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Regional heterogeneity and spatial interdependence as determinants of the cultivation of an emerging alternative crop: The case of the Styrian Oil Pumpkin

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ABSTRACT

In the course of the liberalisation and globalisation of agricultural markets the Common Agricultural Policy (CAP) of the European Union (EU) has shifted from quantity-based to quality-based policies, encouraging a diversification of agricultural production. For policy makers it is therefore relevant to understand better the drivers which influence the adoption and spatial distribution of emerging alternative products and production systems in agriculture. Taking the Styrian Oil Pumpkin as an example, the aim of this study is to quantify the determinants of spatial variations in the cultivation of an emerging alternative crop. We estimate Tobit and SLX Tobit models for two regions, drawing on cross-sectional data from the year 2010 of 549 municipalities in the Styrian Oil Pumpkin Protected Geographical Indication (PGI) area. Our findings indicate that, apart from (i) crop-specific factors, there are also (ii) region-specific factors such as marketing possibilities and there is (iii) spatial interdependence influencing spatial variations in oil-pumpkin-cultivated area and we conclude that these factors also need to be considered for the support of other emerging alternative products and production systems in agriculture.

1. Introduction

In recent decades, the ongoing liberalisation and globalisation of agricultural markets have led to agriculture in the European Union (EU) being increasingly exposed to competition from the world market (McNamara and Weiss, 2005; Thompson et al., 2000). In response to this development, farmers have chosen different strategies, ranging from farm growth and intensification (Bartolini and Viaggi, 2013; Weiss, 1999), farm exit or part-time farming (Raggi et al., 2013) to the diversification of agricultural production (McNamara and Weiss, 2005). The latter strategy has led to a growing interest in alternative production systems such as organic farming (Darnhofer et al., 2005) or emerging alternative products like regional food products (Lamarque and Lambin, 2015; Tregear et al., 2007). This marks a shift in the EU's Common Agricultural Policy (CAP) from quantity-based to quality-based policies.

In the literature, a variety of factors has been identified which influences the adoption and spatial distribution of alternative products or production systems in agriculture. However, the relevant factors depend to a great extent on the specific product/production system and it is therefore difficult to summarise them at a general level (Knowler and Bradshaw, 2007). For example, adopting a new seed variety of a crop which is already cultivated is less complicated than, and depends on different factors compared to, the adoption of a new crop which requires special machinery and is therefore associated with higher transition costs (Pannell et al., 2006).

Aside from the context of the product or production system, one aspect which has received less attention in empirical research is the regional context of the analysis. The drivers which affect the adoption of a product or production system may, for example, differ among regions within a study area due to heterogeneous preconditions for agricultural production (Useche et al., 2009). Another source of heterogeneity in adoption which is recognised in the theoretical literature (Pannell et al., 2006) but also mainly not considered in empirical studies is spatial interdependence – meaning any form of strategic interaction, indirect effect or spatial correlation among neighbouring observations (Storm et al., 2015). If spatial interdependence is not considered in an empirical analysis, this can lead to biased results (LeSage, 2009).

The present study focuses on these two aspects as sources of heterogeneity in the adoption of a product/production system, thereby filling an existing knowledge gap in the current literature. Specifi-

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cally, we aim to analyse the spatial distribution of an alternative crop, considering (i) the crop-specific context, (ii) the region-specific context and (iii) spatial interdependence. For our analysis we choose the cultivation of Styrian Oil Pumpkin in Austria as an example.[1] This is for several reasons. First of all, it is an alternative crop which is currently undergoing a very dynamic development. Secondly, since 1996 the name "Styrian Pumpkin Seed Oil" is registered as a Protected Geographical Indication (PGI), which limits the production of Styrian Pumpkin Seed Oil to a defined area (European Union, 1995). Within this PGI area, the cultivation of Styrian Oil Pumpkin is very unevenly distributed and local agglomerations can be identified which may be related to spatial interdependence. Thirdly, the PGI area consists of two separate regions (northern and southern), which differ in terms of production and marketing structure and are therefore likely to have developed in a different manner in terms of oil-pumpkin cultivation. To the best of our knowledge, no previous study has analysed the determinants of spatial variations in the cultivation of an emerging alternative crop, considering all of the above-mentioned aspects.[2] However, from a policy perspective, we think that including the spatial dimension in such an analysis – in our case the regional context and spatial interdependence – leads to a better understanding of the drivers of alternative products, as well as production systems, and this therefore enables a more effective targeting of policies aimed at promoting their diffusion. Piorr and Viaggi (2015) follow the same line of argument in the context of rural-development policy evaluation.

For the analysis we apply an econometric approach. This decision is based on the fact that we have previously gathered valuable information on the possible drivers of oil-pumpkin production from discussions with experts. Additionally, we have access to a unique cross-sectional dataset from the year 2010, comprising biophysical, socio-economic and infrastructural data from 563 municipalities located in the PGI area. Due to a high proportion of zeroes in the dependent variable (the percentage of arable land cultivated with oil pumpkin), we apply a Tobit model (Wooldridge, 2012). To consider regional differences, we estimate separate models for the northern and southern region of the PGI area, using the same set of independent variables. As a final step, we control our results for the presence of spatial interdependence which may lead to positive or negative externalities, by additionally estimating a Spatial Lag of X (SLX) model, introduced by LeSage (2009) and recently also advocated by Halleck Vega and Elhorst (2015).

The structure of the paper is as follows: in the next section, we present a brief literature review and put forward our basic econometric model. We then introduce our case study, the Styrian Oil Pumpkin, and describe our data basis, as well as the model variables. We proceed to the presentation and discussion of our results and, finally, we provide concluding remarks.

2. Methodology

2.1. Background information on the adoption and spatial distribution of emerging products and production systems in agriculture

The literature which analyses the adoption and spatial distribution of emerging products and production systems in agriculture comprises production systems such as organic farming (Padel, 2001; Schmidtner et al., 2012) or conservation agriculture (Arslan et al., 2014; Rodríguez-Entrena and Arriaza, 2013) and products like switchgrass (Jensen et al., 2007) or soy (Garrett et al., 2013). Essentially, the aim of such studies is to quantify the drivers which influence the adoption of, and therefore also determine the spatial distribution of, emerging production systems and products with different econometric models.

An initial type of study which has developed from the analysis of technology adoption (e.g. Lindner, 1987) focuses on adoption as a decision process. For example, Abadi Ghadim and Pannell (1999) develop a conceptual framework of individual farmers' decisions to adopt a new crop and they emphasise the importance of learning, risk perception and uncertainty. In an application of their framework (Abadi Ghadim et al., 2005), where the adoption of chickpeas in Western Australia is analysed, it is pointed out that adoption depends on economic motives as well as how risky farmers perceive the crop to be and whether the farmers have previous experience with the crop. Other studies which focus more on farm and farmer characteristics identify, for example, farm size, farm profitability, access to credit, the biophysical quality of land or the age and level of education of the farmer as relevant factors for adoption (for an overview see e.g. Knowler and Bradshaw, 2007; or Pannell et al., 2006; for an application see e.g. Rodríguez-Entrena and Arriaza, 2013). However, all these factors are very heterogeneous, because they vary, for example, with the product or production system of interest or the historical and cultural background of regions (Knowler and Bradshaw, 2007). One of the few studies which takes regional heterogeneity into account is by Useche et al. (2009), who discover that the factors which influence the adoption of improved maize varieties vary among different regions in the USA. A central finding of our literature review is therefore that research should focus on identification of crop-specific instead of universally applicable factors and should also take into account the regional heterogeneity of factors and their respective effects on adoption.

A second branch of literature concentrates on the role of spatial interdependence in explaining heterogeneity in the spatial distribution of a crop or production system. The basic idea is that adoption (e.g. planting of a new crop) and intensity of adoption (e.g. share of suitable arable land planted with a new crop) also depend on what happens in the neighbourhood. Such analyses mostly apply spatial regression models which relax the assumption – usually imposed by non-spatial regression models – that observations are independent from one another. Investigation in this area comprises, for example, the spatial distribution of major agricultural products like dairy and pig production (Isik, 2004; Roe et al., 2002) and soy and maize cultivation (Garrett et al., 2013; Odgaard et al., 2011), as well as alternative production systems like organic farming (Läpple and Kelley, 2015; Schmidtner et al., 2015; Schmidtner et al., 2012). For example, Garrett et al. (2013) analyse the determinants of soybean cultivation in Brazil with a cross-sectional spatial lag model at the county level. Their main findings are that beneficial biophysical conditions, which lead to higher yields and certain supply-chain configurations (co-operative membership and access to credit), promote soybean cultivation. Schmidtner et al. (2015) analyse spatial variations in organic farming in the German federal states of Bavaria and Baden-Württemberg at municipal and county levels, also with cross-sectional data. They find that less favourable climatic conditions and a favourable social and political environment have a positive influence on the share of organic farms in a municipality/county and they conclude that the share of organic farms also depends on the share of organic farms in neighbouring municipalities or counties – implying the presence of spatial interdependence.

[1] Throughout the text we refer to the Styrian Oil Pumpkin when we use the term "oil pumpkin".

[2] We would here point out that it is not the aim of this study to evaluate the PGI for Styrian Pumpkin Seed Oil as it is done for other products in other analyses (e.g. Lamarque and Lambin, 2015; or Quetier et al., 2005).