Using System Dynamics for Holistic Rural Policy Assessments and Data Envelopment Analysis for Evaluation of Comparative Policy Efficiency at Regional level .

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Paper prepared for presentation at the 118th seminar of the EAAE

(European Association of Agricultural Economists),

'Rural development: governance, policy design and delivery'

Ljubljana, Slovenia, August 25 - 27, 2010

Abstract

The TOP-MARD (FW6) project was designed to evaluate the impact of a range of optional rural development policies on the multiple functions of agriculture and assess the differing economic, social and environmental outcomes over time in 11 European rural regions. Two main tools were used, namely dynamic system modelling and Data Envelopment Analysis (DEA). Dynamic System Modelling allowed (*ex ante*) evaluation of the outcomes of various policy scenarios, while DEA provided the means of comparing these outcomes with relevant expenditures in the 11 regions studied. This paper describes and discusses these two tools, and suggests that they complement the evaluators' tool-kit. System dynamics provides the means of assessing economic, social and environmental outcomes over time, while DEA analysis provides clues as to the relative efficiency of policies in delivering desired outcomes.

Introduction

This paper draws on the EU FW6 STREP project 'TOP-MARD' which set out to analyse the outcomes of alternative rural policies on the multiple functions of agriculture, territorial rural economies, environments, demographics and quality of life. The main research tool adopted was system dynamics, designed to explore complex inter-relationships in natural and human systems. In support of this we also undertook surveys of farmers, entrepreneurs and citizens. In addition, we used the results of the system modeling work to compare policy efficiency between regions using Data Envelopment Analysis (DEA). The research, its relationship to other work on multifunctionality, rural development and sustainability is fully discussed in Bryden *et al.* (2010f). The systems model developed is also discussed in Johnson *et al.* (2009), Bryden & Refsgaard (2009) and Refsgaard & Johnson (2010). Further discussion of the policy scenario analysis using the system dynamic models we adapted to 11 rural regions in Europe is contained in Bryden (2010f). This paper focuses on the use of the system dynamics model for *ex ante* analysis of a range of EU policy scenarios for post 2013, and on the use of DEA analysis to compare policy efficiency across regions.

The whole paper, as with the TOP-MARD project, is set in the context of growing complexity both of 'rural Europe' and of rural policy itself, which now has multiple objectives embracing agricultural competitiveness, rural environmental quality, territorial development and cohesion, and the quality of life of rural citizens.

System Dynamics

Systems thinking seeks to understand any system by *"examining the linkages and interactions between the elements that compose the entirety of the system" (Wikipaedia)*. It is based on the belief that *"the component parts of a system can best be understood in the context of relationships with each other and with other systems, rather than in isolation. Systems thinking's focus is on effect, not cause."*

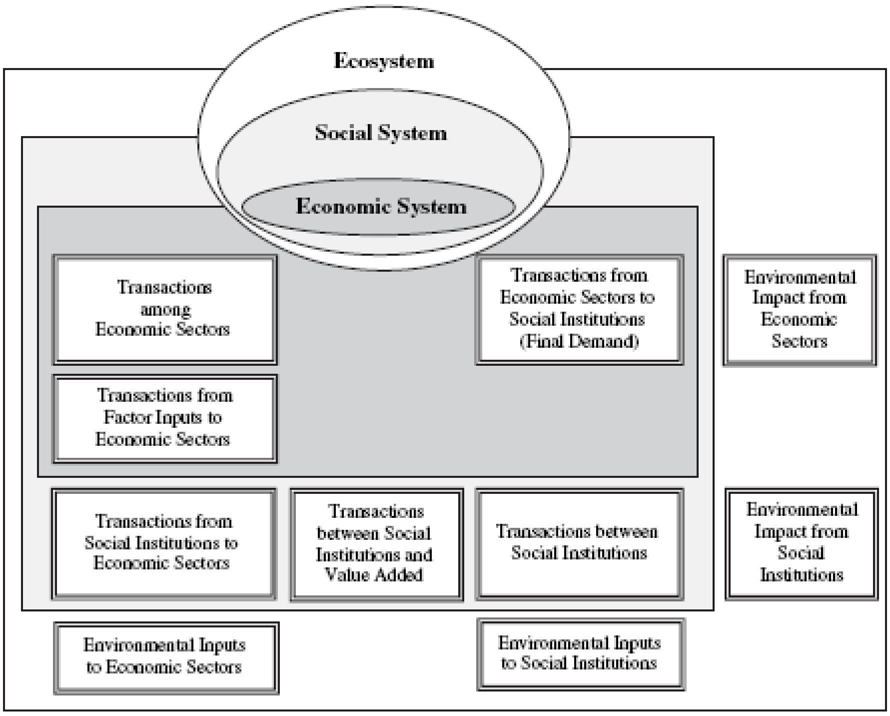
In TOP-MARD we were explicitly interested in the interactions between policy decisions (or scenarios), decisions of human agents (in this case farmers and their households as well as tourists and potential migrants), and the effects of these decisions on land use, production of 'commodities' and 'non-commodities', tourist spending, regional economies, quality of life, demography, etc. The basic tenets of the systems thinking approach are found in Skyttner (2006) and include the existence of systematic relationships between the elements of any system and interactivity between causes and effects leading to outcomes undetectable by other methods.

'System Modelling' is founded on the idea that most of the elements of a given system and its subsystems can – at least in principle - be quantified, or at least expressed in quantitative relationships. Dynamic system modelling examines causes and effects over time, accepting that complex interactions and feedbacks between subsystems do not occur simultaneously and are not observable in the same space or time. Senge (1990:71) argues that we have great difficulty in dealing with 'dynamic complexity' associated with systems where cause and effect are separated by time and/or space. This is because we are not able to easily observe connections between the parts of the system and their interactions.

In conceptualising and formalising the linkages between policies, farming and land use, production of commodities and non-commodities, and territorial economic and social performance over time, we used STELLA™, which offers a practical set of tools to visualise and communicate how complex systems and ideas really work over time and space. Like other systems models, the core elements of a STELLA model are 'stocks' and 'flows'. Flows add to or subtract from stocks.

In conceptualising the systems of interest for TOP-MARD, we drew on a wide range of social science literature including ecological economics, a heterodox school of economics focusing on the human economy both as a social system, and as one constrained by the biophysical world (Gowdy and Erickson, 2005). Ecological economic models of economic behaviour encompass consumption and production in the broadest sense, including their ecological, social and ethical dimensions, as well as their market consequences. Figure 1 below shows how the economic, the social and the biophysical world are interlinked in an ecological economics perspective.

Figure 1: An Ecological Economic View of Nested Systems of Accounts.



Source: Gowdy & Erickson (2005)

This figure also illustrates some of the important subsystems of rural regions including their economy, society and environment. The regional economic activities shown in the left side of the figure are the well-known ones, such as agriculture, tourism and other enterprises. Regional economic activities are characterized by monetary flows between the agricultural and related activities, households, public institutions, capital markets, and the external economy or 'rest of the world'. These activities are linked both with the social system and with the ecosystem. The social system within which decisions are being made is shown in the middle with its multiple layers of different contexts. The right-hand panel illustrates how the ecosystem of the region is influenced by the economic activities and the decisions taken in the social sphere.

The three systems are linked in several ways. Economic activities are linked to the ecosystem through resource use, as, for example, when agricultural practices impact the ecosystem through phosphorus run-off, or when maintenance of grazing land for hay production indirectly improves the habitat for birds, or directly through disposal of waste. The ecosystem also impacts economic activities directly, as for instance when soil erosion reduces agricultural productivity, or indirectly when the lack of flowering orchards decreases the tourism in an area.

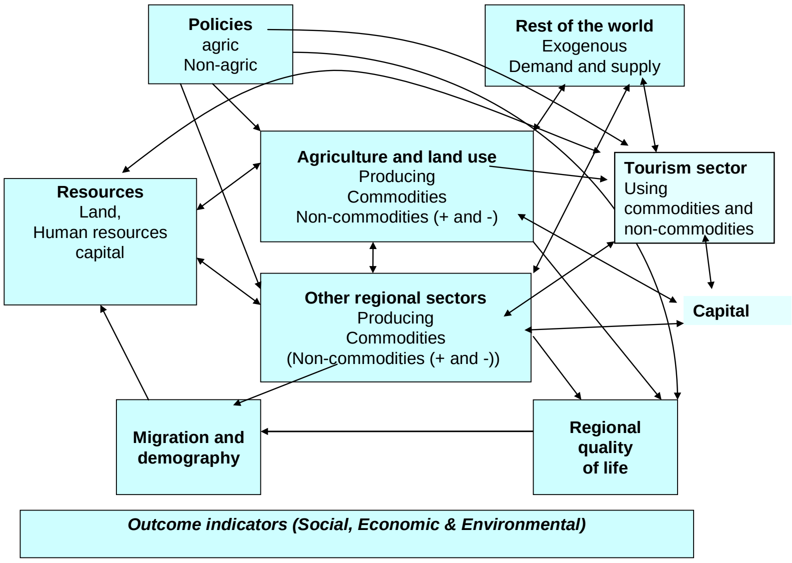
The other important linkages to consider are those between the economic and social systems (Erickson *et al* 2006), and the natural systems and social systems. The key linkages here are through quality of life, which is determined by both material and non-material elements, and the effect of quality of life on decisions to migrate into – or out of – rural regions.

In our case, the regional economic system is described by a Social Accounting Matrix or SAM (Stone, 1970; Pyatt and Round, 1985). SAMs include embedded Input-Output tables as well as detail on households, government, and assets. SAMs form the basis of simple models (in our case a dynamic model) in which flows among sectors of the economy are fully accounted for, and which adhere to the relationships in the SAM. Because of the importance of agriculture and tourism, we modelled these as separate subsystems with linkages back to the SAM. In a SAM, the components of final demand and value-added are referred to as institutions. The interdependencies between and among economic activities and institutions are illustrated by the three boxes linked to the social sphere of Figure 1 above. For instance, households, when specified as an institution (not just a supplier of labour), can reveal their non-labour inputs to economic activity in the left-hand box, distribution of labour income in the centre box, and interdependencies with other institutions in the right-hand box (the distribution of rents, profits, and net taxes to households (Erickson *et al* 2006).

Main elements and subsystems of the generic model

Since we aimed to build a model for policy analysis, we called it POMMARD, or Policy Model for Multifunctional Agriculture and Rural Development. The simplest representation of this Model is shown in Figure 2 below.

Figure 2: The Structure of the POMMARD Model



Source: Bryden *et al.* 2010f

POMMARD is largely a 'supply-orientated' model (with demand constraints), in which changes in supply drive the economy. A demand-orientated model assumes that supplies change in response to changing demand. In reality both supply and demand forces affect an economy. In much of POMMARD, change is initiated by changes in supply.

Our problematic concerns the impact of different policies on farming decisions - and hence the production of both commodities and non-commodities, and from there on the economic, social and environmental outcomes for rural regions. Regional land use is taken to be the primary economic driver. Farmers are assumed to take their decisions under the influence of commodity and factor markets, policies, and their structural and personal circumstances. We therefore start with the regional agricultural and land use subsystem. Land use is determined by the choice of production systems in each region. These 'production systems' must be understood rather differently from the conventional definition since they not only refer to the commodities involved, but also to other attributes, especially intensities of production, and they may also include non-agricultural systems such as agri-tourism. Thus it is possible to have several production systems each with the same commodity (say, grain or sheep) but with high and low intensities of production, or high or low use of inputs, allowing us to capture some important non-commodity outputs/impacts such as nitrate usage. Land use determines agricultural production of private goods and services ('commodities') and public goods and services ('non-commodity outputs' or NCOs). It also determines the amount of labour employed in agriculture, other inputs required, and incomes from farming[1].

The second subsystem we developed was the non-commodities subsystem. These NCO's may be negative or positive – for example, production system changes which lead to increased surplus nitrogen would be regarded as negative. We identified eleven NCO categories and indicators, reflecting the major European environmental concerns. These deal with cumulative changes in the area of forest, arable, grass, and permanent crops respectively; the Shannon Index (an entropy measure of land use diversity); annual applications of mineral fertilizer;

[1] The overall model explicitly allows for pluriactivity in farming systems, and income may come from several sources, in particular from farming, non-regional labour markets, and non-agricultural entrepreneurial activities.

excess nitrogen, or the total surplus of nitrogen applied over that used by plants; a biodiversity indicator, namely total utilized agricultural land under low-input farming systems; livestock density in livestock units per hectare; land cover change (hectares) measured by the total negative change in cropland; and CO2 balance in the form of total net emissions of CO2. These eleven indicators span the key issues of cultural landscapes, ground water pollution, and greenhouse gas emissions.

The NCO subsystem is related importantly to two other subsystems. The first is the tourism subsystem, which is the most common way in which non-commodities taking the form of public goods are commercialized or 'commodified' in rural regions. Bryden & Dawe (1998) identify the importance of a range of 'less mobile' public goods for new economic activities in rural areas. The work of the OECD (1999), McGranahan (1999), Deller et al (2001) and Van der Ploeg et al. (2008) on amenities in rural development provides a further theoretical background while Knickel and Peter (2005; 2008) present relevant empirical data for 18 regions in Germany. The importance of effective transformation of public goods into new rural economic activities is also demonstrated by Bryden & Hart (2004) comparison of the dynamics of rural regions in Europe. On the basis of this and other evidence, an increase in positive NCOs will attract more tourists, and this in turn will lead to more investment in tourist accommodation and other facilities, depending on industry capacities. There may be constraints on the level or rate of increase in tourism numbers, caused by infrastructure capacities, transportation limitations, or seasonality concerns. All of these potential constraints are built into our tourism subsystem.

The next important subsystem directly impacted by NCOs is the Quality of Life subsystem, which relates to income ('material capital') from the regional economy subsystem (see below) and to natural and environmental changes ('natural capital') from the NCOs subsystem. Here we draw largely on the evidence discussed in greater detail later that perceived quality of life can be related to the 'five capitals', namely material or economic, social, cultural, and natural (Costanza *et al*, 2007). This evidence comes from a wide variety of sources at different levels – global, North American, European, and national. Not only is improving quality of life for rural citizens an important objective in its own right[2], but there is abundant evidence that it drives both outward and inward migration. Here we both drew on previous research and gathered our own evidence from surveys of rural citizens, identifying past in-migrants, long term 'stayers' and intending out-migrants by age and education groups. The challenge here was to relate inward and outward migration to specific changes in the different 'capitals', both material and non-material, for which we used our survey data and econometric analysis described below. Suffice to say that even with limited survey data we were able to establish statistically significant relationships between migration of different age and education groups and changes in natural and material capital.

The regional economy subsystem, described by a regional SAM, is partly driven by the supply-orientated agriculture module, but also by the tourism and resources modules, by induced supply-driven net in-migration arising from changes in quality of life, and by exogenous demand from the larger (national or global) economy.

There is abundant evidence in both North America and Europe of 'supply driven' inward migration to rural regions. In North America we refer to the work of Deller *et al* (2001) and of McGranahan (1999), both of whom show how rural amenities attract new residents, and of

[2] Indeed it is an explicit objective of the EUs Rural Development Policy after 2006.

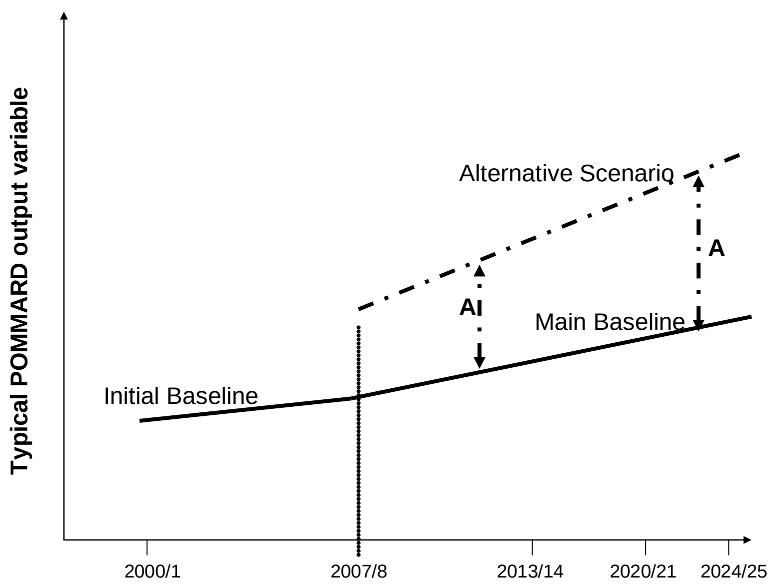
Dillman, Salant and Carley (1995) who provide evidence on the migration of footloose entrepreneurs ('lone eagles') into the rural regions of the USA. Migration movements in POMMARD are explicitly modelled in the demographic subsystem and arise from two subsystems. One is the quality of life subsystem, which drives 'supply driven' inward and outward migration. The other is the regional economy subsystem, which drives demand driven migration though labour market demand. Migratory movements are combined with the forces of natural population change at the regional level to predict labour market conditions (supply and demand of working age labour) and population by education and age cohort. Supply driven in-migrants are either retirees or footloose entrepreneurs. In the former case, they bring income with them in the form of pensions. In the latter case they are assumed to bring their own work and income through 'entrepreneurship' or by the process of "jobs following people."

The core, generic, model was adapted to the 11 rural regions studied in Europe and populated with published data from these regions and from special surveys we undertook of farmers, rural entrepreneurs and citizens.

Using POMMARD for Policy Evaluation

A key problem in all policy evaluation relates to the conditions that would have prevailed in the absence of policy – the 'counterfactual' or 'without' case. It is essential to know this if the additional effects of any policy are to be measured, since continuation of an existing policy regime will have dynamic effects over time, as will market factors. Although various methods have been used to compute the 'without' case, none have met with universal approval and all can be reasonably criticised. In our case, we also model future conditions under the existing policy regime, and this provides a dynamic baseline against which to assess probable added effects from policy changes. This is illustrated in Figure 3 below.

Figure 2 Impact Analysis of TOP-MARD Scenarios



Source: Bryden *et al.* (2010f)

We started with study area data for the major census year 2001, thereby recognising the Agenda 2000 reforms, including area payments, and implementation of the 2000-2006 Rural Development Programmes.

Nevertheless, use of 2001 without modification as the starting point and comparator for scenario simulations would have ignored the major changes in the EU's agricultural and rural development policies which followed adoption of the 2003 Mid-Term CAP Reform package, the 2004 EU-accession of Hungary and Slovenia, and the start of a new EU budget and Programming period in 2007. Thus, in addition to the 'Initial' Base Scenario projecting forward from 2001, a second ('Main') Baseline scenario was adopted. This incorporated post-2001 policy and other conditions. The 'Main Baseline' scenario base year is 2007, for which CAP conditions, such as the total budget for the new European Agricultural Fund for Rural Development, and for the new Rural Development Programme budgets, as well as Single Payment rates, are known. By extrapolation and annualisation, conditions could then be assumed out to 2013[3] [4].

Some Results from the Policy Scenario Analysis

The main focus in TOP-MARD is on the possible impacts of CAP Reform scenarios for post-2013. The main questions addressed are:-
What happens to farming, regional economies and quality of life, and regional natural environments in different contexts if there is (1) a major reduction in the Pillar 1 budget, without reallocation to Pillar 2, or (2) a reallocation of a significant part of the Pillar 1 budget to Pillar II either through 'modulation' or otherwise, with or without (3) Major reallocations between the Axes within Pillar 2?

Five main CAP reform scenarios are used, namely:-
Scenario A1: 50% cut in Pillar 1 direct payments
Scenario A2: 50% cut in Pillar 1, with 'modulation' of proceeds to Pillar 2
Scenario B: All Pillar 2 reallocated to Axis 2 (agri-environment)
Scenario C: All Pillar 2 reallocated to Axis 3 (rural development)
Scenario Z: All Pillar 2 funding to Axis 1 (agricultural competitiveness)

The actual results of the scenario analysis are discussed in Bryden (2010f) and Bryden et al (2010f), and this paper does not need them to be detailed and discussed here. Suffice to say that the both the direction and strength of the economic, social and demographic outcomes from any given scenario vary considerably between the 11 different regions studied, supporting the maximum possible devolution of policy design and delivery. We also point to several different possible reasons for the variation in outcomes including variability in both tangible and less tangible factors.

[3] Norway, as a non-EU Member State, has different policy time-frames, involving annual deliberations. However, the Norwegian TOP-MARD partner agreed to conform to the time frames and horizons, as well as to categorize their policies and associated expenditure at regional level accordingly to the Pillars and Axes of the EU CAP.
[4] Moreover, an 'initial' and a 'main' baseline scenario allowed calibration of the latter using "real-world data" for the years 2001 to 2007 (e.g. agricultural prices, demographics, regional GDP, etc.).

An important question raised previously by several economists concerns the extent to which such variability is caused by differences in the efficiency of policy design and delivery between nations and regions. To tackle this question we turned to Data Envelopment Analysis (DEA).

Evaluating Policy Efficiency with DEA[5]

Data Envelopment Analysis (DEA) is a powerful service management and benchmarking technique originally developed within operations research by Charnes, Cooper and Rhodes (1978) to evaluate non-profit and public sector organizations. DEA has proved helpful in identifying ways to improve services.

In our case, DEA compares regions considering all the resources used and services provided as inputs, and compares these with outputs measured from outcome indicators (including NCOs). Undesirable output indicators, which have negative impact on outcomes (e.g. mineral fertiliser applications or high livestock density which reduce NCOs), comprise part of the inputs. The different inputs and outputs are commonly weighted. Branches of organisations, or different implementations of a policy regime, can be compared, those with the highest ratio of output to input providing a 'benchmark' against which others can be judged.

Efficiency is simply defined as the ratio of output to input. The more output per unit of input, the greater the efficiency. If the greatest possible output per unit of input is achieved, a state of absolute or optimum efficiency has been achieved and it is not possible to become more efficient without new technology or other changes in the production process (Zhu, 2003). The main problems with the DEA approach, and which need to be considered when interpreting the results, are:-

1. the choice of input and output/ outcome indicators;
2. the weights to be applied to each of these indicators (in this case we use an implicit weight of 1 for each);
3. that many other forces determine the effectiveness and efficiency of any policy or 'branches' than the variables used, in our case policy expenditure.

In this analysis, we used the results of the scenario modelling using system dynamics and considered *NCOs,* measured by Biodiversity change and Shannon index, mineral fertiliser use per hectare and livestock units per hectare; *tourism* measured by the labour employed in Hotels & Catering; and regional *per capita income* as outcome indicators. These are a diverse set of indicators, but what they have in common is that they are expected to be changed by rural development policies. Biodiversity and Shannon index should be increased; fertiliser use and livestock density decreased in farming, sectors like tourism should be expanded, and regional incomes should be increased.

EU Rural Development (Pillar 2) Axis 1, Axis 2, Axis 3 and Leader payments are the inputs of the DEA model. For technical reasons, since they create undesirable outputs, fertiliser use and livestock density are also treated as input variables.

The comparative analysis was made for two periods: the 2000-2006 and 2007-2013 EU programming periods. For the inputs, rural development payments were available as the

[5] See also Chapter 8 'Comparative Analysis of POMMARD Results using the Adapted Models' by Tibor Ferenczi, John Bryden, Krisztina Fodor and Attila Jambor *in* Bryden *et al* (2008), and Chapter 13 in Bryden *et al.* 2010f.

annual average payments for both the first period and the second period.

Output indicators were taken from the baseline scenario results using the POMMARD model in each region, 2007 for the first period, and 2015 for the second (Table 1).

Table 1: Output Indicators of DEA Model

2007 Outputs		AT	DE	ES	GR	HU	IE
-Fertiliser/UAA	kg/ha	11,5	131,1	23,2	1814,6	191,4	128,7
-LU/UAA	LU/ha	0,170	0,347	0,738	0,280	0,041	0,962
Shannon index	index	1,073	2,774	1,188	1,070	1,254	0,403
Biodiversity change 2007/2001	2007/2001	1,005	1,002	0,980	1,003	1,000	1,000
Labour_Hotel&catering change	2007/2001	1,055	1,005	1,120	1,161	1,038	0,993
p.c. income	€000/head	22,88	9,71	15,98	10,39	12,83	38,54

Cont.		IT	NO	SE	SI	UK
-Fertiliser/UAA	kg/ha	281,6	551,1	415,2	479,9	93,3
-LU/UAA	LU/ha	0,313	0,127	0,010	1,168	0,226
Shannon index	index	1,308	0,744	0,730	1,011	1,377
Biodiversity change 2007/2001	2007/2001	1,024	1,069	1,030	1,005	1,004
Labour_Hotel&catering change	2007/2001	1,114	1,040	1,016	1,208	1,123
p.c. income	€000/head	22,85	20,20	28,92	10,62	12,21

2015 Outputs		AT	DE	ES	GR	HU	IE
-Fertiliser/UAA	kg/ha	11,4	133,2	23,2	1722,9	191,4	128,7
-LU/UAA	LU/ha	0,168	0,337	0,738	0,280	0,041	0,962
Shannon index	index	1,074	2,789	1,188	1,070	1,256	0,403
Biodiversity change 2015/2007	2015/2007	1,007	1,003	1,000	1,006	1,001	1,000
Labour_Hotel&catering change	2015/2007	1,037	1,001	1,071	1,025	1,100	1,099
p.c. income	€000/head	22,604	9,800	16,588	10,460	12,509	39,211

Cont.		IT	NO	SE	SI	UK
-Fertiliser/UAA	kg/ha	277,1	551,1	415,7	480,7	93,3
-LU/UAA	LU/ha	0,248	0,127	0,010	1,166	0,226
Shannon index	index	1,252	0,744	0,730	1,008	1,377
Biodiversity change 2015/2007	2015/2007	1,024	1,000	1,092	1,006	1,005
Labour_Hotel&catering change	2015/2007	1,088	1,023	1,111	0,998	0,894
p.c. income	€000/head	23,992	20,533	30,360	10,281	11,661

The input variables are given in Table 2.

Table 2: Input Variables of DEA Model

2000-2006 INPUTS		**AT**	**DE**	**ES**	**GR**	**HU**	**IE**
A1 - annual payments	mio €	2,89	0,53	1,07	19,02	2,42	5,61
A2 - annual payments	mio €	37,06	1,81	0,80	8,26	14,53	0,84
A3+Leader a. payments	mio €	0,74	0,49	0,64	3,33	0,59	0,24
Cont.			**IT**	**NO**	**SE**	**SI**	**UK**
A1 - annual payments	mio €		9,02	143,57	29,37	0,89	0,00
A2 - annual payments	mio €		2,88	18,37	288,14	4,24	9,56
A3+Leader a. payments	mio €		1,90	113,63	25,74	0,24	0,36
2007-2013 INPUTS		**AT**	**DE**	**ES**	**GR**	**HU**	**IE**
A1 - annual payments	mio €	5,70	0,71	1,46	18,29	96,65	3,76
A2 - annual payments	mio €	35,57	1,36	1,38	8,12	71,61	27,24
A3+Leader a.payments	mio €	4,33	0,39	0,94	4,97	20,27	3,22
Cont.			**IT**	**NO**	**SE**	**SI**	**UK**
A1 - annual payments	mio €		11,27	..	4,25	7,07	11,74
A2 - annual payments	mio €		1,98	..	0,54	10,38	31,43
A3+Leader a. payments	mio €		2,26	..	3,38	2,33	0,56

The calculations were made by DEA Frontier software, and provided the results shown in Table 3.

Table 3: Results of DEA Analysis

Region No.	Region Name	Input-Oriented CRS Efficiency	*2000-2006* □□	**Benchmarks**			
1	AT	1,00000	1,000	1,000	AT		
2	DE	1,00000	1,000	1,000	DE		
3	ES	1,00000	1,000	1,000	ES		
4	GR	0,85686	1,066	0,344	HU	0,722	IT
5	HU	1,00000	1,000	1,000	HU		
6	IE	1,00000	1,000	1,000	IE		
7	IT	1,00000	1,000	1,000	IT		
8	NO	0,95059	1,390	1,155	HU	0,236	IT
9	SE	1,00000	1,000	1,000	SE		
10	SI	1,00000	1,000	1,000	SI		
11	UK	1,00000	1,000	1,000	UK		

DMU No.	DMU Name	Input-Oriented θ Efficiency	*2007-2013* □□	**Benchmarks**							
1	AT	1,00000	1,000	1,000	AT						
2	DE	1,00000	1,000	1,000	DE						
3	ES	1,00000	1,000	1,000	ES						
4	GR	0,22954	0,997	0,166	DE	0,831	SE				
5	HU	1,00000	1,000	1,000	HU						
6	IE	1,00000	1,000	1,000	IE						
7	IT	0,98343	1,029	0,030	AT	0,187	DE	0,230	ES	0,582	SE
8	NO	..	..	..							
9	SE	1,00000	1,000	1,000	SE						
10	SI	0,27738	1,001	0,045	AT	0,937	DE	0,019	SE		
11	UK	0,81266	0,992	0,686	AT	0,200	DE	0,011	HU	0,094	SE

The interpretation of DEA results is as follows:

1. The efficiency ratings are generated by the model. Units that are efficient ($\theta = 1$) are relatively, and not absolutely, efficient. That is, no other region is obviously utilising the RD measures more efficiently than these regions, but it is possible that all regions, including those deemed relatively efficient, can be operated more efficiently. Therefore, the efficient regions represent the best existing (but not necessarily the best possible) treatment of RD resources with respect to NCO production, Tourism growth and per capita income, provided that these are all equally valued.
2. Inefficient regions are identified by an efficiency rating of $\theta < 1$. These regions are inefficient (with respect to the selected NCO generation) compared to all other regions.
3. The efficiency reference regions indicate the relatively efficient regions against which the inefficient regions were most clearly determined to be inefficient. Table 8.6 summarises the magnitude of the identified inefficiencies by comparing the inefficient region with its efficiency reference set of regions.
4. The reference inputs and outputs are multiplied by the weights derived by DEA. These are then added together to create a composite „region" that provides as much or more NCO services as the inefficient region, while also using less inputs that this latter one. These reference weights are generally referred to as Lambda - λ - values in the DEA models.

According to these considerations the following main comparisons can be drawn based on the results:

1. In the 2000-2006 period, there are only two 'inefficient' regions Trikala (GR) and the Hordaland (NO). In both, there appears to be too much RD support in relation to NCOs, per capita income and Tourism growth. The inefficiency lag can be measured by the indicators of Bács-Kiskun (HU) and Latina (IT).
2. For the current projected period (2007-2013) the picture is more interesting: for some outputs certain regions will be less efficient than the others. Trikala (GR) is inefficient measured by the Wetteraukreis (DE) and Västerbotten (SW), and Latina also joins the inefficient regions measured by Pinzgau/Pungau (AT), Wetteraukreis, Berguedà (ES) and Västerbotten (SW). Gorenjska (SL) has also become inefficient compared with Pinzgau/Pungau, Wetteraukreis and Västerbotten. Caithness and Sutherland (UK) has also become inefficient.
3. Naturally, this ranking is established for NCO production, tourism and per capita income in parallel, under the current structure. Certainly, central, regional and local governments may and certainly do have different preferences (weights) about these three and other indicators, which would yield other results. In addition, as mentioned previously, changes in tourism and per capita income are the consequence of much more than the second Pillar of the CAP and its equivalent! Therefore this analysis must be viewed with caution.

Conclusion

This paper has reviewed two methods of policy evaluation which were used in tandem during the TOP-MARD research project, covering 11 European rural regions. The POMMARD model used system dynamics to examine economic, social and environmental outcomes from existing and alternative rural development policies, for the period to 2025. The DEA model used the outputs of the POMMARD model to assess comparative policy efficiency between the 11 regions studied. While POMMARD represented a new approach to holistic modelling, simultaneously dealing with economic, social and environmental policy goals and outcomes, DEA is a well established econometric technique which normally deals with a narrower set of outcomes. POMMARD must still be regarded as work in progress, but we believe that the results offer a useful contribution to current policy debates and the method is a promising one for future evaluation studies.

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