Farm Diversification in Relation to Landscape Properties

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Abstract— **Current European Common Agricultural Policy (CAP) has been moving from production support subsidies to direct decoupled income support. The emergence in policy making of the concept of multifunctional agriculture leads to the recognition that a farmer produces more than food: he produces jointly both commodity and non-commodity goods. Environmental contracts were developed in order to encourage the provision of non-commodity goods such as landscape or biodiversity. Next to these contracts, other activities as for example recreation can be observed. They are the result of farm diversification.**

The role of location in farmers' decision making to diversify is pointed out in literature but geographical information is generally reduced to the location within a political delimitation unit the empirical work.

Objective of this paper is two-fold. Firstly, it addresses the role of location, in term of site specific natural conditions as well as neighbouring emerging dynamics in farmer's decision making to diversify. Attention is paid to number of activities as well as the specific types of activities, notably green services, daily recreation and other farm-linked services. Secondly, this paper introduces income from agriculture explicitly allowing testing short term price sensitivity.

It was found that attractive landscape is a driver for diversification as these landscape offer more opportunities. Furthermore, diversification is responsive to price. Thirdly, role of density of past multifunctional activities in the neighborhood influences farm diversification: multifunctional activities create an externality effects as new activities emerge next to already existing ones. This dynamic may lead to the emergence of 'multifunctional hotspots' in landscape.

Keywords— *Farmer diversification, landscape services, location*

I. INTRODUCTION

The current European Common Agricultural Policy (CAP) has been moving from production support subsidies to direct decoupled income support (European Union, 2006). The emergence in policy making of the concept of multifunctional agriculture as described by the OECD (2001) leads to the recognition that a farmer produces more than food: he produces jointly both commodity and non-commodity goods. New forms of regulation such as individual or collective contracts between farmers and government, also called green services, were developed in order to encourage the provision of non-commodity such as landscape biodiversity or wildlife habitat maintenance.

Next to green services, various other activities as for example recreation or care activities can be observed in rural area and are the result of farm diversification. It is achieved by allocating inputs to other on-farm activities (*e.g.* provide recreational activities) or search for additional off-farm employment(Schmitt, 1988).

Diversification is stimulated by the transition from production landscapes towards consumption landscapes that aim at fulfilling societal demands for a wide range of rural goods and services (Marsden, 1999). Multifunctional landscapes are landscapes that on one given location provide various goods and services to humans. They are the base of consumption landscapes (Holmes, 2008). From this perspective, farm diversification can be seen as the supply of multifunctional activities, which increase the multifunctionality of landscapes.

The role of location in farmers' decision making is often pointed out in literature (Dalgaard, et al., 2007, Jongeneel, et al., 2008, Vandermeulen, et al., 2006, Vanslembrouck, et al., 2002), but often geographical information is omitted in the empirical work or reduced to the location within a political delimitation unit such as a municipality or a provinces. In this paper a dataset that allows to locate the farm more precisely based on their 5 digit postcode is used. Thanks to Geographic Information System techniques, site specific conditions as well as local neighbourhood effects can be measured, linked to each farm. This

level of precision in measurement of location in empirical estimation have not yet been widely covered yet in literature (Van Huylenbroeck, et al., 2007).

The objective of this paper is two-fold. Firstly, it wants to address the role of location, in term of site specific natural conditions as well as neighbouring emerging dynamics in farmer's decision making to provide multifunctional activities. Attention is paid to the number of activities started as well as the specific types of activities, notably green services, daily recreation and other farm-linked services (on farm shop, care farms). Secondly, this paper introduces income from agriculture explicitly allowing to test short term price sensitivity.

II. METHODS

A. Study area and data description

The Gelderse Vallei study area is located in the center of the Netherlands in the provinces of Utrecht and Gelderland and covers about 1100 square kilometres. The western part of the study area fulfils a central position attracts new residents. The eastern part is dominated by intensive livestock production. There are increasing multiple claims on land for various functions.

In 2005 a survey has been sent to all 1821 officially registered farmers in the region, out of which 258 (14.2%) were returned. The survey includes next to the classical farm census data information about the take up of multifunctional activities, farmer's attitude to multifunctionality, farming style, income generation, participation in NGOs, trust in institutions and future perspective. From the returned survey 241 farmers could be geo-referenced on the base of their postal code.

Furthermore the Geographical Information System for Agricultural Businesses (GIAB) dataset was used. It is based on a farm census run every year at all the registered farmers in the Netherlands. It includes location and farm production characteristics, but unfortunately does not include any attitudinal information. For 1999, 2003 and 2005 the survey contains questions referring to diversification. This dataset was used in order to test if the 2005 was survey was representative. Only green services suffer from sample selection: a take up of 32% in the sample compared to a take up of 16% in GIAB.

B. Conceptual framework

Analyzing the role of landscape properties with farmers' decision making, implies connecting a biophysical hierarchically organized complex system to a micro-economic unit following a utility maximization approach. Hence, spatially explicit landscape properties are translated into location assets at the farm level.

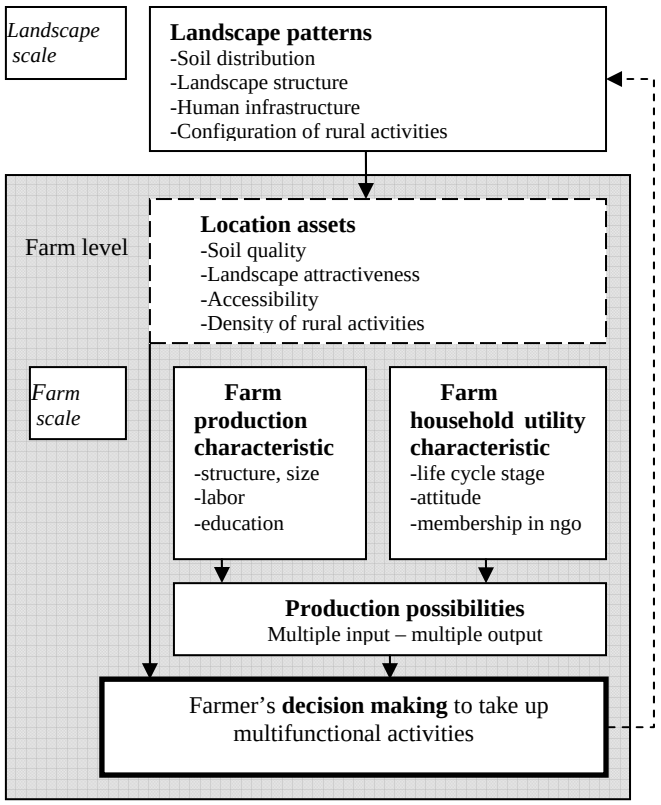

Figure 1 : conceptual framework

Figure 1 shows the conceptual framework linking landscape to farm decision making. The bottom part represents the farm scale, which is driven by a household decision making unit that maximizes utility subject to a multiple input output farm technology. The upper part represents the landscape scale as well as the redefinition of landscape pattern into location assets at farm level. Note that famer's decision making in return may partly influence the landscape patterns.

C. Estimations techniques

The framework in Figure 1 has been translated into an estimable farm household model. Two different models have been estimated: model 1 explaining the number of multifunctional activities taken up and model 2 explaining the take up of specific multifunctional activities.

For model 1 a zero-inflated count model has been fitted. This model takes into account that the observation is an integer and addresses the excess of zeros observed. It assumes that the observed zero is the result of two different processes; an unobserved state of nature and a choice.

The model 2 investigates the take up of specific activities: green services, daily recreation and other services in a simultaneous framework. It estimates choice of providing daily recreation, green services and other services, taking correlation between these choices into account. The simultaneous framework calls for a multivariate probit, which can only be estimated with simulation techniques. (Train, 2003)

III. RESULTS

A. Model 1

Table 1 shows the estimation results for the zero-inflated model. The inflated model indicates that a high hourly income from agriculture as well as an off-farm job increases the probability to observe a zero outcome, in this case no multifunctional activity.

Off farm job significance can be interpreted in two different manners: labour allocation and income availability. Firstly, by having a member of the household working outside the farm, less labour is available to take up a multifunctional activity, which in most of the case is labour intensive. Secondly, having an off farm job brings a supplementary income to the household, which does not need to seek for new opportunities for financial reasons. A high hourly return from agriculture increases the probability of having no multifunctional activity. Hourly return from agriculture depends on the chosen product mix which cannot be adjusted in the short run and therefore can be seen as short term price sensitivity.

Location matters to explain the number of activities taken up. Indeed, proximity to national parks is drivers for diversification. It suggests that this kind of landscape attracts people, and therefore it is more attractive to provide multifunctional good and services in such areas. Thirdly, the density of activities around a farm in 2003 is highly significant and suggests that multifunctional farmers create a positive externality that motivates other farmers to do the same. Indeed, multifunctional activities are often complementary in offering more opportunities when various services are offered together on the same location. This suggests a self-enforcing dynamic that leads to clustering of farms that diversify in multifunctional activities and to "multifunctional hotspots" in landscapes.

Table 1 : zero inflated count estimation for the number of multifunctional activities taken up.

Zero inflated negative binomial model	
Negative binomial regression	
Mean age of head of farm	0.294 (3.39)**
Mean age of head of farm squared	-0.003 (3.65)**
Non-monetary motivation	0.190 (2.62)*
Size	-0.012 (2.61)**
Location within 1.5 km from a national park	0.571 (2.96)**
Density of activities in the neighbourhood in 2003	0.630 (2.12)*
Constant	-7.243 (3.32)**
inflation Poisson regression	
Hourly income from agriculture	0.064 (2.14)*
Off-farm job	16.43 (2.91)**
Constant	-17.57 (2.89)**

1. *Robust z statistics in parentheses*
2. ** significant at 5%; ** significant at 1%*

Non monetary motivation significance suggests that altruistic behaviour increase the number of activities observed. The household life cycle significantly influences the number of multifunctional activities.

B. Model 2

Table 2 shows the result for the multivariate estimation for the take up of specific multifunctional

activities. Firstly, location assets turn out to be significant, but in a different manner for each type of activity. Daily recreation emerges next to attractive landscapes, and green services are more likely to occur on less productive and wet soils. Density of green services around the farm in 2003 is significantly driving daily recreation in 2005 suggesting synergies between these two variables. Proximity to cities could not be found as a driver for other services within the multivariate framework. This is probably due of the high diversity of services that are taken into account with this variable.

Table 2: multivariate probit estimation for the take up of specific multifunctional activities

multivariate probit estimation	Daily recreation	Other services	Green services
Mean age of head of farm	0.400 (3.70)**	0.222 (2.48)*	
Mean age of head of farm squared	-0.004 (3.67)**	-0.009 (2.61)*	
Hourly return from agriculture	-0.041 (3.72)*	-0.049 (3.08)*	-0.020 (2.60)*
Location within 1.5 km from a national park	0.490 (2.04)*		
Location within 2 km from a city		0.294 (1.55)	
Density of green services activities in the neighborhood in 2003	2.379 (2.58)*		
Highest level of education in the household			0.138 (2.32)*
Factor for independency			-0.216 (2.56)*
Factor for trust in governmental institution			-0.165 (1.82)
Percentage of bad quality soils within a buffer			0.009 (2.31)*
Constant	-12.43 (4.19)**	-5.24 (1.55)	-1.228 (4.39)**
Correlation daily recreation- other services	0.865 (17.04)**		
Correlation daily recreation– green services	-0.207 (1.41)		
Correlation other services– green services	0.222 (1.86)		
Observations	232		
Pseudo R square	0.14		

Robust z statistics in parentheses
** significant at 5%; ** significant at 1%*
500 draws

Secondly, the hourly return from agriculture turns out to be significant for all the activities, implying that the separate take up of multifunctional activities is in the short run price sensitive. Finally, with respect to farm and household characteristics two different dynamics can be identified. Marketable goods, including daily recreation and other services shows quite a different dynamics than green services, where the latter are non-marketable goods. For marketable goods the stage of life cycle appears to be a significant driver, just as it was for the number of activities taken up. For green services, education increases the probability to take up nature or landscape conservation scheme. Indeed specific knowledge and training is needed in order to be able to fulfil the governmental requirements associated with this service, but also because of the knowledge needed to take up a contract with the government and understand the administrative process. Farm size is also a driver and suggests that bigger farmers tend to take up green services.

The factor for independency presents a negative sign, implying that the more a farmer wants to stay independent the less likely to take up green services. Indeed a farmer needs to take up a contract with the government for a minimum duration of 6 years. For this reason, Jongeneel et al. (2008) suggest that trust in the contracting party is an important factor for taking up green services. The factor trust is not significant in the multivariate framework, insinuating that it is not as important as indicated in literature.

IV. CONCLUSION

Linking previously discussed results to each other allows for identifying future dynamics in landscape patterns. Firstly, locations near to attractive landscape are important for the take up of multifunctional activities as attractive landscape offer more diverse opportunities for farmer to diversify. For example daily recreation occurs not only next national parks or next to biking routes but also on location where green services occurred in the past. This suggests that here might be synergies between these two activities, indeed green services contribute to a more attractive landscape. Green services are an activity that is more

likely to occur on less suitable soils given the current regulation.

Secondly, it was found that farm diversification is responsive to price signals. On the one hand the switch from price support to direct payments, which is a trend since the MacSharry reform of the early 1990s, by lowering the relative prices for agricultural products, as well as the increased emphasis on rural policies by extension of the second pillar of the CAP, both contribute to the increasing popularity of multifunctional activities. On the other hand, recent price increases caused by increased world-wide demand for agricultural products, mainly driven by the demand for bio-fuels, increased animal origin product demand in Asia, might induce a reverse trend in the future, making multifunctional activities relatively less attractive.

Thirdly, the significant role of density of past multifunctional activities in the neighbourhood suggests that multifunctional activities create an externality effects as new activities particularly emerge next to already existing ones. This dynamic may lead to the emergence of 'multifunctional hotspots' in the European landscape. The mirror side of this argument is that other areas might develop into, or stay as 'multifunctional cold spots'. Generalizing our case study result would imply that areas with less suitable soils next to urban centres profit from path dependency. Indeed due to their past disadvantages, they may have today a more preserved landscape that meets the current demand. It is not obvious what will happen to these areas in which multifunctionality is less likely to emerge. Areas with suitable soils and/or easy access to markets will probably intensify production. Intensive production will shape the landscape that will not provide many other functions than food production.

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