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Using spatial econometrics in impact assessment

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Abbreviations

CAP	Common Agricultural Policy
EAFRD	European Agricultural Fund for Rural Development
ESDA	Explanatory Spatial Data Analysis
EU	European Union
HNV	High Natural Value (HNV) agricultural land
NUTS	French abbreviation for Nomenclature des Unités Territoriales Statistiques, a geocode standard for referencing the subdivisions of EU countries for statistical purposes
RD	Rural Development
RDP	Rural Development Programme
SPARD	Spatial Analysis of Rural Development

Summary

SPARD has been undertaken to develop a modelling tool that will help policy-makers understand the causal relationships between rural development measures and their results in a spatial dimension. Spatial econometrics can contribute to the methodological challenges of the ex-post impact assessments of RDP.

The advantages of using (spatial) econometrics, based on the SPARD project are:

1. Assessment against counterfactual: In the spatial analysis of SPARD, the counterfactual is incorporated by analysing NUTS2 regions with different spending on the measures and different development trajectories of the baseline indicator (e.g. agricultural labour productivity).
2. Measuring micro and macro level effects: Impact assessment was explored at the EU level, while participation of RDP measures was predominantly analysed at case study level. Only impact analyses for France and Slovenia were feasible for the case study areas. More structural impact assessment at case study level with spatial econometric approaches would improve the opportunities to compare micro- and macro effects more adequately.
3. Net effects of programs: The spatial econometric analysis uses information on two RDP axis and shows that other spending of Axis 1 and total spending on Axis2 might have counter effects on the other axes.
4. Data and information requirements: When using econometric or spatial econometric analysis, a consolidated data base on impact indicators and baseline indicators as well as other general trends is a prerequisite.
5. Gap between indicator measurement and judgement of RDP: Our analysis provided more inside in the existence of spillovers and the impact of other axes on the effectiveness of RDP measures. Our assessment provided more insight in the effectiveness of measures encouraging tourism by taking into account different types of tourism indicators and spillovers.

1 Introduction

1.1 Objective of WP4.5

SPARD has been undertaken to develop a modelling tool that will help policy-makers understand the causal relationships between rural development measures and their results in a spatial dimension. One aspect of the SPARD work programme is to test the application of spatial econometric modelling for the impact assessment of Rural Development Programme (RDP). In SPARD, spatial econometric models were explored at different spatial levels that are corresponding to the different territorial levels of both rural development (RD) planning and monitoring.

Territorial subsidiarity is a guiding principle in the construction of the EU chain of governance. In the implementation of the rural development part of the CAP through the EAFRD (European Agricultural Fund for Rural Development), indicators that monitor effects of implementation are often at a lower level than the policy-making for the programming of RD specific measures (either a regional or national level), which is itself at a lower level than the decision-making regarding the orientations for the programming (co-decision with the EU).

Lukesch and Schuh (2010) provided reasons for the importance of assessment of impacts of given policy measures. We can categorize them into three types. First of all, assessments provide empirical evidence on whether or not a specific policy measure is effective and whether they contribute to more general societal goals (e.g. concerning growth or development); Secondly, assessments can also help to re-design a policy measure or programme to make them more effective and efficient (by taking into consideration costs of intervention). In addition, assessments provide arguments for continuation or discontinuation of policies/programmes by comparing social costs and benefits of specific policy interventions. Thirdly, assessments have got a learning effect: they help to learn about the functioning of economic, social and environmental processes. They improve institutional capacities of organisations involved in impact evaluations, to improve decision making and to provide information regarding accountability of institutions involved in formulation and implementation of policies.

As already mentioned in Reinhard *et al*. (2013, p. 16), (spatial) econometrics has never been used in ex-post assessments of RDP EU wide. It has however been used in the evaluation of the effectiveness of the EU Structural Funds and convergence between European regions (Dall'erba & Le Gallo, 2008; Gallo Le & Dall'erba, 2008).

In order to foster a common perspective and approach to impact evaluation of Rural Development Programmes and their potential impacts on people, society and the environment, the European Commission has produced a Handbook on Common Monitoring and Evaluation Framework (Com, 2007). It defines impacts as the effects of an intervention lasting in medium or long term. Some impacts appear indirectly (e.g. turnover generated for the

suppliers of assisted firms or unexpected such as spillovers). Some can be observed at the macro-economic or macro-social level (e.g. improvement of the image of the assisted area). Impacts may be positive or negative, expected or unexpected. See Com (2007).

Lukesch and Schuh (2010) defined five key issues for the assessments of the impact of the rural development programme in the context of multiple intervening factors:

1. Assess the programme impact against their counterfactual;
2. Measure both the micro and macro level effects;
3. Estimate the net effects of the programme, by netting out the deadweight, substitution and multiplier effects;
4. Construct a data and information base;
5. Bridge the gap between indicator measurement and a judgement of the functioning of the Rural Development Programme as a whole.

Spatial econometrics could be a helpful tool to overcome the methodological challenges raised by (Lukesch & Schuh, 2010). The research question of this report is how spatial econometrics contributes to the methodological challenges of the *ex-post* impact assessments of RDP. We will use our experiences of impact and participation assessment in the SPARD project at EU27 level (Reinhard *et al*., 2013) and at case study level (Viaggi *et al*., 2013)}.

1.2 Outline of the report

As mentioned above, spatial econometric analyses can contribute to the assessment of the effectiveness of RDP measures. Chapter 2 discusses the added value of using (spatial) econometrics in ex post evaluations. In addition, we also point at the disadvantages of requirements econometric methods. In Chapter 3, we present the contributions of the spatial econometric analyses in the SPARD project to methodological challenges in the context of multiple intervening factors with respect to the RDP assessment. Finally, Chapter 4 concludes.

2 Econometrics versus other assessment analyses

2.1 Introduction

Lukesch and Schuh (2010) distinguish three phases in the process of RDP assessment: 1) Gauging the evidence. This includes the structuring of the evaluation process, data collection and information gathering, the measurement of changes in the indicator values and their interpretation. Impacts have to be corrected for other influences than RDP, such as general trends, external economic shocks, and impacts form other policy interventions. 2) Identifying the drivers of change. This phase provides lessons of why and how the RDP measures have worked. In particular, the contributions of specific measures to (expected or unexpected) impacts in relation to specific context conditions or behaviour patterns of programme beneficiaries, non-beneficiaries and/or stakeholders. 3) Understanding the change and concluding on future interventions. The third phase informs rural development policy as the ultimate goal of RDP evaluation. The interpretation of measured indicators and of qualitative (subjective and objective) information eventually allows for judging on the contribution of rural development measures to change and on the impact of the programme as a whole given their respective budgetary endowments.

According to Lukesch and Schuh (2010), impact evaluation of Rural Development Programmes should give answers to two questions, as its rationale and purpose is to improve programme performance and inform and improve rural development policy,:

- To what extent did the policy work?
- Why and how did (or not) the policy work?

Quantitative methods have comparative advantages to provide answers to the first question, and a mix of quantitative and qualitative methods may better be used to explore the second type of questions. In particular, quantitative approaches based on analysis of observables should be combined with a qualitative analysis of un-observables that may have affected the obtained results. Qualitative approaches include surveys, interviews, focus groups, process monitoring, and experimental approaches, (Lukesch & Schuh, 2010).

This report – as a part of the SPARD project – emphasises the use of spatial econometrics as one of the quantitative approaches. Basically, spatial interaction effects are important because regions are interlinked in many ways, such as infrastructure, economy, environment, tourism, amongst others. Policy in one region can have an (additional) effect on nearby regions. In SPARD, we have (among other things) analysed the spatial reach of policy measures with the use of spatial econometrics, see Uthes *et al.* (2011). Below, we will summarize the advantages and requirements of using spatial econometrics in RDP assessment. We base this summary on the experiences witnessed in the SPARD project with EU27 analyses (Reinhard *et al.*, 2013) and case study analyses (Viaggi *et al.*, 2013) during the project workshop on October 25-26, 2012 in The Hague (the Netherlands).

2.2 Advantages of using (spatial) econometrics

Before discussing the advantages of spatial econometrics over the ordinary methods, we briefly discuss the advantages of the Exploratory Spatial Data Analysis (ESDA), see Smit *et*

al. (2011). With ESDA, spatial information can be visualised conveniently. There are two types of spatial patterns of general interest. The first type is clustering: both high and low values, can indicate underlying factors for farms, firms or people to agglomerate. These agglomeration patterns are studied in agricultural economics (Larue & Latruffe, 2009) and agriculture labour productivity in Chapter 3 of Reinhard *et al*. (2013). The second type of spatial patterns is that where high values and low values occur side-by-side. This can be the case for example where an urban region is surrounded by rural areas, and rural-to-urban migration leads to positive population growth in the city, but negative population growth around it. If either one of the spatial patterns is present, this might have consequences for targeting with respect to RDP objectives. Once spatial patterns are discerned, those pattern have to be taken into account such as in spatial econometrics. In the analyses of agricultural productivity, biodiversity, water quality and tourism, spatial patterns were present in the indicators as well as in the RDP expenditure associated with them, see Reinhard *et al*. (2013).
For this discussion, we distinguish between advantages of spatial econometrics over non-econometric methods (see previous section on quantitative and qualitative approaches) and spatial econometrics over a-spatial econometrics.

There are two ways to conduct spatial econometrics (Uthes *et al*., 2011). Firstly, spatial heterogeneity is rather straightforward and can be captured reasonably well with regional dummies, possibly interacted with an independent variable if the effect of that variable varies by region, or land use indicators. The policy design of RDP, for instance, is different in all Member States. For most measures, farmers and other entrepreneurs in the tourism industry change their behaviour (management of the firm) based on the RDP. These changes have direct impacts on the region. Hence, each element of the impact of RDP is related to a level in spatial scale. With country-specific dummy variables, institutional differences across countries were taken into account. Another type of spatial heterogeneity are spatial variables that is encounter distances to some important location (e.g., to the nearest airport, harbour or rail and road infrastructure). Secondly, spatial dependence is present if:

- the outcome in one region is affected by the outcome in neighbouring regions and
- the where the outcome in one region is affected by (unknown) characteristics of the neighbouring regions.

Spatial heterogeneity can be captured with linear econometric specifications as well. Spatial econometrics are necessary to take into account spatial dependence.

Advantages of spatial econometrics over standard econometrics

If spatial dependence is present in the data, spatial econometrics can take account of this spatial dependence and produce unbiased results. Reversely, if the spatial dependence is ignored, non-spatial econometric methods will produce biased results. One of the reasons for spatial dependence is the presence of omitted (spatial) variables. Spatial econometrics dealt with this omission and produce unbiased results. As a consequence, the goodness of fit of the spatial econometric specification improves compared to the linear. (larger part of the variances of the residuals is explained). Finally, spatial econometrics also allows researchers to identify cluster effects taking into account all other effects included in the specification. Information on clustering might be useful in targeting RDP measures.

2.3 Requirements for spatial econometric analysis

The characteristics of the subject of investigation determine the choice of spatial scale for spatial econometrics. If, like in the Brandenburg case study (Zasada *et al*., 2012), farm holdings are so large, that they cover entire municipalities or span into neighbouring municipalities, the spatial level of NUTS4 has only limited value for spatial econometrics, because it might refer to the neighbourhood of individual holdings or even refer to the same holding. Also with increasing size of the actors (large co-operatives) the spatial neighbourhood is becoming less important in comparison to the "social" neighbourhood, which might be outside the local farming community. The actual loci where spill-over effects are captured by spatial econometrics. Here, the scale of the potential spillover determines whether spatial econometrics can produce significant results at the distinguished aggregation level.

Moreover, data availability varies across different spatial levels. Indicators available at NUTS2 level are not necessarily available at lower aggregation level as was witnessed in the comparison of SPARD case studies and the SPARD EU-wide analyses, see Linderhof *et al*. (2013). Data availability also determines the feasibility of particular econometric specifications. The type of data might change with aggregation levels (see Linderhof *et al*. (2013). Desjeux *et al*. (2012) and Travnikar *et al*. (2012) used probit and tobit specifications for their spatial econometric analyses of impact assessment of RDP for respectively France and Slovenia.

Data requirements for spatial analysis and spatial econometric analyses are more stringent than in a-spatial (econometric) analysis. Spatial (econometric) analyses requires also information on neighbouring regions or areas. Whenever one of the neighbouring regions is not taken into account, the spatial patterns might not yield reliable information. Moreover, outliers cannot be discarded easily, because that will affect the spatial structure of the econometric analyses (Desjeux *et al*., 2012).

In addition to data availability, the administrative level is not always the most appropriate level to measure data, especially in the case of area-related measures. For area-related measures a mismatch between scales can exist as indicated by Travnikar *et al*. (2012) and already earlier recognised by Lukesch and Schuh (2010). Impact and data are preferably measured at areas that correspond to the system (impact indicator or decision maker) rather than administrative regions, because economic activities are usually not bounded by administrative areas. Then, however, data availability at the appropriate level if the system is usually not available.

From an econometric point of view there were some limitations witnessed in the case study analyses. Coefficients, which were significant in linear models, became insignificant when using spatial econometrics. Apparently, the significant results in the linear specifications were spurious because spatial dependencies were not taken into account. Finally, there are no clear objective criteria for the choice of best spatial econometric model or the use of the weight matrix.

3 Econometric in assessments of RDP

3.1 Introduction

The EC working paper on approaches for assessing the impact of the rural development programme in the context of multiple intervening factors (Lukesch & Schuh, 2010) presents five key issues related to the methodological challenges.

1. To assess the programme impact against their counterfactual
2. The requirement to measure both the micro and macro level effects
3. The requirement to estimate the net effects of the programme, by netting out the deadweight, substitution and multiplier effects
4. The requirement to construct a data and information base
5. Bridge the gap between indicator measurement and a judgement of the functioning of the Rural Development Programme as a whole

The spatial econometric approach explored in SPARD is a potential solution for most of these challenges.

3.2 Assessment against counterfactual

In our spatial analysis, the counterfactual is incorporated by analysing NUTS2 regions with different spending on the measures and different development trajectories of agricultural labour productivity, biodiversity, water quality and tourism. These differences allowed for a spatial econometric analysis that assesses the impact of expenditures. Also the difference in labour productivity across Member States due to their main agricultural activities and the level of wealth can be accounted for in the econometric analysis. The significant coefficients for some of the RDP expenditures mean that the impact indicators develop differently in case of absence of RDP policy. Moreover, spatial heterogeneity was taken into account in the EU27 analyses (Reinhard *et al*., 2013) and the case study analyse (Viaggi *et al*., 2013).

3.3 Measuring micro and macro level effects

Due to the ambition to analyse the impact of measures for all EU Member States and the related data constraints we applied our model at NUTS0 and NUTS2 level only. In that case the micro and macro effects can be determined and be compared. Economic impacts (like labour productivity) can be analysed best at firm and national level (at intermediate levels, economic data have to be constructed based on member state data). Environmental effects can be observed best at micro level, but they are only sparsely available. Nitrogen surplus is a practical indicator because it can be aggregated fairly easily. The related water quality cannot be aggregated. The measures for encouraging tourism are often project-based measures which makes it more relevant to use micro level indicators. In addition, particular types of spillovers are observed at lower administrative levels.

Linderhof *et al*. (2013)showed the comparison of the econometric analysis of the EU27 level and the case study level. Impact assessment was explored at the EU level, while participation of RDP measures was predominantly explored at case study level. Only impact analyses of

labour productivity and biodiversity were undertaken in the France and Slovenian case studies.

In the EU analysis (Reinhard *et al*., 2013), we took the macro effects of RDP expenditures into account. The methodology developed can also be used at micro level (farm level), if the data are available. This was incidentally the case. In the France case study, impact analyses were explored on labour productivity and biodiversity (Desjeux *et al*., 2012). RDP expenditures appeared not to be very relevant for the explanation of labour productivity and biodiversity (High Natural Value of HNV index and crop diversity index). Only one particular variant of measure 214 (adoption of organics production) showed a positive impact on labour productivity and the HNV index. In the Slovenian case study, the impact of RDP expenditures of measure 121 significantly and positively affected land productivity and agricultural labour productivity (Travnikar *et al*., 2012). Obviously, the evidence effect of RDP spending at the case study level is not very convincing. The main differences are: the level of impact analyses differs across Slovenia (municipality or NUTS5) and France (NUTS4 areas), and the definition of Impact indicators amongst others.

In contrast to positive effects of RDP spending on labour productivity and biodiversity in the case studies, the EU analyses did not yield any significant impact of Measure 121 and 214 on labour productivity and biodiversity respectively (Reinhard *et al*., 2013). Apparently, impacts show up in analyses at the level of the system and impacts at higher level. The impact are often project-based and do not sum up to a macro-level effect. However, more structural impact assessment at case study level would improve the opportunities to compare micro- and macro effects more adequate with spatial econometric approaches.

3.4 Net effects of programs

The isolation of the effect of a single measure or programme is not straightforward. Impact indicators are affected by autonomous trends (population growth, for instance), other policy measures and programmes (like Water Framework Directive, Birds Directive etc.) or other measures within the programme. Trends and one or more policies affect several Impact indicators from CMEF like economic growth, job creation, biodiversity. The use of econometric analyses makes it feasible to disentangle the effects of trends and policies, so that the net impact of a measure can be evaluated. In addition, impact of other policies and trends is controlled for.

Econometric analyses contribute to insights in the net effect of programs in two ways. Firstly, the impact of a particular RDP measure can be affected by other RDP measures or other RDP Axis. This cross-measure effect can be analyse with econometric analyses. Moreover, the analyses in SPARD also controlled for other trends reflected by socio-economic characteristics amongst others. The use of spatial econometric analyses is not required. Secondly, the implementation of a RDP measure can induce spillovers: neighbouring areas or region benefit from RDP expenditure in a region or vice versa. These spillovers can be detected with spatial econometrics using spatially lagged variables.

Cross measure effects

In the EU analyses, interaction effects between RDP expenditures on other measures and other Axes were analysed (Reinhard *et al*., 2013). The analyses of agricultural labour productivity included expenditure on Axis 1, Axis 2 and other Axes (i.e. Axis 3 and Leader). Total expenditures on Axis2 did not affect agricultural labour productivity. Expenditures on other Axes had a significant positive impact. Moreover, the spatially lagged expenditures on other Axes also had a significant positive impact.

The econometric analysis of agri-environmental measures in the EU analyses tested for cross measure effects from expenditures on other Axis 2 measures and on Axis 1. None of the different types of RDP expenditures had a significant effect on water quality or biodiversity. two RDP axis and showed that spending on Axis1 will reduce the effectiveness of spending on Axis2. With econometric analysis direct and indirect effects of the tourism measures were estimated.

Only in the French case study, RDP expenditures were taken into account in the impact analyses. Note however that the expenditures were replaced by predicted values derived from the participation models. For labour (reflecting an Impact indicator for labour productivity), there was no impact of measure 121 itself.

Spatial spillovers

Spatial spillovers can be tested for in spatial econometrics, using spatial either lagged variables (alike the Durbin model) or a spatial lag specification, see SPARD deliverable 4.1 (Linderhof *et al*., 2011). The labour productivity model contained a spatial lag of the total RDP expenditures, but the parameter estimated is not significant, indicating that spillovers of total RDP expenditures are absent. Taking the expenditures for the axes separately could show spillovers for the individual axes. In the two environmental models (nitrogen surplus and HNV) spatial spillovers were not tested for by incorporating the spatial lags of measure 214 and axis 1 and 2, but no spill overs were found. This result might be related to the fact that the level of analysis (NUTS0 and NUTS2 respectively) are larger than the scale of the actual spillovers.

In the tourism model tests for spillovers are performed. In case of domestic tourism, evidence for spillover effects for DP spending from neighbouring regions is found.

3.5 Data and information requirements

The assessment requires specific information for agriculture which is prepared by Cambridge Econometrics. Particular explanatory variables were collected separately which took quite some time. A lot of time was spent to construct data on the HNV-index for the entire EU at NUTS2 level, based on FSS data. Nitrogen surplus time series data were not available at NUTS2 level. Tourism indicators were available. When using econometric or spatial econometric analysis, a consolidated data base on impact indicators and baseline indicators as well as other general trends is a prerequisite. Currently, the CMEF seems to be primarily focused on the NUTS2 level for a EU analysis. All case studies had to collect data in the

national statistical offices. There was no coordinated activity on collecting data for case studies.

3.6 Gap between indicator measurement and judgement of RDP

Our analysis provided more inside in the existence of spillovers and the impact of other axis on the effectiveness of RDP measures 121. Analysis at lower aggregation levels would be required to close the gap further. Our analysis did not contribute to bridge the gap, because the environmental model assessments where explores at NUTS1-2 levels. However, we provided more insight in the effectiveness of measure 214 in relation with spillovers and spending of other RDP axis. Our assessment provided more insight in the effectiveness of measures encouraging tourism by taking into account different types of tourism indicators and spillovers.

With regards to the missing impact indicators at case study level, micro impacts of measures are hardly available because data are lacking and consequently econometric analyses of impacts at case study level are infeasible.

4 Concluding remarks

Spatial econometric approaches for the impact assessment of the effectiveness of RDP measures can be applied at different scale levels.

- Spatial econometrics in SPARD takes into account a counterfactual for agricultural labour productivity, biodiversity, water quality and tourism;
- In SPARD, micro-level and macro-level analyses were explored: macro-level analyses for impact assessment, and case study level for participation. Micro-level impact analyses was hardly feasible due to lack of data on impact indicators;
- For agricultural labour productivity, biodiversity and water quality, the net effect of programs was tested by including expenditures on other axis and RDP measures.
- Data requirements are stringent for spatial econometrics. Spatial econometric analyses seems to be applied best on higher level assessments (NUTS0-2) because of data availability, while the impacts and spillovers are more likely to show up at lower aggregation level (closer to levels of decision-making level and impact indicators).
- Due to the differences in the types of analyses, , results of EU analyses and case study analyses are hard to compare. SPARD has, however, provided more insight in the economic and environmental processes with respect to driving forces, the effectiveness of RPD expenditures, and the presence of spillovers.

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