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Analysis

# Simulating the diffusion of organic farming practices in two New EU Member States

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ABSTRACT

Agriculture continues to be a major contributor to water pollution, climate change and loss of biodiversity although policies to encourage farmers to work to higher sustainability standards in food and energy crop production have increased throughout the European Union. In New Member States, accession to the European Union mostly brought a substantially increased public support to foster the diffusion of certified organic farming. However, the take-up of organic farming is varied for reasons that are not yet well understood. In this paper, we analyse the diffusion of organic farming through farm populations. This involves an understanding of farmer behaviour and how it can change over time. We present a generic agent based model that builds on the Theory of Planned Behaviour as framework for understanding and modelling farmers' decision-making processes. The model is applied to high-diffusion regions in two New EU Member States, Latvia and Estonia. The values for the model's parameters are informed by survey data. The model reproduces the interdependence of social influence and economic factors. Social influence alone is shown to make little difference to the model dynamics; organic farmers remain organic, and conventional farmers remain conventional. Introducing a change to the environment (e.g. a subsidy) results in an increase in the proportion of adopters. Thus, economic factors appear to be more influential than social factors. However, only when allowing for both, the subsidy and social influence, do we reveal the whole picture and the combined adoption rate is higher than the sum of the proportion of adopters resulting from just social influence (without a subsidy) and from just a subsidy (without social influence). We also compare the effect of the subsidy with the effect of influence from organic farm advisors to develop policy recommendations.


## 1. Introduction

Organic farming (among other measures) is widely perceived as a step toward sustainable agriculture. To stimulate its diffusion in the EU, agri-environmental measures (AEM) were introduced to encourage conventional farmers to convert to organic practices. Still, the diffusion of organic farming practices is at an early stage especially in the New Member States (NMS) of the European Union where AEM were introduced in the late 1990s and at the turn of the millennium. In some NMS, adoption rates have increased quickly since then, but the relative importance of factors influencing the diffusion of organic farming such as financial incentives (subsidies, market opportunities), farm support mechanisms (organic farm advisors), but also farm level influences like farmer attitudes and social context have not been systematically analysed.

Against this background, we investigate what determines diffusion patterns under these circumstances and which (combinations of) interventions are likely to be most effective. To improve the design of policy measures we need to understand the factors influencing farmers' decision-processes on whether or not to convert to organic practices. Agent-based models are increasingly used to study social and other influences on decision-making. They allow us to simulate individual actions of diverse agents, measuring the resulting system behaviour and outcomes over time; therefore providing a test bed for exploring innovation patterns.

Innovation diffusion studies based on various disciplinary backgrounds have investigated aspects of the diffusion process with some success. This work resulted in a general theory of innovation diffusion (comprehensively summarized in Rogers, 1995). In the context of organic farming, the contributions of sociologists are particularly relevant as they deal with the decision process, adopter categories, the perceived attributes of innovations, the rate of adoption, and the characteristics of change agents and opinion leaders. Hereby the decision process is split into the five stages knowledge, persuasion, decision, implementation, and confirmation. Interestingly, motivational factors were largely not investigated in this literature. As Rogers (1995, page 109) asserts, this is largely the case because motivations “are a difficult issue to investigate”.

Over the last 30 years, theoretical developments in social psychology have improved the predictive relationship of behaviour

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with its underlying constructs. Of the many approaches, the analysis of attitude-behaviour relationships has been most successful. Compared to world views or values, attitudes are conceptually closer to behaviour and thus increase predictive relationships. This has shed light on how the decision-maker develops favourable or unfavourable beliefs towards an attitude object (here: behaviour) and on how these beliefs can be related to certain behaviours. Some attitude theories focus on explaining reasoned behaviour based on cognitive processes, others incorporate affect explicitly, and others again incorporate habit formation due to automatic activation of previously formed attitudes (Ajzen, 2001; Fazio and Olson, 2003). Choosing a theoretical framework and developing a model requires a good understanding of the institutional context and potential drivers for the behaviour under investigation. As the decision whether to convert to organic farming is at least a medium-term commitment with potentially substantial changes for farm management, a reasoned approach seems more likely to capture the relevant determinants of this complex decision. Here, popular contenders are expectancy-value models, mostly based on Martin Fishbein's work (1963), which regard attitudes toward behaviours and associated social influences as important causes to explain the motivation to perform certain behaviours. Because of its parsimony and relatively successful applications, the most popular contemporary model is the Theory of Planned Behaviour (TPB), which was chosen as the conceptual framework for constructing the agent-based model in this paper. We develop a generic model of decision-making that accounts for social influences on individual motivations and builds on recent theoretical advances in understanding human behaviour. We use the model to simulate behavioural reactions of farmers on policy interventions like the introduction of a subsidy and of organic farm advisors.

The model is applied to two high-diffusion regions in Latvia and Estonia and uses data from a survey, which was designed for this purpose. Here, we are not interested in the emergence of innovators, but the effect that existing innovators have on the diffusion of the innovation throughout the population of farmers for the successive stages (i.e. early adopters through to laggards). The main purpose of the model is to perform a dynamic analysis of the diffusion of organic farming practises by incorporating a relatively sophisticated but still parsimonious conceptual model that promises to reflect more realistic decision-making processes of farmers.

The structure of the paper is as follows: first we discuss previous approaches to simulating innovation diffusion; then, we discuss the TPB; finally we present the model, along with its results and implications for policy.

## 2. Previous modelling approaches

Threshold models have been widely used to study innovation diffusion (Valente, 1995). These models assume simple adoption behaviour: if the number of adopters in an agent's social network exceeds a given threshold then the agent adopts the innovation. Threshold models have been useful for gaining tractable insights into principles underlying innovation diffusion, such as levels of critical mass (the necessary number of adopters) to propagate the innovation to the rest of the population in various systems. However, such models are limited to capturing simple decision processes. We need a different approach to model more complex decision processes.

Agent-based modelling is a flexible tool which allows agents to assess their situation and to make decisions on the basis of a set of rules. Each agent may execute various behaviours appropriate for the system they represent, e.g. producing, buying or selling. ABM is particularly suitable for exploring the reciprocal relationships between behaviours and their dynamic environments. The number of ABM applications has risen sharply in the last few years (Bonabeau, 2002); they include social dilemmas (Jager et al., 2000; Mosler, 2005), management of environmental resources (Jager and Mosler, 2007), climate change (Janssen and Vries, 1998), the study of energy systems (Bruckner et al., 2005) and agricultural systems (Happe et al., 2006: Balmann et al., 2002; Schreinemachers et al., 2007), and innovation diffusion (Berger, 2001; Deffuant et al., 2002b; Gilbert et al., 2001; Dawid, 2006; Carrillo-Hermosilla, 2006; Janssen and Jager, 2002; López-Pintado, 2008; Schwoon, 2006).

Agent-based models allow us to relax some of the simplifying assumptions of analytic approaches, such as the threshold model. With agent-based models, individual heterogeneous agents (farmers) and their interactions can be modelled explicitly. This bottom-up approach facilitates the examination of system-level properties (e.g. adoption rates over time) resulting from the dynamics of interactions between agents. The IMAGES model (Deffuant et al., 2002a) is an agent-based model of the diffusion of AEM, which extended threshold models to include more cognitive agents for the first time. Individual farmers were connected to each other in a social network, and their decision of whether or not to adopt was based on social influence from their neighbours, their attitude, and whether or not they have information regarding the AEM. These attributes were used to calculate a finite interest state: low, medium, or high. The interest state was used to calculate a finite decision state: reject, await-info, or adopt. Agents would reject if they had a low intention, and adopt if they had a high intention for a given number of time-steps. Agents that had a high intention but no information would wait for information to be passed on to them.

In our model we adopted the relative agreement model, but otherwise our model differs from the first model in significant ways. We simplified the overall modelling approach, used new conceptual foundations explaining agent behaviour (Theory of Planned Behaviour), secured adequate sample sizes for the empirical validation of assumptions, and introduced a continuous motivation with a threshold level (instead of three interest states).

## 3. The Theory of Planned Behaviour

In search of a decision-making model that is both theoretically and empirically founded, we turned to social psychology and the Theory of Planned Behaviour (Ajzen, 1991)—an extension of the Theory of Reasoned Action (Fishbein and Ajzen, 1975). The theory suggests that someone's intention (motivation) towards a behaviour is a reliable predictor as to whether or not they will perform the behaviour. The higher the intention, the more likely it is that the person will pursue the behaviour. In the case of organic farming, if a farmer has a high intention of adopting organic farming practices then it is likely that they will adopt. The lower the intention, the more likely it is that the farmer will stay with conventional farming practices. Thus, behaviour is mediated through intentions. This leaves the question of how we can predict intentions. The theory identifies three global variables that together contribute towards predicting the intention. These are: attitudes, subjective norms, and perceived behavioural control. Attitudes represent beliefs and evaluations of different aspects of the behaviour, and are influenced by assumptions about the profitability, management, health and environmental effects, and other aspects of organic farming salient in the farm population. Subjective norms are the perceived level of approval or disapproval of the behaviour by “important others” such as respected farmer colleagues, farm advisors, family members, and customers. Perceived behavioural control (PBC) represents the perceived ability to perform the behaviour, and is influenced by the farmer's assessment of affordability, risks, necessary farming skills, farm structural issues, and so forth. Standardised principles to construct TPB measures are laid out in Ajzen (2002) and Francis et al. (2004). How these were implemented in this study is described in Appendix A. Weights defining the relative contributions of each predictor are derived empirically by means of regression analysis.

A large share of the many TPB applications investigates health-related behaviours like taking exercises, smoking, sexual behaviour, or food consumption. Increasingly, also more complex behaviours were