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Spatial Microsimulation for Rural Policy Analysis

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Spatial Microsimulation for Rural Policy Analysis

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Dedicated to the memory of our colleague
Packie Commins

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Cathal O'Donoghue, Dimitris Ballas, Graham Clarke,
Stephen Hynes and Karyn Morrissey

Chapter 1
Introduction

Dimitris Ballas, Graham Clarke, Stephen Hynes, Karyn Morrissey, and Cathal O'Donoghue

1.1 Background

Rural areas across the world face many unique problems and challenges. Such communities have had an economy based historically on farming, forestry or mineral abstraction. Rural incomes and livelihoods have therefore been linked directly to the fortunes of these primary production sectors, with farming being the most common occupation in many rural areas. In Europe, rural incomes have been boosted, or at least secured, by very favourable policies relating to agricultural subsidies in particular. Farmers have been rewarded for (in effect) over producing, often resulting in wastage on a vast scale (butter mountains; wine lakes etc.). In the wake of the clearly unsustainable nature of such production systems these policies

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are changing and farmers are likely to get subsidies in the future for the non-production related goods associated with agriculture such as taking care of the rural landscape, the protection of biodiversity and sensitive habitats and allowing public access for recreational pursuits. The implication for farm incomes and for rural life in general is immense.

Other socio-economic challenges in rural areas include limited non-agricultural related employment, limited educational and vocational opportunities, low access to services and lower recreational choices. In addition, rural communities are exposed to as many stressors (if not more) as urban communities. Rural stress levels seem to vary with gender (higher for women), occupation (higher for farmers and agricultural labourers) and are higher for those with lower income levels.

Service provision is especially important in a rural geographical context. As noted above, such communities have traditionally suffered from poor access to schools, hospitals, GPs, retail centres etc. The situation is deteriorating as service providers in both the public and private sectors look to cut costs by removing unprofitable or expensive facilities. This can be seen in relation to cottage hospitals, postal services, petrol stations, village shops and even now the traditional rural pub. This leaves a number of key questions such as: How have accessibility levels to key services changed? How does the location of service outlets impact on demand? Who suffers most from service decline and where are these residents located?

For those rural areas closer to urban centres the economy has become more mixed. As well as farming, these areas might now have light industry as firms seek more space and perhaps cheaper land outside the urban core. Undoubtedly, these areas will have witnessed an increase in commuters – city folk keen to escape the noise and congestion of the city for a more idyllic life in the countryside or peri-urban area. Where this invasion has been substantial services may have followed (a new GP or perhaps an out-of-town superstore on the urban/rural fringe) or at least been saved from closure. More likely is the scenario that these people continue to use city-based services as they are relatively mobile and commute daily to the city. The worst case scenario is that this population growth has led to even more pressure on existing services. Again key questions relate to access and service provision for the different type of geodemographic groups that live in these commuter belts.

The aim of this book is to explore the challenges facing rural communities and economies through the development and usage of a particular spatial micro-simulation model called SMILE (Simulation Model of the Irish Local Economy). The model has been developed over a 10 year period for applied policy analysis in Ireland through a partnership between the Universities of Leeds, Sheffield and Galway and the Rural Economy Research Centre (RERC) of Teagasc, an organisation which has been set up in Ireland to advise on rural affairs. It can be argued that the Republic of Ireland is an ideal study area to base a prototype spatial microsimulation model for rural policy analysis, given that 42 % and 57 % of its population live in rural areas (depending upon the definition; see Meredith 2007).

Microsimulation is a technique that has been broadly developed and used by economists over the last 50 years, building on the conceptual framework first proposed by Guy Orcutt (1957). The results of microsimulation models are widely quoted in the media when covering the possible impact of government budget

changes upon different types of households and it can be argued that micro-simulation modelling methodologies have long become accepted tools in the evaluation of economic and social policy, in the analysis of tax-benefit options and in other areas of public policy (Harding 1996; Redmond et al. 1998; Mitton et al. 2000). In addition, over the past 30 years there have been numerous attempts by geographers and regional scientists to add a geographical dimension to micro-simulation existing microsimulation models and thus develop spatial micro-simulation techniques capable of modelling the impacts of urban and regional policies as well as national social policies (Clarke 1996; Ballas et al. 2005; Ballas and Clarke 2009).

Nevertheless, most of the early spatial microsimulation models focused on urban systems and on modelling policies and there has been a relative paucity of work focusing on rural areas. This is surprising, given the considerable interest in the European Union in rural policy. In particular, the EU Commission and Member States have long placed particular emphasis on rural development with special reference to:

- Enhancing the competitiveness of rural areas, maintaining and creating employment.
- Reducing socio-economic disparities between regions, adapting to new market place realities.
- Providing appropriate training and converting and re-orientating agricultural production potential (CEC Commission of the European Communities 1988; Ray 1998).

A key development demonstrating the increasing concern for rural development in Europe 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 dimension.

In practice rural development policies are implemented at international (e.g. European), national and regional level. In Ireland a white paper on Rural Development (Department of Agriculture and Food 1999) commits 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. The policies promised in the White Paper included the preparation of a national spatial development strategy to facilitate the balanced sustainable development of the country as a whole. In parallel with these developments there has been in a change in entitlement to EU structural funding since January 2001. A significant part of the country is no longer entitled to funding as an objective one region. Different levels of subsidisation therefore apply to capital projects in different regions.

With increasing recognition that rural development is not synonymous with agricultural development (and with an increasing range and diversity of policy measures) 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. The Rural Economy Research Centre (RERC) of Ireland, Teagasc (a state sponsored research and development organisation, which had already established credibility in projecting the impact of changes in agricultural policy) was eager to embark on similar analyses in relation to changes in rural development policy.

The traditional tool for evaluating the regional impact of a policy is a regional economic model, usually computed using input/output techniques. The RERC formed the view that this technique would be inadequate for the type of analysis of rural development policy in Ireland, which it wanted to conduct, for the following reasons

(a) There were no existing government regional economic models for Ireland. New models would have to be constructed from the start. Much of the data required would have to be generated from surveys.
(b) Input–output models are usually constructed on 1 years" data (generally at least 5 years old to make sure that all the data are captured) and assumptions are made that the structural relationships in the economy will not vary substantially. This assumption would hardly be valid in Ireland in recent times where growth rates over the period 1993–2001 have exceeded 8 % per annum throughout the period.
(c) Most input–output models do not differentiate between locations within a broad region, providing only estimates for the region as a whole.
(d) Input–output models generally only estimated economic impacts, with a few exceptions of local studies which evaluate local impacts for small areas.
(e) Input–output analysis was not suitable for the type of scenario analysis, which RERC wished to carry out.

They were therefore forced to look for alternative methodologies, which appeared to meet their objectives better. Spatial microsimulation appeared to offer many advantages. Although it had not to date been used in analysis of rural development policies, the type of scenario analysis carried out by two of the editors of this book in the urban conurbation of Leeds (Ballas and Clarke 1999, 2001), where the implications in small areas of the closure of a large factory were explored, appeared to match the objectives of the RERC.

Accordingly a programme of collaboration between the Rural Economy Research Centre and the University of Leeds (and subsequently also with the Universities of Galway and Sheffield) was emaciated with a view to developing a model, which would be capable of analysing the differential impacts of changing rural development policies. The initial steps in the process were concerned with estimating population developments (Ballas et al. 2001). Subsequently, other elements including population dynamics (Ballas et al. 2005), the incorporation of farm size (Ballas et al. 2006) and estimation of incomes at a small area level (Shrestha et al. 2007; Morrissey and O'Donoghue 2011) were added to the model

over time leading to the development of a comprehensive model that was used in a wide range of contexts. This book provides an overview of the SMILE modelling project, the methodological approaches underpinning it, as well as a detailed discussion of some of the most recent key applications of the model.

The remainder of this introductory chapter briefly discusses the rural policy context and highlights the key issues and problems in the European Union which influenced the thinking that led to the development of SMILE over 10 years ago. There is particular emphasis on rural policy issues in the Republic of Ireland which is the study region of the modelling work presented in the book. The last section of this chapter provides an outline of the contents of the book.

1.2 Modelling Frameworks for Rural Policy Analysis

1.2.1 Context

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, 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.

With the publication of The Future of Rural Society in 1988 (CEC Commission of the European Communities 1988 the EC Commission laid the basis for a more focused approach to rural development. Among the significant points made by the Commission were: the diversity of rural circumstances and problems across the Community required differentiated policy responses; rural development cannot be divorced from regional development; there was a need for a more balanced spatial distribution of economic investment but this should be accompanied by the strengthening of intermediate centres (smaller towns) and the formation of geographical clusters of economic activities so as to enable vital services to function profitably; rural development should be an objective of the reform of the Community's Structural Funds; and rural development needs must become an intrinsic part of Community research programmes.

Against this background, 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. Analyses conducted in the early 1990s proposed "area-based" models of rural development within which sectoral objectives could be pursued (Commins and Keane 1994; Commins 1995). An assessment of national investment priorities for the period 2000–2006 (Fitz Gerald et al. 1999) proposed an approach to regional development structured around selected development nodes, with the potential to support more diffuse production systems than was the case with the traditional concept of growth centres. In 1999, a Government White Paper stated that a strategy for rural development would aim to sustain population through fostering a settlement pattern in which a network of urban centres would act as "hubs" for economic and social development and help to sustain dispersed rural communities in towns and villages in their hinterlands (Department of Agriculture and Food 1999: 22). Subsequently, the National Development Plan (2000: 45) announced that the broad approach to regional development in the Plan would be translated into a more detailed blueprint for national spatial development over the longer term. Accordingly, the process of devising a National Spatial Strategy has commenced. This will identify emerging geographical patterns and, inter alia, set down indicative policies in regard to the location of industrial development, residential development, tourism, heritage and rural development.

Underlying all of this re-orientation of Irish rural and regional policy has been one basic aspiration, namely, to maintain rural population numbers and provide job opportunities for those living in rural areas. This must be seen in the context of the unique features of Ireland's demography whereby one-third of the Republic's population reside in the Greater Dublin area, and outside of this metropolitan centre 60 % of people live in rural areas (places of less than 1,500 persons).

1.2.2 Rural Policy: The Need for Appropriate Analytical Frameworks

Two central points are evident from the foregoing discussion. The first is that rural and regional development are very much policy-driven; the other is that spatially based strategies are essential characteristics of interventions in this policy area.

However, a basic problem with rural policy formulation and 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.

The SMILE project was based on the proposition that microsimulation modelling methodologies offer an improved basis for rural policy analysis in the

European Union and the Republic of Ireland in particular. As noted above, microsimulation techniques have become accepted tools in the evaluation of economic and social policy, in the analysis of tax-benefit options and other areas of public policy. These techniques have also been extensively used in Ireland to evaluate the household impacts of the annual national budget (e.g. see Callan 1991; Callan and Sutherland 1997).

However, it has long been argued (Ballas and Clarke 2000; Birkin and Clarke 1988, 1989; Birkin et al. 1996), that there is a need, and a possibility, to add a geographical dimension to microsimulation and thus develop spatial microsimulation techniques. The SMILE model built on earlier geographical microsimulation research that focused on urban systems (Ballas and Clarke 2001a, b), by employing similar modelling techniques for the analysis of change in rural areas. In particular, the SMILE model refined existing static and dynamic spatial microsimulation methodologies and implemented with the use of new unique survey data pertaining to rural issues such as the farming survey. It should be noted that, from a methodological point of view, although SMILE is a model developed specifically for rural policy analysis, it is similar in design to many other spatial microsimulation models in the literature. However, unlike many other models, SMILE has been subject to a raft of applications involving estimating 'missing data' (an important contribution of spatial microsimulation modelling) and estimating the impacts of various policy changes. In addition, another innovative feature of the work presented in this book is the type of applications of the model which include new subject areas in the spatial microsimulation literature such as modelling of recreation, greenhouse gas emissions, biomass production for electricity generation as well as more "traditional" applications, such as the modelling of access to health services and the spatial analysis of tax policy.

1.3 Overview of the Book

This book aims to provide a comprehensive overview of the SMILE modelling framework, both in terms of methodological approaches and innovations as well as by demonstrating the potential of spatial microsimulation for policy analysis in a rural context. The book reviews the policy context and the state of the art in spatial microsimulation against which SMILE was developed. It then describes in detail the model design and calibration of SMILE, with examples of outputs showing the new information that the model provides by matching the small-area Census data with a variety of unique surveys. This spatial matching process is a key feature of spatial microsimulation: the ability to simulate what is in effect 'missing' data at the small area level. The rest of the book then explores a series of rural issues or problems in turn (including the impacts of new or changing Government or EU policies) and examines the contribution that spatial microsimulation can provide in each area.

Chapter 2 sets the agriculture, environmental, rural and spatial policy context against which the SMILE model has been developed over the past 10 years. In particular, it describes some of the main policy drivers that shape rural and regional

planning, focusing on the main planning instruments of the state, the EU and governmental agencies. The chapter provides a review of historic trends pertaining to the economic context of rural areas in Ireland. It also briefly discusses the main original goals of the EU Common Agricultural Policy (CAP) and the key issues that are tackled by the current policies. The chapter also discusses the key priorities of EU Rural Development Policy as well as relevant Irish national policies. Environmental policy issues and the ways in which the CAP impacts on the environment are also discussed with a particular focus on issues pertaining to climate change and energy as well as water quality. The chapter also includes a discussion of the spatial planning policy context in Ireland. It concludes by arguing the case for a spatial microsimulation approach to addressing the issues raised in the chapter.

Chapter 3 introduces microsimulation and spatial microsimulation and shows how it can be used for policy analysis. The chapter provides a detailed review of relevant literature, focusing particularly on spatial models and their applications for policy analysis in different fields.

Chapter 4 presents the SMILE model. It builds on the discussion of spatial microsimulation methods presented in Chap. 3 by providing more details on techniques aimed at generating small area microdata. The chapter presents the different approaches and data sets that were considered and evaluated in the context of the SMILE project and discusses in more detail the methods that were developed and implemented.

Chapter 5 discusses in more details key issues pertaining to model validation and describes methods that were developed in order to address such issues in the SMILE model.

Chapter 6 presents Farm Level Microsimulation model that was developed in the context of the SMILE project and which is the first such static microsimulation model developed for the farming sector. The chapter discusses relevant data and methodological issues and presents some policy relevant outputs.

Chapter 7 describes how SMILE was used to evaluate the socio-economic and spatial implications and impacts of conservation and rural environmental protection schemes. In particular, it discusses the relevant policy context and theoretical considerations and relevant data. It then presents the refinements that were made to the SMILE methodologies in order to use these data and produce policy-relevant results.

Chapter 8 shows how SMILE was used to model greenhouse gas emissions from agriculture. In particular, it shows SMILE was used to examine the regional implication of a methane tax introduced by the Irish Government in order to meet the agricultural targets set out in the Irish National Climate Change Strategy. SMILE is used to examine the spatial impacts of an agricultural tax based on a rate per unit of methane emissions.

Chapter 9 presents an application of SMILE for the analysis of biomass production for electricity generation. The factors that may influence the production of biomass and the probability of farmers switching from historical production activities such as beef, sheep, dairy or cereal growing to biomass electricity production are discussed. SMILE is then used to estimate the potential probability

of farms converting to biomass electricity generation as a function of individual and farm specific characteristics and circumstances as well as incentives provided by the government. In addition, SMILE is linked to a farm-level optimisation model in order to quantify the potential transport costs that would be faced by biomass producers across Ireland.

Chapter 10 shows how SMILE was used to model farm viability. In particular, SMILE is used to explore spatial heterogeneity in agricultural activity, in the spatial pattern of policy supports and in off-farm employment, building upon the national level picture highlighted in this section. An analysis of the pattern of off-farm labour income is presented as well as a discussion of the contribution of subsidies and agricultural supports. The Chapter then considers the spatial pattern of viability and sustainability of farms.

Chapter 11 describes the use of SMILE for the analysis of the spatial and socio-economic impacts of tax policy, building on the work presented in Chap. 4 in order to simulate taxes and benefits and to generate measures of disposable income. It also presents a method of measuring within and between spatial area income inequality and it considers the degree to which individual level tax-benefit policies reduce inter-spatial inequality.

Chapter 12 shows how SMILE was used to analyse rural population access to health services. After a brief review of accessibility analysis methods it shows how SMILE has been used to model both demand and supply of hospital services in Ireland, focusing on the estimation of accessibility for individuals with high health care demands.

Chapter 13 demonstrates the potential of SMILE for the analysis of spatial patterns of rural tourism and recreation activities. In particular, it shows how SMILE was used to combine micro-level behavioural data on white water kayaking in Ireland with GIS and econometric techniques, in order to predict the demand for kayaking recreation activities across locations in Ireland.

Chapter 14 offers some concluding remarks and discusses the way forward for SMILE and spatial microsimulation in general.

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Chapter 2
The Spatial Policy Context of Economic, Agricultural and Environmental Change in Rural Ireland

Cathal O'Donoghue

2.1 Introduction

Policy affecting rural areas is multi-faceted and multi sectoral, spanning traditional agricultural policy and enterprise, rural and regional development, environmental policy and spatial policy. In this chapter, we provide a policy context for the development of a spatial microsimulation model, focusing in particular on the policy context in Ireland, the setting for the model.

Despite rapid urbanisation and major economic growth, subsequent financial crisis, Ireland remains a comparatively rural country with between 42 % and 57 % of the Irish population living in rural areas depending upon the definition (Meredith 2007).[1] This confers particular advantages in terms of quality of life, heritage, tourism and differentiated economic activities. However, the challenges faced by rural areas are substantial, ranging from infrastructure and employment to distinctive needs of local enterprises. Rural Ireland is not a single homogenous area with a single common shared experience, economic, social or cultural character, but rather, regions vary from rapidly expanding areas close to urban areas to more disadvantaged areas in some remote locations (National Development Plan 2007). Meanwhile, other remote areas have experienced growth in tourism, inward-migration and the development of rurally based micro-enterprises. As agriculture

[1] Ninety-eight percent of the land area of Ireland is classified as rural under the official classification that has remained constant since 1898, while under the OECD definition, where rural space is defined as those areas with a population density of less than 150 per km^2, 96 % of the land area is rural (Meredith 2007).

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