

Agricultural policies and farm structures

Agent-based modelling and application to EU-policy reform

by
Kathrin Happe

IAMO
2004

Table of contents

List of figures	IX
List of tables	XIII
1 General introduction	1
1.1 Problem assessment.....	1
1.1.1 The role of agricultural policies in structural adjustment.....	1
1.1.2 The scope for policy reform	3
1.1.3 Consequences for modelling	4
1.2 Objectives of the study and methodological approach	5
1.3 Structure of the study	6
Part I Agent-based modelling of regional agricultural structures	9
2 Agent-based modelling: motivation, definition, and applications ..	11
2.1 Introduction	11
2.2 Motivation	12
2.2.1 General: agent-based modelling of economic systems.....	12
2.2.2 Specific: agent-based modelling in agricultural policy analysis and structural change analysis	13
2.3 Agents and agent-based systems	16
2.3.1 Definition.....	16
2.3.2 Origins of agent-based systems	18
2.3.3 Modelling procedure.....	18
2.4 Selected features of ABS applied to economic systems.....	19
2.4.1 Flexibility with regard to assumptions	19
2.4.2 Complex structures and emergence.....	21
2.4.3 Spatial representation	21
2.5 Examples of applications of agent-based systems	22
2.5.1 Problem solving.....	22
2.5.1.1 Distributed problem solving.....	22
2.5.1.2 Solution rivalry.....	24

2.5.2	Social systems analysis.....	24
2.5.2.1	Rule-based behaviour.....	24
2.5.2.2	Normative agent behaviour.....	25
2.5.2.3	Artificial intelligence.....	25
2.5.2.4	Human agents and role-playing games.....	26
2.5.3	Land-use/land-cover change and integrated modelling.....	27
2.6	Potential challenges to agent-based modelling.....	27
2.6.1	Modelling the co-ordination of agents.....	27
2.6.2	Verification and validation.....	29
3	The Agricultural Policy Simulator (AgriPoliS).....	31
3.1	Introduction.....	31
3.2	Conceptual framework.....	31
3.2.1	Agents involved.....	33
3.2.2	Farm agent actions and behaviour.....	34
3.2.3	The spatial, technological and political environment.....	35
3.2.4	Agent interactions.....	36
3.2.5	Central modelling assumptions.....	38
3.3	Implementation of the conceptual model.....	38
3.3.1	Object-oriented structure and design.....	38
3.3.2	Model dynamics.....	41
3.4	Input and output objects.....	43
3.4.1	Production factors.....	44
3.4.1.1	Land.....	44
3.4.1.2	Labour.....	44
3.4.1.3	Capital.....	45
3.4.2	Production activities.....	47
3.5	The farm agent.....	48
3.5.1	Behavioural foundation.....	48
3.5.1.1	Farm planning.....	48
3.5.1.2	General remarks about expectation formation.....	50
3.5.1.3	Price expectations.....	51
3.5.1.4	Cost expectations.....	51
3.5.1.5	Expectations about policy changes.....	53
3.5.1.6	Managerial ability.....	53
3.5.2	Farm actions.....	54
3.5.2.1	Renting land.....	55
3.5.2.2	Investment.....	58
3.5.2.3	Production.....	59
3.5.2.4	Farm accounting.....	60
3.6	Factor market agents.....	62
3.6.1	Land auctioneer.....	62

3.6.2	Product market.....	64
3.7	Data input, results preparation and data output	65
Part II Applying and testing AgriPoliS.....		67
4	Adapting AgriPoliS to the region Hohenlohe.....	69
4.1	Introduction	69
4.2	Study region 'Hohenlohe'	70
4.3	Representing Hohenlohe's agricultural structure based on typical farms	72
4.4	Product prices.....	76
4.5	Production activities.....	76
4.5.1	Arable and grassland production activities.....	77
4.5.2	Livestock production activities.....	78
4.5.3	Additional activities.....	79
4.6	Investments	80
4.7	Initialising AgriPoliS.....	83
4.8	Further assumptions	86
4.9	Definition of the reference scenario.....	87
5	Exploring the behaviour of AgriPoliS.....	91
5.1	Introduction	91
5.2	Design of experiments	92
5.2.1	Experimental design and data output.....	94
5.2.1.1	Experimental design	94
5.2.1.2	Data output	96
5.2.1.3	Analysis of results and definition of the metamodel.....	97
5.2.2	Results	98
5.2.2.1	Graphical analysis	98
5.2.2.2	Metamodel analysis.....	103
5.2.3	Discussion.....	105
5.3	Impact of random initialisations.....	106
5.3.1	Experimental design and data output.....	106
5.3.2	Results	106
5.3.3	Discussion.....	108
5.4	Structural impact of heterogeneous managerial ability	109
5.4.1	Experimental design and data output.....	109
5.4.2	Results	111

5.4.2.1	Homogeneous vs. heterogeneous managerial ability	111
5.4.2.2	High managerial ability vs. low managerial ability	115
5.4.3	Discussion.....	116
5.5	Conclusions from the analyses	117
Part III Policy analysis.....		119
6	Analytical framework and assumptions for measuring policy impacts	121
6.1	Introduction	121
6.2	Performance indicators.....	122
6.3	Measuring production efficiency of agricultural structures	123
6.3.1	Starting points for measuring efficiency	123
6.3.2	Traditional efficiency measures of individual firms.....	125
6.3.3	Non-parametric estimation of technical efficiencies	128
6.3.4	Structural efficiency of a group of firms	129
6.3.5	Application to data simulated for Hohenlohe.....	131
6.3.5.1	Inputs	131
6.3.5.2	Output.....	132
6.3.5.3	Assumptions	133
6.3.6	Measuring overall economic efficiency	133
6.4	Other analysis techniques.....	134
6.4.1	Kernel density estimation	134
6.4.2	The Lorenz curve and the Gini index	135
6.5	General assumptions underlying the policy analyses.....	136
7	Retirement payment, phasing out, and a decoupled single farm payment	139
7.1	Introduction and policies analysed	139
7.2	Summary of results	142
7.3	Structural adjustments following a policy change	144
7.3.1	Farm size dynamics	144
7.3.2	Economic farm size	151
7.3.3	Impacts on production and factor input.....	153
7.4	Efficiency implications.....	159
7.4.1	Analysis of individual and structural efficiency.....	160
7.4.2	Economic efficiency	165
7.4.3	Impact on rental prices	170
7.5	Income implications	173

7.5.1	Income differences by size and farm type	175
7.5.2	Impact on income distribution	178
7.5.3	Off-farm income sources	180
7.6	Government outlays	182
7.7	Summary and discussion of results	184
7.7.1	Agricultural structure	184
7.7.2	Efficiency	187
7.7.3	Income	187
7.7.4	General	188
8	Decoupling direct payments	189
8.1	Introduction	189
8.2	Policies considered	191
8.3	Impact on farm size	194
8.4	Impact on production	197
8.5	Efficiency implications	199
8.5.1	Analysis of individual and structural efficiency	200
8.5.2	Economic efficiency	204
8.6	Implications for incomes and farm specialisation	210
8.6.1	Impact on farm incomes	210
8.6.2	Farm specialisation	212
8.7	Redistribution effects of a single area payment	214
8.8	Government outlays and social efficiency	216
8.9	Summary and discussion of results	218
8.9.1	Policies	220
8.9.2	Winners and Losers	221
9	General discussion	223
9.1	Introduction	223
9.2	Methodological implications	224
9.2.1	AgriPoliS	224
9.2.2	Design of Experiments	226
9.2.3	DEA-model and structural efficiencies	226
9.3	Data issues	227
9.4	Policy implications	228
9.5	Implications for further research	231
	Summary	233

Zusammenfassung	236
References	241
Appendix	255
A.1 Definition of livestock production activities	255
A.2 AgriPoliS data output	258
A.3 Bootstrap procedure to derive confidence intervals on structural efficiency measures	259
A.4 The test for equality of structural and mean efficiencies of two sub-groups	261
A.5 DEA-model inputs and output	262
A.6 Additional tables and figures of chapter 7 and chapter 8	264
A.7 Ensuring the management of agricultural area	266