THE DEVELOPMENT OF A STATIC FARM-LEVEL SPATIAL MICROSIMULATION MODEL TO ANALYSE ON- AND OFF-FARM ACTIVITIES OF DUTCH FARMERS;

Presenting the research framework

-draft paper-

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Abstract

The behaviour of individual economic agents (e.g. persons, households or firms) influences policy efficiency. At the same time, policy and changes to policy affect behaviour of economic agents. In this paper, we focus on on- and off-farm activities of Dutch farmers. The share of income gained by off-farm activities, such as a job in town, has been steadily increasing among farmers the past few years. The relationship between off-farm work and a farm's economic performance suggests that a farm household's dependence on off-farm income affects the distributional consequences of agricultural policies. In order to analyse how behaviour of farmers on a micro-level generate economic regularities on a macro-level, we describe a framework for the development of a spatial microsimulation model in this paper. The latter process will be supported by the use of Geographic Information Systems (GIS). With this model we can, in a next step, analyse the importance of off-farm activities in distinctive regions in the Netherlands and possible effects on the efficiency of agricultural policies. Furthermore, we can use it to project the spatial implications of economic development and policy changes at a more disaggregated level.

Keywords: microsimulation, agriculture, economic agents, GIS

JEL-codes: O18, Q12

1. INTRODUCTION

For years, improvements in the well being of farm households have been possible through the interaction between technological adoption that released labor from farms and economic growth that pulled labor off farms. The dependence of farm households on income from non-farm sources has increased steadily, narrowing, or actually reversing, the gap between incomes of farm and non-farm households. According to ERS data, in the United States, off-farm income is now the largest component of farm household income (Boisvert and Chang, 2006).

The relationship between off-farm work and a farm's economic performance suggests that a farm household's dependence on off-farm income affects the distributional consequences of agricultural policies. Conservation, research and development, extension services, and farm support programs may affect farm households differently depending on the relative importance of on-farm and off-farm income-generating activities (Fernandez-Cornejo, 2007). Therefore, it is important to analyse on- and off-farm activities in more detail. In this paper, we will develop a framework for a static spatial microsimulation model of Dutch farmers, focussing on their on-farm and off-farm activities.

Over the last five years, there has been an increase in interest in the application of spatial microsimulation. Microsimulation (MSM) is a technique that aims at modelling the likely behaviour of either individual persons, households or individual firms, including communicative qualities along with more analytical qualities. It uses micro-data on individuals, farms or firms, so called agents, to build large-scale data sets based on the real-life attributes of the specific agents for the purpose of studying how individual (i.e. micro) behaviours generate aggregate (i.e. macro) regularities. Spatial microsimulation is designed to analyse the relationships among regions and localities and to project the spatial implications of economic development and policy changes at a more disaggregated level.

For our analysis of Dutch farmers, we will use information on about 380 farm households of which 150 receive income from off-farm employment. First, we will explore which are important factors for on- and off-farm activities. The focus will be on three groups of factors: household characteristics, farm characteristics and (local) spatial characteristics. Information about household and farm characteristics is collected using questionnaires. The spatial characteristics of the farms, for instance distance to the nearest urban area, will be determined using spatially-referenced data in a Geographical Information System (GIS). Second, after

applying regression analysis to determine the relevant factors, we will use them to construct a microsimulation model. We use the static-deterministic microsimulation techniques as they were applied by Ballas et al. (2005) and enhanced by Smith et al. (2007).
The newly-constructed farm-level spatial microsimulation model and the associated spatially disaggregated farm population micro-data will increase our understanding of the importance of off-farm activities in distinctive regions in the Netherlands and possible effects on the efficiency of agricultural policies.

This paper first introduces the problem at hand and elaborates on off-farm employment (Section 2). We will then discuss the technique of microsimulation modelling, its history and its application related to farms (Section 3). Next, in Section 4 we present our methodological-technical research framework and explain how the three analyses in this framework are related. Finally, we include a descriptive overview of collected data.

2. PROBLEM DEFINITION

Focus in this part is a relevant economic problem that is the cause for us to do this analysis: The relationship between off-farm work and a farm's economic performance suggests that a farm household's dependence on off-farm income affects the distributional consequences of agricultural policies. Therefore, in this paper we want to analyze which variables affect off-farm activities and then, how farms with extra off-farm income are spread over the Netherlands.

2.1 Determinants of off-farm employment

Reasons for off-farm employment

All over the world, farmers can be found who struggle for sufficient income. Although many of them would agree with the statement that farming is more than just an occupation, the uncertainty of the level of production and income each year can make it a hard way of living.
In some developing countries, the low cost of living, possibilities for self-provisioning, available housing, and social network ties have attracted dislocated urban workers and retained longer-term rural residents. A feature of (full) employment in agriculture in those areas is then underemployment and hidden unemployment (Rizov, 2005). In other regions, full employment of a farmer in agricultural activities would indicate that the firm is doing well and enough income is raised. According to Findeis et al. (1991) in some regions declines

in (rural) wages in manufacturing and in the service sector may increase the likelihood of labor moving into agriculture to supplement declining wages in other sectors.

According to Bowler (1992), there are three pathways in which a farmer can develop. First of all, by maintaining the full-time, profitable and mainly food-producing role of a viable agricultural enterprise; secondly by income diversification by restructuring the fixed assets of the farm household into non-agricultural activities, including off-farm employment; and thirdly, marginalisation of the farm as a profitable enterprise.

According to Alasia et al. (2008), off-farm employment can arise from different motivations. Engaging in off-farm employment can, for example, be a self-insurance mechanism for households associated with an agricultural holding to help to stabilize total household income given the inherent variability in net farm income. Next, off-farm employment may be necessary to provide sufficient income to cover family living expenses if the operator of the farm is unable to generate enough revenue to support a family. Furthermore, off-farm labour may be the primary household employment for some residents, who have chosen a rural lifestyle.

Relevant variables

According to several studies there are numerous factors that affect the farmer's household's choice to go into off-farm employment. Those factors can be divided into household, farm and spatial characteristics (Table 1).

Table 1: Overview of relevant characteristics impacting on- and off-farm activities

Variable	Studies
Household characteristics	
Education	Alasia et al. (2008), Chaplin et al. (2004), Mishra and Goodwin (1997)
Age	Alasia et al. (2008), Goodwin and Mishra (2004)
Number of members	Lass et al. (1991), Goodwin and Mishra (2004)
Farm attachment (i.e. ownership)	Sofer (2005)
Income	Sofer (2005)
Farm characteristics	
Size	Alasia et al. (2008), Meert et al. (2005), Fernandez-Cornejo (2007)
Ownership / tenancy	Boisvert and Chang (2006)
Farm type (sector)	Boisvert and Chang (2006)

Spatial characteristics	
Level of rurality	Gardner`(2001), Goodwin and Mishra (2004)
Level of accessibility / Distance to nearest job concentration	Chaplin et al. (2004)
Distance to nearest city	Chaplin et al. (2004). Lass et al. (1991), Goodwin and Mishra (2004)
Available jobs in other sectors	Boisvert and Chang (2006)

Household variables

Several studies indicate that the level of education affects the choice for off-farm employment. Higher education extends the number of jobs for which a person is qualified, with usually higher salaries. Increases in marginal returns from education are higher for off-farm employment than farm work. This would imply a positive effect for education on off-farm employment, which is also found by Chaplin et al. (2004) and Alasia et al. (2008). On the other hand, a higher education also allows a farmer to better manage its enterprise and to apply for subsidies and grants. Therefore Mishra and Goodwin (1997) found a negative effect of education on off-farm employment, Woldehanna et al. (2000) found no positive or negative effect at all.

Possibly the size or potential of the farm is also important. This is also what Alasia et al. (2008) find: Compared to the average operator, the average farmer with a university degree is almost 20 per cent more likely to work off-farm; however for operators of larger farms, this probability differential reduces to about 9 per cent.

Related to this, family income can be an important reason for engaging in off-farm employment. Among others, Sjofer (2005) finds that, by a comparison of Israelian households with low or medium income, the latter are more likely to conduct business off the farm.

Concerning age it appears that old farmers often combine their agricultural activities with retirement pensions and they are not likely to start off-farm employment as it is more difficult to get a job at an older age (see also Goodwin and Mishra, 2004). According to Alasia et al. (2008), younger farmers are more likely to take an off-farm employment but when they reach the age of 35 this probability decreases.

The number of household members is supposed to have a positive impact on the share of off-farm income because they can divide the on-farm work and some members will choose to fully work off-farm. At the same time, the presence of children under the age of thirteen years in the household significantly reduces the supply of off-farm labor. Such an effect is typically confirmed for spouses though expectations for farm operators (typically male heads of households) are less clear (Goodwin and Mishra, 2004). According to Lass et al. (1991) the number of children is positively associated with off-farm employment for farm men, but the association is negative for farm women. More children may imply more need for additional income but also additional child care at home. Finally, attachment to the farm, in terms of how long the farm has been owned by the family for example, is expected to negatively affect off farm income (Sofer, 2005).

Farm variables

The size of the farm (expressed in hectares, or in number of workers, or the turnover in case of intensive farming) is supposed to have a major impact on off-farm employment. Industrial development often demands large investments (technology, land) and is therefore only a realistic option for medium- and large-sized farms (Meert et al., 2005). Also Fernandez-Cornejo (2007) found that operators of smaller farms typically participated more in off-farm employment, worked more hours off the farm, and had a higher off-farm income than those of larger farms. Therefore, it is expected that farmers with a medium or large farm will less often be involved in off-farm employment.

With regard to ownership, Boisvert and Chang (2006) find that the negative effect of tenancy (as measured by the proportion of acreage owned) on the likelihood for off-farm job participation reflects a greater commitment to agricultural production from operators who own their own land.

Finally, Boisvert and Chang (2006) expect that the level of off-farm employment will differ between farm types, such as arable- dairy -, or horticulture farms.

Spatial variables

The supply of off-farm labor has been shown to be positively related to urban proximity (Lass et al., 1991). Moreover, Gardner (2001) found that in the United States, farmers’ income growth is inversely related to the rural share of a State’s population. Apparently, a larger non-agricultural population has a positive effect on farmers’ incomes, because it increases their off-farm earnings opportunities and increases the demand for the goods and services that farmers produce.

Chaplin et al. (2004) find that public transport in countries as Poland and Hungary has a positive effect on off-farm employment. However, Goodwin and Mishra (2004) find in their study about US farm families that the number of miles to the nearest town, a factor representing the cost of commuting, does not appear to significantly influence the supply of labor off the farm.

In addition, according to Boisvert and Chang (2006), there is some indication that the strength of the local economy, as measured by the proportion of jobs that are manufacturing, increases the likelihood of participation in off-farm work. The extent to which the local economy depends on jobs in the trade sector reduces the likelihood of participation in off-farm work.

3. MICROSIMULATION

3.1 Introduction

Microsimulation is a technique that aims at modelling the likely behaviour of individual persons, households, or individual firms, combining communicative qualities together with more analytical qualities. In simulation modelling, the analyst is interested in information relating to the joint distribution of attributes over a population (Clarke and Holm, 1987). In these models, agents represent members of a population for the purpose of studying how individual (i.e. micro-) behaviour generates aggregate (i.e. macro-) regularities from the bottom-up (e.g. Epstein, 1999). This results in a natural instrument to anticipate trends in the environment by means of monitoring and early warning, as well as to predict and value the short-term and long-term consequences of implementing certain policy measures (Saarloos, 2006). The simulations can be helpful in showing (a bandwidth of) spatial dynamics, especially if linked to Geographical Information Systems (GIS).

Microsimulation models can generally be divided into two classes: static and dynamic (Merz, 1991). They differ insofar as the response of the micro-data unit in a dynamic model evolves with time due to response changes at earlier time points, whereas in a static model the distribution of the response remains fixed. Spatial microsimulation models link individuals, households or firms to a specific location. They can be used to explore spatial relationships and to analyse the spatial implications of policy scenarios (Ballas et al, 2006). The development of spatial microsimulation studies over the last ten years is characterized by an increasing number of application fields. In particular, the publication of large public sample data sets allowed researchers to apply spatial microsimulation modelling to various socio-economic subjects.

3.2 Short history of MSM

MSM started with the pioneering work of Guy Orcutt and his colleagues around 1960. Within the economics community, he advocated a shift from a traditional focus on sectors of the economy (as Leontief, 1951, did with his input-output models) to individual decision-making units. His main aim was to identify and represent individual actors in the economic system and their changing behaviour over time (Clarke and Holm, 1987). Orcutt (1957) developed an MSM system because he observed that models at that time were not able to predict the effects of governmental actions. Neither were they able to predict distributions of individuals, households, or firms in single or multi-variate classifications, because the models were not built in terms of such units. He argued that, if certain (simple) relationships are linear, it is relatively easy to aggregate them. But, to aggregate relationships about decision-making units into comprehensible relationships between large aggregated units, such as the household sector, is almost impossible. Therefore, his aim was to develop a new type of model of a socio-economic system designed to capitalize on the growing knowledge about decision-making units (DMUs) (Orcutt, 1957:117). Most important is the key role played by actual DMUs, such as an individual, household, or firm.

Today, MSM can be seen as a modelling technique that operates at the level of individual units such as persons, households, vehicles, or firms. Usually, these units do not interact, although in some (dynamic) models individuals can interact, for example by getting married. Within the model, each unit is represented by a record containing a unique identifier and a set of associated attributes. A set of rules (transition probabilities) is then applied to these units leading to simulated changes in state and behaviour (Clarke, 1996).

3.3 Farm microsimulation

Most MSM tools deal with households as decision making units. They are often used to investigate the impacts of fiscal and demographic changes on social equity or to simulate traffic flows over a street network. One of the very first was DYNASIM (later followed by DYNASIM 2). It is a dynamic MSM, developed by, amongst others, Guy Orcutt (see Orcutt et al., 1976). A major purpose of DYNASIM was to promote basic research about the impacts of demographic and economic forces on the population of the future. The government of the United States used DYNASIM extensively for analyses of Social Security policy in the late 1970s.

An important example of an MSM model focusing on farms is SMILE, which is a spatial MSM. In spatial MSMs the agents are associated with a location in geometric space. They can live, for example, in different zip-code areas with different characteristics, or, in a mobility model, they can move/travel between distinct areas. SMILE analyses the impact of policy changes and economic development in rural areas in Ireland. The model simulates fertility, mortality, and migration to provide county-level population and labour force projections, in order to evaluate the spatial impact of changes in society and the economy (Ballas et al., 2006). Recently, Cullinan et al. (2006) extended the model with environmental information to create indicators for potential agri-tourism hotspots in Ireland in order to explore the potential (i.e. total demand for outdoor activities) to diversify from agriculture to agri-tourism. However, there are not many more MSMs developed that focus on farms.

4. METHODOLOGICAL-TECHNICAL DESIGN

The most important components of our research framework are the farm micropopulation, the behavioural model and the total simulated farm population. Together, they form SIMfarm, a static spatial MSM that will give insight in off-farm employment opportunities in the Netherlands. This section describes the necessary steps; figure 1 gives a schematic overview.

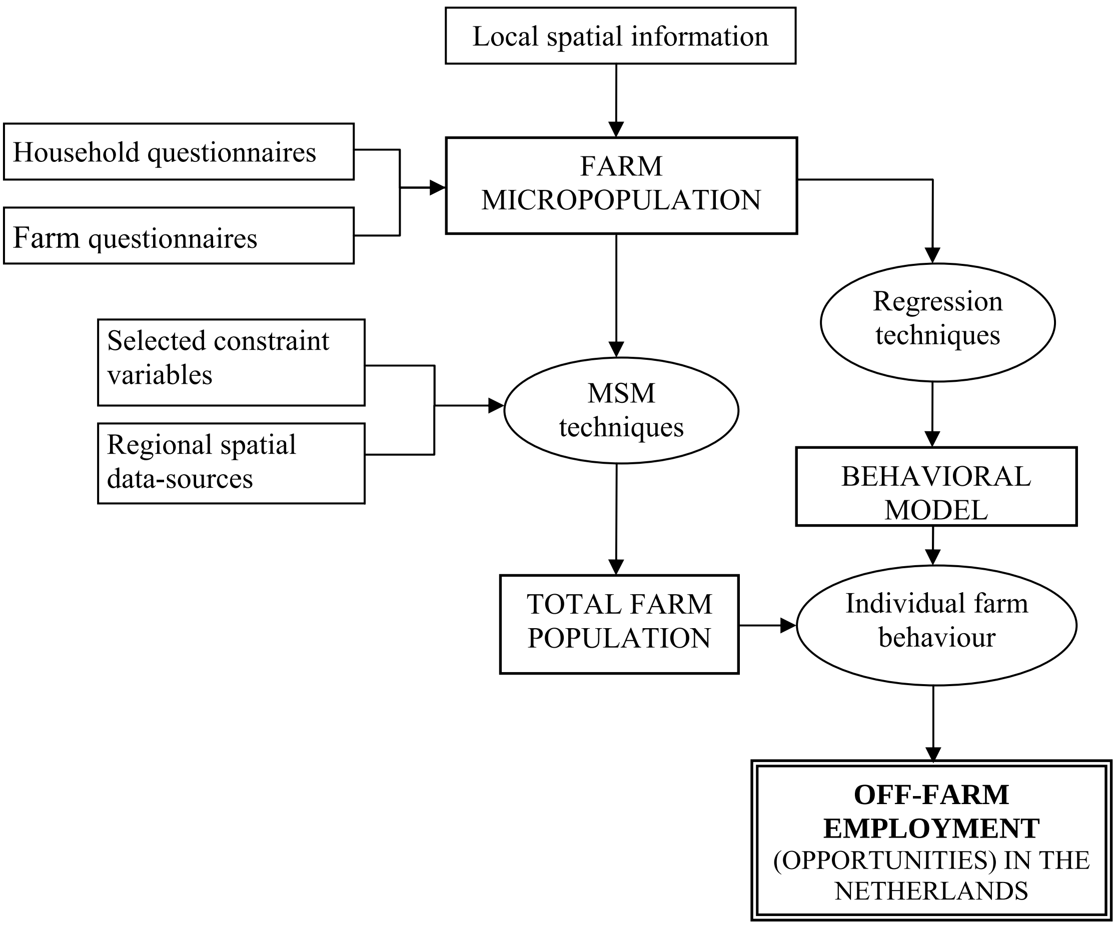

Figure 1: Schematic overview of the SIMfarm framework.

The first step of the process is to define the farm micropopulation. This is essentially a database of individual farm households containing information about the farm, the household and their location. In this database information from household and farm questionnaires are combined, together with spatial information derived from spatially-referenced data using a Geographical Information System.

The second step is to estimate a behavioural model from the micropopulation. Firstly, through a literature review, relevant variables that affect the choice of a farm household to search for a job outside the farm are selected. Then, with help of regression techniques a behavioural model can be estimated, explaining the level of off-farm employment of farm households.

The selection of relevant variables, both by the literature review and the regression analyses, forms an important input for the microsimulation as well. To reweight the farm micropopulation to the total farm population in the Netherlands, carefully selected constraint variables are essential. Each of the constraints must be present in both the farm micropopulation and in regional spatial data sources at the local level. With help of iterative proportional fitting techniques the total farm population, including relevant characteristics will be simulated. The total farm population, as the micropopulation consists of a database with individual farm households and their (spatial) characteristics.

When both the behavioural model and the simulated total farm population are available, the most likely behaviour per farm (taking into account the characteristics of the farm, the household and of the location) can be estimated. The sum then, of all individual farms gives a picture of off-farm employment in the Netherlands.

4.1 Setting up a spatially-explicit microsimulation model (SIMfarm)

For the development of our MSM model, called SIMfarm, we use the static deterministic micro-simulation techniques applied by Ballas et al. (2005) and enhanced by Smith et al. (2007).

The deterministic method used to create the synthetic population (micropopulation) is an iterative proportional fitting technique. Using this deterministic reweighting methodology, households from the questionnaires database that best fit chosen farm, household and location characteristics (e.g. farm-size, household-income, distance to an highway exit) are 'cloned'[1] until the all farms in each zip-code area are simulated. The reliability of these synthetic

[1] Households, including all their characteristics, are copied.

populations can be validated against other census variables to ensure the synthetic population resembles the actual population (Ballas et al., 2006).

The procedure is repeated until each farm has been reweighted to reflect the probability of living in each output area. This method ensures that every farm has the opportunity to be allocated to every area. However, there may be no 'clones' of a farm in an area, or there may be, for example, six copies of a single farm. The criterion is simply how well each farm matches the constraints from the regional spatial statistics.

Constraint variables are used to fit the micro-data to the real situation (i.e. number of farms) in the zip-code areas. Each of the constraints must be present in both the base survey (micro-data set) and the small-area data set, (in our case the Neighbourhood Statistics of Statistics Netherlands, as well as various other data sources).

The choice of which variables to use is very important as it affects the outcomes. In some models, the order of constraints in the model, as well as the number of distinguished classes, also has an effect on the results. Unfortunately, there are only a few publications dealing with these subjects (e.g. Smith et al., 2007; Van Leeuwen, 2008). Furthermore, the best variables to be used as a constraint are not always available. When using small areas, the available data can be limited.

4.2 Case study selection

For a large part of the analyses in this paper, data derived from the European Union research project 'Marketowns'[2] has been used. The Marketowns project, which finished in 2004, focused on the role of small and medium-sized towns as growth poles in regional economic development. For this purpose, the flow of goods, services and labour between firms, farms and households in a sample of 30 small and medium-sized towns in five EU countries has been measured, of which 6 in the Netherlands. The towns vary between a population of 5,000 and 20,000.

To mirror the different range of circumstances and contexts across rural Europe, in each country two towns[3] per area typology were selected: *agricultural* areas, i.e. where

[2] Marketowns project funded by the European Commission under the Fifth Framework Programme for Research and Technology Development, Contract QLRT -2000-01923. The project involves the collaboration of The University of Reading (UK), the University of Plymouth (UK), the Joint Research Unit INRA-ENESAD (France), the Agricultural Economics Research Institute LEI (The Netherlands), Polish Academy of Sciences (Poland) and The University of Trás-os-Montes e Alto Douro (Portugal).

[3] One small (5,000-10,000 inhabitants) and one medium-sized town (15,000-20,000 inhabitants).

employment in agriculture is well above the national average; *tourism* areas, i.e. where employment in tourism is well above the national average; and accessible *peri-urban* areas, i.e. those within daily commuting distance of a metropolitan centre. In the Netherlands, the selected agricultural towns are Schagen and Dalfsen, the touristic towns are Bolsward and Nunspeet and the towns in urban areas are Oudewater and Gemert. As Figure 2 shows, the case-study areas are relatively equally spread over the Netherlands, only Dalfsen and Nunspeet are quite close to each other. Appendix II shows the representativeness of the Dutch towns.

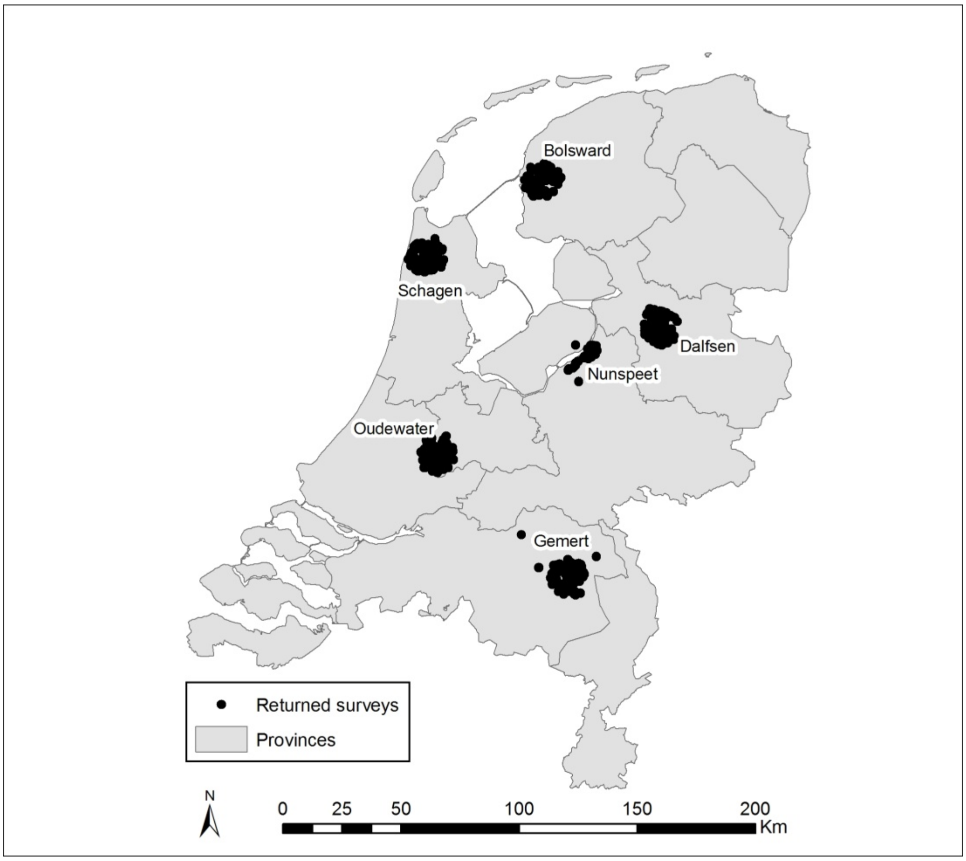

Figure 2: Location of rural study areas and returned surveys.

4.3 Data collection and preparation

In 2003, two types of surveys were set out for the collection of both household and farm characteristics in the six Dutch rural study areas within the framework of the earlier mentioned Marketowns project. The surveys as such contained much more questions than are relevant for our specific analysis (see Appendix I for the questionnaires). Unfortunately, not all questions that we would like to have answered for our research have been included in the questionnaires, meaning that for some characteristics we have to use proxy variables. In Table

2 we describe what factors from Table 1 we decided and were able to include in our initial spatial microsimulation model.

Table 2: Selection of characteristics for the initial spatial microsimulation model: variables (left) and operationalization (right)

Variables	Operationalization
Structural characteristics (household and farm)	
Size (surface)	Measured in hectares
Size (turnover)	(x 1,000 euro)
Farm type	Nine types of farms
Income	Income on a scale of 1-10 (equal interval scale for Dutch population)
Age	Age of the farmer
Farm attachment (ownership)	Number of years a farm business is located on the current location
Number of members	Number of agricultural household members (continuous variable)
Spatial characteristics	
Distance to nearest city > 50,000 inhabitants	Euclidean distance (in kilometres) to nearest urban area with more than 50,000 inhabitants
Level of rurality	Address density data from Statistics Netherlands (www.cbs.nl), measured as a weighted average of the address densities per neighbourhood
Available jobs in other sectors per corop-region	Regional employment data (number of jobs per 1,000 inhabitants) for different sectors from Real Estate Monitor 2007 (ABF Research)

From both households and farms, in total 455 respondents returned the surveys, the response rates for the different surveys and study areas ranging from 13 to 20 per cent. In 290 of these cases (64 per cent) we could link an agricultural household to its individual farm business. Further, in these cases also the response to questions about on- and off-farm income of the household and the business questionnaire were filled out completely and matched in both surveys. These 290 cases give us a vast amount of information on both the farm business and the related household simultaneously. We will use these cases in our analysis. For the spatial characteristics related to the survey respondents we collected various spatial datasets and made intensive use of a Geographical Information System to derive spatially-explicit variables for our analysis.

Off-farm activities

From the total 290 farm households, 44 receive income from pensions or allowances and 177 receive income from an off-farm job. Not unexpectedly, it appears that the older the farmer is, the higher the share of income from pensions or allowances. However, in this paper, we are in particular interested in off-farm employment, so the focus is on income from 'payroll employment'. From all farm households included in this analysis, 61 per cent does not have an off-farm job, 15 per cent receives 1-20 per cent of their income from a job outside the farm, 8 per cent earns 21-40 per cent of their income at an off-farm job, 8 per cent 41-60 percent and another 8 per cent obtains more than 61 percent off-farm (Table 11). The off-farm sector in which the households are most often involved is the public administration, education and health sector. This sector is in general a very important employment sector in rural areas (see Van Leeuwen, 2008). Table 11 further shows that in Gemert and Schagen the level of off-farm employment is relatively low, while it is relatively high in Nunspeet and Dalfsen (which are located in the same region). Apparently, the level off-farm activities differ quite a lot between the towns.

Table 3: Percentage distribution of off-farm income classes per case-study

Payroll employment	**n**	**0**	**1-20**	**21-40**	**41-60**	**61-80**	**81-100**	**Total**
Dalfsen	60	50,0	16,7	6,7	11,7	6,7	8,3	100,0
Schagen	51	68,6	17,6	3,9	7,8	2,0	0,0	100,0
Bolsward	52	59,6	19,2	11,5	5,8	1,9	1,9	100,0
Nunspeet	17	41,2	5,9	5,9	17,6	17,6	11,8	100,0
Oudewater	52	55,8	17,3	5,8	7,7	9,6	3,8	100,0
Gemert	58	77,6	8,6	12,1	1,7	0,0	0,0	100,0
Total	**290**	**61,0**	**15,2**	**7,9**	**7,6**	**4,8**	**3,4**	**100,0**

Table 12 shows the importance of off-farm employment for different kinds of farms. First of all, it appears that in intensive livestock farming 75 per cent of the farmers receive their income totally from farm activities. This is the highest share. In dairy farming, this share is only 56 per cent, and as much as 14 per cent earns more than 61 per cent of their income off-farm. Finally, Table 13, shows that, the younger the farmers, the higher the share of off-farm employment. Form the farm households of which the farmers is between 25 and 44 years old, almost half has a member with an off-farm job. For the age group of 55-64 years old this is only a quarter.

Table 4: Percentage distribution of off-farm income classes in farm types

Payroll employment	n	0	0-20	21-40	41-60	61-80	81-100	Total
Dairy farming	100	56,0	12,0	10,0	8,0	8,0	6,0	100,0
Arable farming	12	58,3	25,0	8,3	8,3	0,0	0,0	100,0
Horticulture	31	61,3	16,1	9,7	12,9	0,0	0,0	100,0
Intensive livestock farming	29	75,9	10,3	3,4	3,4	6,9	0,0	100,0
Mixed livestock	72	63,9	18,1	6,9	5,6	2,8	2,8	100,0
Mixed cropping and livestock	40	60,0	17,5	10,0	10,0	0,0	2,5	100,0
Other	6	50,0	16,7	0,0	0,0	16,7	16,7	100,0
Total	**290**	**61,0**	**15,2**	**8,3**	**7,6**	**4,5**	**3,4**	**100,0**

Table 5: Percentage distribution of off-farm income classes in age groups

Payroll employment	0	0-20	21-40	41-60	61-80	81-100	Total
≤25	100.0	0.0	0.0	0.0	0.0	0.0	100.0
25-34	52.9	17.6	8.8	11.8	5.9	2.9	100.0
35-44	51.0	18.8	12.5	6.3	6.3	5.2	100.0
45-54	61.6	14.0	7.0	11.6	4.7	1.2	100.0
55-64	75.0	12.5	3.6	3.6	1.8	3.6	100.0
≥65	86.7	6.7	0.0	0.0	0.0	6.7	100.0
Total	**61.1**	**15.3**	**8.0**	**7.6**	**4.5**	**3.5**	**100.0**

5. REGRESSION TECHNIQUES AND BEHAVIORAL MODEL

To estimate the share of off-farm employment we use a tobit model. A tobit model is a regression model in which the dependent variable is observed in only some of the ranges. The model can also be referred to as the censored regression model. It is a standard regression model, where all negative values are mapped to zero (this means that observations are censored (from below) at zero). The model thus described two things: the probability that y_i is zero and the distribution of y_i given that it is positive (Maddala, 1983).

The interpretation can be done as follows. The marginal effect of a change in an independent variable upon the expected outcome of the dependent variable is given by the model's coefficient multipliers by the probability of having a positive outcome. If the probability is one for a particular case, the marginal effect is the same as in a linear model.

Because we use percentages of total household income, we have an upper and lower limit in the data (respectively 0 and 100 per cent). Therefore, a two-limited tobit model will be used.

The explanatory variables are grouped in three groups: farm characteristics, household characteristics and spatial characteristics. The results of the model are presented in Table 14, with in bold the significant variables.

Table 14: Results of the two-limited tobit models estimating the share of off-farm employment (%)

Variable		Farm	Household	Spatial	All
Surface (ha)		**-0.419**			**-0.381**
	t-value	-2.606			-1.823
Turnover (*1000)		-0.013			-0.013
	t-value	-0.988			-1.031
Dairy farm (d)		**16.955**			**13.115**
	t-value	2.334			1.634
Intensive livestock (d)		-9.191			-5.317
	t-value	-0.694			-0.366
Horticulture (d)		-6.899			-5.838
	t-value	-0.524			-0.401
Other (d)		17.583			**29.139**
	t-value	1.081			1.836
Non-labor income (%)*			-0.430		-0.366
	t-value		-1.498		-1.370
Age farmer (6 classes)			**-8.943**		**-7.537**
	t-value		-3.736		-2.138
Always lived here (d)			**11.903**		**13.408**
	t-value		1.590		1.785
Family members (#)			**3.902**		**4.379**
	t-value		2.057		1.820
Distance city >50.000 inh. (km)				-0.452	-0.093
	t-value			-0.862	-0.169
Avg. address density within 1 km				**0.048**	**0.038**
	t-value			2.067	1.681
Jobs per Corop-region per sector (/1000 inh.)					
In agriculture				**-2,315**	**-1.628**
	t-value			-4.176	-2.589
In industry				-0.058	-0.005
	t-value			-0.576	-0.042
In commercial services				**-0.314**	**-0.284**
	t-value			-2.735	-2.522
In non-commercial services				**0.563**	**0.493**
	t-value			3.341	3.005
	log likelihood	-668,281	-666.159	-663.685	-650.791

*Percentage of the rest of the income (total income - off-farm labor income)

First of all, the table shows us that the selected farm characteristics have a relatively weak explanatory power, the household characteristics have a little more explanatory power while the spatial variables explain most of the diversity in share in off-farm income. Not surprisingly, the combination of all characteristics explains different off-farm income levels the best.

From the farm characteristics, in particular the surface of the farm is important, even when controlling for turnover; the larger the farm, the lower the share of off-farm employment. The turnover itself does not seem to significantly affect off-farm income. Furthermore, there are differences between different kinds of farms, in particular family members from dairy farms tend to have an additional job outside the farm.

Most of the household characteristics we included significantly affect the share of off-farm income. Only the share of non-labor income, obtained from the government (such as pensions) or from financial institutions (such as interest) is not significant. The age of the farmer plays a significant role: the older, the higher the share of income obtained from the farm, even when taking into account non-labor income such as pensions. Furthermore, households that always lived in the specific area more often tend to obtain income from outside the farm. Furthermore, also in larger families, a higher share of the total household income is earned outside the farm by one of the members.

As mentioned earlier, the spatial characteristics seem to be relatively important, in particular the availability of jobs per 1,000 inhabitants in the region. When the region is more oriented towards agricultural activities (a larger number of agricultural jobs) it is less likely that someone from the household takes an off-farm job. This could indicate that in regions with a relatively large number of jobs in agriculture there are less possibilities for off-farm employment, or that off-farm employment is not necessary due to economies of scale or efficiency reasons. Furthermore, also the number of jobs in the industrial sector and in the commercial services sector has a negative impact on off-farm employment. However, when there are a large number of jobs available in the non-commercial services sector, it is more likely that the farmer households obtain off-farm income. In addition, also the closeness of a bigger town (>50,000 inhabitants) positively affects the share of off-farm income, as does the address density: more urbanized rural areas offer more off-farm employment or less on-farm employment opportunities.

In the model including all variables, with the highest explanatory power, we do not observe many changes. The size of the farm remains important as does the kind of farm. Only now, 'other' kinds of farms are also significantly related to higher shares of off-farm income (compared to mixed farms). The family characteristics have the same impact. From the spatial variables the significant ones are again the same: address density, and the number of jobs in the agricultural, commercial and non-commercial sectors.

6. DISCUSSION AND NEXT STEPS

The research done so far showed us that almost half of the farm households from our sample receive income from off-farm activities. From the literature we selected a list of variables that could significantly affect the choice for off-farm activities. From these first results we learned more about our dataset and it appeared that most insights from the literature also hold for our dataset. Both in the partial tobit estimations (i.e. only using either farm, household or spatial characteristics) as in the full estimation including all variables, the dairy farm type, whether or not a farm household has always lived here, the number of family members, the address density and the number of jobs per 1,000 inhabitants in the non-commercial services sector in the region all positively influence the share of off-farm employment. In contrast, in all estimations the size of the farm expressed in surface, the farmer's age and the number of jobs per 1,000 inhabitants in the region for the agriculture and the commercial services sectors influence the share of off-farm employment negatively. Furthermore, in the full estimation other types of farms also has a positive influence.
If we recall our notion from page 14 that the non-commercial services sector (i.e. public administration, education and health) is in general a very important employment sector in rural areas, then it is particularly interesting to see our model confirm that presence of the public sector in a region plays an important stimulating role for increasing the share of off-farm employment.

In this paper, we have taken the first steps in our SIMfarm framework (recall Figure 1). We have applied the regression analysis on the farm micropopulation to determine a behavioural model containing the important factors for on- and off-farm activities. In the next step, we will use them to construct a spatial static microsimulation model to analyse the importance of off-farm activities in distinctive regions in the Netherlands and possible effects on the efficiency of agricultural policies. Furthermore, we can use it to project the spatial implications of economic development and policy changes at a more disaggregated level.

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APPENDIX I – FARM BUSINESS SURVEY

The role of small and medium-sized towns in rural development
part of a Europe-wide rural development project

Person completing the form
1 Are you the
1) farm owner 2) farm manager 3) other *please give details*

2 How old are you?
24 or below 45–54 25–34 55–64 35–44 65 or over

About the farm and its occupancy
3 What is the area of the farm?
… hectares or … acres

4 What type of farm is it?
Tick one box only.
1) Arable land 6) Mixed cropping
2) Horticulture7) Mixed livestock
3) Permanent crops 8) Mixed cropping and livestock
4) Grazing livestock 9) Other *please give details*
5) Pigs/poultry

5 Is the farm business
1) Sole ownership
2) General partnership (V.O.F.)
3) Private Limited Company (B.V.)
4) Public Limited Company (N.V.)
5) Other please give details

6 Has the farm business always been on this location?
1) Yes, the farm business has been located here for … years
2) No, the farm business has been located here for … years

7 Was the owner or family farming before this?
1) Yes
2) No

If yes, please say where they were farming previously
Please refer to the enclosed zone map and tick one box here
A B C D E F G H

8 Does the principal farmer or farm manager live on the farm?
1) Yes → go to question 9
2) No → go to question 10

9 Have they lived here for less than 10 years?
1) Yes
2) No → go to question 11

If yes, where did they live previously?
Please refer to the enclosed zone map and tick one box here
A B C D E F G H
Now go to question 11

10 Do they live within a 7-kilometre radius of the town (zones A and B on the map)?
1) Yes
2) No

What you bought in the most recent financial year
If you cannot give exact figures, estimates are extremely valuable and much appreciated.

11 What was the approximate total value of all goods and services bought during the most recent financial year?
Exclude VAT, labour and rent. Include creditors.

What you sold in the most recent financial year
If you cannot give exact figures, estimates are extremely valuable and much appreciated.

13 What was the approximate total value of all goods and services sold during the most recent financial year?
Exclude VAT, grants and subsidies. Include debtors.

About the people employed at this address
15 In the table below the people employed in your farm business are divided into family members and other employees. For each group, state the number of persons (including yourself) and divide these into full-timers, part-timers and seasonal workers.

	Employee numbers			
	Total	Full-time (36 hours and more per week)	Part-time (less than 36 hours per week)	Seasonal and casual
Yourself and family				
All other employees				

Farm household income

17 Please provide the following information for up to 10 employees

	Employee status please tick the codes	Skills group please tick the codes	Gross annual salary or payment please enter the code	Where the person lives (see the zone map enclosed and tick below)
Employee	1. Family – ≥ 36 hrs 2. Family – <36 hrs 3. Family – seasonal 4. Other – ≥ 36 hrs 5. Other – < 36 hrs 6. Other – seasonal	1.Farmer / family worker 2. Farm manager 3. Administrator 4. Farm worker – skilled 5. Farm worker – unskilled	1. < € 16,000 2. € 16,001 - € 20,000 3. € 20,001 - € 25,000 4. € 25,001 - € 30,000 5. € 30,001 - € 35,000 6. € 35,001 - € 45,000 7. € 45,001 - € 55,000 8. € 55,001 - € 65,000 9. € 65,001 - € 75,000 10. ≥ € 75,000	1. In village 2. within 7km of village 3. between 7-16 km of village 4. Other location in the province 5. Other location in the Netherlands 6. Other location in the EU 7. Other location in the world
Yourself				
Person 2				
Person 3				
Person 4				
Person 5				
Person 6				
Person 7				
Person 8				
Person 9				
Person 10				

20 About what percentage of your annual household income is generated by the following activities?

Source activities — % of income

a) farm/agricultural business … %

b) other on-farm please specify e.g. B&B, shooting

b.1 … %

b.2 … %

c) off-farm please specify e.g. other businesses, work by family members

c.1 … %

c.2 … %

100%

21 For any off-farm income, please tell us where the activity is done

Please refer to the enclosed zone map.

Off-farm source 1 → A B C D E F G H

Off-farm source 2 → A B C D E F G H

APPENDIX II REPRESENTATIVENESS OF DUTCH TOWNS

	Population (%)				Firms (%)		
	0-15 years	15-65 years	>65 years	4-years HH growth*	Industry	Services: commercial	Services: non-commercial
Netherlands total	19	67	14	3	18	45	31
Netherlands towns **							
Average	19	66	15	2	21	43	29
Range	13-33	58-73	7-27	-19-31	9-41	32-61	17-47
Dutch case-study towns***							
Dalfsen	21	64	14	1	22	42	33
Schagen	17	68	15	13	19	45	32
Bolsward	18	66	16	0	23	41	32
Nunspeet	21	64	15	2	24	42	28
Oudewater	21	65	14	1	23	48	25
Gemert	18	69	12	2	28	37	28

Source: CBS data.
*Growth in number of households between 2003 and 2007.
**All Dutch towns with a population between 5,000-20,000 (220 in total).
*** Only the towns have been taken into account, not the hinterland.