fertilizer quotas for different response flexibilities in French and German agriculture
a) Fertilizer tax of 50% on fertilizer demand
relative decline in fertilizer demand
−0.80
−0.70
−0.60
−0.50
−0.40
−0.30
−0.20
−0.10
0
Germany
France
b) Fertilizer quota of 80% on fertilizer shadow prices
relative increase of fertilizer shadow price
2.50
2.00
1.50
1.00
0.50
0
Germany −0.10 −0.19 −0.29 −0.39 −0.48 −0.58 −0.68 −0.77 −0.87 −0.97 −1.06 −1.16
France −0.13 −0.27 −0.40 −0.54 −0.67 −0.81 −0.94 −1.07 −1.21 −1.34 −1.48 −1.61
increasing fertilizer response flexibility
(own fertilizer price elasticity)

Finally it will be shown under which production conditions fertilizer taxation or fertilizer quotas would be more appropriate if the policy objective would be to increase fertilizer prices (shadow prices) in such a way that a market for liquid manure would be probably implemented. Therefore the second partial derivatives of fertilizer to other netputs are increased or decreased with a multiplicative factor of 0.25 to 3. A factor greater (smaller) than 1 would increase (decrease) the absolute value of the fertilizer price elasticity. Part a in the figure shows the impact of different fertilizers responses within German und French agriculture on fertilizer demand, using simulation model I and imposing a fertilizer tax of 50 %. Part b in the figure shows the impact of different fertilizers responses within both sectors on fertilizer shadow prices, using simulation model II imposing a fertilizer quota which reduces fertilizer availability by 20 %.

A decline in fertilizer response flexibility reduces the impact on fertilizer demand, with a fertilizer elasticity of about -0.5 fertilizer demand reduction would amount to 20 %.

Part b documents that fertilizer shadow price increase will be higher for situations with low fertilizer response flexibilities. Therefore the smaller the fertilizer price elasticities are the more appropriate would be fertilizer quotas to stimulate liquid manure markets and it can be concluded that fertilizer (shadow) price increase imposed by the introduction of a fertilizer quota of 20 % will be above the price increase of 50 % due to the fertilizer taxation if the absolute value of the own fertilizer price elasticity is
below 0.5.

4 Summary

This contribution focusses on the incidence of a reduction of output prices, input taxation, output and input quotas in French and German agriculture on regional level. Therefore a comparative static neoclassical production model is used taking explicitely into account output and input quotas. This model is used to compare the effects of fertilizer taxation or fertilizer quotas on output supply, factor demand and value added applying the concept of a restricted profit function. The presented concept is limited to the fact that regional restricted profit function could not be estimated but regional Hessian matrices have been defined using available information on production structures.

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