Spatial Modelling for Rural Policy Analysis

End of Project Report

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Summary

The objective of the project was to provide the diverse group of interest groups associated with the agri-food sector (farmers, policy makers etc.) with a microsimulation tool for the analysis of the relationships among regions and localities. This tool would also be able to project the spatial implications of economic development and policy change in rural areas. To this end the SMILE (Simulation Model for the Irish Local Economy) model was developed. SMILE is a static and dynamic spatial microsimulation model designed to analyse the impact of policy change and economic development on rural areas in Ireland. The model developed provides projection for population growth, spatial information on incomes and models farm activity at the electoral division (ED) level.

The sub-projects funded under this project were concerned with the simulation, development and enhancement of a spatial econometric model of the Irish rural economy which would compliment the existing econometric models used in Teagasc; focusing on the agriculture and food sectors, previously constructed under the auspices of the FAPRI-Ireland Partnership by staff at Teagasc and NUI Maynooth. That partnership has produced an econometric model of the entire agri-food sector that has been simulated to produce estimates of the impact of policy changes on commodity prices, agricultural sector variables, food industry production, consumption of food both in Ireland and the EU and trade in food products, as well as costs, revenue and income of the agricultural sector. The SMILE model was built to compliment these other econometric models by using an holistic modelling approach that takes into account the spatial difference of rural populations, rural labour force and rural income.

1. List of Sub-Projects:

- Spatial Modelling and Scenario Analysis for Rural Development.
- Spatial Modelling of Irish Agriculture and Scenario Analysis.

2. Collaborating Institutions:

RERC, Teagasc, University of Leeds and the National University of Ireland, Galway.

Introduction

In the project the SMILE model was used to analyse a variety of policy scenarios that were seen as appropriate to the clients of the project (primarily the Department of Agriculture and Food as well as the representatives of the agri-food industry). These included analysis of policy proposals and policy reforms stemming from the Mid-Term Review of the Common Agricultural Policy which were ultimately finalised in the Luxembourg Agreement of June 2003; the economic impacts on local communities of alternative specifications of the single farm payment that came into effect in 2005 and; changes in domestic policy in relation to a methane emissions tax put in place to achieve environmental objectives.

The work of the project was organised into ten tasks which were:

1. Validating and Updating Model

2. Expansion to Include Families

3. Local Labour Market Database

4. Labour Market Transitions

5. Incorporating Spatial Relationships

6. Modelling Economic Change

7. Spatial Impact of Policies

8. Expanding Farm Dataset

9. Farm Labour Market Transitions

10. Agricultural Policy Analysis

Tasks 1 to 7 are those tasks in which Teagasc, NUI Galway and Leeds University were involved in. Leeds University was not involved in tasks 8, 9 and 10. In what follows, the expected benefits from the RSF supported activity under this project and the physical outputs associated with this activity are reviewed and discussed.

Materials and Methods

1. Validating and Updating Model

Using data from the Sample of Anonymised Records (SARs), the Agricultural Census, the National Farm Survey and the Census of Population, the distribution of individuals in model projections were validated against known distributions. Various methodologies for statistical matching were examined to determine which method gives the most accurate distributional estimates. In the end the method chosen was a statistical matching technique. Using a combinational optimisation approach, households in the European Community Household Panel dataset were matched to those in the 1996 Census of Population. This resulted in the creation of the Static microsimulation model. It was also necessary during the course of the project to update the static model by using the 2002 Census of Population SAPS tables once they became available. The matching process that was previously performed using the 1996 census information was rerun using the 2002 information and the results validated. The dynamic component of the model was also added over the life of the project and the results validated.

The expected benefit of this research is the provision of improved information for use by policy decision makers in Government and industry.

Leeds University, with the support of the RSF, acted as an advisor to the Teagasc and NUI Galway research team and played a central role in the maintenance of the scientific integrity of the econometric models, developed for policy analysis purposes, in the project.

There were a number of key outputs under this task, namely;

(a) Revised county-level estimates of population for 2006 based on results of validation and incorporation of the 2002 Census data.
(b) A working paper on population projections at county level.
(c) A technical manual on the SMILE Static Microsimulation Model.

2. Expansion to Include Families

The initial population model had individuals as the base unit. The objective of Task 2 was to reformulate the existing model to include families. To this end a marriage and family formation process has been included into the dynamic component of the model. Logit models were used to estimate the probability of an individual getting married year on year if he or she was not previously married. The probabilities of an individual in a state of being single, cohabiting or divorcing were also estimated. Based on the estimated probabilities (calculated using the ECHP dataset) individuals who were assigned to get married were assigned partners in the SMILE dataset. This modelling approach was adopted from O'Donoghue (memo 2005). Using the ECHP dataset the probabilities of a woman having a child year on year was also estimated using logit models.

The expected benefits of this research, supported by the RSF, will be the provision of projections in populations that takes into account family formation and transitions between different marital states.

3. Local Labour Market Database

The objective of Task 3 was to build the base dataset for the local labour market module to link to the spatial microsimulation model. For each Baseline year (1996 and 2002) produced under this project, individuals' labour market characteristics were estimated and projected forward in time in the dynamic model (see Kelly (2005), for a more in-depth discussion of what this process involved). In order to build a local labour market model, non-Census characteristics such as employment duration and initial earnings were imputed for each individual in the static model.

The European Community Household Panel Survey was used to include these characteristics. One feature of microsimulation models is the relative ease with which data from various sources can be combined. In this task, we used the matched data from the European Community Household Panel Survey and the data from the Census of Population so that each individual in the population model was given certain labour market characteristics, such as earnings, hours, weeks and months worked, duration since last unemployed state, etc. In the dynamic process these characteristics were then projected forward using equations estimated from the ECHP Panel dataset.

The expected benefits of this research, supported by the RSF, will be the availability of a national database that for the first time contains information on labour market characteristics at a disaggregated level (ED). Also, by including this labour market information in our models we are able to investigate the impact at the local level of scenarios such as an industry closing down. Because of the information on movement between employment states and changes in income levels we are also able to map the economic effects of a plant closure in a particular area.

4. Labour Market Transitions

In order to model income mobility and transitions between employment states in a dynamic modelling situation, panel data was required. The advantage of using longitudinal "panel" design is that it makes it possible to model over time as well as across individuals, by examining how people's behaviour evolve over a certain period of time, rather than simply taking a snapshot at one particular point in time. By using the ECHP dataset for Ireland it was possible not only to look at the number of people employed in Ireland, but also to look at moves into and out of an employed state and the reasons for these moves. The first six waves (1994 – 1999) of the ECHP are used to analyse the dynamic structure of employment and income levels in Ireland.

The labour market module assesses individuals for transitions in employment status, occupation, hours (discrete), sector, and industry. Examples of these employment status transitions include entry into the labour market from school or third-level education, becoming unemployed and retiring. Other transitions include moving from full-time to part-time employment and changing occupation. As mentioned above the labour market module also contains an income component so that income can be estimated at the local area level. Incomes are modelled separately for the three employment categories (employee, self-employed (farm) and self-employed (non-farm)).

Methods used to model the labour market included Panel Data Earnings Equations estimated using the European Community Household Panel Survey, Logistic models of employment status and hours transition and transition matrices of sector, occupation and industry transitions and alignment so that aggregate employment rates were comparable with macro-economic projections.

The expected benefits of this research, supported by the RSF, will be the provision of projections in employment and income changes over time. As with task 3, this means that the SMILE model will be able to carry out analysis on the impact on surrounding EDs of the closure of particular industries key to economic activity in these areas. A working paper on the labour market module, transitions between states of employment and occupation, and the models used to estimate local income estimates has also been produced (Hynes and O'Donoghue, 2006).

5. Incorporating Spatial Relationships

The objective of Task 5 was to capture the relationship between and among EDs, particularly the links between towns and their rural hinterlands. Particular emphasis was placed on the commuting to work patterns of local residents. It was necessary to incorporate information regarding commuting patterns into the model to enable the model to project alternative scenarios regarding spatial planning. Data from the CSO (the POWSAR dataset) was used to model commuting.

The benefits of this research will be a deeper understanding of the commuting patterns of Irish residents and because we know what occupations individuals have and where individuals are commuting from in the SMILE dataset it will allow researchers to analyse the economic repercussions of, for example, the opening of a new shopping centre in a certain ED. The research supported by the RSF will also through peer reviewed publications contribute to the international literature on these and other issues. To this end an analysis of commuting flows in County Galway was undertaken as a preliminary/exploratory exercise to investigate (using the data available) what insights commuting patterns could give on the scale, strength and shape of functional areas within the confines of Galway city and county. This study examined Census travel-to-work data for 1991 and 1996 using Exploratory Data Analysis (EDA) methods. The methods used were successful in identifying some relatively robust patterns in the data (Keane and Lennon, 2006).

6. Modelling Economic Change

The objective of Task 6 was to model the impact of economic change and to develop the spatial distribution of population and employment in rural areas. To this end the regional policy scenario to be looked at was the regional implications of the decoupling of direct payments for farmers in Ireland. The Mid-Term Review made provision for member states to decouple all direct payments from production or to choose one of a number of partial decoupling options. In Ireland, all payments were decoupled from production from January 1st 2005 and each farmer's payment was based on the number of premium claims made in an historical reference period. The future of the decoupled payment system beyond 2012 is still uncertain and many political commentators and academic papers suggest that decoupled payments in their current form will be increasingly difficult to defend. Apart from world trade concerns, it is argued, that it will be increasingly difficult to defend payments made to farmers in 2010 or 2013 based on production decisions taken more than ten years earlier.

Decoupled payments, if they are sustained into the next decade, are more likely to be presented within political circles as payments made to farmers for the provision of public goods in order to support the multifunctional nature of agriculture. If this is the case, it is more likely that such payments will be made on a flat rate basis rather than being linked to production decisions taken ten years earlier. For this reason, we also considered the regional implications for farming in Ireland if it became necessary to switch to a flat rate scheme. Under the flat rate scheme every farmer in the country would have the same decoupled payment per hectare. This payment would be a function of the national envelope of decoupled payments and the total area of eligible land in the country. The analysis shows, using the SMILE farm level module that a shift to a flat rate national calculation of the decoupled payment would result in a significant shift in revenues from the southeast of the country to the northwest. In particular, large beef and dairy farms in the south would lose out while small dairy and sheep farmers in the west and northwest would be most likely to gain. It was obvious from the analysis that farms who received higher single farm payments under the current historical payment system would suffer greater loses in terms of the size of the "the cheque in the post" when a flat rate was implemented than farms receiving smaller payments under the current system. This scenario is discussed in depth in Hennessy et al. (2006).

The second objective of Task 6 was to develop projections of the spatial distribution of the Irish population over the period 2002-2021. Projections are usually made at either national or regional level. The SMILE projections reported here project the populations for each county and are based upon an extrapolation of recent and past demographic trends. In particular four baseline projection options were used:

1. Project forward from 2001 estimations.
2. Project forward from the average of our 1996-2001 estimations.
3. Project forward from the average of our 1991-2001 estimations.
4. Project forward from the average of our 1986-2001 estimations.

These projections were also constrained by, and subject to various Regional population projections made by the CSO in May 2005 and the various assumptions they make regarding the major demographic components of fertility, mortality, international and internal migration. The CSO Regional projections were provided for the six combinations of fertility and migration assumptions: M1F2 Recent, M1F2 Medium, M1F2 Traditional, M2F2 Recent, M2F2 Medium, and M2F2 Traditional. The four baseline projection options were run simultaneously with the six CSO Regional Projection scenarios. Estimates of the population were disaggregated by age, sex and county, for the inter-census years 1986-2002 and all years in the projection period up to 2021 by adding estimates of the number of births, subtracting estimates of the number of deaths, and then adding the estimated number of net migrants to the population at the end of the previous year. For each year migration was further disaggregated by internal immigration, internal emigration, international immigration (Irish born), international immigration (Foreign born) and international emigration. The following are some results projected from our 2001 estimations and based on the Regional CSO M1F2 Medium assumption (which mainly assumes a continuation of recent demographic trends).

All counties with the exception of Cork city will experience population growth over the 19 year period 2002 to 2021. The populations of the Dublin City, Fingal and Cork County are projected to increase by over 100,000. The fastest growing areas (Counties/Cities) will be the Meath (+66%), followed by Fingal (+61%), Kildare (+56%) and Galway City (+45%). These areas will grow mainly due to natural population increase and gains through internal migration movements from other counties. The projected main beneficiaries from international migration (i.e., where immigrants outweigh emigrants in various counties) are Dublin City (+90,000), Fingal (+76,000), Cork County (+75.000), South Dublin (+45,000) and Galway County (+37,000). Meath will gain most (+40,000) from internal migration over the projection period, followed by Kildare (+16,000) and Galway City (+12,000).

The Dublin areas are projected to lose out to other counties because of internal migration, with 112,000 more persons leaving these areas than entering them, Dublin City (-48,000), Dun Laoighaire Rathdown (-25,000), South Dublin (-23,000) and Fingal (-16,000). Cork City, Limerick City, Monaghan, Sligo, Tipperary North, Waterford County, Galway County and Limerick County will also lose out, although on a much smaller scale, while all other counties are projected to gain from internal migration flows. Births will exceed deaths in each of the regions, with the excess being most pronounced for Dublin City, Cork County, South Dublin and Fingal. Dublin City is projected to account for 11% of the total projected population of 5 million in 2021, followed by Cork County (8%), South Dublin (7%), Fingal (6%), Kildare (5%), Meath (4%).

The above are some results from the projection of the 2001 estimations based on the Regional CSO M1F2 Medium assumptions. The "County Population Projections 2002-2021" working paper also exhibits the resulting estimates of the population disaggregated by age, sex and county and detailed results when projecting the four baseline projection options under the six CSO Regional Projection scenarios.

7. Spatial Impact of Policies

The objective of this task was to assess the impact of alternative regional and spatial policies on local areas. We first used the matched NFS and Census information to produce small area farm population microdata estimates for the year 2002. Using the newly constructed farm level spatial microsimulation model and the associated spatially disaggregated farm population microdata, we analysed the spatial distribution of family farm income in Ireland. Using the synthetic microdata we were able to produce a spatial analysis of average family farm income across each ED.

Results of this analysis showed that the majority of family farm incomes are between €12,777 and €35,695. Indeed, according to our Static Farm Level Spatial Microsimulation microdata, in 2002 average family farm income across Ireland was approximately £13,872 while average family farm income by ED was £15,218. It is clear from the analysis that there are clear regional and local differences in terms of the average income earned on the farm. Although farm earnings have previously been analysed in Ireland these studies have tended to mask a substantial degree of county and sub-county variation in family farm earnings.

The results of our Static Farm Level Spatial Microsimulation Model provided clear evidence of the substantial regional variation in family farm income. It was clear that the Border and West region of the country contain the lowest levels of family farm earnings while the provinces of Munster and Leinster in the South and South East of the country enjoy the highest. This however was found to be strongly correlated with the average size of farm holdings.

There are a number of expected benefits from this research, supported by the RSF. With the SMILE model, we will be able to produce spatially disaggregated data, so that policy-makers can simulate the effect of new policy proposals on household and farming behaviour down to the ED and individual household and farm level. For example, the Static Farm Level Spatial Microsimulation Model would allow us to analyse the spatial implications of adhering to the Nitrates Directive for Irish farmers or the spatial implications of further CAP reform or the spatial impact of a new capital tax being placed on land owner. The synthetic microdata could also be used in multivariate analyses where ED location can now be used as an explanatory variable.

8. Expanding Farm Dataset

The objective of Task 1 was to add further data on farmers into the model and to address methodological issues arising from combining data from various sources. The statistical matching technique of simulated annealing was once again used to match the National Farm Survey (NFS) to the Census of Agriculture (COA) 2002, so that agricultural variables can be matched to the SMILE model. Up to this point, the SMILE model had information on whether an individual is a farmer and his income level but no further information on the farm enterprise. By spatially matching the NFS and COA we got a more in-depth view of farms across the country. The three variables that were matched across were farmsize, the type of farm and the soil type. While both the NFS and the Census had the size and system variables, the variable categories of the two variables were different in the NFS and the Census of Agriculture. Thus, in order to ensure that the two datasets were compatible it was necessary to derive both a new farm size? variable, and a new type of Farm variable in the Census, to match the farmsize, and type of farm variables in the NFS.

Finally, we matched the ECHP/Census of Population to the NFS/Census of Agriculture to create a full synthetic microdata set containing social, spatial, agricultural and demographic attributes. Validation of the farm matching process was carried out by using internal statistics (relative errors and z scores) and comparing the average farm size and system estimates by county, produced by SMILE, to the average farm size and system values by county in the Census of Agriculture (See Hynes et al. (2006) for a further discussion on the matching process and these validation techniques).

The main benefit of this research, supported by the RSF, is that it has created the first static microsimulation model developed specifically for the farming sector. It is envisaged that the model's principle contribution will be its ability to analyse policy change in the agricultural sector, at a disaggregated spatial level that was not possible previously in Ireland. This is all the more relevant given that the government's new territorial focus of rural development requires modelling economic policy below county level and preferably at the ED level.

9. Farm Labour Market Transitions

The objective of this task was to model transitions within farming and into off-farm employment. Logistic regression models were once again used to derive probabilities of various transitions. The transition probabilities were then used to model dynamic changes among farmers in the SMILE population model. In particular, the model predicts year-on-year those farmers who leave the farming sector and follows their progress between other employment states using the labour market module discussed above under tasks 2 and 3.

Under this task heading we have also built on existing work to develop a model of transitions in farm activity over time such as expanding dairy quota, taking a part-time job, and retiring (Hennessy et al, 2006 and Hennessy and Hennessy and Rehman, 2005). These are binary outcome models incorporating the probability of an individual farmer engaging in, for example off-farm employment given a particular set of farm and demographic characteristics and the local labour market conditions. In recent years the number of Irish farmers working off-farm has been increasing: in 1992, 21 per cent of farm operators in Ireland reported earning wages, salaries or income from non-farm activities and by 2002 this figure had increased to 34 per cent. Indeed, farm operators' participation in off-farm employment appears to be a strong feature of restructuring in farming throughout the developed world. For this reason, theoretical models were developed under this task. Econometric models for labour participation were developed, in conjunction with colleagues in Teagasc working on the FAPRI-Ireland project, treating the decision to work off-farm as a binary outcome and in some cases determined jointly with the spouse's decision in a bivariate probit framework. Once the probability of taking on off-farm employment was established, a separate labour supply model was developed to estimate the number of hours supplied by those who choose to participate in the off-farm employment market. A theoretical agricultural household model was developed incorporating the role of government subsidies, particularly decoupled payments, into the model. Although the theoretical models have been developed by Teagasc they have not as of yet been incorporated into the SMILE model but it is envisaged that this will be accomplished in the near future. At present the SMILE model simply predicts year on year those farmers who leave the farming sector and follows their progress between other employment states within a logit model framework.

The main benefit of this research, supported by the RSF, is that the movement of farmers into and (mainly) out off farming can be modelled. Given the spatial information in the model we can also map the movement of farmers between states at a regional, county and ED level. Also, the agricultural household decision-making model provides the conceptual and theoretical framework to examine at a future date the interaction between government subsidies and farmers' time allocation decisions

10. Agricultural Policy Analysis

The objective of this task was to assess the spatial impact of alternative agricultural policies. The FAPRI-Ireland agricultural sectoral models operated by Teagasc in collaboration with the University of Missouri and Irish universities produce aggregate and farm level estimates of changes in agricultural policy. They do not however have a spatial component and are not designed to analyse the regional or local area impact of alternative policies. The new agricultural component of the SMILE model enables the results of the FAPRI-Ireland model to be analysed at a local or regional level. Two agricultural policy change scenarios were looked at under this task. These are outlined below.

Using our static model the first agricultural scenario we analysed was Irish methane emissions using the synthetic microdata produced by the SMILE (Static Model of the Irish Local Economy) model, and following up on the Minister McCreevy's 2002 proposal; we asked the question: "what would be the impact of implementing a methane emissions tax on farmers in an effort to meet Irelands Kyoto Protocol obligations?" The analysis continues by looking at the effect on average family farm income at both the farm and DED level of the redistribution of the tax revenue (tax revenue generated by a tax of €7.50 per metric ton of methane) among REPS recipients and individually. Results showed that counties Waterford and Cork would be the worst hit by a methane emissions tax. With regard to

REPS recipients at the DED level (tables 8, 9 and 10); there are 2,807 EDs with REPS recipients in our SMILE microdata. Before the methane tax was implemented 1,541 of these EDs had an average farm income of £0 - £10,000, 1,167 had an average farm income of between £10,000 and £20,000, while 99 EDs had an average farm income of £20,001 – £30,000.

After the proceeds of the low tax revenue were redistributed on top of the post low-tax income among the EDs with REPS recipients in our SMILE microdata, we found that there were now 286 EDs with negative income, an increase of 10%. There was a 28% decrease in EDs in income band two. There was a 5% decrease in EDs in income band three. There was an 11% increase in EDs in income band four. Finally there is a 1.64% increase in EDs with REPS in income band five.

The second agricultural scenario to be looked at also involved the examination of the regional implications of the decoupling of direct payments for farmers in Ireland. In this case however, we were interested in the likely spatial distribution of winners and losers under CAP reform and the spatial distribution of unemployment. We identified areas where agriculture and employment were strong and areas where agriculture and employment were or will be weaker. We wanted to explore whether those areas that show potential problems under CAP reform and employment change correspond to designated growth areas in the National Spatial Strategy (NSS). In particular, we were interested in identifying areas where CAP reform may impede achievement of NSS goals and areas where CAP reform may help achieve these goals.

The results suggest that under CAP reform, those areas already highlighted as in need of investment and attention under the National Spatial Strategy were likely to be further weakened under CAP Reform. If this is indeed the case, then initiatives designed to promote forestry, fisheries and rural tourism may become even more important in the aftermath of CAP reform is implemented. If the NSS is successful and the western corridor is strengthened, it could combat some of the adverse effects of CAP reform highlighted using the SMILE model. This agricultural policy scenario is discussed in the paper by Ballas, Clarke and Wiemers (2006).

The main benefits of this research, supported by the RSF, is that the SMILE model can now be used to analyse changes in agriculture such as the spatial implications of structural change in farming. In this new era of decoupled farm payments the model will provide a powerful research tool for any policy analysis in the agricultural sector.

Discussion of Results

Overall the Project has been a success. All of its objectives as outlined in the project summary have been achieved. The research undertaken with the support of the Research Stimulus Fund in Teagasc, NUI Galway and the University of Leeds has supported the development and enhancement of the SMILE model and has thereby supported agricultural policy making in Ireland. Evidence for the success and policy impact of the research supported by the Research Stimulus Funds can be found in the references to the SMILE research in the popular press and by other agricultural researchers in Ireland (see for example the article entitled "Model takes the hard work out of assessing national policy" in the Irish Independent May 23rd 2006). In addition to supporting essential policy analysis work of Teagasc, the work undertaken under the auspices of this project as outlined earlier in this document (see especially Tasks 7 and 11) has led to a Journal Article already published and 1 other forthcoming in The International Journal of Microsimulation (O'Donoghue, forthcoming) and a number of articles currently under review by journals) and other activities that have made a significant contribution to the agricultural economics literature.

There have also been a number of significant methodological innovations in the building of the SMILE computing framework:

- Cohort and Cross-section in one Framework. Although not discussed in detail in the tasks outlined above, the model allows both cohort and cross-section type dynamic models to be used in the same framework (see Kelly, 2005).
- Parameterisation: parameterisation has been used extensively throughout the model. This aids flexibility as code does not need to be reprogrammed when parameters change. This in turn improves the durability of the model as it allows new parameters to be included when better information becomes available.
- Defining the data structure outside the model improves the transparency and the robustness of the model. When adding new variables to the model, alterations need only to be made in one place, in a parameter file. It therefore reduces the possibility of error and makes the model easier to change.
- Modularisation: All modules work independently of others, which means that new modules can be added without affecting the integrity of the model. It therefore adds to the robustness of the model. Also, allowing the user to focus on small sections of code at time improves the transparency of the model.
- Generalisation of main features of the dynamic model: The code which runs transitions, alignment and transformations can all be reused under different names and different parameter files. These building blocks can be classified into four types. Taking these as templates, one can declare a new module in the parameterisation of an existing type and simply change the parameters in order to produce a new process module. Also because the number order and type of module is parameterised, the model can handle any number of modules of each type and in any order without any need for extra programming. This is perhaps the most important feature of the model as it allows the model to be used for a wide variety of purposes. It thus allows for ease of expansion as improved data and micro-behaviour become available. Although this not an attempt at writing a microsimulation programming language, it should allow for a variety of different applications to be constructed without the need for extensive recoding. In addition it may be possible to use this framework as a template for other dynamic models because the model itself is entirely independent of data and behavioural equations to be used.
- Finally in order to avoid robustness problems due to modules being incorrectly specified, the model contains a debug device which ensures that all inputs required by a module are actually available (i.e., have either been generated in the model or read from the database) before each module can be run.

Ultimately, this project has developed the potential of microsimulation to address small-area impacts of major national or international rural policy change. Within the EU, the increasing concern for rural development was encapsulated in The Cork Declaration (European Conference on Rural Development, 1996) which announced a 10 point rural development Programme for the European Union. It asserted that sustainable rural development must be put at the top of the agenda of the European Union and defined its aims as reversing rural out-migration, combating poverty, stimulating employment and equality of opportunity, and responding to growing requests for more quality, health, safety, personal development and leisure, and improved rural well-being. It also asserted that a rural development policy must be multi-disciplinary in concept, and multi-sectoral in application, with a clear territorial or spatial dimension. Thus the explicitly spatial focus adopted in this project is argued to be crucial for future policy analysis.

In practice rural development policies are implemented at international (e.g., European), national and regional level. In Ireland the white paper on Rural Development (Department of Agriculture and Food, 1999) committed the Government to the "rural proofing" of all national policies so as to ensure that policy makers are aware of the likely impact of policy proposals on the economic, social, cultural and environmental well-being of rural communities. There is an increasing recognition that there is a need to develop tools of analysis which will enable the impact of rural development policy to be assessed ex-post and also to enable the potential impact of new policies, to be assessed before implementation. We believe that the microsimulation modelling techniques developed under this project and implemented for policy analysis under tasks 6, 7 and 10, offer such an opportunity. In this project, the particular case studies we have used to show the potential of such models has been reforms to CAP. Since the mid–1980s a number of developments in the EU countries have given a new impetus to the debate on rural (and regional) policy issues, and, by extension, to rural policy research. In Ireland, it was becoming increasingly clear that the longer-term restructuring of agriculture (and especially the need for farming to adjust to market realities) would mean a continued decline in the numbers of farmers and farm workers. In many regions, the labour out-flow from farming, together with a reduction in utilised agricultural area, has resulted in agriculture losing a great deal of its importance, not only as an employer but also in terms of its contribution to regional economic output. At the policy level there was a growing sense of dissatisfaction with the Common Agricultural Policy (CAP), arising in particular, from surplus production, an unsustainable level of market price supports, strains on the CAP budget and concern for the environmental consequences of intensive farming. Furthermore, there was a clear realisation that the CAP, despite its obvious success as a policy for food production, was not a solution to rural problems of low incomes and out-migration. However, reforms to such policies are always likely to bring new additional problems.

Conclusions

In this project, we have shown an example of how broad regional plans for growth (such as those encapsulated in the National Spatial Strategy) may actually be threatened by changes such as CAP reform. In this case, this project has shown that reforms to the CAP can create winners and losers in Irish agriculture. Understanding the location of such winners and losers is paramount if we are to analyse the impacts of such reforms for regional development policy. However, it should be noted that the microsimulation modelling framework developed in this project offers greater long term potential for policy analysis than agricultural change alone. Rural development analysis, policy and practice have been taking a definite shape in Ireland, over the past decade. A feature of the Irish debate has been a clear shift of emphasis from sectoral policies towards territorial strategies, and the consolidation of rural development as multi-sectoral but integrated programmes, attuned to the specific circumstances of regions and sub-regions.

An assessment of national investment priorities for the period 2000-2006 proposed an approach to regional development structured around selected development nodes, with the potential to support more diverse? production systems than was the case with the traditional concept of growth centres. However, we would argue that a basic problem with rural policy formulation and its implementation in "the new rural economy" is that there is little systematic research by which the efficiency of policy measures can be assessed. This is particularly the case in Ireland where rural policy evaluation has, so far, lagged behind progress in agricultural policy analysis. In fact, significant advances have been made in modelling the Irish agricultural sector. The deficit in applying model building approaches to the rural economy is partly due to weaknesses in the traditional spatial modelling frameworks, for example input/output analysis, which tend to become extremely difficult to operationalise when disaggregated to small spatial scales. The main benefit of this project has been the creation of a modelling tool to overcome this weakness by developing a spatial microsimulation modelling approach that is disaggregated to small spatial scales in rural Ireland.

In this project we have reviewed the development of an alternative type of small area spatial socio-economic model for Ireland which offers much greater flexibility for future what-if scenarios of rural socio-economic change. To tackle the broader policy questions outlined above, the model already includes a labour market model that allows for the two types of rural development policies to be further analysed in parallel. The model has also been developed to contain a greater analytic capacity by introducing logistic regression equations for labour market movements, and it is intended to expand this to include agricultural production decisions (which are currently only static in the model) and the inclusion of more spatial interactions, such as business, health and education facilities. It is hoped then that the model will have even greater potential for rural policy applications.

Appendices

(Numbers in this table only relate to those outputs that had either a direct or an indirect involvement by the project team members from Teagasc, NUI Galway and the University of Leeds. All outputs associated with the overall project are included but are listed in the following pages.)

Project/Sub Project Title	No. of projects/ sub projects that achieved objectives	No. of presentations, open days, seminars and training courses	No. of publications in refereed International Journals	Outcomes with commercial/ economic potential
Project Title: ***Spatial Modelling for Rural Policy Analysis***	**1**	**29**	**2**	**all**

<u>Refereed publications in international journals</u>

Ballas, D., Clarke, G. P., Wiemers, E., (2006). Spatial microsimulation for rural policy analysis in Ireland: The implications of CAP reforms for the national spatial strategy, Journal of Rural Studies, vol. 22, pp. 367-378.

Cathal O'Donoghue, (forthcoming). The Life-Cycle Income Analysis Model (LIAM): A Study of a Flexible Dynamic Microsimulation Modelling Computing Framework. The International Journal of Microsimulation.

<u>Scientific/Technical articles or reports</u>

E. Wiemers, D. Ballas and G. Clarke, “A Spatial Microsimulation Model for Rural Ireland: Evidence from the 2002 Irish Census of Population,”, Teagasc working paper, 2002.*

Wiemers, E. (2002). Using spatial microsimulation to model farming system and off-farm employment in Ireland. In: Agricultural Economists Congress, Zaragoza, 28-Aug-2002, 17 pp 7172 A7

E. Wiemers, D. Ballas and G. Clarke “A Spatial Microsimulation Model for Rural Ireland,”, presented at the Population Association of America Conference, Minneapolis, 2003. *

D. Ballas “Simulated Annealing based on Reweighting of ECHP Households,”, working paper in progress, 2003.

S. Hynes and C. O’Donoghue “Permanent and Transitory Earnings Inequality in Ireland 1994-1999,”, presented at the Irish Economic Association, Limerick, 2003.

Wiemers, E., Ballas, Dimitris and Clarke Graham (2003). A Spatial Microsimulation Model for Rural Ireland-Evidence from the 2002 Irish Census of Population (Teagasc Rural Economy Research Centre Working Paper). World Wide Web (Internet) 20pp 9304 B1.

Stephen Hynes and Cathal O'Donoghue, (2004). "Irish Family Farm Income Dynamics 1994-2001", paper presented at Irish Economic Association conference, Belfast, April 22nd.

Ballas D., Wiemers, E. and Clarke G (2004). Spatial Microsimulation for Rural Policy Analysis in Ireland,. In: The 34th annual conference of the Regional Science Association International: British and Irish Sect, Cork, 18-Aug-2004, 15pp 10152 A7.

Stephen Hynes and Cathal O'Donoghue, (2004). "Irish Family Farm Income Mobility and Inequality 1994-2001", National University of Ireland Working paper.

Lennon, J, O'Donoghue C and Wiemers, E. (2004). Modelling demographic transitions, using spatial micro-simulation models. In: ESPRU Symposium on Demography research, Fertility, Migration and Mortality, Galway, 04-Mar-2004.

Cathal O'Donoghue, John Lennon and D. Ballas (2005). Locational Choice Decisions in Ireland. In: Modelling Urban Social Dynamics, University of Surrey, 07-Apr-2005.

Karyn Morrissey, Stephen Hynes and Cathal O'Donoghue (2005). "The Statistical Matching of the National Farm Survey to the Census of Agriculture and the Spatial distribution of Family Farm Income in Ireland", National University of Ireland Working paper.

Cathal O'Donoghue (2005) "The Marriage Market Module" Teagasc memo.

Karyn Morrissey, Stephen Hynes and Cathal O'Donoghue (2005). "Using the Matched NFS/Census of Agriculture SMILE microdata to look at Methane Emissions across Irish Farms", National University of Ireland Working paper.

Karyn Morrissey "Statistical Matching techniques used in Microsimulation modelling" 2005. Masters dissertation, Department of Economics, National University of Ireland, Galway.

John Lennon and Cathal O'Donoghue, 2006. "Population Projections 2002-2021" Teagasc Working Paper.

<u>Open days, workshops and seminars at which reports were presented</u>

Stephen Hynes "The Smile Model and Labour market transitions" presentation at work in progress seminar, Teagasc, Feb, 2004.

John Lennon "The Migration Module of the Smile Model" presentation at work in progress seminar, Teagasc, Feb, 2005.

Cathal O'Donoghue and Stephen Hynes "The SMILE Framework" presentation at the first MIDAS international microsimulation seminar, NUIG, May, 2005.

Michael J. Keane and John Lennon, Department of Economics, National University of Ireland, Galway. “Delineating Daily Activity Spaces in Rural Areas” seminar organised by the Regional Studies Association, Irish Branch at NUI, Galway, May 15th 2005.

Cathal O’Donoghue “Irish Income Dynamics – An Application of the SMILE Model” principle speaker at the Agricultural Society of Ireland seminar, the ERSI, Dublin, 26 September 2005.

Cathal O’Donoghue and Stephen Hynes “Using Microsimulation Models for Spatial Planning” presentation at the seminar in the Department of Economics, University of Turin, May13, 2005.

Hynes, S. and O'Donoghue, C. 2005. “A Spatial Microsimulation Approach to Estimating Individual Earnings” Presented at the Rural Economy Research Seminar: Estimating Irish Income Levels – 3 Methodologies, November.

John Cullinan, Stephen Hynes, Cathal O'Donoghue, 2006. “The Use of Spatial Microsimulation and Geographic Information Systems (GIS) in Benefit Function Transfer – An Application to Modelling the Demand for Recreational Activities in Ireland” Paper presented at the twentieth annual IEA Conference in Wexford, April.

No of practical/ popular publications

Cathal O’Donoghue “Specification of SMILE Model- A technical review of the underlying data structure” technical report 2004.

Donal Kelly “SMILE Static Simulator Software User Manual” Teagasc, Athenry Publication, October 2004.

Donal Kelly “SMILE Dynamic Simulator Software User Manual” Teagasc, Athenry Publication, Nonember 2004.

Cathal O’Donoghue and Donal Kelly “The Life-Cycle Income Analysis Model (LIAM): A Study of a Flexible Dynamic Microsimulation Modelling Computing Framework” sent for review to Journal of Computational Economics.