Modelling policies for sustainable rural development

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Abstract

This paper discusses the concept of sustainable territorial development in rural contexts, and the modeling of environmental, economic and social components to allow simulation of the inter-connected dynamic impacts of different kinds of policy over time. The paper builds on recent research (TOP-MARD) which explored the complex inter-relationships between policies, the multiple (public and private) functions of agriculture and farm households ('multifunctionality'), and the development of rural regions and the quality of life of people living there. System dynamics was appropriate in this case because of our interest in the interaction and feed back effects among economic, social and environmental systems. A model was developed in common between 11 European research partners and then adapted to the individual study regions. In this paper the model is applied to the Norwegian study area, Hordaland County. The study finds that reducing agricultural subsidies can lead to improvements in regional economic performance by releasing labour and capital to uses with higher returns and by creating positive feedback to the economy by improving environmental quality and overall quality of life. Using these results we develop a general discussion on the importance of a holistic approach to the analysis of policy - and indeed market impacts -over time if progress is to be made towards more sustainable rural futures. In many situations, and especially in remoter rural regions, the findings reinforce the arguments for encouraging farmers and other local enterprises to invest in non-agricultural opportunities and especially those that link to local public goods including culture, nature and resources for renewable energy, as this will help both the regional economy and the continuation of farming activities by pluriactive farm households on relatively small farms (Fuller,1990; Bryden et al.,1994).

Introduction

'Multifunctionality' has become a key part of the rationale for agricultural subsidies in the European Union. The development of evidence around the relationships involved has therefore been vital for Common Agriculture Policy reform from the 1992 Macsharry reforms onwards, which have all reflected the changes triggered by the Uruguay Round of International Trade Talks which included agriculture, and the subsequent establishment – and decisions - of WTO. This paper describes the 'policy model of multifunctional agriculture and rural development' (POMMARD) developed in the TOP-MARD (Towards a Policy Model of Multifunctional Agriculture and Rural Development) project and demonstrates its use in the Norwegian case. It reports on an analysis of CAP scenarios using the regional-scale system dynamics model. The project set out to examine how agricultural multifunctionality affects the sustainable development of rural regions, and how different policy reforms might influence this relationship. The analysis was undertaken at a time when the 2009-10 budget review was expected to exert heavy pressure on the CAP, and to potentially major reforms in the two 'pillars' of the CAP from 2013 onwards.

A range of non-market services (often referred to as 'externalities', or public and quasi-public and club goods) influence the livelihoods, work, and quality of life of rural peoples, and are thus important for rural development (Bryden and Hart, 2004; Knickel and Peter, 2005; OECD, 2006). We refer to these as agriculture's 'Non-Commodity Outputs' (NCOs), even if some of them may

have a partial market reward. Examples of the NCOs are given in Figure 1. The range of 'com- 'commodity' outputs such as meat or cereals and NCOs are jointly produced, support or hinder rural competitive advantages, and combine in the concept and practice of 'multifunctionality'.

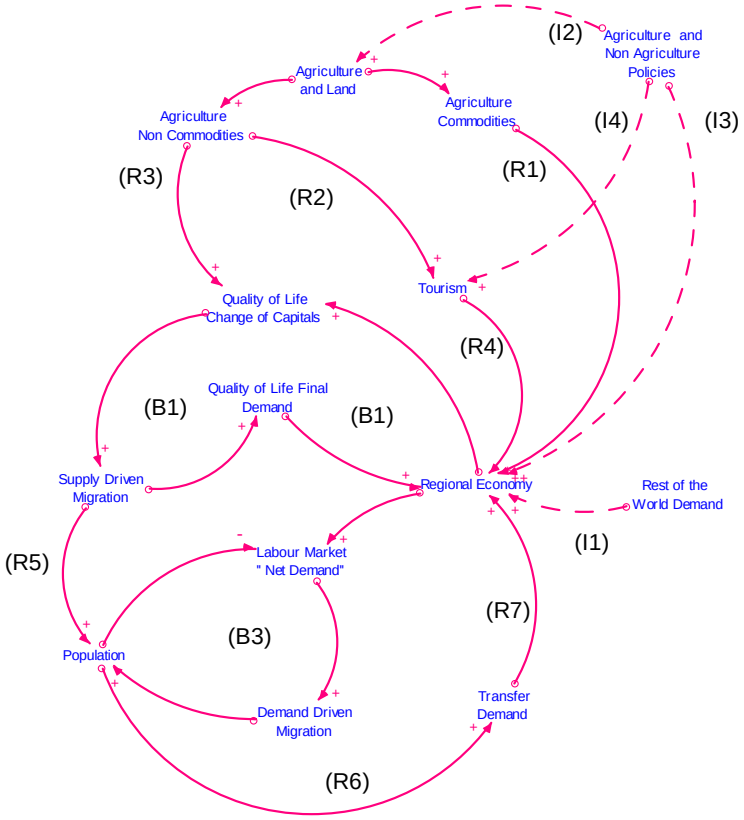

Figure 1: Structure of the POMMARD model

In successful rural economies, commodities and non-commodities are both effectively transformed into new activities and income-earning opportunities (Terluin and Post, 2001; Bryden and Hart, 2004) by farmers, other landowners, entrepreneurs, and community organisations. Policies vary in their efforts and success in encouraging such transformation, depending on institutional structures and modes of governance at regional levels, as well as policy implementation efficiency. The most typical transformation of agricultural commodities is the processing of food and raw materials. The most usual medium for the transformation of NCOs is farm and rural tourism. Activities utilising commodity and/or non-commodity inputs can thus either contribute directly to the regional economy and to regional quality of life or indirectly to the tangible and less tangible community assets underpinning them. NCOs also directly affect the quality of life of rural residents and the perceptions and decisions of potential migrants through their impact on less tangible assets such as 'natural', 'cultural', 'social' and 'human' capital as well as on material conditions.

Modelling multifunctionality, rural development and quality of life relationships

POMMARD uses system dynamics as its foundation. System dynamics allows a holistic approach in which models are built with differential and partial differential equations, feedback effects, non-

linear relationships and lags of various lengths to describe a system in the process of change (Costanza & Ruth 1997; Scholl, 2001; Meyer et al., 2009). It distinguished itself from other mathematical approaches by explicitly defining causal relationships in time. Variables are either stocks, flows, coefficients or indicators (Shilling, 2003; Nicholson, 2007). One advantage of the system dynamics modelling approach is its emphasis on disequilibrium rather than equilibrium processes. This is important because markets are rarely in equilibrium. In contrast to the assumptions in economic theory, real world markets involve continuous interaction between forces of supply and demand and commonly exhibit temporary shortages and surpluses (Shilling, 2003). This leads to reactions in prices, production and consumption as the system moves towards ever changing equilibria.

Methodological framework of POMMARD - Causal Relationships

In a system dynamics model, levels and/or rates of change in all system (endogenous) variables are caused by levels and/or rates of change in exogenous variables or other system variables. All relationships are causal, rather than simultaneous, and because of implicit and explicit lags frequently introduce feed-back loops. Models of this type may be described using a causal loop diagram (CLD) which displays the direction of causality between all system variables and identifies feed-back loops.

Feed-back loops may be reinforcing (R), balancing (B) or informative (I). A CLD for the POMMARD is shown in Figure 1. We start with the premise that non-commodities (those not produced for market) are joint products of marketed agricultural commodities. Consumption of agricultural commodities affects production in the regional economy (R1) through local markets. Non-commodities (NCOs) are public goods which often generate impacts in other sectors of the rural region. In POMMARD it is assumed that NCOs affect quality of life and thus the attractiveness of the region to residents and tourists. Regional quality of life is defined using a capitals approach developed by Costanza et al. (2007). Five capitals are defined in the model, although only natural and material capitals are explicitly modelled. Per capital income is adopted as a proxy for material capital while the extent of forested land is a proxy for natural capital. Changes in quality of life induce delayed migration flows which, in turn, alter the demographic and social dimensions of the regional economy (R5). This type of migration is referred to as supply driven since employment opportunities are secondary in these migration decisions. Changes in regional attractiveness also affect the number of annual tourists (R2) who consume additional goods and services from the local economy (R4).

Figure 1 also identifies a feed-back loop between changes in quality of life and the regional economy. Loop B1 represents the effects of quality of life on the regional economy. As levels of material and natural capital change, the flow of migrants changes, resulting in changes in consumption and production in the regional economy. These changes have a feed-back effect on quality of life (in particular material capital) reinforcing or offsetting migration depending on the effect of the changing demographics and economics on material and natural capital. In addition, loop B3 shows a balancing feed-back mechanism between population, labour markets (Net Demand) and migration. If labour demand (determined by the size of the regional economy) is higher than labour supply (determined by the population), demand driven in-migration occurs increasing population. The resulting population growth increases labour supply reducing the unmet demand for labour thus stifling demand led in-migration. Population increases also induce additional consumption associated with employment income and transfers (R6) which reinforces production and growth in the regional economy (R7). In addition, there are other exogenously

determined forces. The first is final demand from outside the economy (I1) which contributes to demand for production by the regional economy. The second force is induced through agriculture and non-agriculture policies, which impact the agriculture sector (I2), the regional economy (I3) and the tourism sector (I4) in various ways depending on the type of policy implemented.

The TOP-MARD methodology and results are described in greater detail in Bryden et al, 2011, while more details describing the assumptions used and the inputs required to run the model can be found in Alva et al. (2011).

Applying POMMARD to Rural Norway

The county of Hordaland, like many other rural Norwegian areas, has a long history of residents diversifying their income, thus farming is integrated into many of the region's economic activities (Rognstad and Steinset 2008) and policy is important for farming. Hordaland was therefore considered an ideal area to study the consequences of multifunctionality policy.

The county is about 15.000 km2 with a landscape of mountains, fjords, glaciers and islands. The population is 450.000 of which 240.000 live in the city of Bergen. The population of Hordaland is increasing due to positive natural growth and immigration from abroad while the domestic net migration is close to zero (SSB 2008a, 2008b and 2008c). Farms in Hordaland, as in all Norway are, with few exceptions, owned by resident working farmers. The settlement pattern in rural areas is typically one of isolated farms surrounding villages with a few industrial enterprises, and basic services supplied by the municipal administration in a larger village or small town. The agriculture is diverse and land is primarily used for forestry, dairy, beef and sheep. Farmers are mainly livestock farmers and 97% of total agricultural land is being used for the production of grass. Traditionally, Hordaland has been a sheep farming region, utilising its huge areas of rough grazing land, although this activity has decreased. Hordaland is known for its centuries old fruit production often based on fjord-adjacent steep slopes. Pears used to be a major crop, but the production has declined considerably. Many farms include some forest land. It is an area with considerable nature diversity and high incidence of low-input farming systems in terms of utilized agriculture area.

Hordaland is an example of a non-agricultural dependent region (measured in terms of employment or GDP share). Demographically, the region has a relatively high rate of employment, and a relative high level of tertiary education. In terms of economic indicators, GDP per capita is relatively high compared to other rural regions. However, Hordaland is less dependent on intermediate demand from other sectors in the regional economy and more dependent on final demand. This means that Hordaland is less susceptible to changes occurring in the local economy and more susceptible to external shocks. Most Hordaland residents live in the coastal areas, on narrow strips of farmland along the fjords and in larger valleys. In the past 15 years, Bergen and most adjacent municipalities together with Stord have experienced population growth of over 10%, while population in the municipalities along the Hardangerfjord decreased by more than 10 %. The rural areas in Hordaland have experienced changes in relation to technological development in the region's basic other industries. The magnitude of change in rural areas has depended on distance from urban centres, availability of jobs and the possibility of combining small scale farming with other sources of income. The industrial sector employed 16%, hotel and restaurant services 17%, other services 57% and agriculture 2% in 2005 (SSB 2006a; Hordaland fylkeskommune 2009).

Although farming contributes only a small portion of the county's GDP, it is still an important factor in the lives of many families, including those not relying on farming as their primary source of income. The average farm income was Euro 8,595 in 2006 however the income from agriculture varies greatly among farmers with one-third of the farmers reporting no positive income from farming at all. The main sources of income for farm families are salary, wages, and self-employment together accounting for three´quarters of farm household income. About one third of the holdings in the county (1,435 farms) had some kind of on-farm diversification. This mainly involves renting out land, buildings or machines; machine contracting; value added and local food; marginal area enterprises like extreme sport, renting out hunting and fishing rights etc; farm tourism activities (e.g. fishing, hunting, hiring out boats); and other services like green care, and hydroelectric power plants. In areas close to cities and other urban centres, alternative uses of farm capital may give higher returns than traditional farm operations.

The tourism sector in Hordaland is closely related to the landscape and therefore to the management of the landscape by farm families. Other multifunctional activities – like hunting and fishing rights, hydropower, processing of food – are also utilised by other businesses and entrepreneurs. Entrepreneurs in Hordaland are engaged in tourism, hunting experiences, production of drinking water, small scale meat production, small scale food production, and supplying equipment and consultancy for small scale hydroelectric plants (FMLA Hordaland, Innovation Norway).
The building of the conceptual model and its adaptation to 11 regions involved team work, populating it with data based on public data sets, previous research, and surveys of farmers, rural entrepreneurs, households and regional experts. Regional stakeholder groups provided advice, contacts, and feedback at every stage, and played a key role in discussing and calibrating results.

Agriculture and Rural Policies: Subsidies and institutional regimes in Norway

Norwegian rural development policy aims to maintain agricultural activities in rural areas, and help farmers start new businesses through four mechanisms: support schemes, the regional environmental programme, rural development grants, and indirect support (via research, education and extension services). Support schemes are differentiated according to production, geographical region and farm size; the highest payments are usually received by farms in remote areas and by smaller farmers. The regional environmental programme is administered by county authorities who are responsible for establishing instruments and schemes to achieve the environmental challenges with the highest priority in the region. Rural development grants are allocated to all counties in Norway based on the number of holdings, utilized agriculture area and proportional agricultural employment; and are meant to support the start up of farm-based enterprises. (Ministry of local government and regional development 2006; Prestegard & Hegrenes 2007; Refsgaard et al. 2010; Refsgaard & Johnson 2010; Refsgaard & Spissøy 2011).

The policy scenarios

To assess the dynamic impacts of different policies, various scenarios were compared to a reference or 'baseline' run of existing policies. A baseline scenario was generated assuming constant rates of change in exogenous factors such as growth rates in final demand for non-agriculture sectors and income. In alternative scenarios changes in the policies and/or in the exogenous drivers of the model are introduced. In TOP-MARD we developed and analysed nine different EU policy scenarios. Norway is not a member of the EU, but has similar agricultural and rural policies, which we adapted to give comparable changes in Norwegian policies. For example, the Norwegian broad-based hectarage and cultural landscape schemes fall between Pillar 1 and

Pillar 2 measures in the EU. To see the impacts of two different approaches for 'support' to rural development we here analyse the following three scenarios:

1. Main Baseline 2007-13 policies in EU, incorporating agricultural and structural policy changes since 2001.
2. A 50% cut in annual direct payments: Reductions occur in year n, and remain for the rest of the simulation. All commodity subsidies, all headage subsidies, all hectarage subsidies and all production system subsidies are halved and with no reallocation of funds.
3. Rebalance 2007-13 Pillar 2 measures to give 100% to Axis 3 activities,1 continuing for 7 years.

The base year for all simulations is 2001. The simulations then covered the period from 2001 until 2026. A 0.15% growth rate was assumed to reflect the actual population from 2001 to 2007. Norwegian policy for both agriculture and rural areas is more short-term than the EU CAP policy. The Norwegian Ministry for Agriculture and the Farmers unions conduct an 'annual review' of policy. Based on this review there are some changes in the policies and subsidies every year.

Scenario Results - 50% cut in annual direct payments

Reducing direct payments to farmers has a strong impact on a range of regional indicators. It was assumed that this type of policy change would lead to a switch from more labour/capital intensive to less intensive production systems, i.e. from milk to lamb and beef. Lamb and beef systems are also mainly part-time production systems, making off-farm employment easier. Dairy production declines to 30 000 ha. The analysis assumes an increase in beef as well as in sheep farming by 5 000 ha each. The remaining 20 000 ha is allocated to forest as some dairy farmers, for example those in Inner Hardanger, are likely to invest their resources in this less resource-dependent system.

This direct shift in land use changes the level of input consumption in the agricultural sector which leads to different purchases from the rest of the regional economy. The change also decreases the agricultural employment – which in turn increases the potential supply of labour to other regional sectors (Figure 5). In Hordaland there is effectively an unlimited demand for labour at the margin (due to the dominance of the oil industry) manifested in temporary in-migration and commuting, which is why we expect agricultural labour to move instantaneously to other sectors. As the labour participation rates are exogenously decided the model induces this labour mobility. Labour moves out of agriculture and into higher productivity occupations when pillar 1 subsidies are cut. The increase in the availability of regional labour displaces external labour and immigrant labour. Thus in 2007 the migration immediately decreases more than in the main baseline (Figure 7), however it soon increases because of increased regional production, consumption, and subsequent increased demand for labour. Figures 4 and 5 show that employment and production decrease in the very short term but then soon increase. Consumption follows the same pattern, but with a slight delay.

[1] Pillar 2 of the CAP has three main Axes, and a fourth for the local development programme 'LEADER' which may be a method of implementing the first 3 Axes. Axis 1 concerns agricultural competitiveness; Axis 2 concerns agri-environment; Axis 3 contains more 'rural development' measures including farm diversification, rural tourism, small rural infrastructure etc.

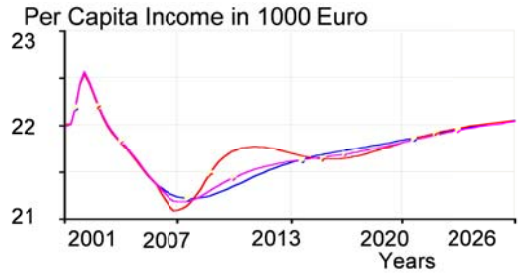

Figure 2: Per Capita Income in 1000 Euro

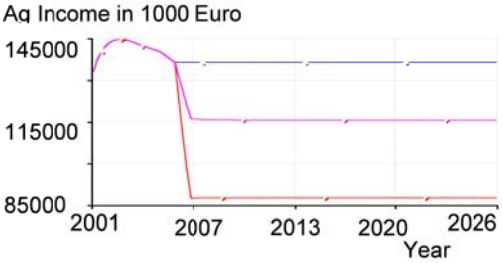

Figure 3: Agricultural income in 1000 Euro

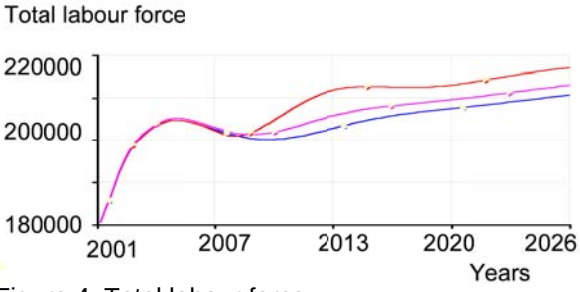

Figure 4: Total labour force

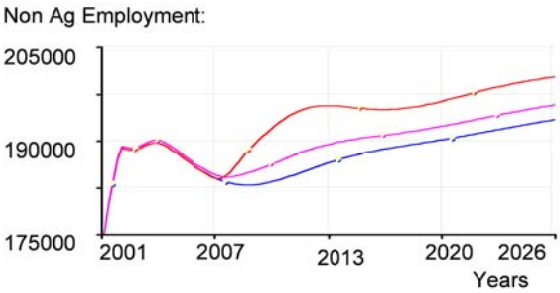

Figure 5: Non-agricultural employment

There is a decline in agricultural employment of about 855 people and a loss in Gross Value of agriculture of about Euro 40 mill, on average about Euro 60.000 per person. However, about Euro 2 billion is gained through increased regional productivity. Net regional employment increases by between 6.900 and 7.600 people since wages and salaries are about five times as high outside agriculture than inside it. So the regional value-added exceeds the loss of subsidy payments implying that the gross regional production and incomes increase (Figures 2 and 3). This in turn creates further secondary and tertiary impacts in the regional economy, and the dynamic process continue over time until a new near-equilibrium is reached with ultimate impacts on population and migration.

There is an asymmetry in this as most small farmers already have off farm jobs and large farmers do not. There may also be a spatial asymmetry, as the new jobs are more accessible to farmers near the coast and towns, while those in peripheral interior rural municipalities may lose out, with implications for the county-wide territorial policies which give higher priority to such municipalities. Even given the place-based nature of this approach the “micro-spatial” aspects are not illuminated.

Another important source of dynamics in the regional economy is the impact of migration driven by quality of life. In this scenario, we see that per capita income actually increases (Fig. 2), due to higher income in non-agricultural sectors. The supply-driven migration for youth is basically driven by income while the supply-driven migration for families is driven to a larger extent by other quality of life factors including nature/wildland (Figure 6). These tendencies can be observed in quality of life induced migration: some youth who prefer to live in regions with higher income (according to our survey) choose to stay instead of leaving. Further there is the lowest proportion of grassland of all scenarios, and higher shift to forestry, increasing the natural capital factor in quality of life. This explains the increase in net in-migration of elderly. The increase in the family age in-migration which also occurs is related both to labour demand factors, as well as incomes and natural capital inducements.

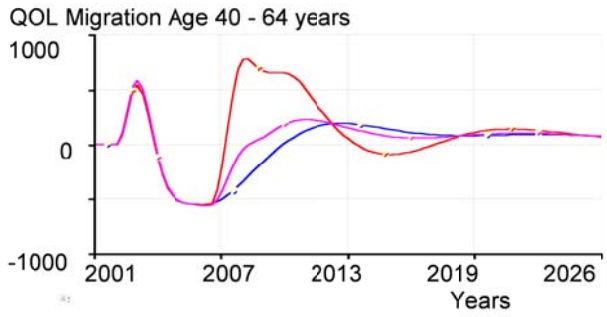

Figure 6: Quality of life migration, age 40-64 years

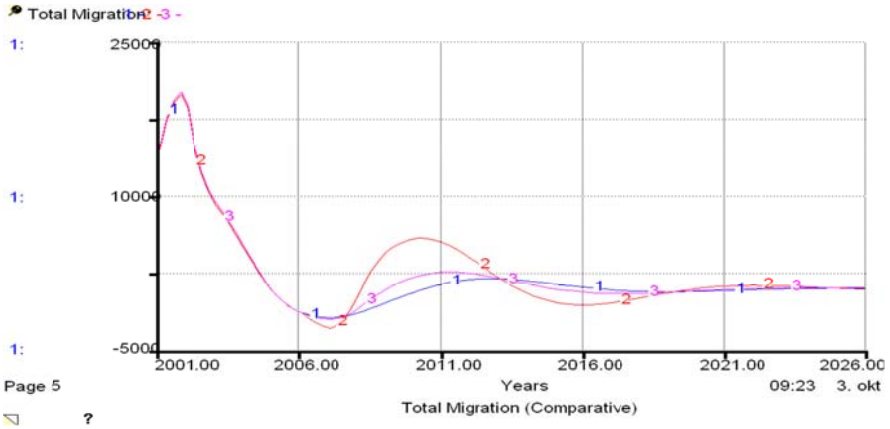

Figure 7: Total migration

Scenario results - Shift all support from direct payments to Axis 3 programs

We assume a double impact from the investments supported by Axis 3. First, there is an initial impact on construction and services. Second, investments continue to produce future output and income to the region, which we assume at a minimum exceeds the opportunity costs of capital. For Hordaland we applied a capital/value-added ratio of 3:1, with impacts accumulating over time (Doblin, 1978; Corsetti et al, 2001)2. According to the priorities for the county, these investments are shared between different sectors (personal Communications with Innovation Norway, FMLAHordaland). For tourism, this 'output' expansion effect is introduced as additional tourist expenditures. The amount of expansion is based on the baseline data. The land allocated to intensive production systems declines, as there is less subsidy for land and for ordinary farm investments. On the other hand additional land is devoted to other production systems, or taken out of agriculture and converted to forest.

We see the same tendencies for many of the indicators in this scenario as for those in the 50% reduction scenario, but the economic effects for agriculture are much less dramatic; income declines from Euro 135 million in the baseline to Euro 115 million. Agricultural employment is only marginally reduced as the increase in Axis 3 payments increases non-traditional employment on farms. Compared to Scenario 2 much less area is taken out of production which in turn impacts the biodiversity and mineral fertilizer use over a longer period. Excess N decreases most for Scenario 2 with a lower amount of excess nitrogen, due to the smaller proportion of grassland.

There is a demand driven in-migration created by the demand for labour due to the increase in incomes – as in scenario 2 (Figure 7). The other source of in-migration is the quality of life, supply-driven migration where higher regional income leads more youth to remain after secondary school. More land in forest attracts seniors and families.

Discussion and Conclusions

Our key hypothesis in TOP-MARD is, that the 'rate of transformation' of public and private goods on farms and by farm households into 'territorial development' and quality of life of territorial residents cannot be taken for granted. Whether, and to what extent, that transformation process occurs in any region is suggested by earlier research on understanding the causes of 'differential

[2] The estimated Capital/Output ratio of 3:1 is computed from data on capital stock and value added in each industry.

economic performance' in rural areas of Europe, and especially by RUREMPLOI (Terluin & Post, 2001), (Terluin, 2003) and by DORA (Bryden & Hart, 2004).

The structure of a model like POMMARD is both its greatest asset and its greatest potential weakness. We have discussed the advantages of a dynamic model, taking an ecological and systems view of processes, and incorporating environmental and social relationships. But this model is unusual, complicated and ambitious. As with any model, the performance - and thus results - depend on the underlying assumptions. Such a model lacks familiar statistical indicators of goodness-of-fit, and robustness. It also pushes the model builders and users into areas where data are rare and untried.

Nevertheless, the approach has valid claims to legitimacy. For one, the system dynamics methodology has achieved a degree of maturity. In addition, the model was a joint effort 11 teams from different regions of Europe, several different disciplines, each with an understanding of multifunctionality, rural development and their respective regions. In the development of the common core model the teams had to debate and agree on the structure, i.e. the important variables, the assumptions, the relevant indicators and the nature of relationships. Further dialogue with national user groups, information from surveys, and interviews with key agents have been critical steps in verifying the model structure, process and results.

In this analysis the POMMARD model demonstrates that it can produce useful and interesting insights into the relationships between economic, environmental, and quality of life dimensions of a rural region. With it we can trace the impacts of alternative policy regimes from their effects on the production of commodities and non-commodities to their impacts on territorial rural economics, population dynamics and quality of life. The model produces a set of clear (if approximate) economic, environmental and social indicators. We see how changes in multifunctional agricultural activities (combined in the concept of production systems) impact on outcome indicators reflecting land use, employment, incomes, changes in natural landscapes and the state of nature and not least migration of different groups. While other modelling approaches could perhaps recursively derive many of these consequences, the systems dynamic approach has two unique capabilities. First it builds dynamic feed back loops into the relationships to more completely and accurately capture to complexities of human behaviour. Second it explicitly describes the process of change including such lags as that between income and consumption, or the much longer demographic lags.

What, then, does the model suggest are the implications of the alternative policy changes? The results of the scenarios show unexpected transformation in the regional economy. A 50% cut in direct payments to farmers over the period from 2007 relative to the period from 2001-2006 leads to a significant net-increase in regional income and employment in Hordaland. This we conclude is due to the dynamic regional economy in Hordaland with a strong growth in well-paid non-agricultural jobs, and a shortage of labour. There is a high proportion of urban-rural linkages with off-farm employment also for farmers. However there are differences in the consequences for the central accessible areas like Bergen and its commuting hinterland. This is the case also for the agricultural labour moving from low to high productivity (and salary) employment.

More than 50% of the EU Pillar 2 type subsidies, the rural development funds, are spent on farm investments and increasing the 'supply' of environmental goods and services related to farming (Critica, 2007, Bryden 2008). Only the Pillar 2 Axis 3 (and Axis 4) support measures are targeted at territorial development, or at the transformation of positive externalities of farming into new

economic activities and quality of life of rural residents (Bryden and Dawe, 1998; Bryden, 2007; Knickel and Peter, 2005, 2008; OECD, 2007). Reallocating all subsidies in Pillar 2 to Axis 3 implies net benefits for regional incomes and employment, but has less dramatic implications for agriculture than Scenario 2 (reducing Direct Farm Payments by 50%). Instead of spending subsidies on farm investments aimed at raising farm efficiency and exporting additional goods out of the region, the subsidies are now spent on non-commodity local-based activities.

The issue of distributional consequences, particularly the difference between the remote rural areas and the areas able to commute, is a challenging one for models without an explicit spatial dimension. Standard demand-based theories of migration suggest that unless there are opportunities for employment in a region, in-migration will not occur. However prevailing research – among others by Richard Florida (Florida 2002) for urban areas and by the increased possibilities for work independent of place – refers to "supply-driven" migration. An important question arising here is therefore: "Will the supply-driven migration to attractive places to live in be strong/large enough to create work either at the place or through place-independent work to overcome the lack of opportunity for every-day commuting"? Put in another way – will the place to live be a stronger incentive for mobility than the place to work?

To understand these issues more precisely we need better data on the motivations for migration, e.g. through better data on the influence of each of the capitals, including the cultural and social capital. This then underscores the need for better data on some of the non-commodities and their relationships to production systems and land uses at the regional level, such as cultural landscapes and biodiversity. Finally there is a need for more information on how alternative policies will be implemented and how they will be perceived by farmers. As POMMARD is now structured it will be relatively easy to incorporate improved and expanded data in the model.

The need for better data is understandable and expected. Data and uses for data co-evolve. Data is rarely collected until its utility can be demonstrated, and rightly so. Experimentation and advancement in methodology must not be avoided because the data do not currently exist. Unlike the case of comparative static methods, data on time lags and temporal processes must be precise in dynamic models. In addition, this model explicitly relates economic, environmental and social processes. This requires data that is not typically collected. With the advent of a model that uses these data, there is a new rationale for collecting it.

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