SIXTH FRAMEWORK PROGRAMME PRIORITY

SSP-4 Policies-1.1

Contract-No.: 022708

ADVANCED-EVAL

Development and application of advanced quantitative methods to ex-ante and ex-post evaluations of rural development programmes in the EU

Instrument: Task 7: Ex-ante and ex-post evaluation tools of rural development policies

Thematic Priority: Modernisation and sustainability of agriculture and forestry, including their multifunctional role in order to ensure the sustainable development and promotion of rural areas

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WORKING PAPER ADVANCED-EVAL

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ADVANCED-EVAL WORKING PAPER SERIES
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Final Project Report

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Part I.

Introduction

by Christian Henning

Policy evaluation has become a major issue for many international organizations including the European Commission. In this context **ADVANCED-EVAL** has started its activities in March 2006. By developing interdisciplinary approaches to model rural development the institutes involved in ADVANCED-EVAL aimed to develop innovative and quantitative methods to improve evaluation techniques applied to EU rural development programmes.

In October 2009 the project ADVANCED-EVAL has been finalized and we are convinced that the project has achieved its main objectives. In particular, ADVANCED-EVAL provides a set of innovative applicable tools for an efficient ex ante and ex post evaluation of rural development policies derived from an innovative quantitative approach to rural policy development that has led to important research findings, theory developments and policy-relevant knowledge.

This final project report summarized main results. However, we consider this final report still as a draft document which has been prepared for internal circulation within the consortium and the European Commission only.

Moreover, although within this report main results of each working group are summarized by each working group leader, these are of course the outcome of joint work that could only be achieved via an efficient cooperation and collaboration of the complete research team of ADVANCED-EVAL. Therefore, in the following brief a overview on the main task and team members of the different working groups of ADVANCED-EVAL is given.
The main task of the working group ***Expost-eval*** was the development and application of innovative quantitative methods to ex post evaluation of EU rural development programmes. To this end the working group applied new econometric estimation techniques, i.e. propensity score matching (PSM) enabling the computation of unbiased baseline scenarios. Based on comparisons of programme participants with an appropriately derived baselines, direct programme impacts (i.e. ATT, MTE, etc.), and indirect effects of RD programmes, (i.e. substitution effects, replacement effects, deadweight loss effects, etc.) have been calculated. ***Expost-eval*** was responsible for testing the applicability of the methodology to an ex-post evaluation of EU RD programmes.

The main task of the working group ***Qual-life*** was the derivation of a Rural Development Index as a measure of the quality of life in rural regions. At methodological level the construction of a RDI was based on a composite welfare index including various economic, environmental, and social RD components with relative weights derived from an econometric estimation of observed migration between communities. Based on empirical data for NUTS 4 and 5 regions in Poland and Slovakia the derived RDI-index was used to evaluate the overall impact of RD policies in individual rural regions.

The working group ***Net-RD*** has analyzed the role of social networks in rural development. At theoretical level new approaches in the field of "network and economics" as well as economic sociology were applied to understand rural development. In particular, the impact of social networks on the diffusion of knowledge, cooperation and on agents' belief formation have been analyzed. Further own collection of relevant network data via business, household and labor market and a policy network survey has been conducted in selected high and low performing regions. Based on collected data a comparison of network structures in high and low performing regions has been conducted. Moreover, econometric estimations have been carried out to assess the role of social network structures on economic and political performance.

The main task of the working group ***Exante-eval*** was the derivation of an adequate model framework for ex ante evaluation of RD policies including social network structures. Further, the derived theoretical model has been calibrated on the basis of empirical case studies of selected high an low performing rural communities. Based on the calibrated model various policy simulations have been conducted for high and low performing rural regions to: (i) identify the impact of specific tangible and intangible factors in rural development, (ii) quantify the impact of specific tangible and intangible factors on the effectiveness of individual RD measures, (iii) identify new RD measures improving local network structures. The theoretical model framework corresponds to a micro-macro linked model combining an interregional computable general political economy equilibrium model at the macro level with a farm household model and agent based models at the micro level. (ABM-CGE). Based on the simulation results of the applied ABM-CGE approach new and interesting insights into the impact of tangible and intangible factors on the efficiency of RD policies could be derived. Moreover, the ABM-CGE has been used as an efficient tool of a quantitative ex ante evaluation analysis.

Furthermore, generalized matching techniques have been applied as an alternative quantitative method of ex ante evaluation.

The main responsibility of working group ***Eval-ind*** was to validate techniques applied in this study by comparing programme effects calculated using quantitative methodologies described above with qualitative results obtained through interviews and surveys and to provide policy recommendations in this respect. Based on these comparisons implications regarding future methods applied for ex ante and ex post evaluation of RD-policies have been derived.

Partners

University of Kiel, Germany

The Institute of Agricultural Economics (IAE) at the University of Kiel is an internationally recognized centre of excellence for research and teaching in agricultural and applied economics. IEA conducts research funded by the European Commission, the German

National and Regional Governments, the German Research Foundation (DFG), World Bank, FAO, OECD, USDA, EIB, EUROSTAT and various prestigious German research foundations.

University of Bonn, Germany

One of the main objectives of the research activities of the Chair of Economic and Agricultural Policy of the Institute of Agricultural Policy, Market Research and Economic Sociology (University of Bonn) is to advise local, national and international policy institutions on policy strategies (economic, social and environmental aspects) based on broad quantitative analysis. The institute has specialised in the development and application of agricultural policy information systems over more then three decades, e.g. the SPEL-System for Eurostat, and different systems for Germany.

University of Sussex, UK

SPRU (Science and Technology Policy Research Centre) is a research centre of the University of Sussex. It is a leading academic institution in the field of science and technology policy research carrying out world-class research and teaching on issues relating to scientific discovery, technical change, and related government policies since 1966. SPRU has been a pioneer in the development of foresight methods and techniques for the evaluation of science and technology policy programmes. The centre has undertaken a very substantial number of research projects for the European Commission and the European Parliament, and has been a core member of the ESTO Network since its creation.

Utrecht University, Netherlands

The Department of Sociology at the Utrecht University is part of the research school ICS (Interuniversity Center for Social Science Theory and Methodology). ICS is one of the world's leading research institutes in the field of social network studies and has been involved in many research projects on "Cooperation in social and economic relations" and "Social capital and social networks".

University of Mannheim, Germany

The Mannheim Centre for European Social Research (MZES) is the largest institute at the University of Mannheim and one of the leading social science centers of Europe specialised in research on changes in societies and political systems of Europe and the process of European integration. The MZES has undertaken a substantial number of research projects in the field of social and political science among these are studies on policy development under the impact of network relations.

IRWIR (Polish Academy of Sciences, Poland)

The Institute of Rural and Agricultural Development was established in 1971. IRWIR adopts an inter-disciplinary approach to its studies focused on various issues related to rural areas in Poland. IRWIR has a long experience in monitoring of development in rural areas from economic and social perspective and was involved in preparation of a long-term strategy for development of rural areas and in the process of integration with the European Union. Important projects carried out by IRWIR include: European Network for Agricultural and Rural Policy Research (ENARPR).

IERIGZ (Institute of Agricultural and Food Economics, Warsaw, Poland)
Institute of Agricultural and Food Economics, Warsaw, Poland The Institute of Agricultural and Food Economics (IERIGZ) is a well-known research and development institution established about 55 years ago. The research carried out by IERIGZ embraces the following areas: development of the agricultural and food industry sector in Poland, rural development in Poland, consequences of EU accession for Polish agricultural industries.

The Research Institute of Agricultural and Food Economics, Slovakia
The Research Institute of Agricultural and Food Economics comprises analytical work concerning the agricultural and rural sectors, preparation of studies, forecasting, and elaboration of strategic policy documents. The Institute operates various statistical information systems such as Farm Accountancy Data Network or Land Valuation Database. It provides regular surveys on farm level economy and monitors national agricultural markets.

Europrojects-LBV
In April 2007 the European Commission approved a formal project request to include the private company EUROPROJECTS-LBV as a new partner to the project. The company (a 100 percent subsidiary of the Landwirtschaftlicher Buchführungsverband Schleswig-Holstein, LBV) is a private SME specialized in consultancy on topics linked to agricultural and rural policies and management of diverse rural development projects.

Finally, I thank all participants of ADVANCED-EVAL for their effective cooperation.

Christian Henning, Project Coordinator
Kiel, December 2009

Part II.

Micro-econometric ex post evaluation methods (WP2)

by Jerzy Michalek

Chapter 1.

Objectives and background

In recent years the mid-term and ex-post evaluation of EU co-founded RD programmes had been assigned increasing importance. To verify that support provided to rural development brings about expected results, comprehensive evaluations of RD programmes have to be carried out. An important purpose of mid-term and ex-post evaluations of EU programmes is to examine effects (i.e. results/impacts) of a given RD programme, and particularly learning about:

1. The programme's *effectiveness*, i.e. the degree to which a programme produced the desired outcome (an assessment of a programme's effectiveness implies a pre-definition of operationally defined objectives and criteria of its achievement), and

2. Programme *efficiency*, i.e. the degree to which overall programme benefits relate to its costs.

While evaluations of RD programmes are expected to deliver well-founded judgements and recommendations in the context of political discussions about rural development policy, their overall objective is to contribute to improvement of the quality and coherence of the policy development process.

Given above mentioned objectives and expectations linked to evaluations, a rigorous assessment of programmes impacts becomes a great challenge for programme evaluators. The main reasons are as follows:

1. The impact of a programme is expected to be described as a *cause-and-effect* analysis.

2. The programme impact should be measured *quantitatively*.

3. The programme impact should be *separated from other exogenously determined factors.*

The methodological problems in evaluation are persistent because:

1. in the majority of cases, the micro-economic results of a given RD programme/measure **depend on a number of factors and their interactions** (e.g. farm and household characteristics, institutional framework and community and social environment), and

2. RD programmes/measures are usually designed to target a specific group of producers/ enterprises/regions, etc., which makes simple comparisons with **an average non-supported group methodologically problematic.**

Programme impacts can only be measured if one knows what would have happened without it. In this sense, determining an appropriate ”non-participate” or counterfactual state is so **central** to evaluation that the whole quality of the evaluation is contingent on answering this question.

Unfortunately, the practice shows that a rigorous assessment of the effects of RD programmes is difficult, in particular, if only crude methodologies and techniques are used (mostly qualitative methods). As a consequence, the quality of evaluation reports has continuously been challenged and improvements have been requested.[1]

Given above circumstances, the general objective of the research under WP-2 was to address the above problems by focusing on the further development of quantitative tools which enable a more accurate assessment of the micro-economic effects of RD programmes. The specific research objectives for WP-2 were as follows:

1. Further development of quantitative techniques (a combined statistical and econometric approach) enabling a non-biased derivation of a counterfactual baseline to be applied for the assessment of the effects of EU RD programmes on supported and non-supported units (e.g. producers, enterprises, etc.) using pre-defined result/impact indicators.

2. Application of above techniques for:

   i.) Calculation and disentangling the effect of the programme from other (exogenously determined) factors

   ii.) Calculation of both direct as well as the programme’s indirect effects (e.g. substitution effect, leverage effects, deadweight loss effect, etc.)

3. Comparisons of empirical results obtained by using advanced evaluation techniques with other tools and procedures commonly applied to evaluate RD programmes (on the base of RD programmes implemented both in new and old EU member states).

[1] For example, a large number of evaluation reports, although generally considered as ”satisfactory”, were given, on an important criteria (i.e. sound analysis), a mark ”poor” only because the conclusions on impacts appeared often to be purely descriptive and had failed to provide a cause-and-effect analysis (Toulemonde et al., 2002).

4. Disseminating results of this research among all interested groups and individuals (potential evaluators, policy makers, research students, etc.)

In view of above objectives, an important part of the research under WP-2 focused on further development of evaluation methodologies enabling answers to the fundamental evaluation question: What would have been a given outcome for the programme beneficiaries if the programme had not been implemented?

The challenge in answering this question arises from the fact that the counterfactual programme outcome is inherently unobservable, because supported producers/enterprises cannot simultaneously participate and not participate in the RD programme. An important task of our research was therefore to further develop advanced methodologies which enable appropriate elaboration of a counterfactual baseline and allow disentangling direct and indirect effects of the programme in question from other exogenously determined factors. Another important task was to empirically test the applicability of these methods to evaluations of EU RD programmes implemented both, in new as well old Member States.

Chapter 2.

Main activities undertaken in WP2

Main research activities undertaken within WP2 include:

I. Application of a PSM-DID matching estimator for ex post evaluation of RD-policies:
   - Application of PSM-DID matching estimator to estimate direct impacts of SAPARD policy in Slovakia: micro level in years 2002- 2004.
   - Application of PSM-DID matching estimator to estimate direct and indirect (including deadweight loss, substitution and displacement effects). of RD-policy in Schleswig-Holstein: micro level in years 2000-2006.

Chapter 3.

Main results of WP2

3.1. Research methodology

A comprehensive description of methodology and its application under the WP-2 is available in [D2], [D13]. The main objective of WP-2 was to show how various micro-economic direct and indirect effects (e.g. deadweight loss, leverage effects, etc.) and selected general equilibrium effects (e.g. substitution and displacement effects) of EU RD programmes can be calculated using advanced evaluation methodologies. The main principle of the analytical approach chosen under WP-2 to evaluate EU RD programmes was to infer the economic return to resources employed in a RD programme by comparing this return to its opportunity costs and answering the question: What would have been earned from the next best alternative use? (Holland, 1986). A standard potential outcome model was selected as one that formalizes the problem of inference about the impact of the participation in the given programme on the outcome of an individual unit (Roy, 1951; Rubin, 1974; Holland, 1986).[1]

Depending on the particular policy interests, answers to the Common Evaluation Questions (CEQ) addressing the effect of a given RD programme on a particular group of

[1] The model adjusted to the RD framework assumes that each farm/enterprise i potentially exposable to the RD programme/measure also fulfils all relevant programme participation criteria (programme general and specific eligibility criteria are usually defined in a country's main programming document, i.e. Rural Development Plan). Observable variable D (a binary variable 0-1) indicates whether an individual unit-i participated or did not participate in the RD programme. Furthermore, the simplified model assumes existence of a set of variables X representing pre-exposure attributes (covariates) for each individual unit i, of which some can be observable (x), and some other are not observable (e) as well as a set of variables Y which depend on D, representing the potential response of unit i to the RD programme Y_i (D_i). Obviously, Y may consist of outcome variables (e.g. specific result indicators) reflecting the effect of the programme at a micro-level: e.g. income, profits, employment, labour productivity, total factor productivity, etc. In the case of EU RD programmes Y represents two variables standing for potential responses: $Y_i(1)$ in case of participation in the RD programme, and $Y_i(0)$ in case of nonparticipation in the same RD programme. Using the potential outcome model, the effect of participation in a EU RD programme for an individual unit i (e.g. farm/region) can be written as: $\tau_i = Y_i(1) - Y_i(0)(1)$ Where: Y_i (1) = outcome for unit i in case of participation in RD programme Y_i (0) = outcome for unit i in case of non participation in RD programme τ_i = the effect of programme participation on unit i, relative to effect of non-participation on the basis of a response variable Y.

”winners” were provided using specific policy indicators such as:

- Average Treatment Effects (ATE)

This indicator is simply the difference of the expected outcomes after participation in the RD programme and non-participation conditional on farms/enterprise characteristics (Heckman, 1996; **?**; **?**).

- Average Treatment on Treated (ATT)

ATT is the most relevant policy indicator commonly applied in evaluations of programme effects. While ATT focuses on the effect of the programme on programme participants only, it also describes the gross gain accruing to the economy from the existence of the programme compared with the alternative of terminating the programme (**?**Heckman, 1997; Smith, 2000; Smith and Todd, 2003). Combined with information on programme costs and general equilibrium effects, the ATT indicator can therefore answer the policy question regarding the net gain to the economy.

- Average Treatment on Non-treated (ATNT)

ATNT indicators were used to answer questions concerning the measurement of the effect of a given RD programme on those who did not participate in this programme.

Although ATE, ATT and ATNT are generally applicable to provide answers to RD common evaluation questions concerning the effect of the RD programme, their empirical estimation in non-experimental studies is not straightforward. In fact, in all above cases the assessment of the programme effects requires a construction of appropriate counterfactuals.

In the context of non-experimental studies the counterfactuals cannot be estimated directly in a manner analogous to the one based on randomization. Given the possibility of a significant bias in results obtained from using crude evaluation techniques, other more advanced methods were therefore applied aiming at elimination/correction of this bias.

Propensity score matching (PSM) in combination with the Difference in Differences (DID) method was the main technique used in this research. The PSM method predicts the probability of receiving support on the basis of observed covariates for both supported and non-supported units.[2] The method balances the observed covariates between the supported group and a control group based on similarity of their predicted probabilities of receiving support, e.g. from the RD programme. Supported units are matched to non-supported units on the basis of propensity scores. The aim of matching is to find the comparison group from a sample of non-supported units that is closest (in terms of observed characteristics) to the sample of programme participants. Exact matching

[2]The usefulness of the PSM methodology has been confirmed in a number of studies carried out by the World Bank (including non-traded goods, e.g. infrastructure, education, etc.)

implies that resulting comparison groups and supported units have the same distribution of covariates.

While propensity score matching can be applied to control for selection bias on observables at the beginning of the programme, a combination of PSM with DID methods (conditional DID estimator) allows for a better controlling of selection bias in both **observables** and **unobservables**. The combined PSM and DID method is a highly applicable estimator in case the outcome data on programme participants and non-participants is available both "before" and "after" periods. The PSM-DID measures the impact of the RD programme by using the differences between comparable to each other programme participants (D=1) and non-participants (D=0) in the before-after situations. In this method observed changes over time for the matched (using PSM) programme non-participants are assumed to be appropriate counterfactual for programme participants.

A decisive advantage of the PSM-DID estimator (conditional DID estimator), compare to a standard DID estimator, is that by applying this methodology, initial conditions regarding observable heterogeneity of both groups (programme participants and non-participants) that could influence subsequent changes over time are largely eliminated. Similarly, an application of a conditional DID estimator (PSM-DID) to the measurement of the effects of a given RD programme may greatly improve research findings compared with a situation where a standard PSM (e.g. for estimation of ATT) that uses post-intervention data only is applied.

The issue of unobservables <**sensitivity tests**> was in our research addressed by applying the bounding approach proposed by Rosenbaum (2002). The approach applied during the sensitivity analysis allows determining how much hidden bias would need to be present to render plausible the null hypothesis of no effect or in another words how strongly an unmeasured variable must influence the selection process in order to undermine the implications of matching analysis.

Other, more general sensitivity checks were carried out to test the stability of obtained results. Sensitivity checks embraced the response of estimated effects from programme participation to small changes, e.g. in the specification of the propensity score, number of selected companies, changes in covariates, changes in parameters of balancing properties, etc.

Given a standardized set of variables describing characteristics of agricultural enterprises (e.g. FADN data) an important sensitivity test was to find out what is a minimal/optimal set of conditional variables to be included in estimation of propensity scores.

3.1.1. Estimation of programme indirect effects

In some cases, RD programme support, may be mis-targeted. **Deadweight loss effect** occurs if a participant of a RD programme would undertake a similar investment also without a RD programme support (i.e. RD support would not change investment behaviour of targeted enterprise). **Leverage effect** can be considered as important micro-economic consequence of RD support. It occurs if public funding (e.g. in form of RD programme) induces private spending among the programme beneficiaries.

General equilibrium effects occur when a programme affects persons/enterprises other than its participants. The most important possible impacts are the **substitution effect** and the **displacement effect**.[3] Both effects play usually a more important role in the evaluation of large programmes than in the evaluation of small programmes. Yet, they cause problems for programme evaluators because most of the partial evaluation methods either miss these effects entirely or produce biased results in their respect. Due to a possibly negative/positive impact on programme non-participants the evaluation of a given programme becomes more complex. Specifically, standard propensity score matching methods assume that outcomes for non-participants in the control group are not affected by the programme (no general equilibrium effects). If general equilibrium effects had occurred during implementation of a given RD programme, i.e. if a given RD programme had a substantial impact (positive or negative) on farms which did not participate in this programme, partial equilibrium evaluation techniques such as standard PSM would produce biased estimates of programme effects. An important challenge of our research under WP-2 was to therefore address these problems and propose alternative solutions, using methodology that would be less time and resource consuming than a standard CGE modelling. In consequence, we proposed a modified approach (i.e. a two stage approach using a combination of a modified and a standard propensity score matching) which successfully solved many of above problems thus leading to unbiased estimation results.

3.2. Empirical application of ex post matching methods

3.2.1. Data used

- Slovakia:
  The dataset comprised FADN farm data collected for 232 Slovak large agricultural companies supported and non-supported through the SAPARD programme in the years 2002-2005 (balanced panel data).

- Schleswig- Holstein, Germany
  The main data source used for the assessment of the effects of the AFP programme in

[3] Another important general equilibrium effect is a multiplier effect (occurring at a macro-level). Methodology for estimation of a **multiplier effect** is provided in description of activities under the Work-package 3

Schleswig-Holstein was farm bookkeeping data comprised of approx. 10 500 farms for the year 2000/2001 and 3 900 farms for the year 2007/2008 (balanced panel consisted of 1333 farms specialized in milk production).

3.2.2. Main analytical steps carried out

The main analytical steps carried out to estimate direct and indirect programme effects of the AFP programme in Germany and the SAPARD programme in Slovakia followed the methodology described in [D2], [D13]. In both cases (Slovakia and Germany) the binary propensity score matching was the crucial methodology applied to evaluate direct and indirect programme results.

The basic analytical steps were as follows:

First, Selection of programme eligible farms (including both beneficiaries and non-beneficiaries)

Second, Selection of the most important farm characteristics (by applying a mix of econometric and expert procedures)

Third, Calculation of individual propensity scores. The propensity scores for each observation in the supported and the non-supported sample of producers/enterprises were econometrically estimated using the predicted values from a standard logit-model. The estimated logit model of programme participation is a function of all the variables in the data describing farm/unit characteristics and economic performance that are likely to determine both participation and programme outcomes. Propensity scores are predicted values of the probability of participation obtained from the logit regression calculated individually for every sampled supported and non-supported unit.

Fourth, Exclusion of non-similar enterprises from the control group. Some of the supported and non-supported units were excluded from further comparisons because their propensity scores were outside the range calculated for supported units (outside of the common support region). Matched pairs of producers/enterprises/regions etc. were constructed on the basis of how close the estimated scores were across the two samples (programme participants vs. controls). Out of several alternative matching algorithms enabling calculation of the average outcome indicator of the matched supported and non-supported groups, ranging from "nearest neighbour" to kernel functions (Gaussian or epanechnikov), the "best" matching algorithm (given a data base) was selected on the basis of three important criteria: minimization of the standardized bias (after matching), satisfaction of balancing property tests, and satisfaction of the pseudo R^2 test.

Fifth, Calculation of relevant outcome indicators. The mean values of the relevant outcome indicators (e.g. profit per company, GVA per employed person, Employment per farm, etc,) for comparable supported and control units were computed using the matching algorithm selected above (e.g. Kernel method).

Sixth, Calculation of the most important policy parameters. All the most important policy parameters, i.e. Average Treatment Effect on treated (ATT), average treatment effect (ATE) and average treatment effects on non-treated (ATNT) were calculated in this step, based on the estimated counterfactuals.
Seventh, Application of the conditional DID method and estimation of programme direct and indirect micro-economic effects. Programme effects were computed on the basis of the estimated differences between respective policy parameters (ATT, ATE, ATNT) prior and after finalization of the programme (conditional DID method).
Eighth, Performing sensitivity analysis. The sensitivity analysis was carried out in order to find out how much hidden bias would need to be present to render plausible the null hypothesis of no programme effect.

Specific activities

Ad Estimation of micro-economic effects of the SAPARD programme in Slovakia

The specific objective of this activity was to improve the estimation of direct effects of the SAPARD programme in Slovakia by applying a newly developed procedure allowing for the selection of the "best" propensity score matching algorithm and inclusion of the most important variables into the estimated logit function.

Description of activity

The following steps were carried out:

a) Selection of variables

  - Step 1. On the basis of expert knowledge the long-list of the most crucial variables determining both participation and outcomes was constructed, **using the entire Slovak FADN data set**. This activity resulted in a pre-selection of ca. 400 out of approximately 7400 potential variables and categories.
  - Step 2: The most important statistically significant variables (out of preselected 400) which simultaneously satisfied balancing property tests were selected as relevant covariates in the estimated logit function. This was done by applying an iterative procedure (by iteratively adding new variable to logit specification) whereby respective balancing property tests were carried out, given common support conditions. As a result, the selection of variables to the logit function was based on a combination of statistical significance methods and expert assessments.

– Step 3: Step two was supplemented by an obligatory selection of variables considered as critical for comparability of economic performance across agricultural companies prior to the beginning of the programme (i.e. profit per company; GVA per employed, employment per farm, etc).

– Step 4: Econometric estimation of logit function and calculation of programme effects

a. Selection of the "best" matching algorithm
The most commonly used matching algorithms involving propensity score are: Nearest Neighbour Matching (using various parameters), Radius Matching (using various parameters), Stratification Matching and Kernel Matching (using various parameters). The selection of a relevant matching technique was carried out using three independent criteria: i) standardized bias (**?**); ii) t-test (**?**); and iii) joint significance and pseudo R2 (**?**). In order to find the "best" matching algorithm an iterative procedure (e.g. linear search) aiming at minimization of the calculated standardized bias (after matching) and minmin as the main selection criterion was applied using data on SAPARD participants and nonparticipants in Slovakia. In all considered cases (various matching algorithms) an optimal solution could be found due to local/global convexity of the objective function with respect to parameters describing each matching algorithm (e.g. radius magnitude in radius matching; or number of nearest neighbours in nearest neighbour matching).

b. Carrying out variables' balancing property tests between selected programme supported and non-supported agricultural companies (common support imposed) Balancing property tests were carried out in order to verify that the selected matching algorithm ensured full comparability of programme beneficiaries and controls (SAPARD data in Slovakia).

c. Selection of relevant result indicators
Seven relevant results indicators were selected from a standard FADN system in order to assess the micro-economic effects of the SAPARD programme in Slovakia on programme beneficiaries (using combination of ATT-DID methods).

  · Profit per company
  · Profit per ha
  · Profit per person employed
  · Gross value added per company
  · Employment per company

  - · Labour productivity (Gross value added per employed)
  - · Land productivity (Gross value added per ha)

d. Estimation of programme results
   Assessment of results of SAPARD (Measure 1) on profit, employment, gross value added, etc. of agricultural companies that were supported by the programme was carried out by applying above described selection techniques within the framework of the conditional DID method (i.e. combination of a binary PSM method and DID technique). Conditional DID method was applied to ATT parameters calculated for all respective result indicators (a-g) before and after the programme (years 2003-2005).

e. Sensitivity analysis
   Sensitivity analysis was carried out by applying the Rosenbaum bounds methodology to the estimated effects of the SAPARD programme in Slovakia (seven result indicators).

f. Comparison of traditional and advanced methodologies
   Obtained results were analysed in detail and compared with outcomes of traditional evaluation methodologies

g. Description of obtained results
   The methodological approach applied to the estimation of direct microeconomic effects of the SAPARD programme in Slovakia and obtained results were described in the project Regional Report [D13].

3.3. Selected results (SAPARD programme in Slovakia)

3.3.1. Scope and distribution of SAPARD funds under Measure 1: Investments in agricultural enterprises.

The SAPARD support provided under Measure 1 was primarily targeting the following agricultural sectors: a) beef sector, b) pork sector, c) sheep sector, d) poultry sector, e) fruits and vegetables sector.
The main objectives of this measure were to:

- Assure compliance with EU animal welfare, hygiene and environmental requirements;
- Increase the labour productivity and improve working conditions;
- Increase quality of agricultural production;

- Increase competitiveness of products and producers;
- Improve storage and post-harvest infrastructure;
- Maintain and use the natural potential of the country and solve employment problems in marginal regions;

Programme support under Measure 1 had the form of a capital grant covering up to 50% of costs of eligible investments in the above sectors. The structure of allocated financial resources from the SAPARD programme to individual programme measures (1-9) shows that the Measure 1 (Investment in agricultural enterprises) was the most important single programme activity. Indeed, between the years 2002-2004 as much as 27.5 Mill EUR or 28% of the total available resources under SAPARD programme (97.3 Mill EUR) were allocated to Measure 1. After 2004, i.e. after Slovakia's EU accession, the amount of total funds (i.e. SAPARD + RDP) allocated to Measure 1 increased to 32.6 Mill EUR i.e. by additional 19%. Out of 450 project proposals submitted under this measure 343 projects (SAPARD and RDP) were contracted and concluded. The major share of available funds under Measure 1 was spent on the support of investments in the cattle sector (34% of funds and 149 projects), followed by the fruit sector (23% of funds and 67 projects), poultry sector (20% of funds and 57 projects), pork sector (18% of funds and 55 projects) and sheep sector (5% of funds and 15 projects). The major beneficiaries of programme support under this measure (receiving approximately 67% of funds available under this measure) were **large agricultural companies** located in relatively well developed regions of West Slovakia (Nitra, Trnava and Bratislava).

At the beginning of the SAPARD programme there was a rather slow uptake of funds and a low level of participation of primary agricultural producers (Measure 1). In the case of large agricultural companies, this was mainly due to their difficulty in meeting the originally strict formal economic eligibility criteria, and their problems in securing external co-financing of their investment projects (50% or more) through commercial banking systems (many large agricultural companies in Slovakia were highly indebted at this time!). In the case of small individual firms, agricultural producers had problems with the interpretation of programme guidelines and were facing huge administrative costs for project preparations. Given the above situations, during the implementation of the SAPARD programme in Slovakia numerous changes to the programme were undertaken by the Programme Managing Authority (i.e. via amendments to the Rural Development Plan) with the aim of facilitating the spending of available SAPARD resources (Michalek and Tvrdonova, FAO, 2004). Many of these changes were initiated by lobbyists of large agricultural/food processing enterprises, which at that time, due to the overall difficulties in the agricultural sector but also due to management inefficiencies, were *economically too weak to qualify as eligible* enterprises under the original programme conditions. Although many studies were pointing out that a drastic weakening of programme eligibility criteria may have diluted the potential impact of the programme, this trend was irreversible.[4] In fact, the unequal distribution of funds under Measure 1 shows clearly that at that time an important goal was to strengthen the competitiveness and financial condition of large agricultural enterprises (in their majority former cooperatives or state farms) enabling a relatively smooth transition for them from a risky pre-accession period to a more stable EU membership (post-accession) stage.[5] Obviously, numerous inefficiencies that, *inter alia* had been caused by a weak farm management were compensated by the state intervention enabling a more stable development for supported large companies in the future

Subject of the evaluation analysis

Deficiencies of the SAPARD monitoring system (especially problems with a data base that would enable (/facilitate/allow/permit) assessment of programme effects on small individual farms) on one side, and a relatively abundant amount of data on large agricultural companies (part of Slovak FADN) on the other side, resulted in focusing assessment of programme results on agricultural companies.

In order to ensure maximum comparability between SAPARD supported and non-supported agricultural companies the eligibility issues were explicitly accounted for.[6] The following steps were carried out:

- SAPARD beneficiaries were identified and selected from the existing FADN databases. Data for each SAPARD beneficiary was collected in the years prior to their participation in SAPARD and in 2005 (after SAPARD).
- SAPARD general and specific eligibility criteria (e.g. pre-defined farm performance coefficients and farm profitability ratios; various minimum/maximum production-, age-, etc. thresholds; etc.) that were valid in individual years were translated into respective quantitative coefficients and applied to all non-SAPARD units included in FADN databases.

[4]Proposed changes were accepted by the EC on the presumption that otherwise the programme funds would not be spent at all.

[5]After EU accession, a stabilization of the situation for large agricultural companies was ensured by taking advantage of available direct payments.

[6]Generally speaking, an individual agricultural company not participating in the SAPARD programme may have chosen not to do so, or may have been ineligible (eligibility criteria were set in the programming document "Rural Development Plan"). Ideally, supported and non-supported companies should only differ in their decision to participate. Yet, if a company is programme ineligible it means that its support (via a given programme) was not policy intended because some critical company background characteristics (e.g. prior economic performance, current capacities, etc.) significantly differed from targeted ones. By including ineligible programme non-beneficiaries (which markedly differ in their background characteristics from eligible firms) into the analysis of programme effectiveness the similarity (balancing property) between programme beneficiaries and the control group would be violated.

- Agricultural companies, which did not receive a support from the SAPARD programme and which satisfied the above participation criteria in years 2002-2005 were selected as *eligible* non-participants.

- Respective balanced panels (i.e. embracing SAPARD beneficiaries and all non-SAPARD units that met SAPARD eligibility criteria in specific years) were constructed for the years 2002-2005, i.e. observations on the same units in period 2002-2005.

On the basis of the available Slovak FADN database, 232 agricultural companies were selected for further analysis (balanced panel data), which was performed for the years 2003 (before SAPARD) and 2005 (after SAPARD).[7] Of the selected 232 agricultural enterprises 51 agricultural farms were SAPARD participants and 181 farms SAPARD non-participants (yet, SAPARD eligible!).

Differences between the groups of programme participants and non-participants

A brief analysis of some key characteristics of the selected groups of farms (SAPARD participants vs. non-participants) shows that these two groups (both SAPARD eligible!) differed considerably. Agricultural companies which received support from the SAPARD programme were generally much larger (ha), they employed more people and were more profitable (i.e. less unprofitable) compared with those agricultural companies which were non-supported.

Assessment of programme results

In our study, we selected seven relevant result indicators available from a standard FADN system:

- Profit per company;

- Profit per ha;

- Profit per person employed;

- Gross value added per company;

- Employment per company;

- Labour productivity (Gross value added per employed);

[7] All selected beneficiaries received support from SAPARD in year 2004. Unfortunately, inclusion of the following years (2006 and 2007) was not possible due to dropping of many former agricultural companies from the data panel.

- Land productivity (Gross value added per ha);

In order to measure the effect of the SAPARD programme on agricultural companies which received support from the SAPARD programme (Measure 1) the ATT (Average Treatment on the Treated) coefficients were estimated for each result indicator separately in two data points: before the programme (year 2003) and after the programme (2005)[8].

The assessment of results of SAPARD (Measure 1) on profit, employment, gross value added, etc. of agricultural companies that were supported by the programme was carried out by applying the conditional DID method (i.e. combination of a binary PSM method and DID technique) to ATT parameters calculated for respective result indicators (a-g) before and after the programme (years 2003-2005).

The results of the ex-post SAPARD evaluation[9] that used national trends as a base-line were extremely positive. For example: on the CEQ question: To what extent have supported investments contributed to improve the income of beneficiary farmers? the answer of SAPARD ex-post evaluators was as follows: "The average salary in the agricultural sector increased from 10958 SKK in 2003 to 13 340 SKK in 2006, i.e. nominally by 30.9%. ... It is logical to assume that the growth of income of beneficiaries was at least the same, more than likely even higher". Following, "the impact of the implementation of Measure 1 Investments in agricultural enterprises was evaluated as excellent" (PCM, 2007).

In a traditional (naive) approach to evaluation, the effects of a given programme are often calculated using data on supported companies before and after the programme. Application of this approach in the context of the SAPARD programme would also indicate that the effect of SAPARD was very positive (e.g. an increase of profits per company from -800 thousand SKK in 2003 to 1589 thousand in 2005, i.e. a gain of 2496 thousand SKK; an increase of profits per person employed from -11.3 thousand SKK to 23.6 thousand SKK, i.e. a gain of 34.6 thousand SKK; or an increase of profits per ha +1.336 thousand SKK).

Since these approaches completely ignore possible effects of other confounding factors (exogenous to the SAPARD programme) they are certainly not reliable.

Indeed, already a simple comparison with non-participants (1-0) or a country average (1-Ø) as control groups would in the case of a result indicator: "profits per company" or "profit per person" lead to completely different results, i.e. would indicate only a slightly positive or almost negligible effect of the SAPARD programme (3.5-4 thousand SKK per person or -30 thousand SKK per agricultural company). Yet, due to a significant selection bias involved in these calculations they would also be unreliable.

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[8] Unfortunately, the estimation of ATT in consecutive years (e.g. 2006, 2007) was not possible due to a growing fluctuation in the data base (dropping of many agricultural companies from the balanced panel).

[9] Ex-post evaluation of the SAPARD programme in the Slovak Republic. Final Report. P.C.M. Group. December 2007.

The PSM-DID approach largely eliminated selection bias, thus making comparisons between supported and control groups more reliable. The PSM-DID results showed clearly that the effect of the SAPARD programme (Measure 1) on total profits per company and value added of supported agricultural companies was **very different from those estimated by the ex-post SAPARD evaluators using naive approach** (PCM, 2007). Indeed, our estimates show that profits per company in the matched **non-supported** group of similar agricultural companies increased from -1264 in 2003 to 815 thousand SKK in 2005 (that is by +2079 thousand SKK), i.e. they grew by more than in the matched **supported** group (+1836 thousand SKK). Subsequently, the effect of SAPARD (measured in terms of this result indicator) was found to be either negative (-243 thousand SKK, profit per company or -346 SKK per ha) or close to zero (profit per person employed).

Similar effects were found by applying other result indicators: i.e. gross value added per company, gross value added per employed person and gross value added per ha. Indeed, while gross value added per company, GVA per person employed and GVA per ha in the matched non-supported agricultural companies increased between 2003 and 2005 in supported companies they either decreased (e.g. GVA per company, labour productivity) or increased at a lower rate compared with matched non beneficiaries (e.g. land productivity). As a consequence the estimated effect of SAPARD on above result indicators in the examined period was found to be either **almost zero** (GVA per employed) or **negative** (GVA per company and GVA per ha).

Concerning the impact of SAPARD (Measure 1) on farm employment , we found that, contrary to some expectations, the total employment in the group of supported agricultural companies remained at the same level over the period of 2003-2005, i.e. 53 persons per company (employment in analysed companies did not decrease), whereas in comparable non-supported companies it dropped slightly (from 59 to 56 per company). As a consequence, the estimated micro effect of SAPARD on employment was found to be **positive**.

The possible explanations of PSM-DID results are as follows:

- The period covered in the analysis of programme impact could be too short to allow for a full unfolding of effects of an investment process supported under the SAPARD programme. Yet, the deterioration of a stability of the balanced panel (the drop of many enterprises from the data base after inclusion of a new year) prevented estimation of programme effects for subsequent years (after 2006).

- Effects of the SAPARD programme on the big agricultural companies in Slovakia were indeed less encouraging than expected, mainly due to a progressive admission of less economically viable agricultural companies to the programme (during implementation of the SAPARD programme the official eligibility criteria (participation criteria) were adjusted several time to enable larger but less efficient agricultural companies to benefit from available EU subsidies.

Clearly the PSM-DID results show that traditional estimates of programme effects can be highly misleading, and that the application of advanced evaluation methodologies leads usually to much more reliable results. Yet, if the available data base is weak (e.g. shows a low number of observations and a high instability of balanced panel data) even a more sophisticated approach cannot provide all answers to relevant evaluation questions, e.g. relatively weak data basis (small number of observations in panel FADN database in Slovakia) hindered the estimation of programme impacts involving general equilibrium effects (e.g. substitution or displacement effects.

All of the methodological problems above could be addressed in a **satisfactory manner** in our next example: the AFP programme in Schleswig-Holstein, Germany.

3.4. Assessment of the results of the AFP programme, Schleswig-Holstein, Germany

3.4.1. Description of the AFP programme

The main objective of the Agrarinvestitionsförderungsprogramm (AFP) implemented in the region of Schleswig-Holstein (Germany) during the years 2000-2006 was to improve the structure and competitiveness of the agricultural sector through financial support provided for the modernisation of agricultural enterprises. The main mechanism of the AFP programme was the subsidy to a commercial interest rate paid by eligible agricultural enterprises for a loan on investment activities (total investment volume was allowed to vary between 175 000 EUR and 500 000 EUR) carried out mainly in the sectors of: milk and beef, pork, and agro-tourism. The subsidy to a commercial interest rate (approximately 13% of eligible investment volume) was provided to eligible individual farms for the period of 10 to 20 years on an average amount of 23 000-30 000 EUR/farm. During the years 2000-2006 total subsidies provided under AFP programme reached approximately 30 Million EUR (29.7 Mill EUR). During the period of 2000-2006 1513 farms received support from the AFP programme (net investment volume of 250 Million EUR). The great majority of the programme budget (approximately 80%) was provided for farm inventory (buildings) investment support, mainly in the milk and beef sectors. The rest was split up for investment support (including purchases of machinery or investments in alternative sources of energy in the fruits and vegetable sectors) among the pork sector, the agro-tourism sector and the horticulture sector. Specific eligibility criteria, such as investment volume higher than 175 000 EUR, eligible personal income up to 90 000 EUR per person or 120 000 EUR per couple, excluded the smallest and the biggest agricultural farms from this support.

Analysis of direct and indirect effects of the AFP programme (Germany)

The specific objective of this activity was to test empirically the applicability of approaches developed under this project to the assessment of indirect programme effects (e.g. deadweight loss, leverage effect, substitution and displacement effects).

Data

The main data source used for the assessment of the effects of the AFP programme in Schleswig-Holstein was farm bookkeeping data comprised of approx. 10 500 farms for the year 2000/2001 and 3 900 farms for the year 2007/2008). Furthermore, for specific comparisons approx. 400 datasets from "Testbetriebe" (part of FADN data set) were used.

Since the main focus of the AFP programme's support was the milk and beef sector 1333 bookkeeping farms specializing in milk/beef production were selected from the available data set and included in a panel for further analysis. The balanced panel (years 2001-2007) consisted of 101 milk/beef farms supported by the AFP programme and 1232 non-supported farms.

Description of activity

Above activity was implemented in four steps:
Step 1: Initial estimation of **direct effects** of the AFP programme (Germany) occurring at the level of direct programme beneficiaries Here the following steps were carried out:

- Using information about general and measure specific conditions for programme participation, all programme eligible farms/enterprises (for a given RD measure) were identified and selected from the available data base (e.g. bookkeeping or FADN data).

- Above group of farms was divided into beneficiaries vs. non-programme beneficiaries. A balanced panel including both sub-groups (direct programme beneficiaries vs. non-beneficiaries) was constructed for years 2000 (i.e. prior to the implementation of the programme) and 2007 i.e. (after the programme).

- On the basis of expert knowledge the most important characteristics determining both economic outcomes as well as decision of farms specialized in milk/beef production to participate in the AFP programme were selected from the list of variables in bookkeeping (or FADN) data set (relevant covariates were included in the estimated logit function). The assessment of the effect of the AFP programme (Schleswig-Holstein) on:

- direct programme beneficiaries (by means of ATT indicator);
- programme non-beneficiaries (potential impact by means of ATNT indicator);
- randomly selected unit from the sample of programme beneficiaries and non-beneficiaries (potential impact by means of ATE indicator);

was carried out using the following result indicators (calculated from **bookkeeping data**):

- Profit per farm;
- Corrected profit per farm;
- Addition to economic assets (capital formation);
- Milk production (total per farm);
- Labour productivity (value of milk and beef production per fully employed persons (AK));
- Transfers from farm to household for living (for assessment of programme leverage effects);
- Transfers from farms to household for building of private assets (for assessment of programme leverage effects);
- Transfers from farm to household (total) (for assessment of programme leverage effects);
- Corrected profit (adjusted for taxes and other payments pre-paid);
- Farm total employment (family labour + hired labour) in fully employed units (AK);
- Corrected profit per family labour45;
- Corrected profit per fully employed person46 (family labour + hired labour);
- Standard profit per family labour;
- Standard profit per fully employed person (family labour + hired labour);
- Extended profit per farm (profit + paid salaries/wages);

• Given information on GVA per enterprise, profits and other important farm characteristics (e.g. land area, employment, value of assets, etc) prior to the programme (T=0) a PSM matching method was applied in order to construct appropriate controls.

- The selection of a relevant matching technique was carried out using three independent criteria: i) standardized bias (?); ii) t-test (?); and iii) joint significance and pseudo R2 (?) and applying methodology described as above
- The ”similarity” of both groups prior to their participation in the programme was verified statistically (e.g. by performing balancing property tests on the most important farm characteristics).
- Specific policy indicators, e.g. Average Treatment Effects on Treated (ATT) were estimated before the programme (T=0) and after the programme (T=1), using GVA per enterprise, profit per employment, etc. as relevant result indicators.
- Conditional DID method (combination of ATT and standard DID) was applied to calculate the first component, i.e. the net effect of the RD programme on GVA generated by programme beneficiaries (at micro-level).
- Sensitivity analysis of obtained results was performed using Rosenbaum bounds.

Step 2: Estimation of **specific indirect effects** (e.g. deadweight loss and leverage effects) of the AFP programme (Germany) at the level of direct programme beneficiaries

a. Estimation of deadweight loss effects at the level of direct programme beneficiaries was carried out in the following steps:
   - Identification of units/farms supported from the AFP programme carrying out investments under specific RD measure (e.g. Measure 1: Modernisation and Restructuring of Agricultural Enterprises)
   - Identification in the control group (i.e. similar programme non-participants) a sub-vector of those farms which undertook similar investments as programme beneficiaries (in period between T=0 and T=1)
   - Calculation of ATT using data from both groups and applying a selected result indicator e.g. investment value per farms) before and after the programme
   - Applying DID on the estimated ATT

b. Calculation of the **leverage effect** was carried out by taking the following steps:
   - selection of individual units j supported by a RD programme
   - identification of a comparison/control group m matching with units j (identical distribution of covariates) in the period T=0 (i.e. prior to j’s access to the programme) using PSM method
   - selection of relevant result indicators as proxies for private spending, e.g money transfers from farm to farm households; level of private and farm consumption, etc.;

- calculation of ATT for selected result indicators between both groups (i.e. j and m)
- Applying DID on the estimated ATT

Step 3: Estimation of **substitution effects** of the AFP programme (Germany)
The approach was implemented in the following steps:

- After disregarding all programme participants, the PSM analysis was performed by computing ATT for "seemingly affected" (non-participants) in the high intensity regions Nordfriesland (NF) and Schleswig-Flensburg (S-F) (P=1) versus non-affected (non-participants) in other regions (P=0) (the economic performance of non-participants in NF and S-F regions can be described as a result of a "non-intended selection to programme" implemented at a given area).
- All other steps were carried out as in a standard PSM analysis (e.g. selection of matching method, testing similarity between matched and controls, sensitivity analysis, etc.)
- Substitution effects were calculated on the basis of the ATTs and ATT-DID coefficients. High values of the estimated DID-ATT indicated significant substitution effects in regions where the programme intensity was the highest (NF and S-F). The preliminary results of PSM applied under the Stage 1 appeared therefore as biased (especially for the year 2007!). In order to remove this bias all "affected non-participants" in respective regions (NF and S-F) were dropped from further analysis and the DID-ATT coefficients were re-estimated again (see: Stage 4).

Step 4: Re-estimation of the Stage 1 (due to a presence of significant substitution effects in the AFP programme - Germany)
The major steps of the further analysis were consistent with those in the Stage 1, and included:

- Re-estimation of the logit function using the same covariates as in the Stage 1 yet, basing on a different number of observations (807 instead of 1333)
- Calculation of individual propensity score for programme beneficiaries and non-beneficiaries
- Selection of a relevant matching technique. This was carried out using three independent criteria: i) standardized bias (**?**); ii) t-test (**?**); and iii) joint significance and pseudo R2 (**?**) and applying methodology described above.
- Statistical verification of the "similarity" of both groups prior to their participation in the programme (e.g. by performing balancing property tests on the most important farm characteristics)

- Calculation of specific policy indicators, e.g. Average Treatment Effects on Treated (ATT) were estimated before the programme (T=0) and after the programme (T=1), using GVA per enterprise, profit per employmed, etc. as relevant result indicators

- Application of conditional DID method (combination of ATT and standard DID) for calculation of the first component, i.e. the net effect of the RD programme on GVA generated by programme beneficiaries (at micro-level)

- Calculation of direct and indirect effects (including displacement effects)

- Performing sensitivity analysis of obtained results using Rosenbaum bounds

All respective **ado-files were written and calculated using the STATA software.**

3.4.2. Main results

Evaluation methodology enabling the assessment of direct and indirect microeconomic programme effects was successfully tested empirically using as example the SAPARD programme in Slovakia and AFP programme in Schleswig-Holstein (Germany). The methodological approach applied to the estimation of direct and indirect effects of RD programmes and obtained results are described in the project regional report [D13].

Selected results (AFP Programme, Schleswig-Holstein, Germany):

After cleaning the data base (by dropping from the set of potential control those agricultural farms which were affected by the AFP programme: results of Step 3) logit function was re-estimated using 807 observations on bookkeeping farms (Schleswig-Holstein) specialized in milk production, of which 101 were programme beneficiaries and 706 programme non-beneficiaries. Among 38 variables selected to match programme beneficiaries with programme non-beneficiaries an important one was the former level of support obtained from RD programme previously implemented in Schleswig-Holstein. Inclusion of this variable allowed to overcome a problem mentioned in many evaluation studies concerning the non-existence of non-supported farms (by current and previous RD programmes) in a specific programme area.

Effects of the AFP programme on direct programme beneficiaries

Leverage effects

Leverage effects were estimated by applying the procedures described in [D2], [D13]. The AFP programme was found to substantially induce private spending among programme beneficiaries, i.e. participation in the AFP programme lead to: an increase of money transfers from farm to farm household for living compared to similar non-beneficiaries by approx. 4,659 EUR per farm; an increase of money transfers from farm to farm household for building of private assets by approx. 9,526 EUR per farm; and an increase of total money transfers from farm to farm households by approx. 22,702 EUR.

The above results show also that an extension of the AFP programme to other non-beneficiaries (ATNT) would result in positive leverage effects (inducement of private spending among non-beneficiaries), i.e. an increase of money transfers from farm to farm household for living by approx. 369 EUR per farm; an increase of money transfers from farm to farm household for building of private assets by approx. 1,909 EUR per farm ; and an increase of total money transfers from farm to farm households by approx. 9,555 EUR. The leverage effects on a randomly selected agricultural farm (consisting of programme beneficiaries and non-beneficiaries; ATE) would also be positive: i.e. respective additional money transfers from farms to farm households would be as follows: 928 EUR per farm for money transfers for living, 2900 EUR per farm for money transfers for building of private assets, and 11265 EUR per farm for total transfers.

Effects of the AFP programme on farm profits

The application of the PSM methodology (ATT-DID) to the assessment of the direct effects of the AFP programme on programme beneficiaries (re-estimated results) shows a positive impact of the programme on both standard profit (ATT-DID = +9,285 EUR per farm) as well as corrected profit achieved by farms supported by the programme (ATT-DID = 6,455 EUR per farm. Should the AFP programme be extended to non-programme beneficiaries its effect would also be positive (+7,634 EUR increase of profits and +9,084 EUR increase in case of corrected profits). The same is also true for the average treatment effects (ATE). The effect of the AFP programme measured in terms of ATE-DID on profits and corrected profits was found to be positive (+ 7,848 EUR and + 8,743 EUR respectively)

Effects of the AFP programme on own capital formation

An important variable showing economic performance of agricultural farming (including farm and household) is the increase of the value in own economic assets (including farm and household) which is measured in terms of current profits + deposits in farm + net transfers for building of private assets. It may be expected that an important long-term goal of farming (in the case of presence of a farm successor) is to increase this variable over the years. As public support provided to the agricultural sector, inter alia, aims at strengthening economic viability of agricultural enterprises, it may be expected that a relative increase of the value of own economic assets in farms receiving public support should be higher than in non-supported enterprises. Unfortunately, our results cannot confirm these expectations. Indeed, it occurs that the value of own economic assets in farms supported by the AFP programme increased over the period 2001-2007 by +35,809 EUR per farm, i.e. it grew by less than in similar agricultural farms that did not receive any support from the AFP programme (the value of economic assets in the control group of agricultural farms increased by +37,045 EUR per farm). This implies that the effect of the AFP programme on this specific variable was negative (-1,237 EUR per farm).

Effects of the AFP programme on milk production

Our results show that the AFP programme significantly contributed to an increase of milk production among programme beneficiaries, i.e. + 61,276 liter per farm. Indeed, due to the AFP programme milk production increased in the examined period in the group of the matched programme beneficiaries by 155,413 l (by 29.5%) while in the control group (i.e. matched non-beneficiaries) it grew by only 94,137 liters per farm (by 18.3 %). Also an extension of the AFP programme to non-supported farms would lead to a significant increase of their milk production (+67,282 l per farm). Furthermore, the estimated ATE effect of the AFP programme on milk production was also found to be positive.

Effects of the AFP programme on farm employment

Our results show that the AFP programme had only a marginal positive impact on farm employment. In the examined period total farm employment (family and hired labour expressed in full-time equivalents, FTE) on farms that were programme beneficiaries increased by 0.103 FTE (from 1.752 FTE to 1.855 FTE per farm) while in comparable farm which did not receive support from the AFP programme it grew by 0.093 FTEs (from 1.732 to 1.825 FTE per farm). Furthermore, should the AFP programme be extended to other farms (non-beneficiaries) a programme participation would bring about a reduction of employment (by -0.054 FTE). Also the ATE effects on farm employment were found to be negative.

Effects of the AFP programme on labour productivity at the farm level

Labour productivity at farm level was measured using the following result indicators:

- Standard profit per total fully employed persons (profit/person in EUR/FTE)
- Standard profit per family labour (profit/family labour in EUR/FTE)
- Corrected profit per total fully employed persons (profit/person in EUR/FTE)
- Corrected profit per family labour (profit/family labour in EUR/FTE)
- Extended profit per total labour employed measured in terms of (standard profit + wages/salaries paid for hired labour)/total labour employed on farm (EUR/FTE)

- Production of milk/beef per a fully employed person (production value/person in EUR/FTE)

Our results show that the AFP programme had a positive impact on labour productivity on direct programme beneficiary farms, irrespectively of the applied productivity measure. In all six cases (i.e. various productivity measures) the estimated ATT-DIDs appeared to be positive, i.e. productivity measures in the group of programme beneficiaries increased over-proportionally compared to the control group of farms. Furthermore, should the AFP programme be extended to include also other programme non-beneficiaries, the AFP programme was found to have a positive impact on labour productivity in these farms, irrespectively of the applied productivity measure. While both ATT-DID as well as ATNT-DID were found to be positive the average effect of the AFP programme (ATE-DID) was also positive.

Deadweight loss effect of the AFP programme

Deadweight loss effects were calculated by comparing relevant outcomes (result indicators) in the group of beneficiary farms with similar non-beneficiary farms (control group) that undertook in the examined period (2002-2007) analogous investment (i.e. modernization of buildings).

Our results show that the re-estimated deadweight loss effect was huge (close to 100%). In fact, in the control group of the **matched** programe **non-beneficiaries** the value of inventories over the period of 2001-2007 increased over proportionally (i.e. by 126.8%) compared with the group of farms supported by the AFP programme (+93.2%). This means that, due to prevailing economic conditions affecting performance of all milk producers (i.e. increase of milk prices) similar investments in the examined period would have been undertaken even without the programme support.

Estimation of programme displacement effects

The analysis of the displacement effect of the AFP programme in regions with high programme intensity (548 observations of which 59 were programem beneficiaries and 489 were programme non-beneficiaries) was carried out by implementing all steps described above. The results showed that in regions with the highest programme exposure, i.e. NF and S-H the employment per farm in the examined period (2002-2007) increased in programme non-beneficiary farms stronger (i.e. by 0.145 FTE units per farm) than in farms which were direct programme beneficiaries (i.e. 0.135 FTE units per farm), i.e. a direct effect of the AFP programme on the employment was negative. The comparison of these results with the effects of the AFP programme on employment per farm calculated without non-beneficiary farms located in regions with the highest programme intensity shows that employment on non-beneficiary farms located in other regions (i.e. low programme intensity) increased at a lower rate (i.e. +0.093 FTE per farm) than employment in the group of direct programme beneficiaries located in regions with the highest programme support (i.e. +0.135 FTE per farm) as well as in the group of programme non-beneficiaries located in regions with the highest programme support (i.e. +0.145 FTE per farm). This may imply that a part of employment in the group of farm non-beneficiaries in regions characterized by a low programme intensity "went" to farms (direct programme beneficiaries as well as programme non-beneficaries) located in the regions with the highest programme exposure, i.e. thus indicating slight programme displacement effects.

Estimation of programme substitution effects

The substitution effect belongs to the indirect general equilibrium or macro-economic effects of a given programme. It is normally defined as the effect occurring in favour of direct programme beneficiaries but at the expense of persons/farms/units that do not participate in a given intervention.

Our results show that profits per farm among programme **non-beneficiaries** located in regions with zero or low intensity of AFP programme increased much stronger (EUR +41,371) in the years 2001-2007 compared with profits per farm in the group of farms (non-beneficiaries) located in the regions where the intensity of the AFP programme was the highest (EUR +37,824). The estimated substitution effects lead therefore to a deterioration of the economic situation of farms which did not received programme support (programme non-beneficiaries), i.e. through a reduction of a profit per farm by EUR -3,546 per farm on average.

Similar negative substitution effects of the AFP programme affecting non programme participants located in regions with the highest programme intensity were found in the cases of the following result indicators: economic corrected profit, quantity of milk production, economic profit per person fully employed (AK), economic profit per family labour, standard profit per fully employed, and standard profit per family labour.

The negative substitution effects could have occurred due to many factors. One possible explanation is that agricultural farms that were directly supported by the AFP programme considerably increased their demand for specific inputs, e.g. land (pastures or arable land) thus leading to an increase of input prices. Indeed, while the leasing price for agricultural land remained at the same level in the regions where support from the AFP programme was very intensive it dropped by 7.3% in those regions where the programme was not implemented or the intensity of AFP implementation was low

3.5. Publications of WP2

Journal papers

[1] Henning Ch. and J. Michalek (2008), ”Econometric policy evaluation techniques: milestone for effective 2nd pillar policies or a pure academic exercise?, Agrarwirtschaft 57 (2008), Heft 3-4.

[2] Henning Ch. and J. Michalek (2008), ”Theoretische Grundlagen und die Rolle parametrischer bzw. Nicht-parametrischer Modellansätze in der Politikevaluation. Replik zu Anne Margarian, Johann Heinrich von Thünen-Institut, Braunschweig”, In: Agrarwirtschaft, 57, (2008) Heft 7, pp. 348-351.

Other unpublished paper

[3] Michalek J. (2009), Contribution to the EC guidelines for evaluators of RD programmes: Approaches for assessing the impact of the rural development programmes in the context of multiple intervening factors. Exploring the state of the art and good practice of impact evaluation and measurement., Brussels: EEIG RurEval, pp 1-197.

Deliverables

[D2] Quantitative tools for ex-post evaluation of EU RD programmes (CR2-1)

[D13] Assessment of the direct and indirect effects of individual RD measures using Propensity Score - Double Difference methods in selected rural regions of Slovakia and Germany". ADVANCED-EVAL Regional Report Series, October, 2009 (RR2-2)

Part III.

Macro-econometric ex post evaluation methods (WP3)

by Jerzy Michalek

Chapter 4.

Objectives and background

4.1. Background and objectives of WP3

While the methodology suggested in WP2 aims to capture micro-economic effects, whether direct or indirect, WP3 aimed at analysing macro-economic effects to be able to calculate an overall net effect of the policy measure investigated.

This was approached in two ways. The first objective was to construct a multi-dimensional Rural Development Index (RDI) as a proxy indicator describing an overall level of regional development and/or quality of life in individual rural regions. The second objective was the to use this RDI, together with other relevant indicators, to estimate the net effect of a given RD programme, i.e. disentangling the effect of programme support from exogenously determined factors at the regional/macro level.

The multi-dimensional (composite) RDI measures the overall level of rural development and quality of life in individual rural regions of a given EU country. Given economic, social and environmental dimensions of rural development, an important objective of this study was to use this RD Index to learn more about the magnitude and major trends in the overall welfare of individual rural areas. It was also used to identify key factors fostering growth (economic, social and environmental) and convergence of rural regions in a given EU country.

Typically, basic knowledge about the overall level of rural/regional development is obtained on the basis of GDP (per capita) or various partial indicators. However, the applicability of these indicators to policy analysis of rural areas at lower regional levels (e.g. NUTS-4 and NUTS-5 levels) is strongly limited. First, GDP per capita is normally not available at NUTS 4 or 5 levels. Second, GDP shows numerous deficiencies as a basic criterion of policy effectiveness (e.g. impact of a cohesion policy) and as a standard measure of regional development. For example, it largely ignores important aspects of regional quality of life, e.g. education, health, intra-regional income variation, environmental quality, etc.; it does not take into account the price variation within a country; and it can be biased due to interregional imbalances in commuting. While deficiencies of GDP encouraged the intensive use of various partial indicators, applicability of the latter to the assessment of an overall welfare of individual rural areas is questionable. First, an increased richness of regional databases at NUTS-4 or NUTS-5 levels makes it difficult to find an appropriate proxy representing a situation objectively within a given RD domain (e.g. economic development, rural education, environmental or health situation). Second, the direct use of partial indicators to the analysis of an overall growth of rural areas (economic, social and environmental) is especially problematic if weights of selected partial indicators/components in the overall rural/regional development are not known. Third, the use of a large number of partial indicators in the evaluation of programmes and policies affecting rural areas can be highly misleading in the case of opposite or dissimilar trends observed for the same area.

A possible solution to the above problems offers a composite index approach measuring the overall level of rural/regional development at any relevant territorial/local base. The proposal of a composite RDI embraces all important rural development domains, e.g. economic output (including agriculture, food industry, rural tourism, etc.), investment, employment, poverty, education, health, housing conditions, crime, environment, urbanization and land use, structure of civil society, etc.), and aggregates them into a one dimensional indicator using objective and statistically verifiable weights. The RDI measures multi-dimensional development concepts which cannot be captured by partial indicators alone and simultaneously overcomes most of the deficiencies of previous studies.[1] The basic methodological concept applied to the construction of the RDI draws on the linkage between quality of life and migration. The weights representing "social importance" of various RD domains used in the calculation of the RDI are derived from an econometrically estimated intra- and inter-regional migration function in which the main arguments are: i) observed differences between a number of economic, social and environmental factors characterizing the origin and destination regions, and, ii) transaction costs linked to a migration decision. While the RDI is calculated as a weighted sum of regional individual characteristics of a given location, the major components of the overall development in individual rural areas are constructed using a factorization method (principal components) applied to all relevant variables describing various aspects of rural development at regional level. In contrast to other studies, the proposed approach neither assumes any unique equivalence between quality of life and migration nor applies subjective and non-verifiable weights to individual rural development domains.

[1]Some major problems associated with the construction of a composite index of development can be summarized as follows: (i) in the majority of relevant studies the choice/selection of the most representative socio-economic indicators was *arbitrary, leaving other available indicators unused or downgraded* as "less representative"; (ii) experts' weights assigned to selected indicators appeared often as *subjective* and not directly transferable from one geographic area to another; (iii) different normalizations of variables could result in different weights; (iv) some weights would become inconsistent when a larger number of indicators/coefficients/variables had been analyzed; (v) weights that were based on pure statistical analysis of factors (e.g. factor loadings) appeared to miss an appropriate welfare (social utility) context; (vi) many assigned weights appeared as region specific, so they were not applicable to other regions in the same country.

From a policy analyst's perspective the reliability and robustness of a composite index can be assessed using various criteria. In this respect the RDI fulfils a number of important requirements:

- The index is based on a sound theoretical framework;
- Basic data used for its construction is of a relatively high quality (the data originate from secondary statistics and is comparable across all regions within a given country, it enables comparisons of regions over years);
- Construction of the index follows an exploratory analysis investigating the overall structure of used indicators, e.g. by grouping available information along at least two dimensions of the dataset: sub-indicators and regional units;
- The index is reported as a single number but can be broken down into components (domains);
- Each domain encompasses a substantial but discrete portion of the construct;
- Each domain has a potential to be measured in both objective and subjective dimensions;
- Each domain of the index is of relevance for most people (not a few groups only);
- Particular attention is given to weighting and aggregation (weights are statistically verifiable);
- The index is checked for robustness and sensitivity;
- The index maintains clear links to other variables and indicators;
- The index is transparent and can be decomposed into its underlying indicators or values;
- The index is based on time series and allows periodic monitoring and aggregation;

As a potential impact indicator to be applied to the evaluation of specific EU RD and structural programmes, the RDI meets all important general evaluation criteria (i.e. efficiency, effectiveness, relevance, sustainability and sufficiency), as well as policy specific criteria (e.g. regionality, rurality, frequency, objectivity, transparency, simplicity and comparability).

A comprehensive assessment of a programme's impact requires separation of various programme effects of which the most important are: a) effect on regions which participated in a given programme (Average Treatment Effect on the Treated - ATT); b) effect on an average region randomly selected from the pool of programme participants and non-participants (Average Treatment Effect - ATE) and c) effect of the programme on the regions which did not participate (Average Treatment Effect on the Untreated - ATU).

Chapter 5.

Main activities undertaken in WP3

Main research activities undertaken within WP3 include:

I. Econometric estimation of a Quality of life index based on regional migration data including the following steps:

- Defining relevant rural development domains to be taken into consideration prior to the assessment of the overall impact of the RD programme;
- Defining variables describing each rural development domain in all regions;
- Translating the above variables into meaningful coefficients (e.g. per capita, per km^2, etc.) in all regions;
- Converting those coefficients into region specific factors (principal component method) in order to reduce the dimension of the analysis (factor analysis);
- Deriving weights for each individual factor (including variables in each rural development domain) to be applied in the construction of the RDI from econometrically estimated migration functions.
- Computing for each rural **region** a synthetic index **RDI**. The latter is defined as a weighted sum of factors (variables, domains) with "s_k derived from a selected inter- and intra-regional migration function according 7 (the optimal number of factors selected to the construction of an RDI was derived from the maximization of the restricted likelihood function used in the estimation of the intra-regional migration model).

II. The application of the GPSM methodology to the analysis of the impact of the SAPARD programme in Poland and Slovakia was carried out using information about programme intensity on a *per region* and *per capita* basis, using data for the years 2002-2005 at NUTS-4 level. Including the following main steps:

- The weights of economic, social and environmental domains entering the RDI index (composite indicator) are derived empirically from the econometrically estimated intra- and inter-regional migration function after selecting the ”bes” model from various alternative model specifications (e.g. panel estimate logistic regression nested error structure model, spatial effect models, etc).

- The impacts of individual RD measures are analysed by means of a counterfactual analysis by applying a combination of the Propensity Score Matching (PSM) (e.g. Kernel matching) and difference-in-differences (DID) methods (i.e. by comparing supported regions and matched control group, prior to the programme and after it).
- Evaluation of programme effects (by programme measures) at regional level is carried out on the basis of the estimated policy parameters: Average Treatment Effects (ATE), Average Treatment on Treated (ATT) and Average Treatment on Untreated (ATU) effects by using the RDI Index and unemployment ratios as impact indicators.
- Given information on regional intensity to programme exposure (financial input flows by regions) the overall impact of obtained support via a given RD programme is estimated by means of a dose-response function and derivative dose-response function within the framework of a generalized propensity score matching (GPS) (**?**Lechner, 2002; Imai and van Dyk, 2002; Hirano and Imbens, 2001).
- Sensitivity analysis (Rosenbaum bounds) is carried out in order to assess a possible influence of unobservables on obtained results (under a binary PSM methodology).

Chapter 6.

Main results of WP3

6.1. Construction and application of the Rural Development Index (RDI)

Due to its comprehensiveness, the RDI can be used as the impact indicator measuring the effects of *various* rural and structural programmes affecting rural areas. In our study, the RDI is applied to the evaluation of the overall impact of the pre-accession SAPARD programme.

The proposed RD Index has been empirically applied to an analysis of the overall welfare and the quality of life in rural areas of Poland and Slovakia. In both countries, regional data covers the four year period (2002-2005). Depending on the availability of data and research hypothesis regarding distribution of the error term, the estimation of weights for RD domains in the RDI can be carried out on the basis of various econometric models (yet, depending on the model's structure and specification of the error term the results, e.g. ranking of the regions may differ considerably). The best econometric model applied to estimation of weights in RDI in this study was selected on the basis of its attractive properties and clear comparative advantages in comparison with other approaches.[1]

[1]The most important characteristics of the selected model are as follows:

1. The model (i.e. panel regression or multi-level mixed-effect regression model), estimated as a balanced panel with random effects, uses statistical data on pair-wise migration flows between all regions in a given country (full regional migration matrix) over a number of years, which significantly increases the number of observations and statistical degree of freedom;
2. The model allows for the incorporation of both the differences in economic, social and environmental characteristics of respective regions and transaction costs as explanatory variables determining a migration decision of an individual moving from one region to another;
3. As a multi-level mixed-effect linear regression model it allows for a more precise specification of correlation between dependent and explanatory variables;
4. The model takes into account different sizes of population in all region pairs where migration flows are observed;
5. Due to non-negativity of dependent variable, the model can be estimated in the form of a logistic function representing a probability of migration from region i to j. This model specification fits better a micro founded analysis of a migration decision;

Data

Data used for calculation of the RDI at (NUTS-4) in Poland originates from the Regional Data Bank (RDB) of the Polish Statistical Office and the Ministry of Finance (e.g. distribution of personal income) and the Ministry of Interior (e.g. crimes). Above data was collected either at the NUTS-5 level and then aggregated to NUTS-4 or directly at NUTS-4 levels for the years 2002 to 2005. Of 379 NUTS-4 regions in Poland 314 rural Powiats (NUTS-4) are included in the analysis (84.2% of all NUTS-4 regions), which excludes 65 big cities. The data basis for Poland covers all relevant rural development dimensions available in regional statistics at the NUTS-4 level and consists of 991 coefficients/indicators collected/calculated either directly at the NUTS-4 level or aggregated from NUTS-5 (approximately 2500 Polish gminas) levels into the NUTS-4 level. Furthermore, above data was supplemented with information on allocation of SAPARD funds (by measures) among NUTS-4 regions. The data base covers the period of 2002-2005.

The database for Slovakia originates from the Slovak Statistical Office whereby 337 indicators/variables collected at 72 regions (NUTS-4) are used for the construction of the RDI. Furthermore, similar as in Poland, above data was supplemented with information provided by RIAFE on allocation of SAPARD funds (by measures) among NUTS-4 regions. The data base covers the period of 2002-2005.

The RDI in Poland was calculated for all (314) rural NUTS-4 regions and the years 2002-2005. On the basis of the estimated RDIs, rural regions were ranked in terms of their overall level of development. The ranking of NUTS-4 regions over the years 2002-2005 is shown in the following figure.

The results of the RDI estimation confirm a clear typological division of Poland based on the performance of individual rural regions into a good performing western- and central part, and a badly performing eastern part (north-eastern and south-eastern). The results also back up a general opinion that suburbs of the biggest cities (e.g. Warsaw, Poznan, Gdansk, Wroclaw, Lodz, Krakow) exhibit the highest quality of life. The lowest RDIs (i.e. less than -0.08) were found in remote regions situated in south-eastern Poland, i.e. hrubieszowski (on the border with Ukraine), bierunsko-ledzinski (a former heavy industrial complex in south Poland), chelmski (on the border with Ukraine), bieszczadzki (a remote region bordering to Ukraine and Slovakia).

The territorial distribution of the RDI in Slovakia (by NUTS-4 regions) in the years 2002-2005 is shown in the following figure.

6. The selected model (due to incorporation of transaction costs) allows for a formal split of the RDI from migration.

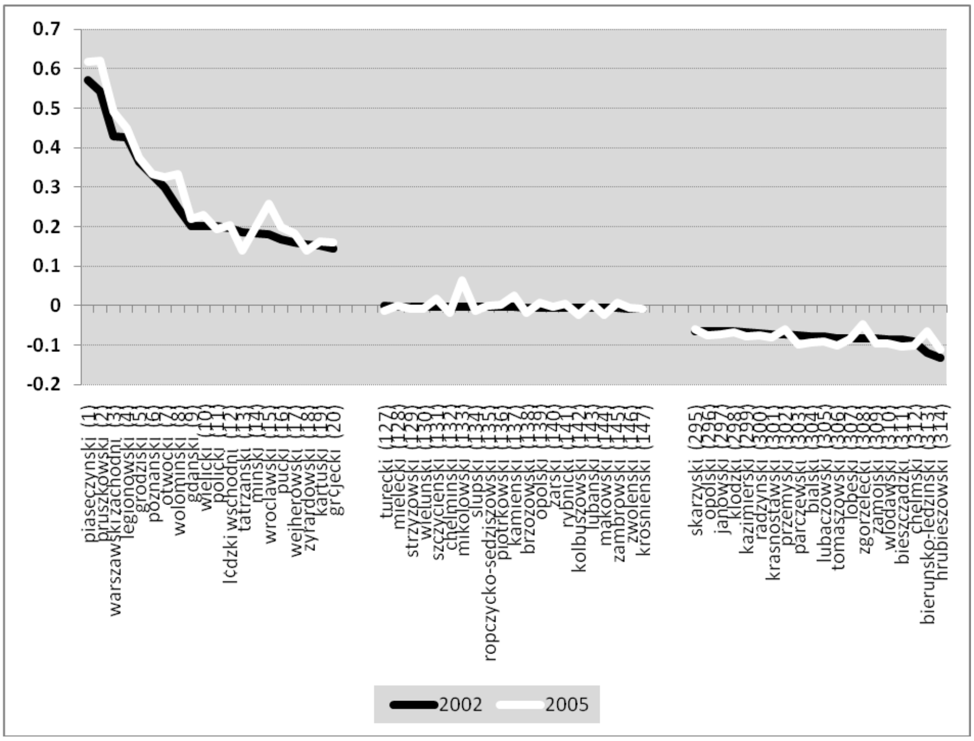


Figure 6.1.: Poland: Ranking of regions. RDI by regions (NUTS-4, 314 regions)

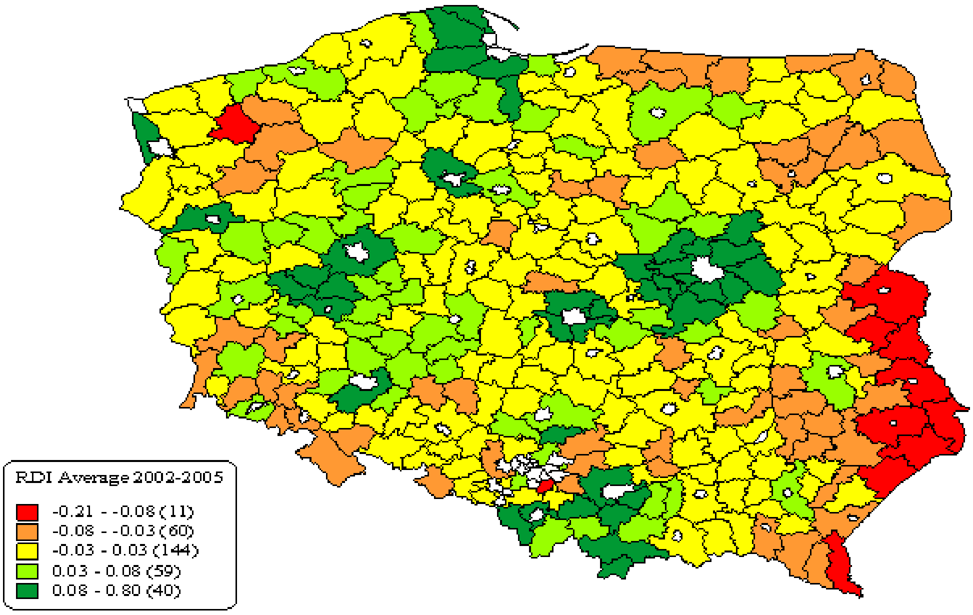


Figure 6.2.: Poland: Average RDI (by regions and years 2002-2005)

During the years 2002-2005 the estimated value of the RDI ranged from -0.51 to +0.91. Regional discrepancies are therefore higher than in Poland. As expected, the highest values of RDI were found in regions located in West Slovakia (e.g. Senec, Pezinok, Dunajska Streda, Galanta, etc.), while regions of Eastern Slovakia and Central Slovakia (e.g. Gelnica, Stropkov, Namestovo, Kezmarok, Stara Lubovna) exhibit the lowest RDI values. The statistical distribution of the average RDI and the geographical distribution of RDI,

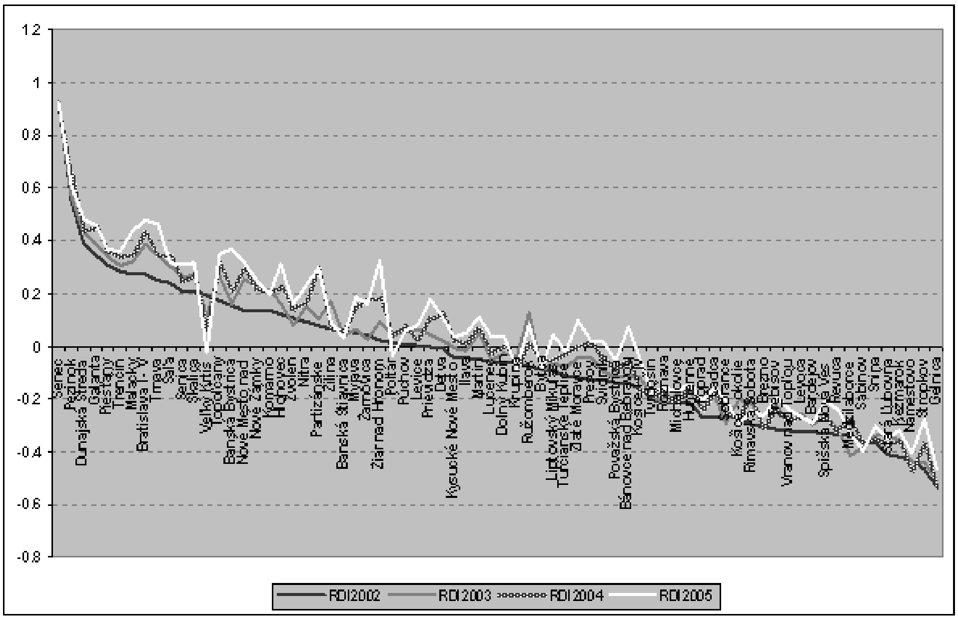


Figure 6.3.: Distribution of RDI (by NUTS-4 regions) in years 2002-2005.

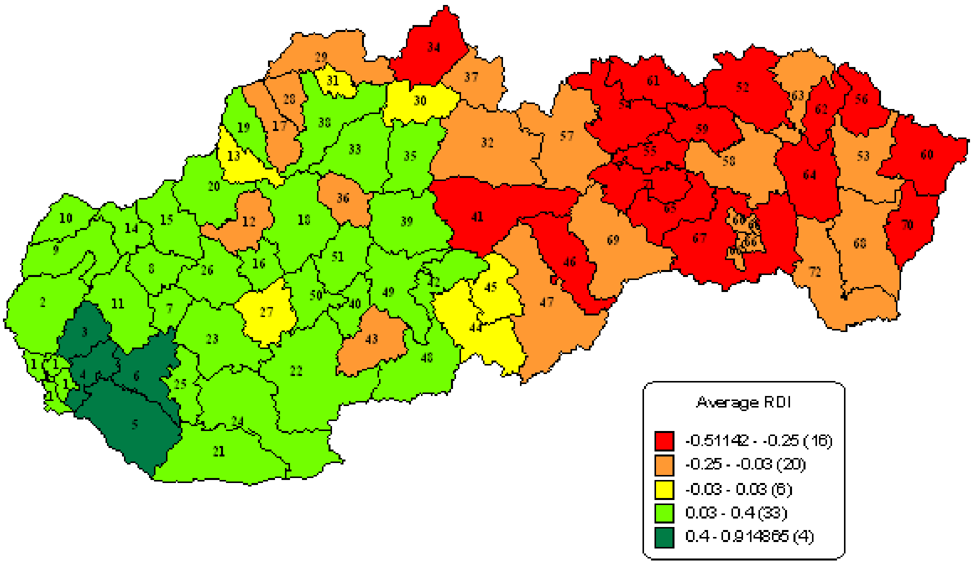


Figure 6.4.: Distribution of RDI (average in years 2002-2005)

including further analyses are presented in [D4b].

The empirical analysis of the overall development and performance of rural regions (NUTS-4 level) using the RDI in Slovakia and Poland shows a number of important common trends: i) huge differences in the level of regional/rural development among rural regions in both countries; ii) a clear deterioration in the level of rural development from West to East both in Poland as well as in Slovakia; iii) positive spill-overs of development from better developed to the neighbouring less developed regions; iv) progressing regional disparities between the highest and the lowest developed regions over time; v) particular importance of specific economic, social and environmental indicators (e.g. high income, availability of housing, lack of pollution, high share of private sector, high share of population in working age and women in population's structure, etc.), contributing to the high overall level of development in rural areas.

A comparison of the ranking of regions in Poland and Slovakia established on the basis of the RDI with alternative rankings based on other selected socio-economic indicators, e.g. populations' income, unemployment rate, density of enterprises, etc., showed clear dissimilarity in obtained results (depending on which partial indicator was selected) thus confirming the full applicability of an approach based on the RDI to the measurement of an overall (synthetic) level of rural development across regions.
The main methodological conclusions are:

- An RDI allows for a comprehensive analysis of various rural development domains (economic, social, environmental, etc.) and their impact on the overall quality of life in rural regions and is powerful at NUTS 2-5 or even village levels;

- The index is not constant over time, easily adjustable and allows for an easy inclusion of additional relevant variables/coefficients representing various aspects of the overall quality of life/rural development;

- The weights applied into the construction of the RDI represent society's valuation of endowments and socio-economic trends observable at local/regional levels, and are representative for society as a whole (reflects both the decision of migrating population as well as the population which stays in the region). The weights are empirically derived and statistically verified (in the actual version the estimated weights are kept constant in time);

- The approach used in our study allows for a technical separation of quality of life from migration;

- Data: an RDI is data hungry with the need for many variables covering all relevant domains of life including the natural environment.

The main conclusion of this study is that due to its comprehensiveness the RDI Index is suitable for both to analyse the overall level of development of rural areas and to evaluate the impacts of RD and structural programmes at regional levels [D3a],[D3b].

6.2. Application of the RDI and generalized propensity score matching to the evaluation of the impact of the SAPARD programme in Poland and Slovakia

The main summative impact indicator used for the evaluation of RD programmes is the RDI. Beyond the RDI, other selected partial performance indicators available at regional level (e.g. employment coefficient, rate of rural unemployment, value added, etc.) were used as relevant impact indicators.

In his study, the policy evaluation parameters ATT, ATE, and ATU were calculated on the basis of the estimated propensity scores using the following impact indicators:

a. The RDI

b. Unemployment (absolute values)

c. Unemployment (per capita)

Poland

The main findings from the application of the generalized propensity score (GPS) matching and dose response function (DRF) are as follows:

Results from the GPS and DRF generally show a *positive* effect of SAPARD (Measure 3) on the overall level of rural development in supported regions. However, they also show that this positive impact was observable only for regions supported from the programme at a higher intensity level (i.e. above approximately 17m PLN per region). Negligible programme effects were mainly found in regions with a *low* programme intensity (this only applies to regions that received less than 40% of the maximum support level, i.e. or lower than 80% of the average programme intensity).

An increase of the intensity of programme support (*per region* basis) was found to bring about a significant increase of returns (positive change in the overall level of rural development or the RDI).

The highest effects of the SAPARD programme (Measure 3) were found in those regions which received the highest programme support (i.e. regions which obtained from the programme between 20-43m PLN from the programme).

Not surprisingly, taking into consideration a generally low absolute level of programme support, the marginal effectiveness of SAPARD funds (Measure 3) was found to be highest in regions that received absolute support far above an average support level. This shows that an expected threshold of programme intensity (rural investments) causing *diminishing* returns was well *above* the obtained maximum (i.e. above 43m PLN per NUTS-4 region).

Measure	Overall growth **(RDI)** ATT (2002)	ATT (2005)	Impact (Cond. DID)	Unemployment (absolute number) ATT (2002)	ATT (2005)	Impact (Cond. DID)	Unemployment **(per capita)** ATT (2002)	ATT (2005)	Impact (Cond. DID)
M 1	0.051	0.07389	+	-928.7	-399.7	- -	-0.0095	-0.0037	-
M 2	0.0413	0.03457	-	492.7	601.3	-	-0.0084	-0.00237	-
M 4a	0.00341	-0.0086	-	3444	1679	+++	0.00672	-0.0008	+
M 4b	0.06113	0.03813	-	595.2	304.5	+	0.00206	0.001736	+
M 5	0.00304	-0.04819	−	2015	1601	+	0.008416	0.008238	++
M 6*	0.10492	0.18014	+++	-3965	-2358	- - -	-0.03151	-0.02211	-
M 7	-0.00333	-0.0073	-	1417	753.8	++	0.001866	-0.00178	+

Table 6.1.: Slovakia: Estimated impact of SAPARD (by measures) using a binary PSM method

For some reason (probably due to high unit costs of the programme), the effectiveness of the SAPARD programme (Measure 3) in regions that received the smallest absolute support (i.e. less than 100k Euro per region) appeared to be *negative*.

While the estimated dose response function shows a plausible causality between SAPARD funds (Measure 3) and the overall rural development, the estimated 95% confidence intervals were found to become wider together with the intensity of programme support, i.e. uncertainty increased (one reason could be a small number of data observations (=10) in the upper scale of support).

Slovakia

The results of ATT, ATE and ATU calculations are shown in Table 25 . Given these parameters, the programme impact was quantified using a *conditional DID estimator*, i.e. combining PSM (ATT, ATE, and ATU) and the difference in differences (DID) method.

Applying the conditional DID estimator to the assessment of the programme impact at the regional level shows that the overall impact of the SAPARD programme in Slovakia on the level of regional development as well as on rural unemployment, were negligible. In fact, our results show that in regions that obtained low support from SAPARD (i.e. below a 600 SKK per capita from all SAPARD measures) improvement of the overall level of rural development (the RDI) and unemployment indicators were generally faster than in comparable regions which received the highest programme support (above 600 SKK per capita).

A slightly differentiated picture concerning the effectiveness of the SAPARD programme in Slovakia was obtained by carrying out an estimation of the programme's impact at *individual measures basis* (Table 26).

Our results show that out of 1-7 measures examined, only two individual SAPARD measures (i.e. Measure 1: investment in agricultural enterprises, and Measure 6: Agricultural production methods designed to protect the environment and maintain the countryside) contributed positively to the overall level of rural development in supported regions (measured in terms of the RDI). On the other hand, the implementation of the measure M5 (Forestry) was found to be highly ineffective (the RDI was negatively affected).[2]

In terms of the impact of SAPARD measures on rural unemployment, Measures 4a, 4b, 5, and 7 were found to have a positive impact on the reduction of rural unemployment (measured both in absolute terms and per capita basis). Measure 4a had an especially positive impact on the reduction of rural unemployment (Investments not involving infrastructure) that was mainly focused on support of local agro-tourist facilities. On the other hand, due to the introduction of technological advancements, implementation of SAPARD measures M1 (investment in agricultural enterprises), M2 (investment in food processing) and M6 (environmental investments) had a negative impact on unemployment, i.e. the above measures were found to lead to an increase of rural unemployment.

6.3. Publications of WP3

Journal papers

[1] Kaufmann, P., Stagl, S., Zawalinska, K. and Michalek, J. 2007 'Measuring Quality of Life in Rural Europe - A Review of Conceptual Foundations', Eastern European Countryside 13: 1-21.

Publication in progress

Monographs:

[2] Michalek, Jerzy and Leszek Klank (2009). Rozwój obszarów wiejskich w Polsce w latach 2003-2006. Analiza i metody pomiaru jego zróznicowania (Development of rural areas in Poland during the years 2003-2006. Analysis and methods of RD quantification and spatial diversification), Warsaw, 2009 (book to be finalized).

Deliverables

[2] Original funds allocation to Measure 5 (forestry) was several times higher than at the end of the SAPARD programme. Out of 35 contracted projects in the forestry sector two major projects (approximately 16 Mill SKK) were suspended due to bankruptcy of contracted forest enterprises. Average amount per project under Measure 5 was the lowest from all average project costs under other measures. No result indicators under Measure 5 set in the RDP plan were monitored. No measure 5 impact indicators were set and monitored. See: Ex-post evaluation of the SAPARD programme in the Slovak Republic. P.C.M. Group, December 2007.

[D3a] Construction and the Measurement of the Rural Development Index Part I: Conceptual Foundations of Indicators for Quality of Life Measurement' ADVANCED-EVAL working paper series, conceptual report (CR3-1).

[D3b] Construction and the Measurement of the Rural Development Index Part I: Conceptual Foundations of Indicators for Quality of Life Measurement' ADVANCED-EVAL working paper series, conceptual report (CR3-2).

[D4a] Empirical measurement of quality of life in rural areas in Slovakia using the RDI (RR3-1)

[D4b] Empirical measurement of quality of life in rural areas in Poland using the RDI (RR3-3)

[D11] Cartographic and statistical analysis of RDI in Poland and Slovakia (RR3-2)

[D12] Application of the Rural Development Index and the generalized propensity score matching to the evaluation of the impact of the SAPARD programme in Poland and Slovakia

Working Paper

[WP3-1] Measuring Quality-of-Life in Rural Poland - A Structural Equation Modelling Approach.

Part IV.

The Role of Networks in Rural Development (WP4)

by Christian Henning

Chapter 7.

Objectives and background

The idea that social relations and networks of such relations have a significant impact on economic and political behavior of individual agents at the micro level and accordingly on aggregate outcome of individual actions at the macro level has been increasingly recognized at both academic and political levels. Especially, also the European Commission has recognized the importance of intangible factors in promoting economic and political cooperation and thus economic development. For example, LEADER has been implemented partly to establish local network structures that facilitate collective action and thus promote rural development. Interestingly, although in academia the importance of social relations among economic agents has been realized for a long time (Sweezy, 1946; Arrow, 1974; Williamson, 1975), only recently has the importance of the structure of network relations between economic agents been systematically examined both at theoretical and empirical levels.

Thus, overall, it is fair to conclude, while the importance of social network structures for rural development have been clearly recognized at both the academic and political level, especially at EU level, adequate methodology and tools to analyze empirically the relation of network structures and economic as well as political performance have not been fully developed, yet.

In this regard it is a global objective of working package 4 (WP4) of the EU-project ***Advanced-Eval*** to develop and apply adequate methodology and tools of quantitative network analyses in rural development.

Accordingly, the main objectives of WP4 are:

I. to identify network structures that enhance or impede the effectiveness of different RD-programmes

II. to identify innovative RD-policies improving the existing rural network structures in terms of access to information and learning, cooperation capacities, access to external markets, etc. (necessary adjustment to the change of framework conditions determining development of rural socio-economic systems).

Given the main objectives of WP4 the following specific objectives of WP4 have been formulated:

A. How is local economic performance determined by network structures?

B. How is local political performance determined by network structures?.

To achieve these main and specific objectives the following operational objectives and milestones of WP4 have been formulated:

a. Structural network analysis to identify structural equivalent rural agents

b. Network structures and economic performance at the micro and macro level

c. Network structures and governmental performance at the micro and macro level

d. Network structures and RD-programm effects at the micro and macro level

e. Derivation of a social capital index

Objectives of this report

In this context this final report summarized main milestones of WP4 and has the following main objectives:

1. Summarizing main activities undertaken within WP4.
2. Summarizing main results of undertaken theoretical and empirical work on the role of networks in rural development.
3. Summarizing main implications of results achieved within WP4 for modeling and evaluation of RD-policies.

Chapter 8.

Main activities undertaken in WP 4

Main research activities undertaken within WP4 include:

I. Derivation of theoretical models analyzing the impact of networks on economic and political behavior

II. Collection of own survey data in 8 selected rural region of Poland and Slovakia. In particular, included surveys are:
- farm survey (1000 individual farms)
- household survey (1000 non-farm and 1000 farm households)
- business survey (400 individual non-farm firms)
- local elite survey (320 persons and 87 local organizations)

III. Empirical network studies:
- Empirical studies on the impact of social networks on economic performance
- Empirical studies on the impact of social networks on political performance

Chapter 9.

Main results

9.1. Theory and methodological concepts

Beyond measuring and describing social network structure the central relevance of networks results from the fact that social networks have an important impact on individual behavior and the corresponding social/collective outcomes.

Pioneering work connecting social network structures with individual behavior goes back to sociologist (Coleman, 1973, 1988, 1990; Granovetter, 1973, 1985; Burt, 1982).

Based on this early and path-breaking work of sociologist social capital or socially embedded action became a new and promising paradigm in economics (Alesina and Ferrara, 2000; Knack and Keefer, 1997; Dasgupta, 1999), sociology (Burt, 1982, 1990; Coleman, 1988; Granovetter, 1985; Fukuyama, 1995), and political science (Putnam, 1993; Hardin, 1999; Van Deth et al., 1999). Motivated by theoretical work on the social capital, several regional studies and studies in economic geography empirically analysed the importance of networks for regional or local economic development (Curran and Blackburn, 1994; Gripaisos et al., 1989; Errington, 1994; Dawe and Bryden, 1999). Comprehensive analyses of the impact of networks have also been undertaken in the EU project "DORA" (Bryden, 2001). Although many interesting results were achieved, e.g. empirically underlying the importance of local and non-local business network relations for local economic performance (Courtney et al., 2001; Atterton, 2003), many theoretical and methodological shortcomings became visible. For example, first, empirical measurement of network relations often proved to be incomplete (e.g. mainly firm's EGO-centered networks were empirically collected, while network nodes were rather vague; Atterton (see 2003, p. 14)). Second, the empirical collection of more complete regional network data, including relations between all relevant agent types, i.e. firms, households, governmental and non-governmental organizations at local, regional, and national levels, has not yet been undertaken. Third, collected network data was not sufficiently analysed using quantitative network tools, e.g. block model analyses or network structures of ex ante blocked networks.

At a theoretical level, the structural theory of action can be understood as an attempt to overcome shortcomings of both the classical sociological and (neo-)classical economic approach to human behavior.

A formal modeling of how social structures affect actors' behavior has been provided by Raub and Weesie (1990); Greif (1994); Calvert (1995) on the basis of game theoretical models.

More recently also economist contributed to the formal modeling of the impact of networks on behavior (Jackson, 2005) (for a more detailed literature overview see CR4-1 and RR4-1).

In general one can distinguish three different approach how social networks influence individual behavior and social outcomes:

1. The impact of networks on cooperation.

2. The impact of networks on information

3. The impact of networks on beliefs

Following main research questions developed in the field of networks and economics within the project ADVANCED-EVAL theoretical work regarding the role of networks in rurla development focused on the following three aspects:

1. The impact of network structure on knowledge spillovers and regional economic growth

2. The impact of network structure on belief formation and economic performance

3. The impact of network structure on firm's transaction costs

9.1.1. The impact of networks on knowledge spillovers and regional economic growth

One main theoretical contribution of the project ADVANCED-EVAL to the role of networks in rural development correspond to the analysis of the impact of business network structure on regional knowledge spillovers and technical progress .

Spatial diffusion of technological progress is a one of the key factors explaining different regional economic growth. Empirical work clearly underlines that innovation diffusion between regions is far from being instantaneous as predicted by the neoclassical theory, but specific regions appear as innovation leaders, while others realize technological progress mainly via spill-over of technological knowledge from innovation leaders. Accordingly, regional growth patterns are determined in part by regional difference in technological progress. Classical approaches explaining technology transfer between regions basically argue that the speed of technology transfer from a more advanced to less advance regions is proportional to the technology gap between these regions. This implies a convergence of technological progress in the long run, i.e. lacking behind regions are catching-up with the technology leader. However, empirical studies hardly support neoclassical catching-up hypothesis especially at the regional level. Moreover, classical catching-up models are criticized for not explicitly modeling the complex process of technological knowledge diffusion among regions.

As a critique of simple neoclassical models evolutionary models of innovation diffusion and technological progress have been developed (Dawid, 2006). In contrast to neoclassic, evolutionary economics focus on a explicit procedural way of representing of decision-making rather than relying on abstract optimizing calculus (Dopfer, 2001; Dosi and Winter, 2002; Fagerberg and Verspagen, 2002; Nelson, 1995; Nelson and Winter, 2002). Focusing on decision-making procedures makes agent-based modeling a natural choice. Accordingly, pioneering work in evolutionary economics in this field apply agent-based models, e.g. Nelson and Winter (1982). Inspired by the work of Nelson and Winter (1982) a large body of literature applying agent based computational economics (ACE) modeling approaches to explain innovation and technological change have been developed, which commonly understand innovation and technological progress as a result of a dynamic process among interacting heterogenous agents. Moreover, this literature highlights in particular the special nature of knowledge as the most important factor for the production of innovation (Dawid, 2006). ACE models contributed significantly to the understanding of the complex process of innovation and technological progress. For example, ACE approaches could provide satisfying explanation for a number of empirically established stylized facts, which have not been predicted by standard equilibrium models. However, although ACE approaches focus on interaction among heterogenous agents existing approaches to innovation and technological progress do not explicitly analyze the impact of specific interaction patterns, that is network relations among firms, on innovation.

The impact of networks on economic behavior is an innovative and emerging field in economics that also profited tremendously from ACE-modeling Wilhite (2006); Jackson (2005). However, economic research on networks is still in its infancy and studies on the impact of network's typology on innovation diffusion and technological progress rather exists yet.

In this context the paper offers an agent based modeling approach that focuses on the impact of network's typology on regional information diffusion and regional technological progress.

Technically, we derive a rather simple model that particulary focus on the role of information networks in the accumulation of knowledge by regional firms. New technological knowledge is exogenously generated in a leader region and randomly transmitted to regional firms. Within a region transmission of technological know-how occurs in information networks. Further, following central findings of existing ACE literature on innovation

(Dawid, 2006) we assume that firms can only transmit information that they were able to process, where firms' capacity to process new technological knowledge depends on accumulated technological know-how. Therefore, given an exogenous rate of generation of new technological information in the technological leader regions, the speed of information accumulation within a region crucially depends on the speed of information transfer within the regional firm network, where the latter depends on network structures.

Applying our simple agent based model we simulate the impact of different network typologies on spatial diffusion of knowledge and regional technological. In particular, we simulate two different network types, i.e. small-world and free-scale networks, varying global network structures, which are clustering and centralization. Main results of our simulation studies are the following:

(i) Information network structures have a significant impact on both spatial information diffusion and regional technological progress.

(ii) Information diffusion in networks is only imperfect, i.e. accumulated knowledge in regional networks correspond only to a constant fraction of technological knowledge generated in leader regions.

(iii) In particular, this fraction is c.p. higher for scale-free networks when compared to small-world networks. Moreover, this fraction increased for scale-free networks with the preferential attachment parameter and for small world networks with the α-parameter.

(iv) In contrast to classical catch-up models our network approach to spatial diffusion of technological knowledge implies that except for extreme centralized or dense networks catching-up does not occur. In contrast, depending on the concrete typology of regional information networks a constant productivity gap to the technological leader is stabilized or regions characterized by extremely clustered information networks are even increasingly falling behind.

In detail, we derived the following simulation results.

Results

Simulated information networks

To be able to analyze the impact of network structures on speed of knowledge accumulation we have systematically simulated information accumulation in various SW- and hybrid networks. Networks have been generated using the modified α-model of Watts (1999) [1]. A central parameter of this network generation algorithm is α which determines

[1] The detailed algorithm is described in a technical paper Henning and Saggau (2009) available under http://www.advanced-eval.eu

global network characteristics, i.e. clustering and characteristic path length (see table 2 in the appendix).

In particular, starting from a basic network comprising $n = 1000$ firms, who on average have $\bar{z} = 10$ direct contacts, we generated different SW-networks assuming α-values ranging from 0 to 10. Furthermore, we also generated different hybrid networks assuming one star with direct contacts in the range of 100, 250, 500, and 1000. Moreover, to analyze the impact of global network size, n, as well as the impact of the local network size, $\bar{z}$, we also ran simulations for $n = 3000$ and $n = 5000$, as well as for $\bar{z} = 15$ and $\bar{z} = 20$.

Overall, each specific network parameter constellation can be characterized by global and local network sizes ($n = 1000, 3000, 5000$; $\bar{z} = 10, 15, 20$), existences of a star (star=yes or star=no), the number of ties of the star (star-density = 100, 250, 500, 1000) and the α-parameter ($\alpha = 0, ..., 10$). Accordingly, we simulated knowledge accumulation in 180 different SW-networks and 720 different hybrid networks. Further, due to the random nature of our model we repeated each simulation run for each network parameter constellation 100 times, which means that all reported variable values generally correspond to the mean over 100 simulation runs.

Moreover, we set $\pi = 1$ for all simulation runs, thus we assumed that knowledge is transferred with certainty whenever firms have established an information tie, i.e. $z_{ij} = 1$. In essence, the main results regarding the impact of network structure on knowledge accumulation will not change if we assume different values for π, although the absolute speed of knowledge accumulation would significantly change.

Finally, the standard setting for p is 0.001 for all simulation runs. However, to analyze the impact of networks on speed of knowledge accumulation under different innovation intensities we also ran simulations assuming $p = 0.01$ and $p = 0.1$.

To get a better understanding of our main results, central network indicators have been calculated for all simulated networks. The mean values over the 100 simulation runs are reported in table 2 in the appendix.

Network typology and knowledge accumulation

The key question of our simulation analysis is how different network typologies influence the accumulation of knowledge in a given network of firms. Accordingly, a relevant indicator is the average knowledge accumulated by an individual firm in the network.[2]

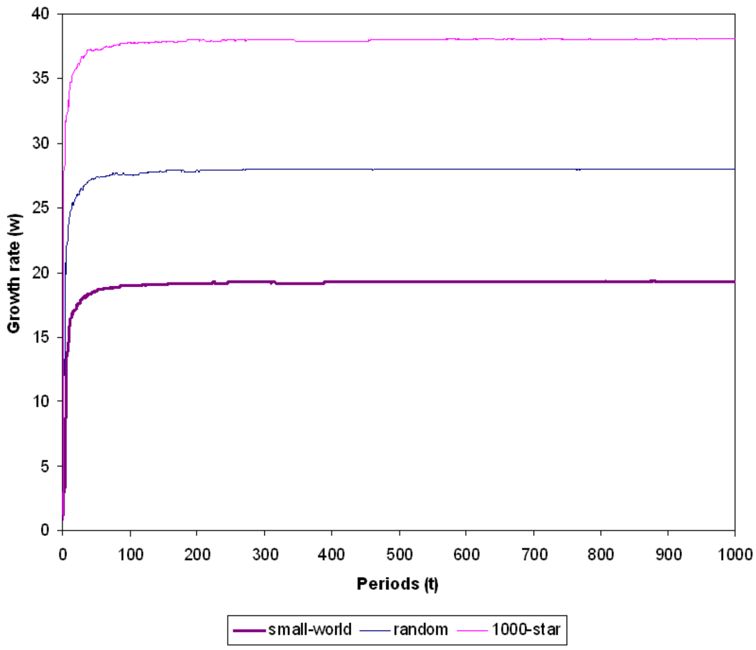
Let $\bar{K}_t$ denote the average accumulated knowledge in period t, while $w_t = \frac{\bar{K}_t}{t}$ denotes the average accumulated knowledge per time period.

[2]Of course, as one anonymous referee pointed out, other indicators, e.g., the maximal accumulated knowledge in the network, are also conceivable. However, we argue that average accumulated knowledge is an appropriate indicator as far as the impact of knowledge accumulation on regional economic growth is concerned. As reported below, in our specific case maximal accumulated knowledge does not differ significantly from average knowledge, thus both indicators have the same economic implications. We thank one anonymous referee for this comment.

Impact of network types

Figure 1 presents average accumulated knowledge per time period for the different network types, namely a random network, a small-world network, and a 1000-star network (i.e. the star has 1000 ties), where the last two networks are both generated setting $\alpha = 7$.

Figure 9.1.: Average growth rates ($w_t = \frac{\bar{K}_t}{t}$) of accumulated knowledge for different networks



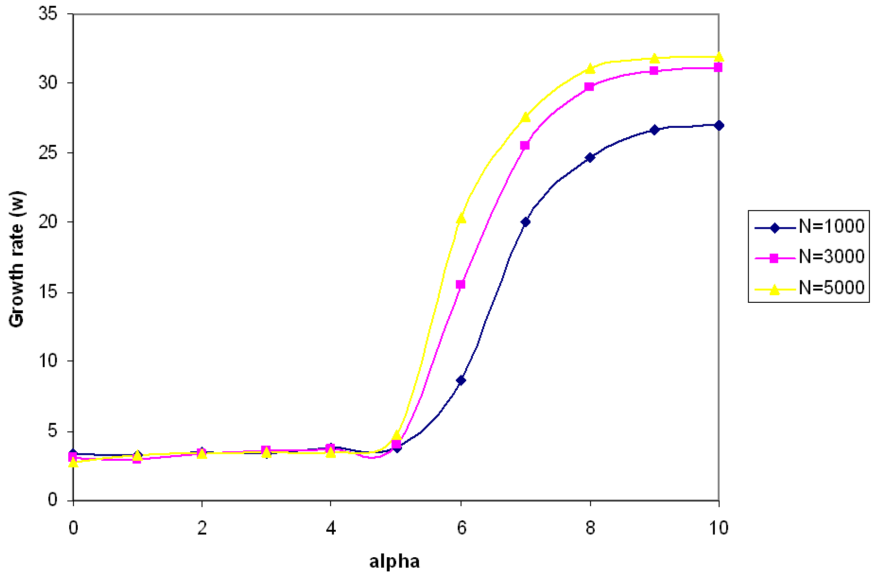
Source: Own calculations

As can be seen from figure 1 for all network types knowledge accumulation follows a linear trend, where simulations normally approach stable linear growth rates after 100 time periods, while each simulation run includes 1000 time periods. Accordingly, we focus our further analyses on long-term linear growth rates, which we denote by w. Technically, in the following analyses reported values of w correspond to the linear growth rate calculated after 100 time periods [3].

In particular, linear growth rates vary significantly over network types. In absolute terms the growth rate is the highest for the 1000-star network followed by the random network, while growth rate is the lowest for the SWN. Furthermore, as can bee seen from reported standard errors in table 1, these differences in growth rates are statistically

[3]Please note that for all undertaken simulation analyses growth rates did not significantly change after 100 time periods as can be seen in figure 1. Therefore, calculated long-term growth rates (w) presented in table 1 as well as in figure 2-4 generally correspond to growth rates calculated in time period 100. Moreover, as we undertook for every network parameter constellation 100 simulation runs, long-term growth rates (w) presented in table 1 as well as in figures 2-4 are the average long-term growth rates calculated over this 100 simulations. Analogously, we calculated the variance of the long term growth rate across firms within the network, where in table 1 the reported variances σ_w^2 correspond again to the average variance calculated over the 100 simulations undertaken for each network parameter constellation. Finally, the standard error of the average long term growth rate (error) presented in table 1 has been calculated based on the 100 repeated simulation runs for each network constellation.

Figure 9.2.: Clustering and growth rates (w in percent) of accumulated knowledge in SWNs



Source: Own calculations

significant.

To see how knowledge accumulation is determined by global network structures beyond different network types, we next analyze how speed of knowledge accumulation varies for different α-values and different star sizes.

Clustering

By construction Watt's α-algorithm implies that the lower the α-value the more networks are locally clustered. As can be seen in table 1 and as illustrated in figure 2 clustering has a significant impact on knowledge accumulation.

In particular, within SW-networks growth rates increase by a factor of almost 8 from 3.4 to 27 percent for α-values ranging from 0 to 10, while for α-values above 10 simulated growth rates do not further increase significantly (see table 1).

Table 1: Simulation results of Knowledge accumulation assuming different network

		alpha										
network type	**growth**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
SWN-1000	w	3.39	3.26	3.45	3.35	3.79	3.84	8.68	20.00	24.66	26.64	27.03
z=10	σ^2_w	5.62	4.24	5.34	3.72	5.24	7.24	18.19	0.14	0.11	0.10	0.10
	error	**0.07**	**0.07**	**0.07**	**0.06**	**0.07**	**0.09**	**0.13**	**0.01**	**0.01**	**0.01**	**0.01**
	w^m	8.35	7.73	8.52	7.72	8.52	9.22	12.95	20.77	25.31	27.24	27.59
SWN-1000	w	3.76	4.14	4.84	4.26	5.46	7.53	22.73	27.99	29.78	30.26	30.48
z=15	σ^2_w	5.05	6.13	6.33	4.68	8.23	12.55	0.14	0.09	0.09	0.08	0.07
	error	**0.07**	**0.08**	**0.08**	**0.07**	**0.09**	**0.11**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**
	w^m	8.62	9.01	9.62	8.71	10.52	12.59	23.45	28.62	30.42	30.75	31.07
SWN-1000	w	4.70	6.88	6.38	6.58	6.86	19.23	28.87	31.22	32.07	32.44	32.60
z=20	σ^2_w	5.78	13.20	12.06	7.70	7.93	9.67	0.10	0.07	0.09	0.09	0.08
	error	**0.08**	**0.11**	**0.11**	**0.09**	**0.09**	**0.10**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**
	w^m	9.55	12.87	12.29	11.18	11.68	20.75	29.52	31.86	32.61	32.97	33.14
SWN-3000	w	3.05	2.96	3.41	3.57	3.70	4.00	15.48	25.52	29.77	30.93	31.12
	σ^2_w	4.32	3.93	4.61	5.44	5.58	6.42	16.75	0.13	0.11	0.09	0.11
	error	**0.04**	**0.04**	**0.04**	**0.04**	**0.04**	**0.05**	**0.07**	**0.01**	**0.01**	**0.01**	**0.01**
	w^m	8.90	8.56	9.20	9.69	9.86	10.09	18.08	26.52	30.61	31.81	31.97
SWN-5000	w	2.79	3.22	3.35	3.53	3.47	4.72	20.37	27.59	31.09	31.79	31.96
	σ^2_w	3.66	4.54	4.55	4.84	4.37	9.43	1.42	0.12	0.12	0.12	0.12
	error	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.04**	**0.02**	**0.00**	**0.00**	**0.00**	**0.00**
	w^m	8.80	9.75	9.46	9.95	9.59	12.46	21.84	28.66	32.07	32.71	32.85
100-star	w	11.08	14.47	15.18	13.39	12.38	10.98	20.58	23.48	25.53	28.41	29.63
	σ^2_w	94.19	94.96	95.58	88.89	89.87	85.64	38.07	0.15	0.11	0.11	0.09
	error	**0.31**	**0.31**	**0.31**	**0.30**	**0.30**	**0.29**	**0.20**	**0.01**	**0.01**	**0.01**	**0.01**
	w^m	21.82	22.98	23.14	22.10	22.04	21.90	23.45	24.23	26.18	29.08	30.21
500-star	w	33.03	33.68	34.97	34.54	34.87	35.05	35.48	35.48	36.55	37.02	37.45
	σ^2_w	11.42	0.11	0.07	17.72	15.95	0.10	0.09	0.11	0.07	0.05	0.03
	error	**0.11**	**0.01**	**0.01**	**0.13**	**0.13**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**
	w^m	33.90	34.13	35.49	35.58	35.81	35.50	35.92	35.93	36.95	37.40	37.92
1000-star	w	38.74	38.71	38.56	38.38	38.85	38.78	38.88	38.68	38.76	38.54	38.87
	σ^2_w	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00
	error	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	w^m	39.09	39.07	39.01	38.71	39.22	39.15	39.32	39.05	39.18	39.00	39.23
1000-star	w	39.74	40.94	39.60	41.94	43.61	41.13	45.47	45.91	46.83	47.65	47.67
n=3000	σ^2_w	118.11	96.97	156.33	132.70	69.51	164.83	0.22	0.15	0.11	0.09	0.08
	error	**0.20**	**0.18**	**0.23**	**0.21**	**0.15**	**0.23**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**
	w^m	43.51	44.13	44.53	45.89	45.94	46.01	46.25	46.68	47.41	48.26	48.31
1000-star	w	33.46	35.47	34.59	35.64	36.08	40.31	45.29	46.16	48.22	48.33	48.41
n=5000	σ^2_w	319.43	292.27	340.93	342.98	344.17	230.05	6.24	0.21	0.15	0.13	0.12
	error	**0.25**	**0.24**	**0.26**	**0.26**	**0.26**	**0.21**	**0.04**	**0.01**	**0.01**	**0.01**	**0.00**
	w^m	44.45	45.03	45.98	46.82	47.22	47.25	46.48	47.09	48.95	49.02	49.16
3000-star	w	48.97	49.18	49.05	49.28	49.02	49.11	49.06	49.13	49.16	48.97	49.07
	σ^2_w	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	error	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	w^m	49.52	49.65	49.54	49.73	49.46	49.58	49.62	49.66	49.61	49.51	49.63
5000-star	w	50.50	50.49	50.50	50.45	50.47	50.29	50.39	50.50	50.42	50.42	50.53
	σ^2_w	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	error	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	w^m	51.05	50.97	50.97	50.92	50.93	50.88	50.91	50.92	50.95	50.93	51.04

w = average knowledge accumulation σ^2_w = variance of average knowledge accumulation

structures w^m = highest information   error = standard error

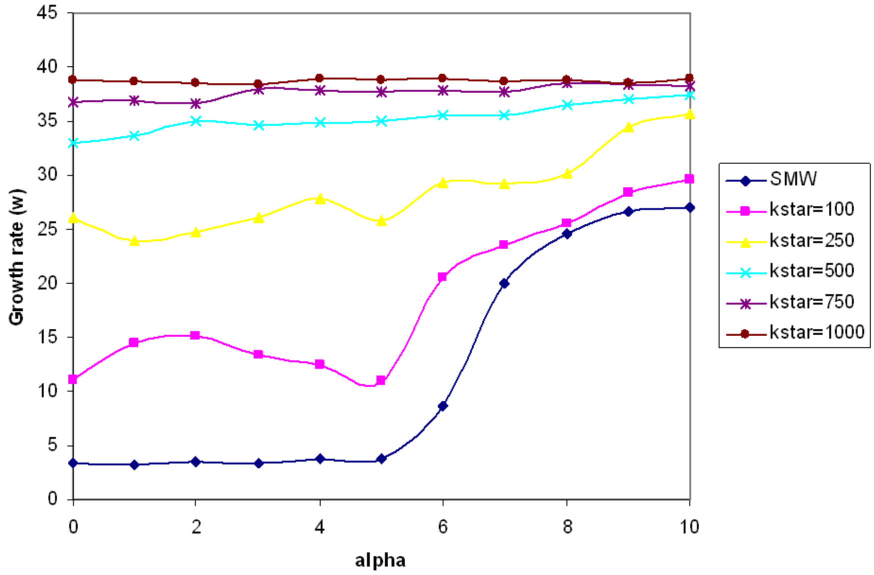
Source: Own calculations

Please note that unconnected networks correspond to an extreme form of clustering. Accordingly, one can observe that growth rates steeply increase between $\alpha = 6$ and $\alpha = 7$, that is, between unconnected and connected networks. However, please note further that also local clustering generally decreases with α. As explained above, this fact is not perfectly reflected by corresponding global cluster coefficient (γ). Thus, for disconnected networks the effective network size is much lower than n depending on the size of the connected components. Accordingly, following our intuitive explanation above, observed low growth rates of knowledge stocks technically result from the low effective global network size in disconnected networks.

Clustering also has a significant impact on speed of knowledge accumulation within connected networks as growth rates increase by 35 percent from 20 to 27 percent, ranging α from 7 to 10. Note that simulated differences between different clustering structures are statistically significant given the extremely low standard errors for average growth rates reported in table 1.

The impact of clustering is clearly attenuated in hybrid networks including a star (see figure 3).

Figure 9.3.: Clustering and growth rates (w) of accumulated knowledge in star networks



Source: Own calculations

For example, for a 100-star network, i.e., a star with 100 ties, increasing clustering from ($\alpha = 10$) to ($\alpha = 7$) implies only a decrease of the growth rate (w) by a factor of 1.26 from 23.5 to 29.5 percent. Moreover, the larger the star the more the impact of clustering vanishes, e.g., for a central star connected to every other firm (star-1000), clustering has almost no impact on knowledge accumulation (see figure 3). Further, star networks are generally completely connected (see table 1). Only the star-100 and -250 networks are not fully connected for α-values below 7, and here we also observe that knowledge accumulation is significantly slower for unconnected networks.

Finally, comparing figures 2 and 3, one can clearly see that although clustering generally reduces the speed of knowledge accumulation in both network types, in quantitative terms the impact is much higher for SWNs.

Again, all simulated differences between different clustering structures are statistically significant given the extremely low standard errors for average growth rates reported in table 1.

Size of the star

Further, figure 3 clearly shows that the larger the size of the star the higher the speed of knowledge accumulation. This clearly results from our intuitive interpretation of our agent-based model, since the higher the number of ties of the star the larger are c.p. the r-neighborhoods and thus the faster knowledge diffuses through the network accelerating knowledge accumulation. Obviously, the existence of a central star being connected to every node in the network (1000-star in figure 3) implies that the 2-path neighborhood already includes the complete network. In this case the growth rate of knowledge accumulation approximates 0.5 as the network learns a new signal approximatively every second time period. An important question is how central stars are conceivable in real firm networks. One idea might be that large firms which are technological leaders become central stars in firm information networks. However, alternative candidates for central stars could be consulting companies or business associations. Empirically, it appears more conceivable for the latter to maintain many network ties than a large firm (Henning and et al., 2008).

Global network size

As can bee seen in figure 2,the global network size for the SW-network significantly increases the speed of knowledge. However, there is a significant negative interaction effect among clustering and network size, where impact of increasing network size almost vanishes when clustering is sufficiently high. For example, for $\alpha = 10$, indicating a cluster coefficient of $\gamma = 0.115$, an increase of global network size from 1000 to 5000 implies an increase of the speed of knowledge accumulation from 0.27 to 0.32, while for $\alpha = 0$ almost no increase can be observed.

A similar increase of knowledge growth induced by a higher global network size can be observed for star networks (see table 1). Note that only n is increased, while the local network size, i.e., the average number of network ties, $\bar{z}$, is held constant, which means the global network density decreases. Moreover, the global cluster coefficient, γ, decreases, while the characteristic path length L increases with global network size (see table 2 in the appendix). Accordingly, the impact of increased global network size on knowledge accumulation can be separated into two different effects. A direct effect results, holding clustering constant. The explanation for the direct effect of global network size results from the fact that a larger network size implies c.p. that the size of all k-path neighborhoods increases, since the probability of redundant network ties decreases with n.

Beyond the direct effect, shifting global network size also has an indirect effect, since an increased global network size implies less clustering for any given $\alpha - value$ (see table 2 in the appendix). This indirect effect on knowledge accumulation via reduced clustering is also positive.

A similar effect of network size can be observed for star-networks (see table 1), although we do not present this effect graphically to save space. However, especially for large stars, the effect of network size on knowledge accumulation is attenuated (see table 1).

Local network size

Finally, obviously the diffusion of knowledge through the network is the faster the higher the average number of direct ties, that is the larger average local network size, $\bar{z}$. As table 1 shows, local network size has a significant impact on average knowledge growth rates. Again, a strong negative interaction effect with clustering can be observed, where the positive impact of a higher average local network size increases with α. Hence, technically, the optimal speed of knowledge would result for a perfectly connected network, where every firm is connected to every other firm. In contrast, economically the cost of establishing network ties must be taken into consideration, implying that completely connected networks are not necessarily most efficient.

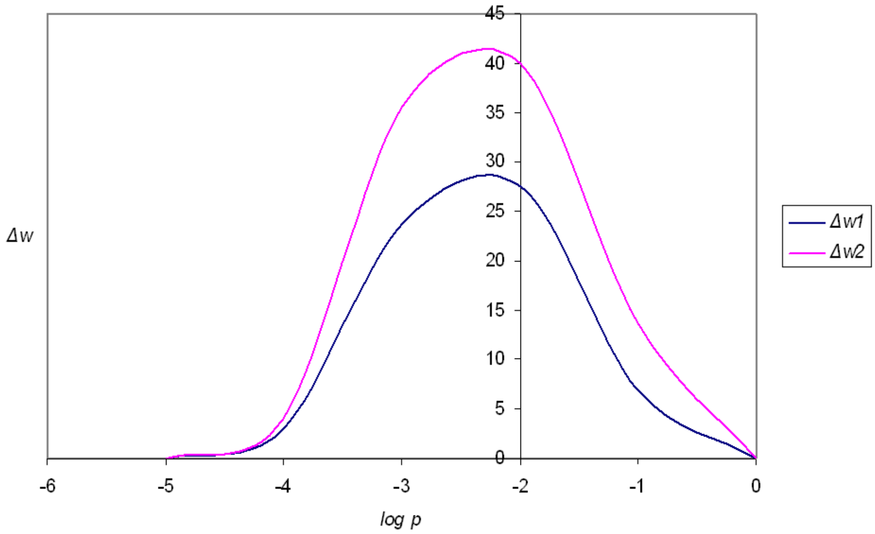
The impact of networks under different innovation intensities

So far we have analyzed to what extend network structures have an impact on knowledge spillovers and thus on knowledge accumulation, assuming a specific innovation intensity, i.e., the probability that an individual firm acquires new knowledge in a given time period was set to $p = 0.001$. However, the impact of network structures obviously depends on the innovation intensity, that is, the firms' investment into absorbtion capacity, m_i. For example, it is obvious that if the innovation intensity is extremely low, e.g., p approximates 0, individual firms quasi never learn. Accordingly, knowledge spillovers and thus network structures become irrelevant. On the other hand, assuming an extremely high innovation intensity, knowledge spillovers and thus network structures become less important, as in essence learning becomes a independent individual process.

In figure 9.4 we report simulated knowledge growth rates assuming different innovation intensities, e.g., ranging p from 0.001 to 0.01 and 0.1. As can be clearly seen for $p > 0.1$, which means ($log\ p > -1$), innovation intensity is sufficiently high that clustering has little impact on speed of knowledge accumulation. Analogously, the impact of a central star is significantly reduced as speed of knowledge is only slightly higher for the 1000-star-network when compared to SW-networks (see figure 9.4).

The lower line ($\Delta w1 = SWN_{10} - SWN_0$) displays the difference between two SW-networks where the first is a SW-network created with $\alpha = 10$ while the second SW-network was constructed with $\alpha = 0$. The second curve ($\Delta w2 = 1000 - star_{10} - SWN_0$) shows the difference for 1000-star-network with $\alpha = 10$ and a SW-network with $\alpha = 0$.

Figure 9.4.: Impact of network structures under different innovations intensities



Source: Own calculations

9.1.2. The impact of networks on belief formation

Decision-making is one of the fundamental processes in social science and in particular in economics. However, considering the bounded rationality of agents, decisions are not taken up on complete a priori information, but on incomplete, limited information that involves uncertainties and is disseminated with finite velocity. Therefore, modeling the flow of information as well as agents strategy to draw their decisions based on incomplete and limited information is crucial for understanding individual behavior and resulting collective outcomes.

In this context two other application of importance in understanding how social network structure impacts behavior, is to understand (1) how information propagates through a network, and (2) how different agents learn from each other, i.e. how agents' opinion and behavior is influenced from other agents' behavior or opinion connected in a social network.

Accordingly, a second main theoretical contribution of the project ADVANCED-EVAL to the role of networks in rural development correspond to the analysis of the impact of communication network structure on agents belief formations .

In particular, we propose an agent-based model of belief formation of individual agents in the framework of fundamental uncertainty. Agents have to make a binary decision which has direct consequences for agents' individual utility. Agents' beliefs of the state of the world are crucial in determining agents' choices. Agents receive decentralized signals which are informational regarding the state of the world, but signals are noisy. Therefore, agents have an incentive to communicate with each other. However, communication can be biased. Simulation analysis show that communication networks are important determinants of the dynamics of belief formation and of agents' decision-making. We identify specific network structures that closely mimic optimal decision-making based on a perfect rational Bayesian updating. Thus, communication networks can be interpreted as social capital. Empirically a mismatch of belief formation strategies and the true informational value of agents' communicated opinions might occur, i.e. collective belief formation via communication is not always efficient.

Results

Main results of our simulation analyses are presented in figures 1-6. Overall, simulations include 200 different force parameters, 100 ranging stepwise from -0.5 to 0 and 100 ranging from 0 to 0.5. As we already explained above, for each network parameter constellation we undertook 20 simulation runs and estimations are based on average discounted profits observed for these 20 simulations. The figures generally present estimated functional relations between force and discounted profits, where we assumed a double logarithmic function without a constant:

$ln\, \pi = \alpha\, lnF$.

Of course, for the super-agent (super avg) as well as the atomistic belief formation scenario (autark avg) simulation results did not change with the force. Analogously, assuming no opinion leader exists (Network without elite) we only got one simulation outcome corresponding to a zero force in figures 1-6. Moreover, results presented in figures 1-3 correspond to scenarios where we assume that local opinion leaders are able to infer information signals observed in their neighborhood, while results presented in figures 4-6 correspond to scenarios assuming that local opinion leaders are unable to infer this information.

In general, the super agent scenario can be considered as a benchmark scenario as it reports maximal profits that can be achieved given the total available information.

Individual beliefs, communication networks and economic performance

As can be seen from figures 1-6, communication networks have a significant impact on average economic performance. Further, as already explained above the impact of communication network crucially depends on agents' belief formation strategy.

Compared to an atomistic strategy, collective belief up-dating via communication leads on average to a significant higher economic performance as long as agents follow an opinion leader strategy (see figures 1-6). The latter holds especially true when opinion leaders can infer the types of the signals received in their neighborhood (see figures 1-3). Interestingly, opinion leader strategies are extremely successful when opinion leaders are positively biased, e.g. even for a low number of signals average profits account for 75 percent (achieved for 100 signals see figure 1) up to 87 percent of maximal profits (achieved for 300 signals see figure 2).

Compared to average profits achieved applying an autarkic belief formation strategy an opinion leader strategy implies an increase of profits ranging from 61 to 220 percent, i.e. the increase of profits implied by an opinion leader strategy amounts to 61 up to 220 percent of total profits achieved under the autarkic strategy.

However, if opinion leaders are pessimistic the positive impact of collective belief formation applying an opinion leader strategy is attenuated, but remains clearly visible as long as we assume that opinion leaders are able to infer the type of signals received in their neighborhood (see left graph for a negative force ranging form 0 to -0,5 in figures 1-3). In quantitative terms pessimistic opinion leaders imply an increase of average profits ranging from a 61 percent (for 100 information signals) to a 113 percent increase of profits (for 300 information signals).

As explained theoretically in our simple linear belief formation model, beyond agents' applied belief formation strategies the structure of the communication network has also a significant impact on the outcomes observed at the macro level. As can be seen from figures 1-3 the force has a significant impact on economic performance implied by the

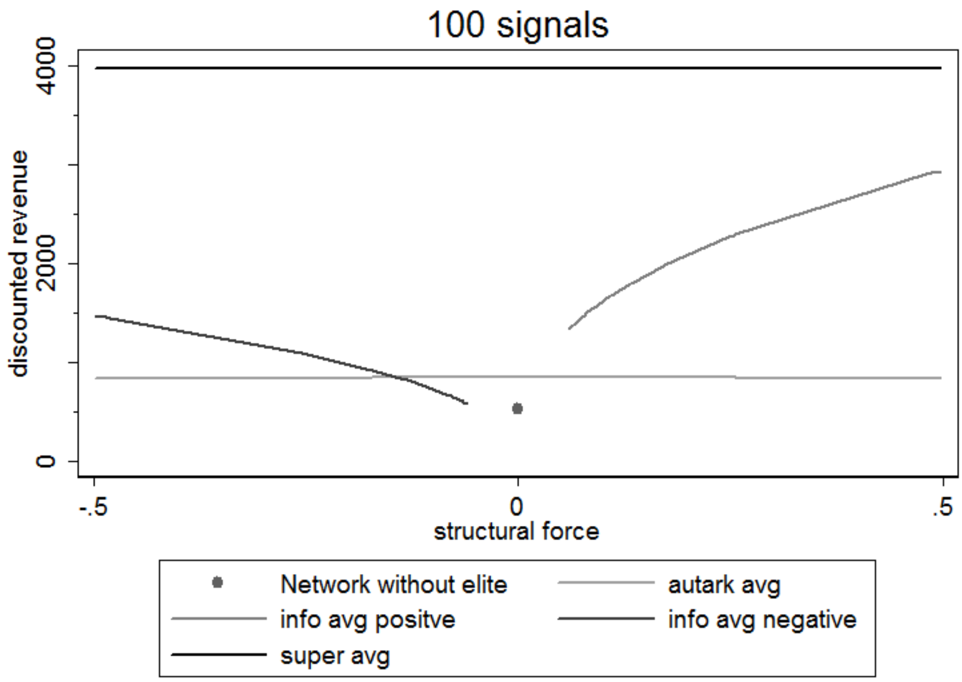


Figure 9.5.: The impact of the force on average economic performance under different belief formation strategies: 100 information signals with information aggregation

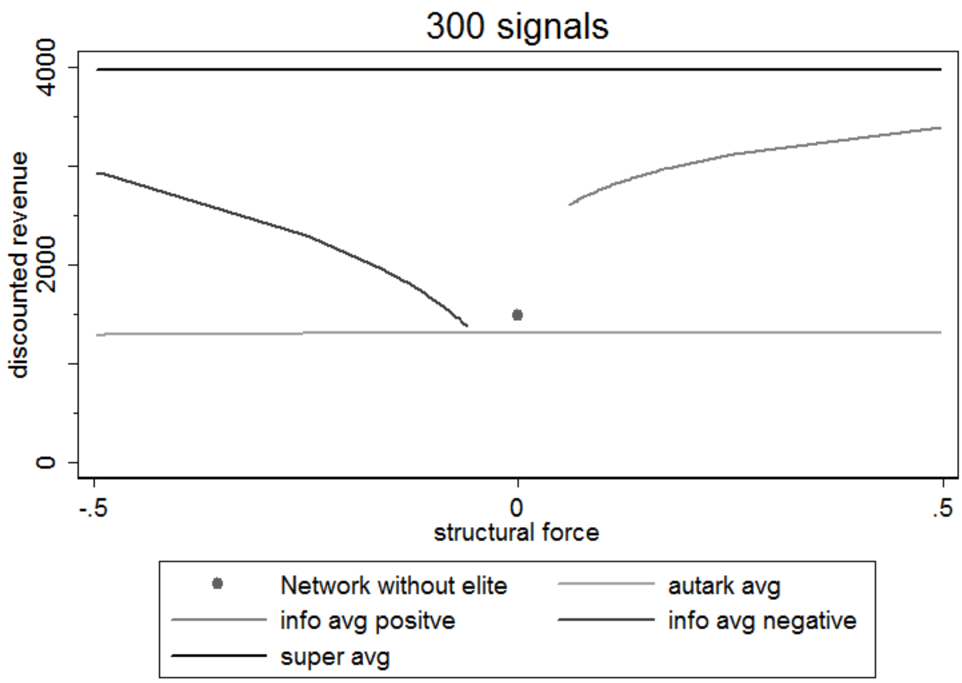


Figure 9.6.: The impact of the force on average economic performance under different belief formation strategies: 300 information signals with information aggregation

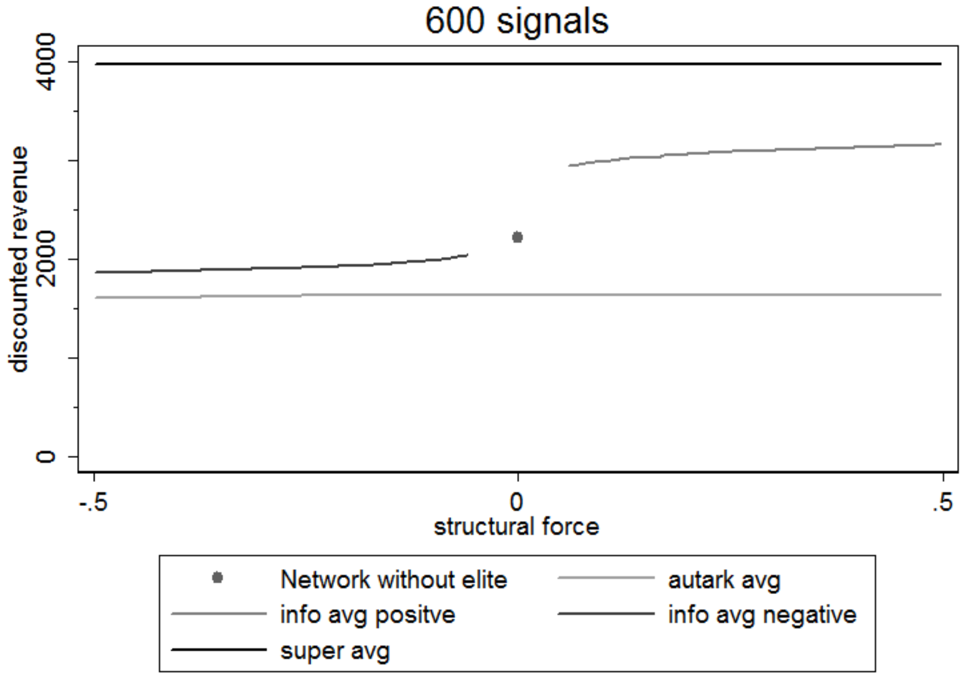


Figure 9.7.: The impact of the force on average economic performance under different belief formation strategies: 600 information signals with information aggregation

opinion leader strategy, where we observe a clear interaction effect with the bias of opinion leaders as well as the number of total information signals (r).

If opinion leaders are positively biased and the number of information signals is low, the force has a strong positive impact on economic performance, e.g. assuming 100 information signals increasing the force from zero to 0.5 implies an increase of average profits from roughly 500 (see Network without elite in figure 1) to roughly 3000 (see info avg positive for $F = 0.5$ in figure 1). However, in quantitative terms the positive effect of the force on performance is attenuated when the number of total signals is increased (see figures 2 and 3).

Moreover, if opinion leaders are negatively biased an increased structural force implies a much lower increase of profits when compared to positively biased opinion leaders (see left graphs in figures 1-3).

A different picture results if we assume that opinion leaders cannot infer the type of information signals received in their neighborhood, i.e. opinion leaders like the other normal agents base their initial opinion on their privately received information signals alone. Under this assumption an opinion leader strategy can no more be rationalized via Bayesian information up-dating.

Interestingly, despite the lack of an informational rationality the opinion leader strategy has a significant and positive impact on average economic performance at least as long as a positive bias of opinion leaders is assumed, as can be seen from figures 4-6. In quantitative terms even without assuming opinion leaders having the capacity to aggregate the information in their neighborhood, for optimistic opinion leaders the opinion leader strategy leads to an average profit of roughly 2500 which amounts to remarkable 63 percent of the maximal profit. Interestingly, neither the force nor the total number of signals received by the system seems to have an impact on this result (see figures 4-6).

However, if we assume that opinion leaders are pessimistic this positive impact turns into the opposite, i.e. compared to an autarkic belief formation strategy the opinion leader strategy leads to lower average profits. The latter holds especially true if the system receives only a low number of signals (see figures 4-6).

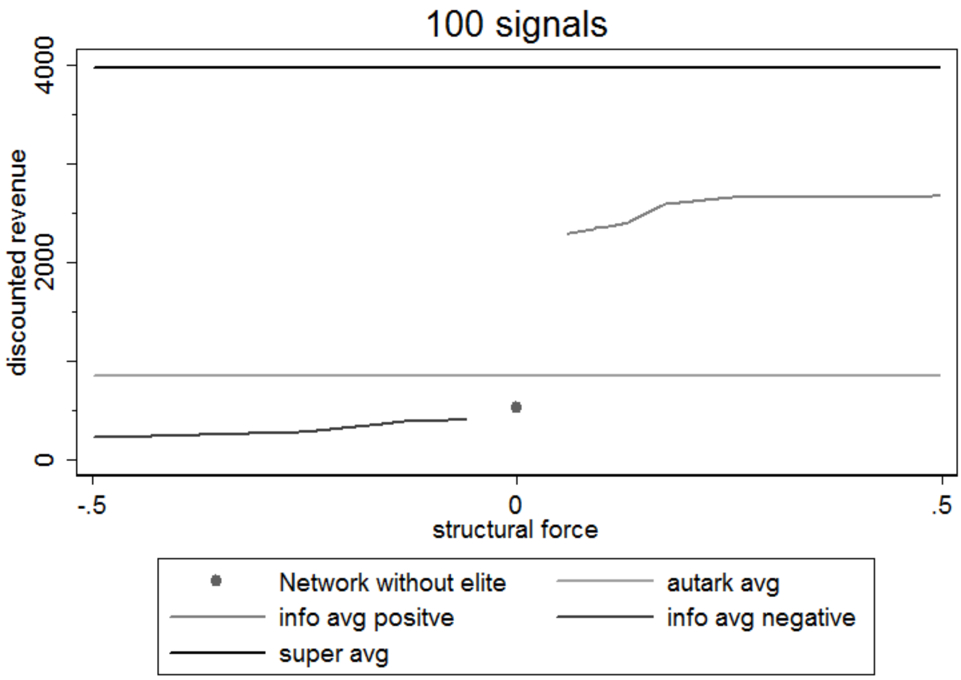


Figure 9.8.: The impact of the force on average economic performance under different belief formation strategies: 100 information signals without information aggregation

Finally, note that without opinion leaders, collective belief formation via communication might lead to lower or higher profits when compared to an autarkic belief formation strategy depending on the total number of signals received in the system (see results for "Network without elite" in figures 1-6). Note that collective belief formation via communication without opinion leaders basically corresponds to an imitation strategy as described above. However, please also note that given our generated network the neighborhood of an average agent includes only 10 other agents. Accordingly, agents' weights are extremely biased, i.e. average agents up-date their opinion basically focusing on 10 agents. In particular, assuming the system receives only 100 signals, collective belief formation in communication networks leads only to an average profit of 500, while an autarkic strategy implies a profit of roughly 900. Assuming 300 (600) signals, ob-

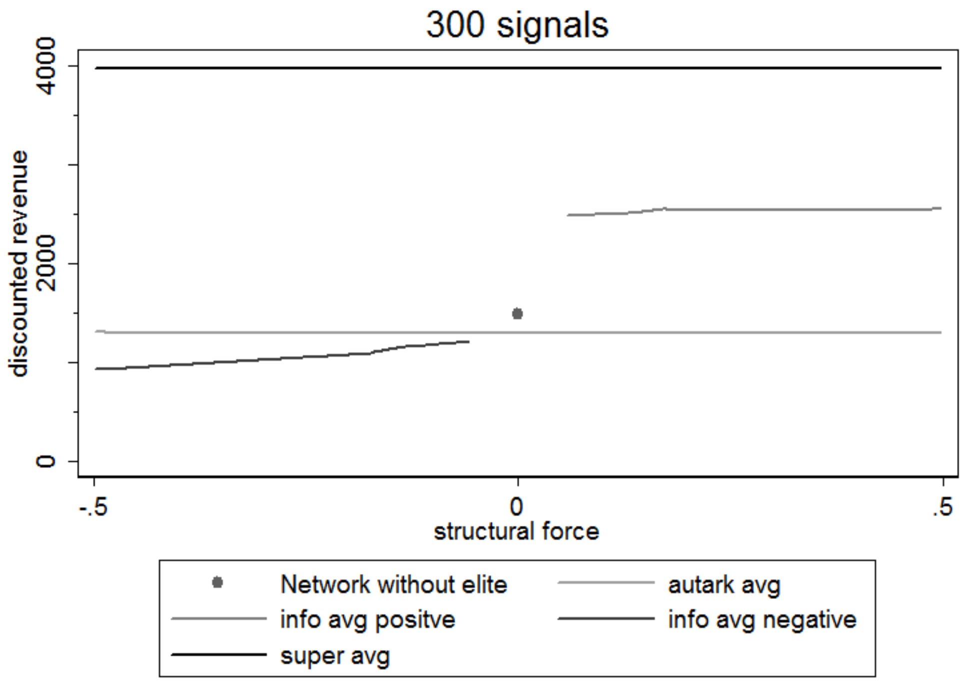


Figure 9.9.: The impact of the force on average economic performance under different belief formation strategies: 300 information signals without information aggregation

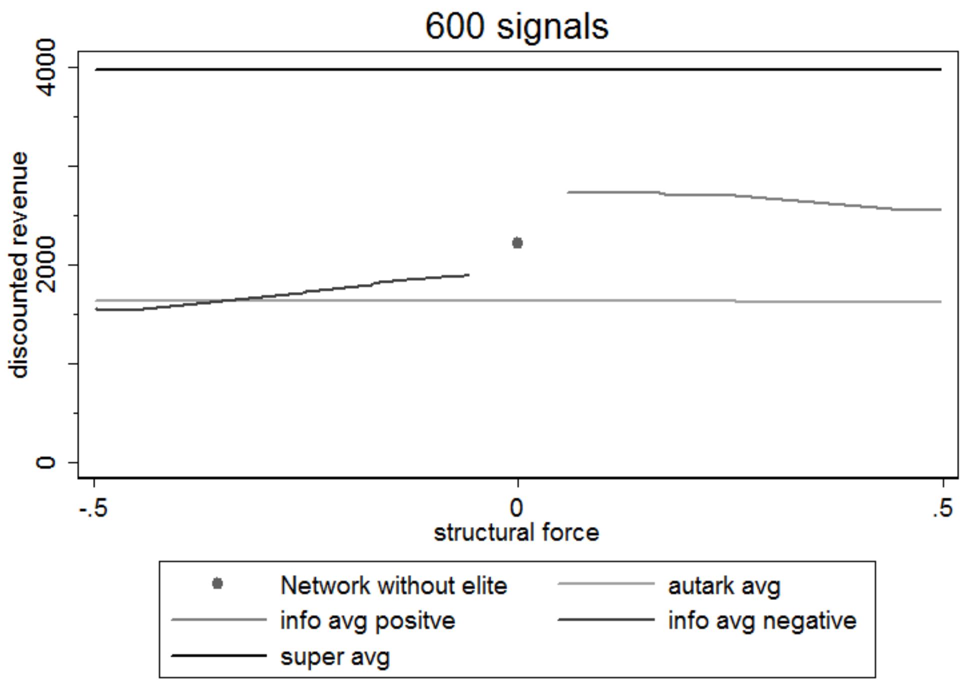


Figure 9.10.: The impact of the force on average economic performance under different belief formation strategies: 600 information signals without information aggregation

served profits for the imitation strategy increase to 1750 (2300) which corresponds to a 25 (41) percent higher average profit when compared to an autarkic belief formation strategy.

How can these results be explained?

Applying again our simple linear model of belief formation it follows that collective belief formation via communication implies that agents beliefs held after communication correspond to a weighted average of agents' initial opinions. Accordingly, as long as agents' initial opinions correspond to their privately received information signals communication is an efficient mechanism to aggregate decentralized information signals.

However, as we already explained above, if agents' initial opinions are biased communication leads to biased beliefs and hence less efficient outcomes when compared to autarkic belief formation. For example, given assumed prior beliefs all agents who do not receive a signal hold a negative view of the state of the world prior to communication. Accordingly, belief up-dating via communication implies that a majority of agents holds negative beliefs after communication. Hence, especially in the case of low information intensity the imitation strategy leads to biased beliefs and to a less efficient performance when compared to an atomistic belief formation strategy.

This is exactly what our simulation results imply. If the number of total signals is low, i.e. below 300, belief formation in networks implies less efficient outcomes (see figures 1 or 4). Only if the number of total signals is sufficiently large, e.g. above 300, the bias is attenuated, since a larger share of agents has received a signal and thus their opinion is informative and collective belief formation via communication without opinion leaders is more efficient when compared to an autarkic belief formation (see figures 2 and 3 as well as figures 5 and 6). Following the same logic centralization of communication would c.p. imply less efficient belief formation. This follows from the fact that centralized communication focuses on a smaller subset of central agents and therefore agents' updated beliefs are based on less information signals. Accordingly, agents on average have a higher probability to hold wrong beliefs regarding the state of the world.

However, assuming that opinion leaders are able to aggregate the information in their neighborhood implies that the opinion leader strategy is an extremely efficient belief formation strategy, as long as opinion leaders use a large number of signals to up-date their beliefs. In the latter case the opinion of opinion leaders is based on a large number of information signals and thus extremely informative regarding the true state of the world. Accordingly, the larger the force the higher is c.p. the weight of opinion leaders in determining agents' final opinion and thus the more efficient is the outcome observed under the opinion leader strategy.

Moreover, please note that the ability of local opinion leaders to truly infer the types of information signals received in their neighborhood depends on the number of ties of the leaders and of the information intensity. If the number of signals and the number of ties are both low the statistical error opinion leader make when discounting non-informative from informative opinions can still be large. Only if the neighborhood of leaders and the number of received signals, respectively, is sufficiently large this approximation is almost accurate and opinions of leaders become a good predictor for the true state of the world. This interaction effect can be nicely seen from figures 1-3, where the impact of force is clearly attenuated when the number of total signals increases. [4]

However, opinion leaders may hold biased opinions. Of course, if opinion leaders hold biased opinions communication dominated by opinion leaders leads c.p. to less efficient decisions.

Nevertheless, even for biased opinion leaders realized profits might still be higher when compared to an atomistic strategy of belief formation, e.g. if the informational benefit implied by the information aggregation overcompensates the belief bias resulting from opinion leaders. This can be seen from figures 1-3 where both overoptimistic and overpessimistic opinion leaders imply higher profits when compared to an autarkic belief formation. In particular, as explained above, due to assumed prior beliefs communication without opinion leaders implies a pessimistic bias, i.e. a majority of agents holds negative beliefs as long as the number of signals is not sufficiently high. Therefore, in this case the influence of overoptimistic opinion leaders might just counterbalances the negative bias induced by uninformed agents and hence induces more efficient individual decisions even when compared to unbiased opinion leaders. This is nicely seen in figures 4-6, where optimistic opinion leaders have a positive impact on performance, although they have not the ability to aggregate the information in their neighborhoods.

But, by the same argument uninformed overpessimistic opinion leaders have a clear negative impact on performance, since they amplify the negative bias inherent in the communication process, where this negative impact increases with the force and a low information intensity (see left graph in figures 4-6).

Bubbles, overinvestment, obesity and other paradox macrobehavior

Given our exposition above, our simulation results clearly demonstrate that communication networks have a significant impact on agents' belief formation at the micro level and accordingly on economic performance at the macro level. However, another interesting question that arises is if our model can also explain behavioral paradoxes observed in reality, e.g. bubbles in financial markets or persisting overinvestment in the agricultural sector or unhealthy nutrition strategies (obesity) or consumption strategies (smoking) that occur although sufficient information is available at least at the system level that would allow a more efficient decision at the micro level.

Technically, given the total available information in our model inefficiency results from

[4]With an increasing force the average number of communication ties held by opinion leaders increases.

a mismatch of belief formation strategies and the true informational value of other agents' opinion. This may occur, for example, if agents apply an autarkic belief formation strategy although opinion leaders exist that are able to aggregate information or, vice versa, if agents apply an opinion leader strategy although opinion leaders are biased and hence their opinion is not informative regarding the true state of the world.

A case in point for the first example would be the fact that many people maintain an unhealthy nutrition, although medical science clearly has proven the relationship between nutrition and health. In this regard existing empirical studies have shown that people stick with inefficient nutrition behavior because they hold biased priors regarding the true technological relations between nutrition and health. Moreover, given the fact that information regarding the true relation between nutrition and health is provided by health professionals these studies highlighted already the role of communication between health professionals and consumers to explain the paradox of the persistence of unhealthy nutrition behavior like obesity (van Dillen et al., 2003). However, while these studies generally highlight the role of communication and individual belief formation, they do not provide a theoretical model, yet. In the framework of our model observed persistent inefficient nutrition behavior could be explained via a mismatch of applied belief formation strategy and the true informational value of the opinion of opinion leaders, i.e. health experts. Assuming a low information density, e.g. a low number of total signals distributed in the system, an autarkic belief formation strategy would imply the persistence of wrong beliefs and thus inefficient decisions at the micro level despite available correct information provided by opinion leaders. In particular, in contrast to the suggestions of existing studies our model would imply that increasing access to nutrition information provided by health experts, e.g. via the media or the internet, would not change observed paradox nutrition behavior. Hence, the problem is not availability of information, but much more the strategy to process available information, i.e. the applied strategy of belief up-dating. Assuming agents' would apply an opinion leader strategy implies that agents would learn the true state of the world and inefficient consumption strategies would rapidly vanish in the system.

An example for the second case of mismatched belief formation strategies and informational value of opinion leaders corresponds to the paradox of persisting investment in the agricultural sector which is a persistent phenomenon for example in the European farm sector (Cochrane, 1958). Applying standard economic theory this phenomenon cannot be explained Koester (1992). In the framework of our model, overinvestment in the farm sector could be explained via a mismatch of an opinion leader belief formation strategy focusing on large farmers as opinion leaders and the true informational value of the opinion of large farmers for small-scale farm technology. Small farmers might apply an opinion leader strategy when making an investment decision, where opinion leaders correspond to large farmers. However, in contrast to large farmers, capital intensive production is not profitable for small farmers. Nevertheless, applying an opinion leader strategy implies that small farmers continue to overinvest in their capital goods, although they continuously experience a negative return on investment (Cochrane, 1958). In contrast, applying an imitation strategy focusing on their local neighbors small farmers would reveal their true technology within a short period of time. Even an autarkic belief formation strategy would probably imply more efficient farm investments.

However, so far we have only given a technical explanation how observed paradox behavior could be explained within our model. The next question that needs to be answered to fully explain observed paradox behavior within our model will be, how can the application of ”inefficient” belief formation strategies be explained.

In this context the classical herding behavior models directly show that individual agents rationally apply an imitation strategy, i.e. it is self-fulfilling, since agents applying an imitaion strategy in fact realize an average performance (Krause, 2004). In contrast, neither overinvestment in the farm sector nor obesity or smoking is self-fullfiling at the micro level. Therefore, the question arises why agents do not adopt more efficient belief formation strategies. Of course, given the fact that in our model belief formation strategies are exogenous this question certainly goes beyond the purpose of this paper.

Nevertheless, we will briefly outline some ideas how the persistence of inefficient belief formation strategies despite cumulative negative experiences could be explained. Following Epstein (2006), one promising approach would be to interpret belief formation strategies as norms, where norms first were learned as self-enforcing behavioral regularities, but second, once entrenched, people conform without thinking about it. The ”higher” rationality behind conforming without thinking is that thinking is not costless and therefore it can be efficient to apply norms without thinking [see Epstein (2006)]. Using Epstein’s word agents ”learn to be thoughtless”.

Accordingly, in the past periods, where small and large-scale farm technologies have been basically the same, small-scale farmers might have rationally adopted an opinion leader strategy, i.e. for the reason explained above it might have been an informational rationality, while due to technical progress in the present large and small farm technologies significantly differ. Accordingly, the opinion leader strategy is no more informationally rational, as large farmers as opinion leaders hold biased opinions from the view point of small farmers. However, small farmers conform without thinking, i.e. they apply their opinion leader strategy without thinking, as they learned to be thoughtless. Only if some strong exogenous shocks occur, e.g. small farmers go bankrupt due to permanent overinvestments or consumers get seriously ill due to unhealthy nutrition, they might start reconsidering their belief formation strategy and adopt more rational strategies.

Finally, interestingly in some specific cases a mismatch of micromotives and macrobehavior might in fact enhance efficiency at both the micro and the macro level. For example, our simulation analyses demonstrated that if agents are extremely risk averse or pessimistic, an opinion leader strategy is especially efficient if opinion leaders are overoptimistic. Ironically, risk averse agents certainly only rely on opinion leaders because they assume they have the same risk attitude and hold similar beliefs as they do. Thus, only because there is an unintended mismatch of agents' assumptions and the true characteristics of opinion leaders at the micro level, a perfect match of belief formation strategies and macrobehavior is realized.

Summary

We propose an agent base-model of belief formation of individual economic agents in the framework of fundamental uncertainty regarding the state of the world. Simulation analyses show that communication network structures are important determinants of the dynamics of belief formation during communication and of agents' final decision-making after communication. In particular, we identify specific network structures at the macro level that closely mimic optimal decision-making based on a perfect rational Bayesian updating using all available decentralized information signals. Thus, communication network structures improving informed decision-making of the set of agents can be interpreted as social capital at the macro level. However, empirically there might also be a mismatch of belief formation strategies and the true informational value of agents' communicated opinions. Hence, collective belief formation via communication is not always more efficient when compared to individual belief formation using privately received information signals. Since belief formation strategies like social norms evolve over time, agents might learn to be thoughtless, i.e. apply strategies without thinking. Accordingly, the persistence of inefficient decisions like overinvestment in the farm sector or firms' resistance or persistence to invest into innovative products, as well as consumer choices regarding innovative consumer goods - e.g. genetically modified products or functional food or consumer choice under fundamental uncertainty of food quality like the BSE crisis - could be explained in the framework of our model.

9.1.3. The impact of networks on transaction costs

In the literature networks obviously facilitate or impede economic cooperation via reducing actors' incentives to behave opportunistically in exchange relations or free ride in the collective provision of public goods. Most studies on networks and exchange assume explicitly that exchange relations are restricted, where only specific pairs of actors have the opportunity to engage in exchange (see Kranton and Minehart (2001) or consider exchange of ex ante fixed amounts of goods Buskens (1999)).

The first kind of analysis does not allow any insight into the mechanism how restricted trade networks come to existence at the first place, but only analyzed the impact of exogenously restricted trade networks on the outcome of economic exchange. In contrast, in the second type of models trade patterns result endogenously from different mechanisms of social embeddedness. In particular, these games assume a fix amount of goods to be exchange and analyze how social network structures determine whether an ex ante fixed amounts of goods are exchanged between different pairs of actors or not.

However, most of the real economic exchange relations are neither characterized by an exogenously fix pattern of trade relations nor by an ex ante fixed amount of goods.

Within the project ADVANCED-EVAL a formal approach that translates the impact of social networks on economic exchange into transaction costs has been further developed based on prior work of Henning (2002).

To understand how embeddedness of economic transaction into a social relation induces cooperation, consider the following linked economic and social exchange game characterized by its game tree in figure 9.11.

The linked game comprises of the economic exchange game as described above. Furthermore, seller and buyer play the following social exchange game.

The a subset of the total set of sellers and buyers is randomly matched in pairs with each other. The share of players playing the social exchange game is r_s. A matched pair of actors plays a social exchange game, which corresponds to simple prisoner dilemma game. Thus, playing a cooperative strategy for an indefinite number of time periods this game yields the following expected lifetime utility V_h^s:

$$\begin{aligned} V_h^s &= A_s \gamma_s \\ A_s &= \frac{1}{1 - r_s \delta \left(1 + \frac{(1+r_s)}{1-\delta(1-r_s)}\right)} \end{aligned} \tag{9.1}$$

Now assume that in each time period the players play first the economic exchange game and then the social exchange game (see figure 9.11). Suppose buyers and sellers ca coordinate their strategies in both games contingent on the outcome of the proceeding games:

1. Each agent plays (nc) in both the economic and the social exchange game whenever

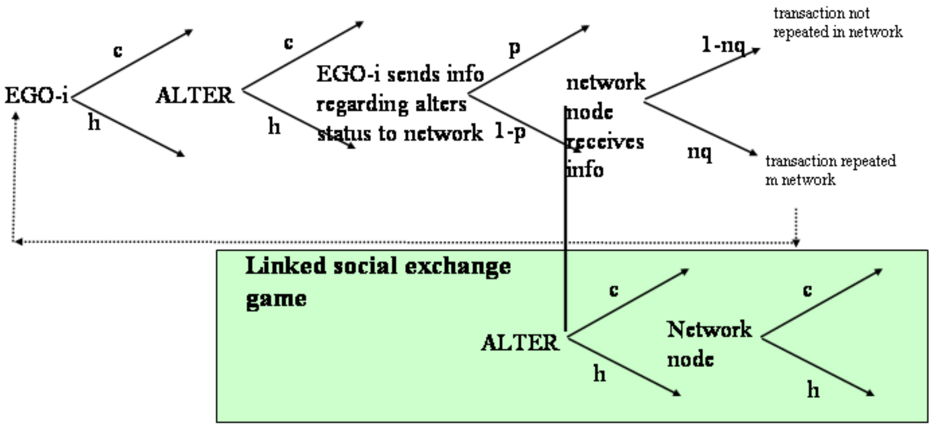


Figure 9.11.: Linked social and economic exchange game

she played (nc) in any previous economic or social exchange game or whenever she is matched with a player who played (nc) in any previous economic or social exchange game.

2. Each player cooperates in both games whenever she is matched with a player who has never cheated in any previous game.

3. All actors belief that all other actor have played and will play in the future the strategy combination as prescribed above except they actually observe a deviation from that strategy.

Obviously, for the linked game the incentive constraint for each buyer not to cheat in the economic exchange game is given by:

$$\omega - \phi + A_s \gamma_s \geq A(\alpha - \phi) \tag{9.2}$$

Therefore, as long as the value of the social exchange game is sufficiently large, buyers can commit to be honest, although the value of exchanged goods is extremely high as in the case of diamonds. Note further that the value of the social exchange game is determined by the probability that an actor is involved in social exchange within the set of buyers and sellers.

In contrast to the game above he derived agents values attached to the different goods, X_a and X_b, from agents' utility functions, $U^1(X_{1a}, X_{1b})$ and $U^2(X_{2a}, X_{2b})$, respectively.

In the OSPD of Henning can exchange any amount of commodities they want, where V_{ab} is the exogenously fixed exchange rate. For a matched pair of seller i and buyer j the seller suggested a trading contract T_{ij}, indicating that he is wiling to exchange T_{ij} units of good X_a in return to $T_{ij}V_{ab}$ units of good B.

He than could proof that in equilibrium of infinite horizon matching game a seller will offer a maximal amount to a buyer j that just guarantees that the buyer will cooperate. Furthermore, Henning interpreted T^*_{ij} as a maximal threshold of trust. i.e. the maximal amount of goods a seller could offer to a buyer in advance without inducing opportunistic behavior of the buyer is a function of business and network parameters. A similar result has been derived by Buskens (1999) for a simple trust game.

Next, Henning introduced uncertainty about the behavior of the buyer. In particular, he assumed that the seller has only incomplete information on the behavior of the buyer. Technically, incomplete information could be incorporated into the game via assuming a probabilistic utility function for buyers. In essence under this assumption buyer's behavior become stochastic from the viewpoint of a seller, where the probability of cooperation is a monotonic function of the difference of the expected lifetime utility derived under cooperation and cheating in one period of time.

Without going into detail here [5] in equilibrium of the game the sellers optimal offer strategy results from the following expected utility maximization:

$$\begin{aligned} & \underset{T_{ij}}{Max}\, P(T_{ij})\; U^s(X_a, X_b) + (1 - P(T_{ij})\; U^s(X_a, B^s) \\ & s.t. \\ & X_a = A^s - T_{ij} \\ & X_b = B^s + V_{ab}T_{ij} \end{aligned} \tag{9.3}$$

Furthermore, the probability that a buyer cooperates, $P(T_ij)$, can be approximated by the following function:

$$P(T_{ij}) = \begin{cases} 1 - \left[\frac{z_{ij} - T_{ij}}{z_{ij}}\right]^{X_{ij}} & \text{for } T_{ij} < z_{ij}, 0 < X_{ij} < 1 \\ 1 & \text{otherwise} \end{cases} \tag{9.4}$$

with $z_{ij} = T^*_{ij}$, the threshold for the actors pair i and j.

Finally, the expected utility function in 9.3 can be approximated by the following function: [6].

$$EU(X_a, X_b, T_{ij}) = \left[X_a^{\beta} X_b^{(1-\beta)}\right]^{\mu} (z_{ij} - T_{ij})^{1-\mu} \tag{9.5}$$

[5] A more detailed derivation of the equilibrium is provided in Henning and Struve (2007)

[6] Note that the resulting Cobb-Douglas function is a specific first order Taylor approximation of the original expected utility function Henning (2002)

In eq. 9.5 the right term can be interpreted as a measure of transaction costs. Note that like leisure can be interpreted as non working time, the term $(z_ij - T_ij$ can be interpreted as the amount of non-traded good. Obviously, the higher this amount, the lower is the corresponding offered transfer and thus the lower is c.p. the risk of buyers opportunistic behavior. Accordingly, the right term measures seller's expected utility derived form a level of non-traded good, $z_{ij} - T_{ij}$. The partial differential of eq. 9.5 with respect to T_{ij} corresponds to the marginal transaction costs of transfers, i.e. the marginal reduction in expected utility a seller c.p. observed when she increases the transfer offer made to a buyer.

9.1.4. Emergence and dynamics of networks

Giving the fact that social networks influence behavior and thus social outcomes prompts the question how networks emerge in the focus of scientific interest. In general, two approaches can be distinguished statistical approaches and economic approaches to network formation Jackson and Yariv (2006).

Within the project ADVANCED-EVAL two alternative statistical approaches have been developed and empirically applied, e.g. a modified α-model of Watts and a latent space model suggested by **?** and **?**.

While both approaches allow the empirical estimation of large-scale networks based on sample data of EGO-centric network data, especially the latent space model appears as a very promising tool to allow empirical studies on the role of networks in rural development. It not only allows the imputation of large-scale network data based on sample network data, but allows the empirical estimation of the network data generating process and thus allows to identify mechanism to manipulate network structure in rural communities. Further details of these approaches are described in [D16], [WP4-16]and [WP4-17].

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9.2. Empirical Evidence

Empirical studies can be subdivided into three parts:

1. Description and comparative studies on social network structures and social capital in rural communities
2. Empirical studies on the role of networks in economic and political performance.
3. Methodological Approaches to Estimate Large Scale Network Data

9.2.1. Comparative network studies in rural regions in Poland and Slovakia

On the one hand comparative network structure were undertaken to analyze EGO-centric networks structures of individual households and firms, which than might influence economic and political behavior at the micro level. Moreover, a comparative policy network survey has been undertaken to analyze to what extend policy network structures at the regional level differ between selected regions. To analyze systematically the impact of network at the macro level the regions were selected in such a way that we had two low and two high performing regions in terms of their economic performance. One of the regions in each of these two groups was located close to a large city, while the other regions was located further away from a large city. Table 9.1 provides an overview of these regions.

Table 9.1.: Selection Gmina (Poland) and Okres (Slovakia), with in brackets the number of households, farms, firms, elite persons interviewed

		Position to city	
Country	Economic performance	close	distant
Poland	high performing	Wieliszew	Kamieniec
		300,150,50,43	300,150,50,39
	low performing	Chotcza	Siemiatkowo
		300,150,50,34	300,150,50,31
Slovakia	high performing	Cifer	Pata
		220,100,50,29	220,100,50,31)
	low performing	Pachovany	Budkovce
		220,100,50,27	220,100,50,33

Detailed results of comparative network studies are presented in the two central deliverables of WP4, i.e. RR4-1 and RR4-2. However, main findings of comparative network studies can be summarized in the following points:

The most prominent and consistent difference that is found is that social capital seems to be larger in Slovak than in Polish rural regions. Consistently, the Slovak respondents indicate to now more different people in the name generators, they have access to more different occupations, and Slovaks have access to more different resources than Poles.

Finally, Slovaks have more macro level social capital than Poles in the sense of general trust, trust in institutions, and organizational memberships, although this last finding is more pronounced for non-farm households than for farm households. Although one might wonder whether these differences are due to the specific regions selected in the two countries, we could not find explicit differences that are obvious explanations for these differences.

As one might expect, social capital is higher in economically high performing regions. Households in high performing regions mention more people on the name generator questions. Especially in farm households, households in high performing regions have access to a larger range of occupations. And, households in high performing regions have access to more resources. Households in high performing regions have more trust, while households in low performing regions have more organizational memberships. Of course the descriptive analyses in this paper, do not provide indications about whether social capital induces the higher performance or the high performance induces better networks. Most likely, both mechanisms are at work simultaneously so it is encouraging to see that the coherence is found.

Comparing regions that are close to a city with regions more distant from a city, we found that regions close to a city have more social capital. Again households from regions close to a city report more contacts in the name generators, have access to more occupations, and have access to more resources. There is also a tendency in terms of macro social capital that households in regions close to a city have more trust and more organizational memberships. Apparently, the vicinity of a city provides easier access to others maybe due to better communication facilities or a higher population density.

Although the different ways in which we have measured social capital are clearly not the same, it is encouraging that we find consistent patterns over the different measurement methods. This provides confidence that all measures give some indication for the existence of a more general concept as social capital from which different facets can be measured with the measurement instruments used in this paper.

Analogously, business network structures are more favorable in high high when compared to low performing rural regions. In particular, effective network size of farm's business networks is significantly higher for high than for low performing rural regions which nicely correspond with our theory regarding the impact of business networks on technical progress and regional economic growth.

Local elite networks also differ significantly across rural regions, where for high performing rural regions political communication networks are more dense and resulting political influence structures are less centralized and less biased in favor of special interest groups, in particular agricultural interests have less political influence in high performing rural regions.

9.2.2. Networks as determinants of economic and political performance

Empirical studies on the impact of networks on economic performance include:

- Analysing the impact of networks on farm exit, diversification and SAPARD participation applying a logistic regression approach [WP4-6]
- Analysing the impact of networks on farm's transaction costs in agricultural markets and off-farm labor markets within a stochastic FHM-model [WP4-7], [WP4-8], [WP4-9], [WP4-19]
- Analysing the impact of network structures on labor market performance of non-farm-households applying a probit function approach [WP4-4]
- Analysing the impact of networks on migration decisions of non-farm households applying a latent cluster model [WP4-18]

Empirical studies on the impact of networks on political performance include:

- Analysing the impact of networks on voter behavior of farm and non-farm households and it's implication for local government performance applying a mixed utility voter model [WP4-10]
- Analysing the impact of policy networks on local government performance applying a political exchange model [WP4-13]

Overall, all empirical studies underline the significant impact of social networks on individual economic and political behavior and it's implication for economic and political performance at the micro and macro level. However, for more detailed result we refer to the corresponding working papers [WP4-16], [WP4-17].

9.2.3. Network dynamics and estimation large scale networks

Within ADVANCED-EVAL we followed two approaches to estimate large-scale networks based on a sample of EGO-centric data. On the one hand this is a modified $\alpha-$algorithm based on work of Watts. On the other hand major work in this field concentrated on innovative MCMC techniques to impute large-scale network data based on sample data of EGO-centric networks.

A large plurality of social network models have been recently suggested and discussed within the literature, see Handcock et al. (2007) and Linkletter (2006). Following Hoff and Ward (2003), the dyadic nature of observation asks social network models to take the following features into account:

1. regressor variables containing information on the dyads,
2. correlation of actions having the same actor,
3. correlation of actions having the same target,
4. correlation of actions between pairs of actors (i.e. reciprocity of actions), and
5. third-order dependencies, e.g. transitivity, clustering, and balance.

Within ADVANCED-EVAL developed and tested different estimation and imputation techniques for social network models in the context of a socio-spatial process. A review of alternative social network models is provided to point at the problem to incorporate individual specific information in a flexible manner. Estimation is performed in a Bayesian setup using MCMC techniques. The corresponding sampling techniques are presented in the context of the employed estimation algorithm. Also imputation of missing values for either dependent of explanatory individual specific variables are presented. Furthermore, model specification via reference distribution are suggested. The numerical adequacy of the suggested algorithms is illustrated within a simulation study using several types of designs for imputation. The simulation study also illustrates the possibility to impute missing values with sufficient precision. Variable selection via reference distribution is shown to work well for identification of relevant individual specific information in binary social network analysis. Finally, the different models summarized within Section 2 can be compared with the proposed socio-spatial process model via cross-validation techniques to ensure comparability of the non nested model setups.

Moreover, both approaches are also empirically applied (see WP5-?? and WP4-??).

9.3. Conclusions and implication for modeling and evaluation of RD-Policies

Overall, undertaken theoretical and empirical network studies clearly underline that social networks are a key factor determining rural development.

In particular, social network structure influence rural development via determining:

- technical progress realized in rural economies
- intra- and intersectoral changed realized via investment, exit and diversification decisions of individual firms
- transaction costs observed by individual firms operating in the local economy

9.4. Publications of WP4

Journal papers

[1] Henning, Christian H.C.A. (2009): Networks of Power in the CAP System of the EU-15 and EU-27. Journal of Public Policy 29(2): 153-177

[2] Henningsen, Arne. and Christian H.C.A Henning (2009): Imposing regional monotonicity on translog stochastic production frontiers with a simple three-step procedure. Journal of Productivity Analysis 32(3): 217-229

[3] Henning, Christian H.C.A. and Volker Saggau (2009): Information networks and knowledge spillovers: simulations in an agent-based model framework, in: "Institutional and social dynamics of growth and distribution" edited by Neri Salvadori, Pisa, forthcoming.

Publication in progress

[4] Henning, Christian H.C.A., Volker Saggau and Johannes Hedtrich (2009): A bayesian rationality to follow opinion leaders? belief formation and social influence in communication networks and their impact on macrobehavior. Submitted to Journal of Mathematical Sociology.

[5] Henning, Christian H.C.A. and Nana Zarnekow (2009): Networks as determinants of rural migration.

[6] Henning, Christian, Hendrik Tietje, Jiangpin Han and Daniel Kleemann (2009): Estimating farm exit, diversification and SAPARD participation of farms in Poland and Slovakia.

[7] Henning, Christian H.C.A. , Henningsen, Geraldine and Arne Henningsen (2009): Measuring the Influence of Information Networks on Farm Productivity Using a Non-parametric Regression Technique.

[8] Aßmann, Christian and Christian H.C.A. Henning (2009): Empirical Analysis of Local Elite Communication Networks via Socio-Spatial Process Models.

[9] Aßmann, Christian and Christian Henning (2009): Estimation and Imputation in Social Network Models using Socio-Spatial Process Models.

Monographs:

[10] Henning, Christian and Volker Saggau (eds.): The Role of Networks in Rural Development: Theory and Applications.

Special Issues:

[11] Henning, Christian and Volker Saggau (eds.): Networks as Determinants of Economic and Political Behavior. To be submitted to a journal.

Deliverables

[D14] The role of networks in rural development: A theoretical framework and empirical application of social network analysis to rural development. Conceptual Report (CR4-1)

[D16] Empirical network studies in high and low performing rural communities in Poland. Regional Report. (RR4-1)

[D17] Empirical network studies in high and low performing rural communities in Slovakia. Regional Report. (RR4-1)

[D18] Policy network structures and governmental performance in low and high performing in rural communities in Poland and Slovakia. (RR4-2)

Working Paper

[WP4-1] Networks and Transaction Costs

[WP4-2] Estimating Network Data from Partial Information: A Literature Review

[WP4-3] Policy network analysis: Models and Methods

[WP4-4] Social Networks and labor market performance of households in rural regions in Poland and Slovakia

[WP4-5] Comparing social networks and social capital of households in rural regions in Poland and Slovakia

[WP4-6] Estimating farm exits in Poland

[WP4-7] Networks and Transaction Costs

[WP4-8] The Influence of Social Networks on the Choice of Governance Structure

[WP4-9] Off-farm Labor Supply and Social Networks: An FHM Approach to Estimate the Impact of Social Networks on Farms' Transaction Costs

[WP4-10] Regional diversity of political behavior and local government performance: The impact of social networks

[WP4-11] Economic and Social Determinants of Migration in Rural Regions: Microeconometric Approach Including Social Networks

[WP4-12] Comparing Policy networks in high and low performing rural regions in Poland and Slovakia.

[WP4-13] Modeling Policy Networks and Local Government Performance: An empirical application to rural communities in Poland and Slovakia

[WP4-14] Social Network Estimation and Imputation

[WP4-15] Belief formation in communication networks and social capital

[WP4-16] Estimating large scale networks with a latent space model

[WP4-17] Understanding rural elite power structures: An application of a latent space model to rural elite networks

[WP4-18] Networks as Determinants of Rural Migration

[WP4-19] Measuring the Influence of Information Networks on Transaction Costs Using a Non-parametric Regression Technique

Technical Reports

[TR4-1] Pre-study Poland

[TR4-2] Pre-study Slovakia

[TR4-3] Business survey: Questionnaire, variables and methodological concepts

[TR4-3a] Business survey: Questionnaire, variables and methodological concepts, second revised version

[TR4-4] Policy network survey: Questionnaire, variables and methodological concepts

[TR4-4a] Policy network survey: Questionnaire, variables and methodological concepts, second revised version.

[TR4-5] Household and labour market survey: Questionnaire, variables and concepts

[TR4-6] Literature overview. networks and transaction costs

Part V.

Quantitative methods of ex ante evaluation (WP5)

by Christian Henning

Chapter 10.

Objectives and background

Ex ante evaluation is a fundamental tool of effective management and an obligatory task in establishing a EU rural development programme for the geographical region concerned. In detail, ex ante evaluation contributes to an efficient **policy planning** . Finding an optimal programme design can be challenging, as it requires not only simulating the impact of potentially many hypothetical programmes, but also simulating programme take-up rates, in order to assess the programme coverage, effectiveness and efficiency. Thus, ex ante evaluation helps to avoid the expense of implementing programmes that are later found to be ineffective. Moreover, ex ante evaluation provides an idea of what impacts to expect after the programme is implemented, which is useful for both programme placement decisions and for choosing adequate sample size and indicators for ex post evaluation. Thus, ex ante evaluation also contributes to improve **policy learning** and control of policy implementation (accountability).

In particular, ex ante evaluation of rural development programmes allows a proper appraisal of whether the proposed level of funding and resources are consistent with the expected results and impacts. Therefore, the EU has strengthened the role of ex ante evaluation in co-founded programmes by incorporating a mandatory ex ante evaluation in many EU policies, including all the rural development programmes since the administrative reform in 2000 (Toulemonde et al., 2002).

However, while the advantages of ex ante evaluation are quite straightforward, and although the Commission requires an obligatory ex ante evaluation for EU policies, an adequate methodology and tools for ex ante evaluations are not fully developed yet, and experience of using ex ante evaluation is still scarce within the Commission.

In this regard, it is a global objective of working package 5 (WP5) of the EU project ***Advanced-Eval*** to develop adequate methodology and tools for ex ante evaluation. Accordingly, the main objectives of WP5 are:

I. Further development and application of specific methodologies allowing an ex ante evaluation of individual RD measures (programme impact) by taking into consideration the impact of tangible and intangible factors (network structures).

II. Identification of the specific impact of innovative RD measures improving local network structures

Given the main methodological objectives of WP5, the following specific objectives of WP5 have been formulated:

A. Identification of the impact of specific tangible and intangible factors in rural development (a quantitative analysis).

B. Simulation of the impact of specific tangible and intangible factors on the effectiveness of individual RD measures.

C. Identification of new RD measures improving local network structures.

To achieve these main and specific objectives the following operational objectives and milestones of WP5 have been formulated:

a. Derivation of an adequate model framework including social network structures of a local rural economy

b. Calibrating the derived theoretical model on the basis of empirical case studies of high and low performing rural communities

c. Performing policy simulation using a calibrated model

d. Simulating the results of ex ante evaluation derived from applying the micro-macro linked ABM-CGE model

e. Simulating the results of ex ante evaluation derived from applying geenralized macthing methods

In particular, in a first step we have within ADVANCED-EVAL developed a Micro-Macro-Linked ABM-CGE approach as an adequate modeling framework for ex ante evaluation (RR5-1). Furthermore, we developed and applied non-parametric matching techniques as an alternative tool of quantitative ex ante evaluation.

The ABM-CGE model has been programmed in GAMS and JAVA and calibrated for 8 selected high and low performing rural communities of Poland and Slovakia (D23).

Moreover, within working package 5 we also tested derived quantitative evaluation methods using simulated data for selected rural regions in Poland and Slovakia. Finally, we compared results derived applying quantitative methods with results derived applying qualitative (current practice) methods o ex ante evaluation of EU RD-policies (D24).

Chapter 11.

Main activities undertaken in WP 5

Main research activities undertaken within WP5 include:

I. Theoretical derivation of a micro-macro linked ABM-CGE model framework applicable for quantitative ex ante evaluation of RD-policies.

II. Programming and empirical calibration of the ABM-CGE model

- Generation of a programming templates of interlinked modules of the ABM-CGE model in GAMS and JAVA
- Calibration of the ABM-CGE based for 8 selected rural region of Poland and Slovakia

III. Undertaking simulation studies:

- Simulating rural development in selected rural regions
- Simulating impacts of selected RD-policies
- Application of ABM-CGE model for ex ante evaluation of RD-policies
- Application of alternative ex ante evaluation techniques (matching) for ex ante evaluation

Chapter 12.

Main results

12.1. Quantitative methods of ex ante evaluation of RD-Policies

12.1.1. A micro-macro-linked ABM-CGE model

An advantage of all model based ex ante evaluation approaches is certainly that these approaches give a - often simplified - picture how the mechanics of policy intervention work via simulating economic development with and without a policy intervention. Based on this counterfactual analysis all ex ante evaluation measures can be calculated for relevant impact indicators comparing the baseline with the simulated policy scenario.

However, as described above, the potential of various model-based approaches to function as suitable tools for ex ante evaluation crucially depends on the potential of the core economic model to mimic ongoing policy responses within the village economies.

Given the general intervention logic of RD policies (see RR5-2) an adequate model approach should include market and non-market interactions occurring simultaneously at the micro, meso and macro level.

In general, different methodological approaches are conceivable fulfilling this task, where the various models differ depending on the set of agents considered and their action sets as well as how individual actions are coordinated.

As described in detail in RR5-1, within the ADVANCED EVAL project, we followed an innovative mixed-modelling approach, incorporating agent based model components into a interregional CGE-model. In particular in contrast to classical CGE-models, we incorporate uncertainty and incomplete information, regarding central economic parameters like prices and technological progress, where we apply an agent based modelling approach to model agents' belief formation. Further, agent specific transaction costs are introduced into our model reflecting local interaction patterns among economic agents. Formally, this implies an extended Walrasian equilibrium including actor specific transaction costs. Finally, for specific markets like the land market, we substitute the complete Walrasian equilibrium concept by introducing a decentralized matching procedure to coordinate individual economic actions. In detail, to include specific imperfections (characteristics) of local land markets, we model local land markets via a sequential Rubenstein type bargaining model.

Moreover, we include the following additional extensions of our basic ABM-CGE approach:

1 incorporation of new economic geography aspects, i.e. agglomeration spillovers in terms of economies of scale or in-migration of skilled labour or increasing linkages with export markets

2 incorporation of endogenous local government behaviour.

3 incorporation of social network dynamics

While the Micro-Macro-linked ABM-CGE model is described in detail in the following section, we briefly describe the main structure below (see figure 12.1).

Our Micro-Macro-linked ABM-CGE model incorporates four modules:

I. Macro Module:

- CGE: A Village CGE module is used to model the coordination of agents' economic actions at the macro level.

II. Micro-Modules:

- FHM: Given the importance of the farm sector for rural development we explicitly link the Village CGE with a farm household model (FHM) at the micro level. The FHM is used to model production and consumption decisions of individual farm-households. In contrast to classical micro models, we incorporate fundamental uncertainty regarding central economic parameters like farm prices and technological progress. Technically, this is done via incorporating individual beliefs driving microeconomic decisions.
- MIG: We apply a micro-econometric approach to model in- and out-migration of non-farm households into or out of the local economy, respectively.

III. Agent based model modules:

- ABM1: First, we apply an agent based approach to model the realization of technological progress via diffusion of technological spillovers in the village economy (ABM1).
- ABM2: Second, we apply an agent based approach to model agents' belief formation embedded in communication networks (ABM2).

- ABM3: Third, we apply an agent based approach to model land transfers occurring on local land market, where individual transfers result from local bargaining processes (ABM3).
- ABM4: Fourth, we apply an agent based approach to model individual farm exit decision and individual farm capital investments as well as other strategic decisions of individual farms, i.e. farm exit decisions or farm diversification (ABM4).

IV. A Network-Module:

- NET-GEN: Given that social networks are key factors driving the agents in our ABM models, we derive a specific network module (NET) that allows the generation of specific network structures. This module is used to specify relevant social network structures in selected local regions as well as to up-date social network structures based on the development of a local economy.

The result is a sequential structure of the ABM-CGE, i.e. different macro-, micro- and ABM-modules are linked to each other in the sense that the endogenous output of one module is the exogenous input of another. The complete sequential link structure of the Macro-Micro linked ABM-CGE model is outlined in figure 12.1. For further details we refer to the project report RR5-1, where our modelling approach is described in more detail.

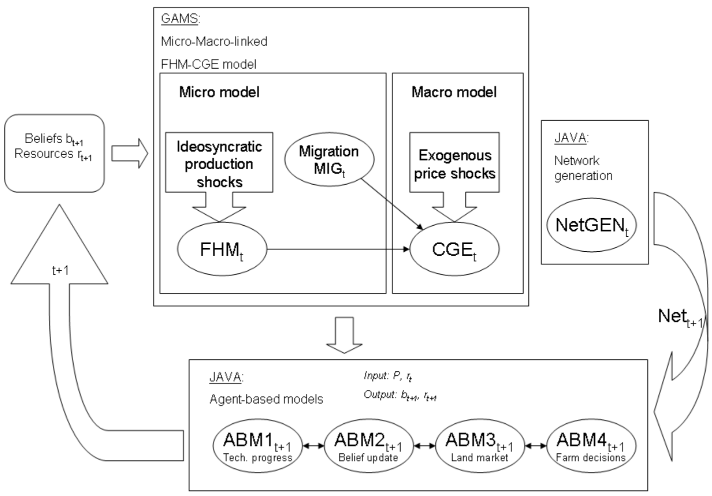

Figure 12.1.: Structure of ABM-CGE-model

As described in figure 12.1 within our Micro-Macro-linked ABM-CGE approach we consider the following sequential structure linking the different Macro-, Micro and ABM-modules to model rural development.

1. In the start period t=0 farm households existing in a local economy hold initial beliefs regarding future prices and realization of technical progress b_t and are equipped with resources r_t. Based on their beliefs b_t and resource endowment r_t in a given time period t individual farm-households make their production and consumption decisions. At the micro level production and consumption decisions are modeled by an individual interdependent farm-household model $(x_a, c_a = FHM_i(b^i, r^i)$. In particular, X^i denotes the vector of netputs and C^i denotes the vector of consumer goods planned by an individual farm-household based on the subjective price and technological beliefs b^i and resources r^i.

2. However, at individual farm level planed production and consumption of individual farm-households differ from finally realized production and consumption due to exogenous economic shocks. In particular, we consider production shocks at the micro level, where partly shocks result from realized technical progress, but partly shocks are pure stochastic. Due to ideosyncratic production shocks realized production of a farm might differ from planned production.

3. After idosyncratic output shocks have been realized, total farm production as well as total net supplied off-farm labor are coordinated with other activities in the local economy. Technically, coordination at macro level is modeled within an interregional CGE approach, $CGE(p, x_a, c_a)$, where at the macro level the CGE model is solved given total sum of production and off-farm labor supply of the farm sector. Given aggregated farm outputs (x_a) and net off-farm labor supply of farm households (c_a) the equilibrium of the local village economy can be computed. In particular, equilibrium commodity and production prices p as well as the local provision of public goods (PG) result from the interregional CGE equilibrium. However, also at the macro level we assume some exogenous shocks. In particular, we assume shocks of exogenously given export and import prices of the local economy. Price shocks basically follow a given price trend, but partly these trends are perturbized by a stochastic component. However, in contrast, to the micro level we assume for the macro level that price shocks are fully anticipated in the village economy equilibrium.

4. We assume that technical progress realized by individual firms in the local economy total results from technological spillovers of a surrounding lead regions. Technological spillovers between firms are organized in business (information) networks. We model the process of interfirm technological spillovers among firms within an agent based model (ABM1). Accordingly, realized technical progress is endogenously determined by the ABM1. In particular, it results from our model that the speed of knowledge accumulation within the local economy and thus realized technical progress crucially depends on network structures. Therefore a simplified version

of AMB1 simply maps given business network structures directly into exogenous technical progress.

5. Given commodity prices p and local public good good provision (PG) resulting as outputs of the village CGE model at the macro level as well as individually realized production shocks observed at the micro level in period t farm-households up-date their beliefs, where b_{t+1} denotes the vector of new individual beliefs. Due to limited information individual farm-households have an incentive to involve in a collective belief up-dating process via communication with other agents. This communication process is not trivial, but organized in given communication networks. Formally we model this collective belief formation processes within an ABM-Module, ABM2.

6. Based on their up-dated beliefs, b_{t+1}, farm-household make strategic decisions, i.e. exit farm sector, diversify, invest in land or capital. We model these various strategic decisions within an agent based approach (ABM3) assuming an exogenously given sequence of decision-making. In particular, farm-households first decide to exit or not to exit the farm sector. If the no exit option has been selected farm-household next decide to diversify farm activities or not. Based on their prior decisions farms decide on investments in land and finally in capital endowments.

7. Obviously, the realization of planned land transfer needs some coordination among farms. To model coordination of land transfers on local land markets a specific agent-based model reflecting sequential multi-actor bargaining processes among farms is applied (ABM4). Obviously, given the sequence of farm decisions modules ABM3 and ABM4 are interlinked with each other, e.g. land market decisions depend on prior exit and diversification decisions, while capital investment depends on realized land transfers.

8 The output of all ABM-modules corresponds to the number of survived farms and their resource endowments for the next time period, r_t+1. Moreover, the systematic technology (production) shock realized after FHM has been solved is determined by module ABM1. The output of the ABM-modules enters the micro-modules (FHM) as new input.

9. Moreover, parallel to the FHM- and sequential ABM-modules migration decisions of non-farm-households are modeled at the micro level applying MIG. In particular, based on the realized village economy equilibrium non-farm households make their migration decision. Basically, we assume that migration decisions of non-farm households result from the comparison of the quality of life perceived for living in the local economy and surrounding regions, respectively. Since central determinants of quality of live of the local economy are determined in the village economy equi-

librium (e.g. household income and provision of local public goods) changed equilibrium outcomes trigger net-migration. Formally, household migration decisions are modeled applying a microeconometric approach (MIG). The result of migration is a changed household composition of the local economy. Since households living in the local economy supply economic factors to the local production sectors , migration has an impact on the village economy equilibrium in the following time period t+1. Formally, the output of the migration module is the relative number of households in different non-farm household categories, which directly changes total factor endowment (r_{t+1}) in the total village economy.

10. Based on resulted market and non-market interactions as well as based on strategic decisions of farm and non-farm households relevant social network structures, e.g. communication and business networks structures are updated. Formally, network dynamics are modeled applying a statistical network generation model (Net-GEN), where Net_t denotes relevant network structures in period t.

11. After relevant social networks have been up-dated the sequential process of time period t ends and the model enters the next time period starting again with step 1. However, up-dated beliefs, b_{t+1} and updated resource endowments of farm and non-farm households, r_{t+1}, as well as up-dated network structures, Net_{t+1} enter the FHM model.

12.1.2. Non-parametric Matching techniques for ex ante evaluation

There are different possibilities to apply matching methods as a tool for ex ante evaluation analyses.

Basically, micro- and macroeconometric approaches as well as ex post and ex ante analyses can be applied. Technically, the application of micro and macroeconometric matching methods for ex post analyses are described in detail in chapter 6. However, these can be used in ex ante evaluation analysis inasmuch RD-measures to be analyzed ex ante have already been applied in the past. In this case ex ante policy impacts can be directly derived from ex post evaluation analyses.Given the fact that corresponding matching procedures are extensively described and discussed in chapter 6, we will not further describe these methods here.

Moreover, if no experience with applied RD-measures exists, generalized matching techniques might still be applied.

A very interesting nonparametric approach applies the propensity score matching techniques, originally developed as an advanced ex post evaluation technique, to simulate policy effects at the micro level (Todd and Wolpin, 2006). An advantage of a nonparametric estimation strategy, when compared to the parametric approaches, follows from the fact that the former is less demanding in its data requirements and does not require any specific functional form assumptions (Todd and Wolpin, 2006). However, in many cases nonparametric approaches are not applicable to ex ante policy evaluation, but stronger modeling assumptions, i.e. functional form assumption, have to be made.

Based on Todd and Wolpin (2006) we have developed a microeconometric matching procedure to evaluate the impact of RD-policy programmes ex ante, which we will briefly describe in the following.

The main difficulty to apply matching methods for ex ante evaluation follows from the fact that naturally prior to implementation no treatment group exist. Thus, ex ante a modified matching methods is applied that allows to estimate treatment effects by matching untreated individuals to other untreated individuals, where the particular set of regressors used to select the matches is implied by a economic model.

For example, the impact of subsidy payments to farms' capital investments can be estimated prior to the programm implementation based on farm accountancy data which contains some variance in individual interest rates of farms. In this case the variance of the interest rate can be used to mimic the choice behavior under the policy intervention.

In particular, assuming that a policy programm implies a subsidy of the interest rate, where r denotes the amount of the subsidy, it follows

$$i(r) = i(1 - r) \tag{12.1}$$

Now we can apply the following matching estimator to evaluate the impact of a subsidy to capital investments:

$$ATT = \frac{1}{n} \sum_{\substack{j=1 \\ j,i \in S_P}} E(Y_{0i} \,|i_i = (1 - r)\, i_j, x^i = x^j) - Y_{0j}(i_j, x^j) \tag{12.2}$$

S_P denotes the supporting regions, e.g. the matches can only be performed where $i(1 - r)$ lies within the support of i in the available sample data.

$E(Y_{0i} \,|i_i = (1 - r)\, i_j, x^i = x^j)$ can be estimated non-parametrically by nearest neighbor, kernel or local linear matching, but in contrast to PSM-matching, where the difference in the propensity scores between treated and control group observation is minimized, matching is based on the difference in a metric defined over covariates x including the interest rate (i). In general different matching metrics are conceivable, which normally correspond to a weighted Euclidian distance function . A prominent metric is the so-called Mahalanobis metric, which used the inverse of the covariance matrix of the covariates as weights. However, we did not use the Mahalanobis metric, but instead we regressed each performance variable on all relevant covariates and used the normalized regression coefficients as relative weights.

Based on simulated data we applied both ex post and ex ante matching methods to estimate the impact of subsidy payments (RD-measure 121) on farms profits, income and land and labor productivity.

In particular, we assume that ex post evaluation analyses are undertaken in the same or in a different region, while ex ante analyses are always undertaken on sample data of the same region. Moreover, we also report the true treatment effects calculated using simulated data from our ABM-CGE-model for individual farms.

12.2. Empirical application

12.2.1. Ex ante evaluation applying a micro-macro ABM-CGE approach

Brief description of methodological procedure

For more concrete comparison of alternative methods we use a simple simulated example of RD-policy interventions in four selected Polish rural regions. In concrete terms we have applied all three approaches to undertake an ex ante evaluation of the simulated RD-policy intervention. In the following we will summarize main results for each approach and based on the derived results will critically assess the potential of each approach to be used for an appropriate ex ante evaluation. Before we present detailed results we will briefly describe the simulated RD-policy intervention and basic economic and demographic structures of four selected rural regions as these information help to understand follow-up discussion of suitability of different approaches.

Selected rural regions

For a more concrete comparison of alternative methods we use a simple simulated example of RD policy interventions in four selected Polish rural regions. We apply all three approaches to undertake an ex ante evaluation of the simulated RD policy intervention. In the following we summarize main results for each approach and, based on the results, will critically assess the potential of each approach for use in an appropriate ex ante evaluation. Before we present detailed results we briefly describe the simulated RD policy intervention and basic economic and demographic structures of the four rural regions as these information helps to understand follow-up discussions of suitability of different approaches.

As explained in more detail in RR5-2 to control for specific framework conditions we used a two dimensional design selecting the four selected rural regions (see table 12.2.1). The first dimension corresponds to the general level of economic development, where we considered two high performing (region 1 and 4) and two low performing (region 2 and 3) rural regions. Geographic distance to a larger city was the second dimension considered, where region 1 and 2 where close to a larger city, while region 3 and 4 where distant to a larger city. Moreover, region 2 and 3 are clearly dominated by the agricultural sector with a GNP-share of over 50 percent, while agriculture is still an important sector in region 4 with a GNP-share of 25 percent and only of minor importance in region 1 with a GNP-share of only 3 percent. Detailed demographic and economic structures are explained in RR5-2.

Table 12.1.: Economic-Structure: GDP-Shares

	region 1	region 2	region 3	region 4
S_F1_Crop	1.7	13.5	5.7	2.6
S_F1_Live	0.8	11.9	6.5	3.2
S_F2_Crop	0.8	11.8	17.8	7.5
S_F2_Live	0.4	12.8	29.9	11
S_AB_Crop	2.7	1	1.8	1.4
S_AB_Live	2.2	0.9	1.6	1.2
S_Man	21.6	2	7.2	6.6
S_Con	22.5	6.3	9.8	6.7
S_Ser_loc	12.6	3	4.1	26.7
S_Ser_oth	33.3	35.9	14.6	31.7
S_Ser_pub	1.4	0.9	1	1.3

Simulated policy scenarios

WWe consider three policy scenarios $s^s, s = 1, 3, 13$. Where scenario 1 corresponds to the application of RD measures of axis 1, scenario 3 corresponds to an application of RD measures of axis 3, and scenario 13 corresponds to a joint application of RD measures of axis 1 and 3. Axis 2 is not included because

As explained in more detail in RR5-2, we considered the following specific RD measures in our simple example, because of their budgetary relevance for these regions:

1. Axis 1
   - training and advisory measures ($s^1_2 = 111, s^1_2 = 115$ and $s^1_3 = 133$)
   - farm and infrastructure investment measures ($s^1_4 = 121, s^1_5 = 123$).
   - infrastructure investment measures ($s^1_6 = 125$).
2. Axis 3

- Measures related to promotion of business environment ($s_1^3 = 312, s_2^3 = 321, s_3^3 = 331$)
- Village renewal and provision of public goods for consumption ($s_4^3 = 322$).

Within axis 1 and axis 3, we basically assume fixed budget shares for RD measures where allocated budget resources mainly correspond to budget allocations observed for these measures for the average of all EU-member states. However, since for specific measures like 121 or 123 and also 322, actual budgetary outlays depend on the response of the village economy's total budget outlays for these measures are endogenously calculated based on actual programme implementation. Accordingly, budget allocations partly vary across rural regions, years and also policy scenarios for these measures. But envisaged total budget outlays for each axis and measure is the same for each policy scenario where the measure is applied. For scenario 1 (Axis 1 only) budget allocation for all Axis 3 measures are zero and vice versa for scenario 3 and budget allocations to Axis 1 measures, while budget outlays for Axis 1 and 3 correspond to scenarios 1 and 13 as well as scenario 3 and 13, respectively.

By applying our linked micro-macro ABM-CGE approach, we proceed as follows:

I. Simulation of the baseline scenario

For each selected rural region, a baseline scenario assuming region specific exogenous trends for all relevant exogenous variables of the model is derived. Exogenous variables of the model include:

1. Technical progress in the surrounding region of the village economy and the rest of the world
2. Development of international commodity prices
3. Minimum wage of unskilled labour
4. Wage level in the surrounding regions of the village economy
5. Demographic development in the village economy and its surrounding regions
6. National interest rate
7. National exchange rate

The baseline scenario is simulated for a period of 15 years.

For the baseline scenario, a full set of relevant baseline, result and impact indicators at the micro, meso and macro level is calculated based on a sequential solution of the complete model.

In particular, the following indicators are included [1]:
Macro level:

- Real Income per Capita
- Unemployment rate
- Labour productivity
- Environment

Meso level:

- Total GNP of agricultural sector
- Total capital stock of agriculture
- Total technological progress realized in the agricultural sector

Micro level:

- Investment made by treated and non-treated farms
- Profits of treated and non-treated farms
- Off-farm labour supply of treated and non-treated farms

Moreover, to be able to undertake sensitivity analyses of ex ante evaluations a set of baseline scenarios is derived assuming different developments for exogenous model variables and assuming different model specifications for each selected region. The latter includes in particular the incorporation of New Economic Geography-effects (NEG). Within our ABM-CGE approach, NEG effects are related to specific large scale network structures. To understand the role of networks in rural development, policies as well as the baseline scenario have been simulated with and without network effects.

The result for each baseline scenario is a set of relevant indicator variables z, which contains for each indicator variable a baseline value for each time period t=1,...,15.

II. Simulation of policy scenarios

In particular we run our model for all three policy scenarios $s_s, s = 1, 3, 13$. To incorporate the different RD measures, we proceeded as follows.

Training and advisory measures of axis 1 (111,115 and 133) are included in our model via an exogenous shift of the technological progress rate realized by individual farms participating in this measure. However, according to our agent based model (ABM1) of knowledge spillovers induced technological progress at individual farm level spread

[1] A full set of indicators is given in the project report RR5-1

out into the complete farm sector. Accordingly, depending on the specific information network structures, we can calculate the induced technological progress realized by all farms applying our specified ABM1 module. In contrast to measures 111 and 133, measure 115 directly changes information network structures. Thus, we assume that measure 115 implies a permanent shift of the technical progress rate that will stay when this measure ends after six years. In contrast, measures 111 and 133 imply only a temporarily increased rate of technological progress that will vanish once these measures will be terminated. All these measures are implemented via an exogenous shift of the scale parameter of the production function of individual farms, where the magnitude of this shift has been calibrated based on existing ex post evaluations of these measures.[2] Moreover, we generally assume that all training and advisory measures only improve technological knowledge of larger farms above 10 hectares, while small farms below 10 hectares are generally unable to profit from these measures.

The investment measures are also implemented at the individual farm level, where programme participants receive an interest rate subsidy. Here we assume for simplicity that selected farms participate jointly in all three investment measures (121,123,125) and receive for all their capital investment an interest rate subsidy of 50 percent. In contrast to training and advisory measures we assume that all farms are eligible for these programs.

To be able to analyze the impact of different implementation strategies we explicitly considered the following three implementation scenarios. 1. Random selection of 20 percent of all existing farms. 2. Random selection only among large farms (above 10 ha), 3. Random selection only among small farms (10 ha or below). Please note that both, the micro and ABM modules, are run including all individual farms that exist in the selected rural region.[3]

III. Calculation of ex ante evaluation measures

Based on our simulation runs we calculated for all relevant indicator variables d (a complete list of calculated indicator variables is given in table ?? in the annex). The evaluation measures $E^1(s,d,t)$, $E^2(s,d)$ and $E^3(s,d)$. Moreover, we calculated medium run and long-run effects (E^4 and E^5).

[2]Please note that here we also have to rely on rather weak semi-quantitative information to specify policy impact within our approach.

[3]In detail 354, 657, 698 and 712 farms existed in region 1 to 4, respectively.

Main Results

Impact indicators: Macro and meso level

Pars pro toto calculated impact indicators $E^1(s, d, t)$ at the macro level are presented in figure 12.2 to 12.5 for region 2. Additionally, to demonstrate regional differences in responses to RD-policies we present for income-per-capita results for all 4 regions in figure 12.6.

Furthermore, complete set of impact indicators calculated for all 4 regions are presented in RR5-2.

The main results for the considered impact indicators can be summarized as follows:

- In contrast to qualitative evaluation results and in contrast to widespread common political beliefs Axis 1 policies have a rather low and partly even negative impact on major impact indicators, e.g. per-capita-income and employment. In particular regarding employment, Axis 1 measures imply higher unemployment when compared to the baseline, ranging from 2 percent for region 2 to up to 8 percent for region 3 in the long run. Only for region 1 a slight reduction of unemployment is implied by Axis 1 policies. Per capita income increased when compared to the baseline for policy scenario 1 in the medium run. However, the impact mainly results from short term demand side effects due to indirect income transfers via capital subsidies and decreased in the long run, when subsidy payments are phased out.

- In contrast to Axis 1 policies, for Axis 3 policies we observe positive impacts on income-per-capita and employment that are also stable in the long run. Especially in the long run, Axis 3 impacts on income and employment are significantly higher when compared to Axis 1 policies (see figures ?ß to ??). Particularly employment is significantly increased by Axis 3 policies giving a reduction of unemployment ranging between 18 percent for region 2 up to over 65 percent for region 1. In comparison to Axis 1 measures, Axis 3 measures operate much more via supply side effects, i.e. increase of technical progress reduction of transaction costs via improved infrastructure which sustain even after the polices have been phased out. Moreover, while Axis 1 is mainly focused on the agricultural sector, Axis 3 focuses on the non-agricultural sector, which has higher multiplier effects compared to the agricultural sector. This holds even true for regions which are dominated by agriculture like region 2 and 3.

- Regarding environmental effects Axis 1 implies negative impacts mainly due to an intensified agricultural sector, while for Axis 3 low but positive impacts on the environment can be observed.

- Finally, for all policy scenarios a positive impact on total labour productivity can be observed. However, taken the corresponding policy impacts on income and employment into account this clearly indicates that labour productivity is not an adequate indicator for monitoring rural development.

- Interestingly, the combination of Axis 1 and 3 policies produces sometimes negative synergy effects, e.g. it would be most effective and efficient to concentrate RD policy mix only on Axis 3. As a matter of fact for Axis 3 the highest cost efficiency parameter result (see figure ??).
- Only regrading agricultural profits more positive impacts result from Axis 1 policies when compared to Axis 3.

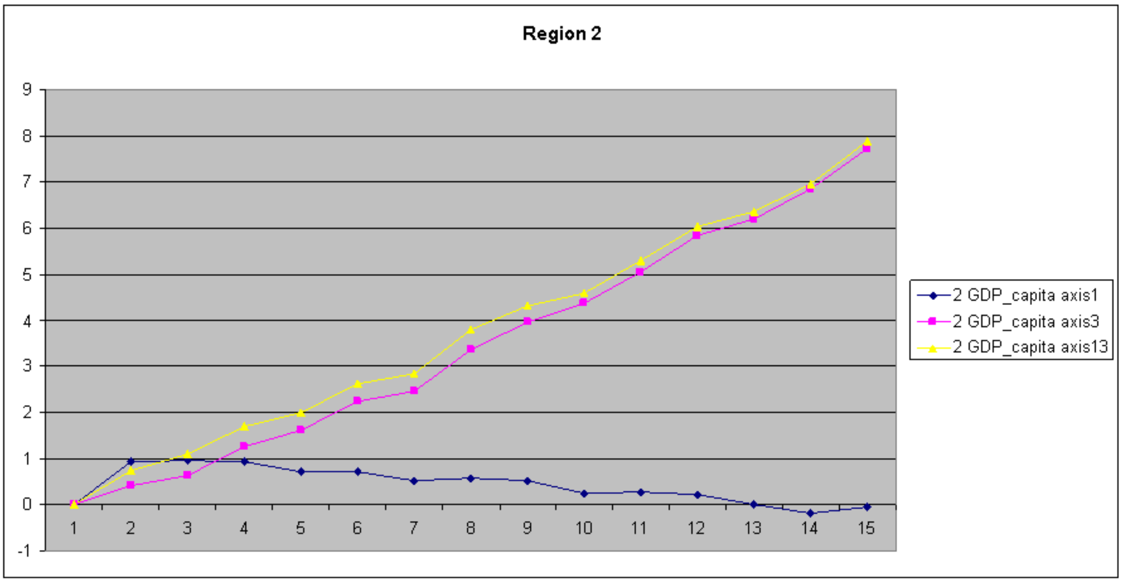

Figure 12.2.: Calculated policy impact on Per-capita income in percentage to baseline Region 2

Impact indicators: Micro Level

One advantage of the applied micro-macro ABM-CGE approach is certainly that it allows simultaneously the derivation of evaluation indicators at the macro, meso and micro level.

One major indicator for policy impacts at the micro levels are the calculation of average treatment effect on treated (ATT). Since we applied a micro-macro linked model we can

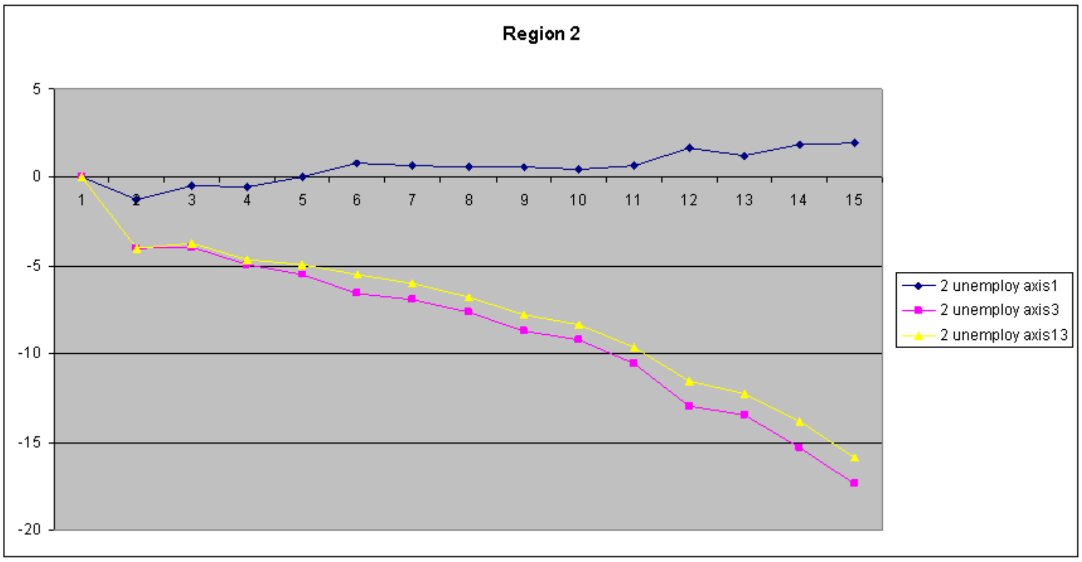

Figure 12.3.: Calculated policy impact on unemployment in percentage to baseline: Region 2

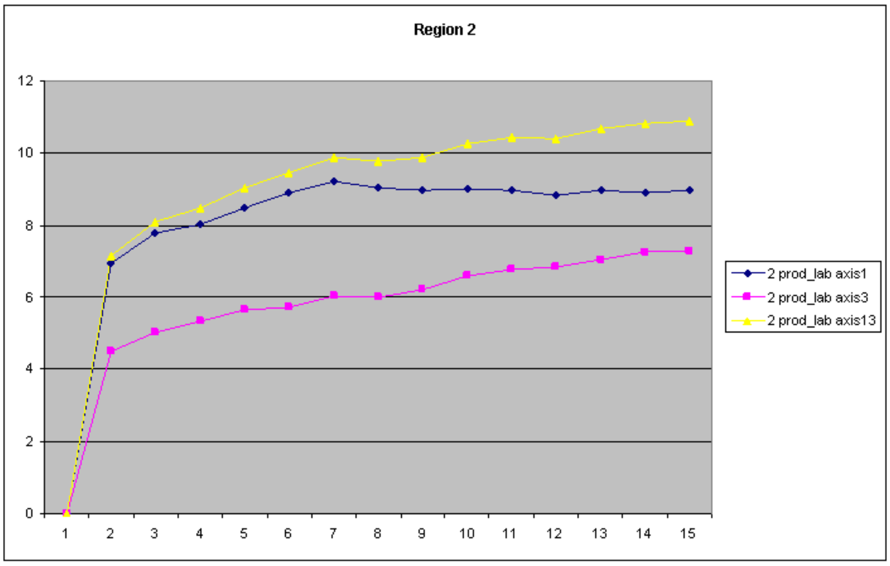

Figure 12.4.: Calculated policy impact on environment in percentage to baseline: Region 2

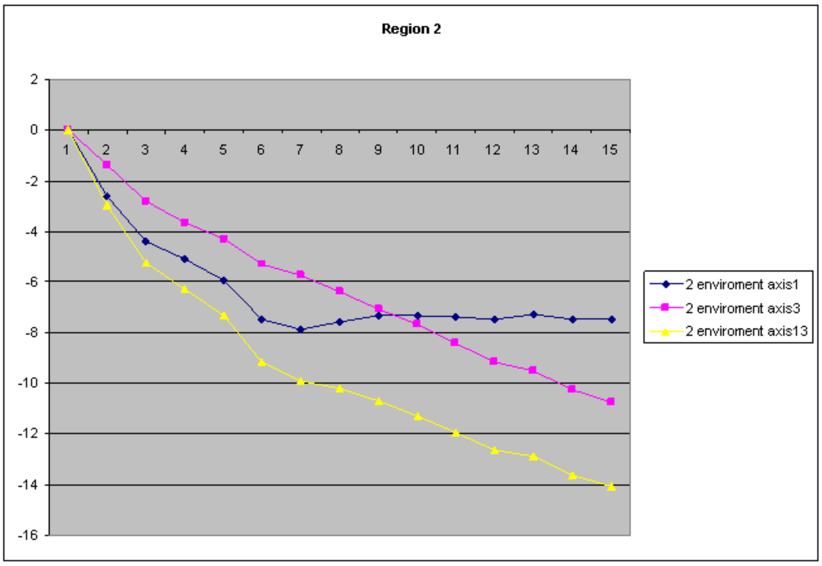

Figure 12.5.: Calculated policy impact on environment in percentage to baseline Region 2

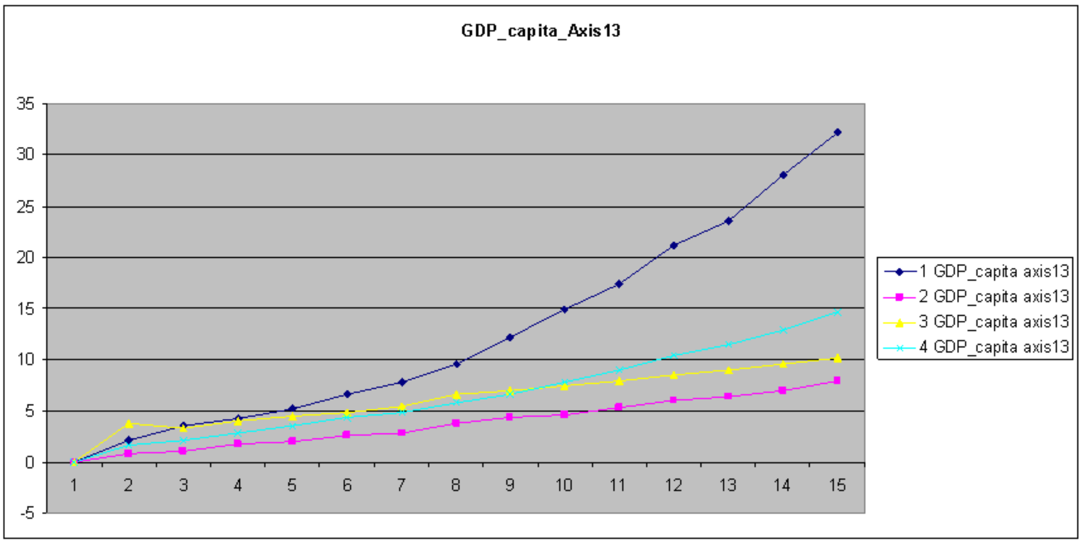

Figure 12.6.: Simulated policy impact on Income in percentage to baseline all Regions

also calculate policy impact on non-treated farms (ATNT), which in our specific model result from market interactions, i.e. general equilibrium effects, and from non-market interactions, e.g. network effects on belief formation and strategic farm investment and exit decisions.

In Figures 12.7 to 12.10 we present calculated ATT and ATNT effects for scenario 1 (Axis 1 policy only) for the variables farm investments, farm profits, farm household income and technical progress at total sector level for region 2, while a complete set of calculated ATT and ATNT for all regions is provided in RR5-2.

Overall, the following implications can be summarized:

- We have a clear treatment effect on treated, where farm investment are significantly increased ranging from 8 up to 14 percent, when compared to the baseline scenario (see figure (). However, as already observed for the macro indicators, policy impacts develop over time, e.g. ATT clearly increase the longer the programme is applied.

- In comparison to the ATT, the policy impact on non-treated farms are negligible (see ATNT in figure)

- Analogously, increased investments and especially capital subsidies paid to farms have a significant increase on farm profits and also farm income. However, especially for farm incomes the impact varies across time, which mainly results from common and ideosyncratic shocks implemented in the model.

- Variance of ATT effects have major implications for ex post analysis, since often analysis focus on a specific year comparing performance between treated and non-treated farms. For example most matching analysis applying PSM-DID methods compare the relative performance of treated and non-treated farms between a base year and a specific point in time after the programme implementation. Obviously, given the fluctuation of ATT effects it is superior to undertake ex post analysis based on comparisons over a longer period in time. Secondly, taking into account that treatment effects evolve over time, where effects can be expected to be comparatively low in the beginning of a policy programme, also implies to undertake ex post evaluations over a longer period of time which is not too close to the start of the following policy programme.

- Finally, it is interesting that although we find a clear positive treatment effect on technical progress induced by Axis 1 policies, this positive effect at the individual farm level does not translate into a positive effect at the sectoral level. For example in our analysis, we derive a negative impact of Axis 1 policies on technological progress realized at sector level (see figure ???). Basically, this contra-intuitive effect follows from the fact that capital subsidies paid to less efficient farms imply that these farms do not exit the farm sector, which impedes a structural change towards more efficient farms in comparison to the baseline.

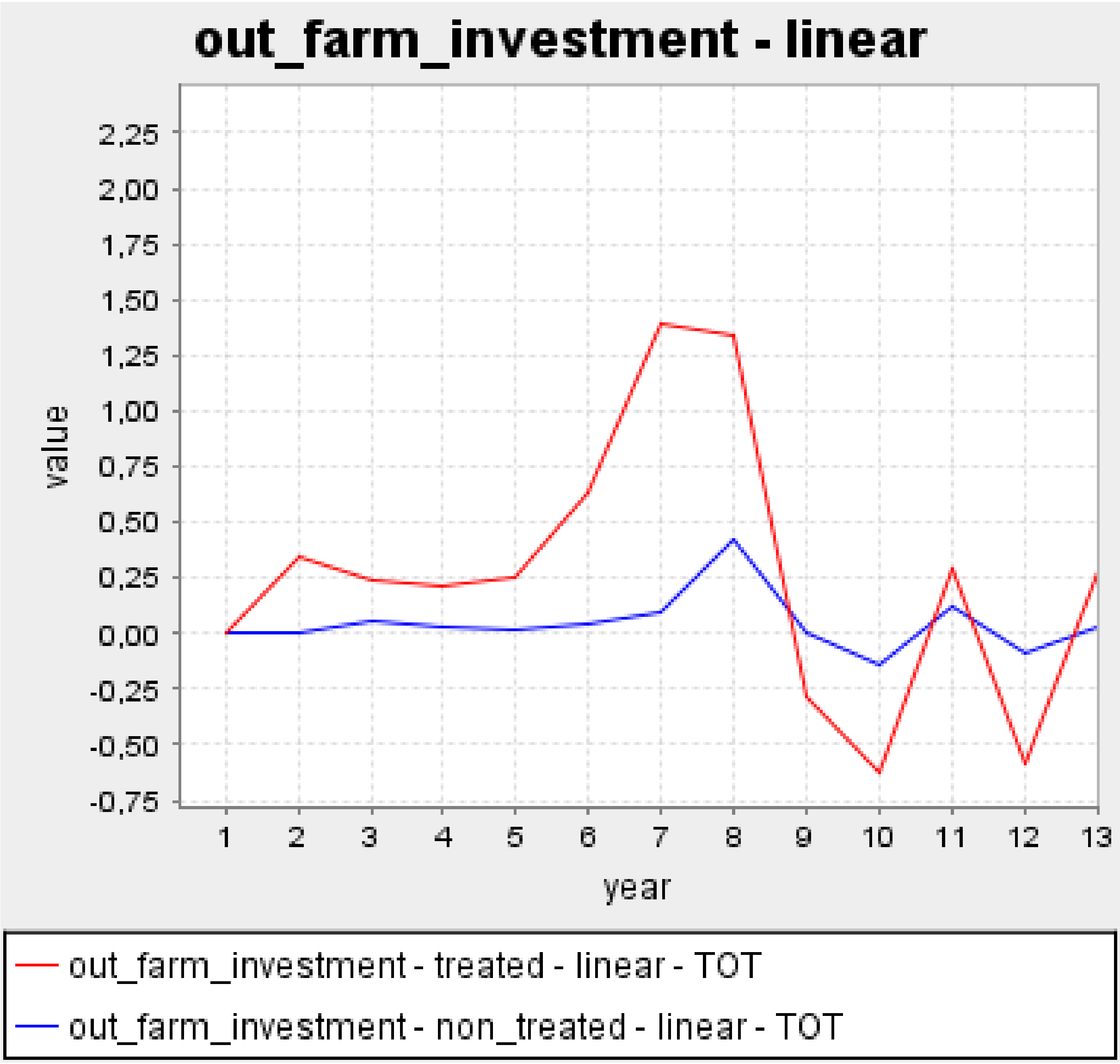

Figure 12.7.: Calculated Axis 1 policy impact on farm investments: ATT and ATNT, region 2

A critical assessment of ex ante evaluation based on the micro-macro linked ABM-CGE model

Overall, the following points summarize a critical assessment of the application of the ABM-CGE-model for ex ante evaluation:

- The micro-macro-linked ABM-CGE model is a promising tool of ex ante evaluation that provides a full set of quantitative evaluation indicators at all levels, i.e. the micro, meso and macro level. Moreover, due to its sequential structure the development of policy impacts can be explicitly analyzed over time.

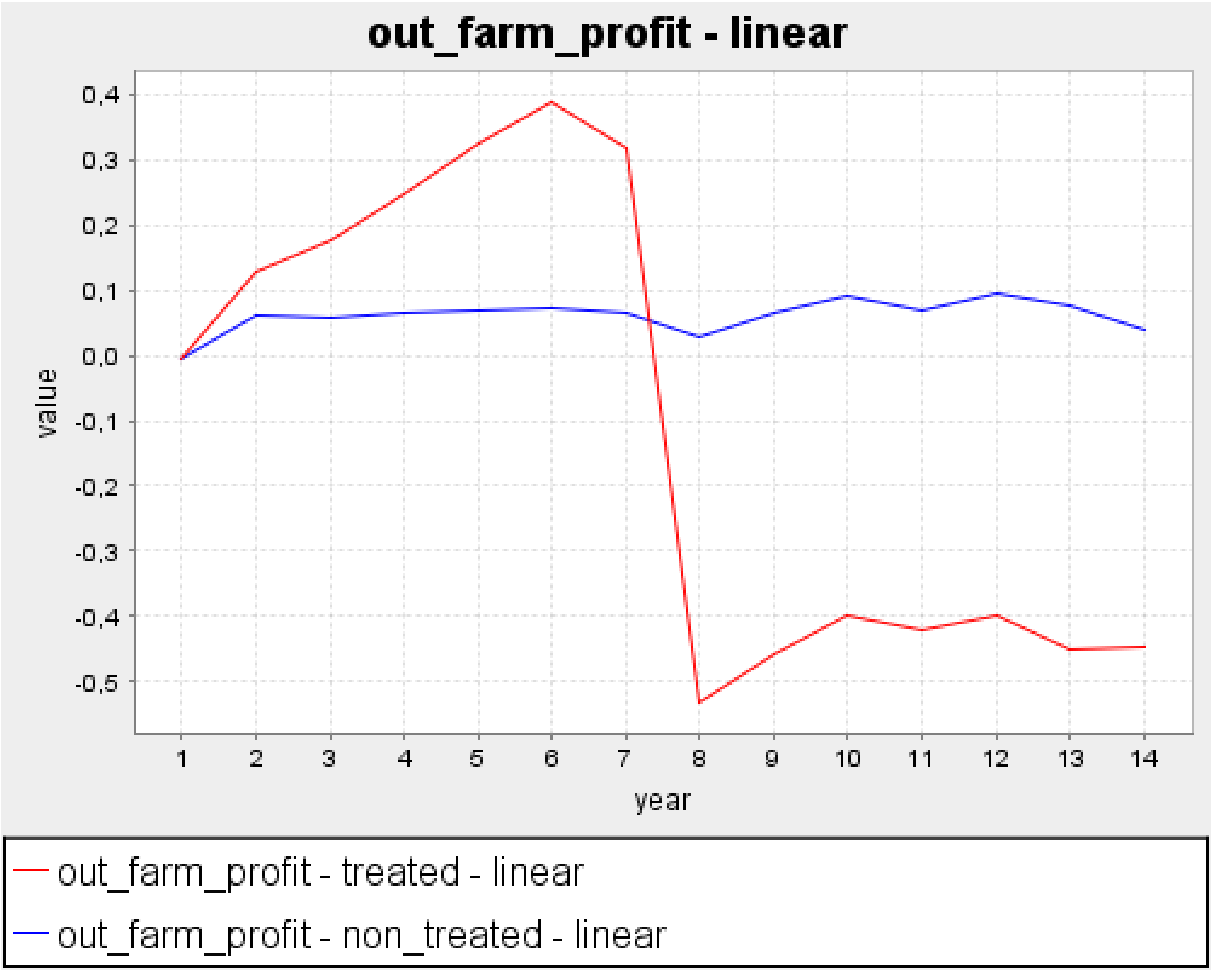

Figure 12.8.: Calculated Axis 1 policy impact on farm profits: ATT and ATNT, region 2

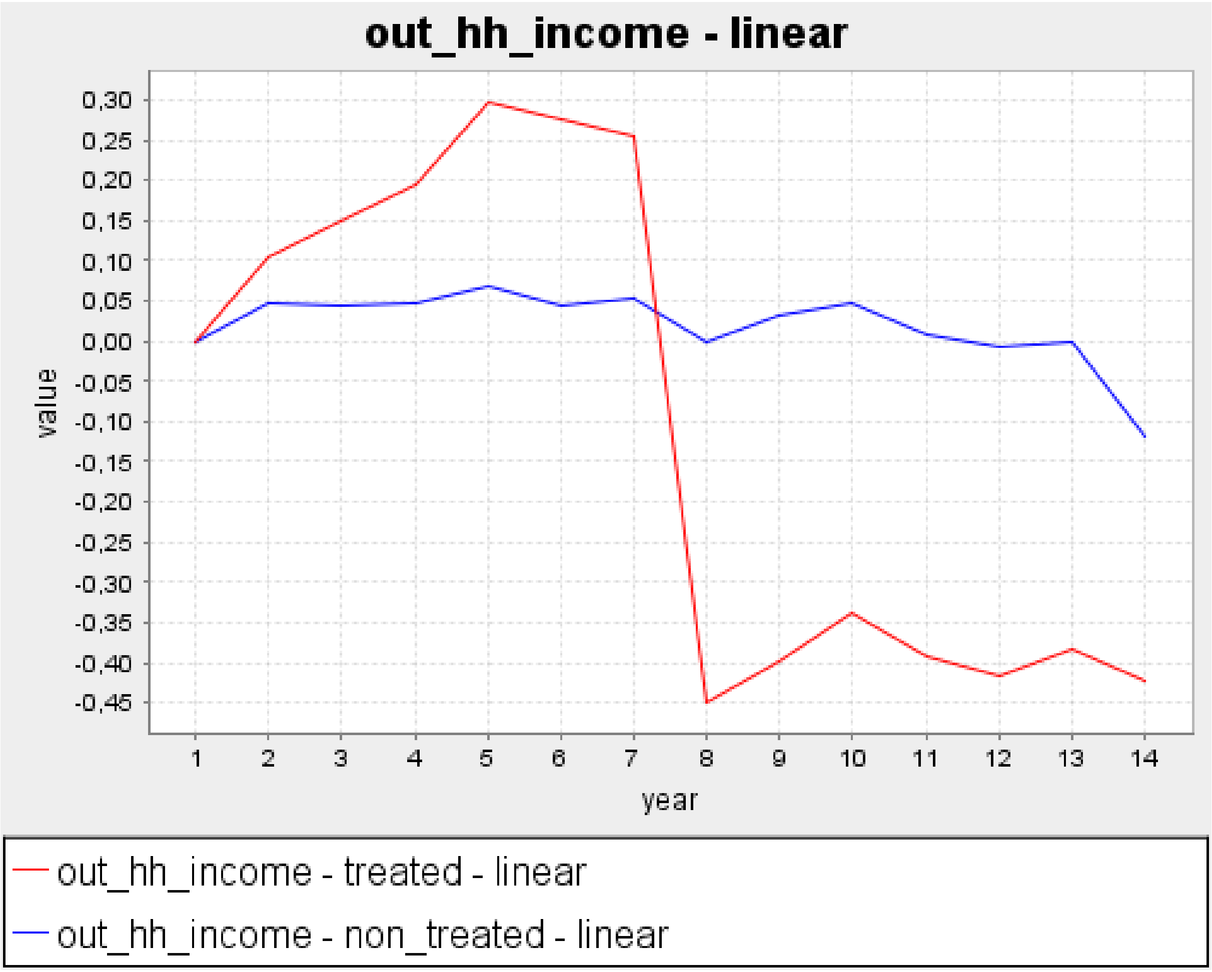

Figure 12.9.: Calculated Axis 1 policy impact on farm income: ATT and ATNT, region 2

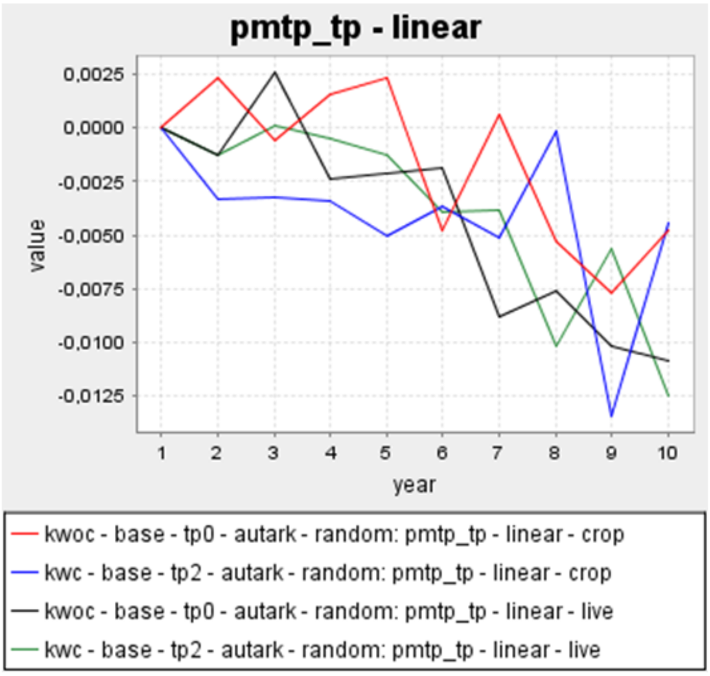

Figure 12.10.: Calculated Axis 1 policy impact on technical progress at sector level, region 2

- In contrast to non-parametric matching as well as qualitative methods, the ABM-CGE approach allows the calculation of short, medium and long-term policy impacts. In particular, short term policy effects operating through Keynesian income effects that vanish after a programme has been phased out, can be separated from long-term policy impacts which operate through supply side factors and sustain even after a programme has been terminated.
- The ABM-CGE approach provides a rather flexible model framework that is generally able to include a wide range of behavioural responses and market and non-market interactions induced by RD polices. Accordingly, complex rural development processes are more realistically modeled which not only allows a better understanding of the intervention logic of existing RD programmes, but this also allows the identification of innovative RD policy measures. A case in point is innovative RD policy programmes that aim to improve large-scale network structures in rural communities.
- Due to its interlinked micro-macro structure the model is able to identify counter-intuitive policy impacts like for example the possibility that investment subsidies have a strong positive impact on technological progress at the individual farm level of programme beneficiaries, but these positive impacts are reversed at the sectoral level due to the fact that subsidies impede the exit of inefficient farms. Another example would be the possibility that investment subsidies imply a reduction of farm profits. This would be excluded by assumption in standard microeconomic models. But in our approach subsidies might trigger overoptimistic beliefs which induce over-investment of farms and hence a reduction of profits.
- Another advantage of the ABM-CGE model is the regional level of analysis. In contrast to most existing macro models, which are applied to Nuts 2 level corresponding to larger economies comprising more than 100,000 people, this approach is applied at the village level with a population ranging from 2000 to 8000 people. This is useful given the fact that especially structural measures like most Axis 3 policies have only a measurable impact at village level, which would be watered down at a higher regional level like Nuts 2.
- Overall, one can conclude that the ABM-CGE model approach certainly provides a very flexible ex ante evaluation tool that not only allows the derivation of a complete set of quantitative evaluation indicators, but beyond this provides a suitable tool to better understand the complex and often counterintuitive intervention logic of certain policies and hence facilitates policy learning.
- Besides these positive aspects, a drawback of the ABM-CGE model is certainly that

it is extremely time consuming and data intensive to calibrate or estimate model parameters for specific cases.

- Moreover, even if the model is empirically estimated or calibrated based on detailed survey data for a specific rural community, it is still fair to conclude that specific model modules can only be roughly calibrated and hence do only to a limited extend reflect true empirical behavioural responses. Accordingly, simulated model results have to be interpreted with caution.

- For example, simulated policy impacts crucially depend on assumed effects of specific RD measures on technological progress. While impacts of exogenously shifted technological progress parameters (at the macro, meso and micro levels) are endogenously derived, the policy induced shift of technological progress is exogenous. Here, more realistic policy impacts on result indicators can be derived applying statistical methods of ex post analysis like matching.

- Accordingly, regional differences of policy impacts mainly result from differences in central economic or demographic structures of analyzed communities, while more interesting institutional variances like local government institutions are not yet explicitly considered. This is especially regrettable since empirically, these institutional factors seem to be crucial in determining why some policies work in some communities but not in others. Partly, local government institutions have been taken explicitly into account via the integration of a political economy module (see RR5-1). This topic is certainly a very worthwhile field for future research.

12.2.2. Ex ante evaluation applying generalized matching methods

We further applied different ex post and ex ante matching techniques to identify ATT of Axis 1 policy using simulated data for all four rural regions.

Regarding ex post matching techniques we applied the following propensity score matching estimator applied to simulated data after policy evaluation:

- nearest neighbor (ex post 1)

- biweight kernel (ex post 2)

- epanechnikov kernel (ex post3)

Moreover, as described above we used a generalized matching estimator (ex ante) applied to simulated data before policy evaluation.

To evaluate goodness of various matching techniques, we calculated for each matching procedure the difference of the estimated ATT with the true (simulated) ATT. In figure

12.11 to 12.14 we report calculated differences for the performance variables farm profit and total farm income in percent to the true ATT for different matching techniques for year 3 and year 6, respectively.

As can be seen from figure 12.11 to 12.14 application of matching techniques deliver mixed results. For some variables, regions and years, e.g. for profits in region 2-4 for year 3 and 6, all matching techniques deliver a good estimation of the true ATT giving differences ranging from -23 percent for expost-1, expost-2 and expost-3 for region 4 to only 1.3 percent for region 2 and expost-3.

Compared to ex post techniques the ex ante matching method delivers less good estimations of the true ATT in most cases. Obviously, the basically reflects the fact that the additional information on actual programm participation is helpful to identify true ATT effects. However, this might change if ex post matching results from other regions are used. Especially if results form region 1 would be used for predicting policy impacts in other regions (ATTs) extremely biased predictions would result. Given the fact that region 1 has a complete different economic structure when compared to region 2, where the latter is dominated by agriculture with a GNP shares of over 60 percent compared to a GNP share of agriculture of less than 3 percent for region 1 this bad prediction clearly correspond to regional selection bias. Analogously, prediction power of ex post matching methods appears extremely sensitive to specific time periods used for estimations, i.e. as we could already demonstrate for ABM-CGE-simulations true ATTs vary significantly across years. Hence, even correctly estimated ATT applying ex post (or ex ante) matching methods could be bad predictions for future policy impacts.

Micro-econometric matching approaches can be applied for RD policy measures that intervene at the individual farm level, like many Axis 1 measures. However, most Axis 3 measures intervene at the macro level and hence it is generally not possible to apply microeconometric matching methods to evaluate these policies (neither ex ante nor ex post). In this case macroeconometric matching methods could be applied. For example, within ADVANCED-EVAL macroeconomtric matching procedures have been developed and applied for ex post analysis, where rural regions at Nuts 3 level have been matched (see RR3-2). But first, it is not straightforward to use these macroeconometric methods also for ex ante evaluation. Second, matching rural regions is often limited due to the fact that the number of regions available for matching are rather low. Thus, matching delivers often extremely biased results. Finally, given existing analysis it is commonly known that the impact of RD policies is often negligible at higher regional levels, i.e. Nuts 3 or higher levels, while it is often not possible to get sufficient statistical data for regional levels below Nuts 3.

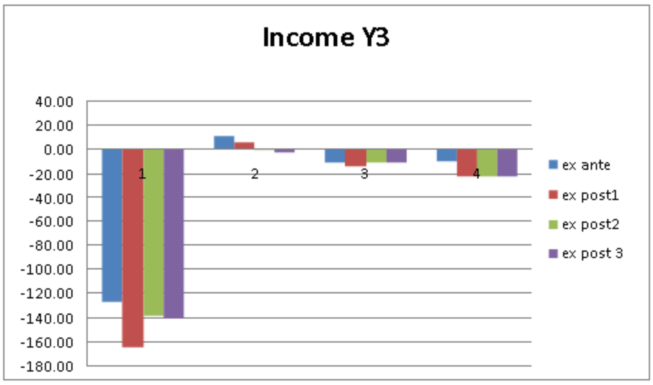

Figure 12.11.: Difference of estimated ATT to true ATT in percent for selected ex post and ex ante matching methods: Income year 3

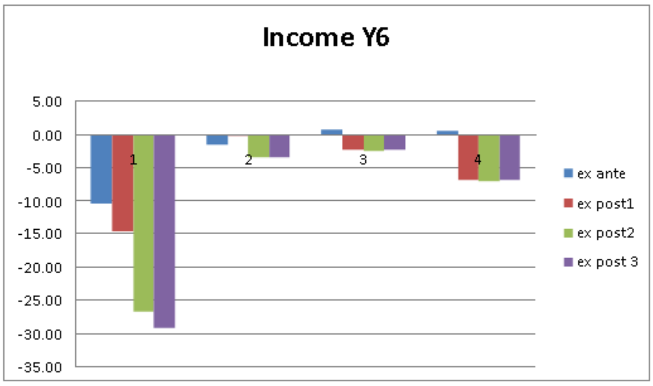

Figure 12.12.: Difference of estimated ATT to true ATT in percent for selected ex post and ex ante matching methods: Income year 6

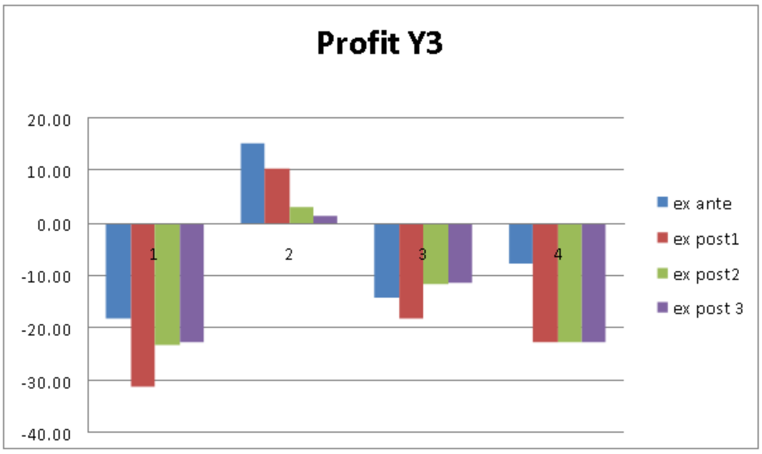

Figure 12.13.: Difference of estimated ATT to true ATT in percent for selected ex post and ex ante matching methods: profit year 3

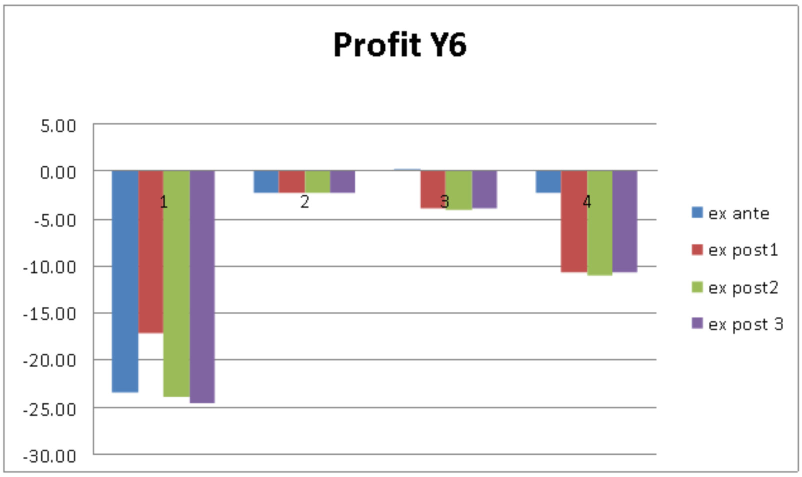

Figure 12.14.: Difference of estimated ATT to true ATT in percent for selected ex post and ex ante matching methods: profit year 6

A critical assessment of the application of non-parametric matching techniques for ex ante evaluation of RD policy programmes

Overall, the following points summarize a critical assessment of the application of non-parametric matching methods for ex ante evaluation:

- In general, micro- and macro econometric matching methods can be suitable tools for ex ante evaluation studies.
- In particular, to estimate impacts of specific RD policy measures on relevant result indicators at the micro level, standard ex post matching methods can be applied to estimate possible policy impacts in ex ante evaluation studies. For example, the impact of training on technological progress realized at farm level could be empirically estimated using ex post matching techniques, which can then be used as inputs of model-based approaches to estimate policy impacts in corresponding ex ante evaluation studies.
- Additionally, generalized micro econometric matching techniques exist that allow the evaluation of a policy measure prior to its implementation.
- While micro-econometric matching approaches can be applied for RD policy measures that intervene at the individual farm level, like many Axis 1 measures, many RD measures like most Axis 3 measures intervene at the macro level which makes it generally not possible to apply microeconometric matching methods to evaluate these policies (neither ex ante nor ex post).
- Furthermore, estimated treatment effects at the micro level can be extremely biased. This is especially true when micro data from other regions is used which results from a regional selection bias.
- In this case macroeconometric matching methods could be applied. For example, within ADVANCED-EVAL macroeconometric matching procedures have been developed and applied for ex post analysis, where rural regions at Nuts 3 level have been matched (see RR3-2).
- But, it is not straightforward to use these macroeconometric methods also for ex ante evaluation.
- Moreover, matching rural regions is often limited due to the fact that the total number of regions available is rather low. Thus, matching delivers often extremely biased results.
- Finally, given existing ex post evaluation analyses, it is commonly accepted that the impact of RD policies is often negligible at higher regional levels, i.e. Nuts 3

or higher levels, while it is often not possible to get sufficient statistical data for regional levels below Nuts 3.

12.3. Publications of WP5

Journal papers

[1] Henning, Christian H.C.A., Carsten Struve and Martina Brockmeier (2008): Die Logik der europäischen Agrarpolitik: Politische Macht oder Ökonomische Gesetzmäßigkeiten? In: Agrarwirtschaft 57(3/4): 179-193, 2008.

[2] Henning, Christian H.C.A. and Volker Saggau (2009): Information networks and knowledge spillovers: simulations in an agent-based model framework, in: "Institutional and social dynamics of growth and distribution" edited by Neri Salvadori, Pisa, forthcoming.

Publication in progress

[3] Henning, Christian H.C.A. and Nana Zarnekow (2009):] Modeling rural migration policies in a micro-macro linked general equilibrium framework.

[4] Henning, Christian H.C.A., Britz, Wolfgang, Hedtrich, Johannes and Volker Saggau (2009): Model based Ex-ante Evaluation of RD-Policies: Derivation and Application of a Micro-macro Linked ABM-CGE Model.

[5] Henning, Christian H.C.A. and Nana Zarnekow (2009): Applied Generalized Matching for Ex-ante Evaluation of RD-Policies: A Critical Assessment.

Monographs:

[6] Henning, Christian and Volker Saggau (eds.): Modelling and Evaluation of RD-Policies: Theory, Methods and Practice.

Special Issues:

[7] Henning, Christian, Abdulai, Awudu and Wolfgang Britz (eds.): Modelling and Evaluation of RD-Policies: Theory, Methods and Practice. Submitted to European Review of Agricultural Economics.

Deliverables

[D15] Modeling Rural Economies as evolving Complex Systems: A theoretical framework for ex ante policy evaluation. Conceptual Report (CR5-1)

[D23] RD-Policy Simulation based on a ABM-CGPE approach in low and high performing in rural communities in Poland and Slovakia. Regional Report (RR5-1)

[D24] Applying an ABM-CGPE approach to derive and test ex ante evaluation tools for RD-programmes (RR5-2)

Working Paper

[WP5-1] Belief Formation and Social Influence in Agent-Based Modelling

[WP5-2] Literature review on agent-based modeling and regional economic models

[WP5-3] An ABM-approach to local land markets

[WP5-4] A model of structural development

[WP5-5] A village CGE with transaction costs: model layout and a simulation experiment

[WP5-6] Modeling rural migration policies in a micro-macro linked general equilibrium framework

[WP5-7] A mean field theory approach to farm's exit, diversification and investment decisions

[WP5-8] An ABM approach to regional knowledge spillover and technical progress in business networks

[WP5-9] The Influence of Social Network Structure and Social Position on Diversification Strategies in Rural Development

[WP5-10] Legislative Bargaining in a general equilibrium framework: Theory and empirical application to the CAP

Technical Reports

TR5-3: Development of a Software Prototype for the Simulation of socio-economic Networks: elaborated version.

Part VI.

Comparison of advanced methods with current practice of EU evaluation (WP6)

by Peter Kaufmann, Christian Henning and Jerzy Michalek

Chapter 13.

Objectives and background

Up to now, the ADVANCED EVAL project developed and applied different quantitative methods/techniques to capture micro and macro-economic impacts. The objective of work package six was then to investigate the institutional background for the evaluation of rural development in the EU, and to compare the results from the application of qualitative methodologies more generally applied in rural development evaluations with quantitative methods developed in ADVANCED EVAL. For this purpose, we first examined the legal and administrative basis for the Rural Development Regulation for the last and present programming periods and established which methodological standards for evaluation reports can be inferred from these. Then we investigated the actual applications in ex-ante, mid-term and ex-post evaluations. By comparing programme effects calculated using quantitative methodologies described in this report with qualitative results, it was then assessed in how far these results differ, and what might be the reasons for this.

Chapter 14.

Main activities undertaken in WP 6

Main research activities undertaken within WP4 include:

I. Examination of the legal and administrative basis for the Rural Development Regulation for the last and present programming periods

II. Description of established methodological standards for ex post and ex ante evaluation reports

III. Comparison of evaluation results derived applying innovative quantitative methods developed by ADVANCED-EVAL with results derived applying qualitative (current practice) methods

Chapter 15.

Main results

15.1. Comparison of quantitative and qualitative (current practice) ex post evaluation methods

15.1.1. Non-parametric matching (e.g. combination of DID with matching approach)

Significant differences in the assessment of results of a given RD programme may occur in dependence on applied evaluation methodology (i.e. traditional vs. advanced evaluation methods). Illustration of the scope and the magnitude of this divergence is provided below using two empirical examples from:

A. Slovakia (i.e. assessment of micro-economic effects of the SAPARD programme implemented in years 2003-2004), and

B. Germany (i.e. assessment of micro-economic effects of the Agrarinvestitionsförderungsprogramme (AFP) implemented in the years 2000-2006 in Schleswig-Holstein).

Example A. Assessment of micro-economic effects of the SAPARD programme (Slovakia)

In Michalek (2009) the PSM-DID approach was applied to assess the micro-economic effects of the SAPARD programme in Slovakia (measure 1: Investment in agricultural enterprises) on programme beneficiaries. The SAPARD support under Measure 1 was primarily targeting the following agricultural sectors: a) beef sector, b) pig sector, c) sheep sector, d) poultry sector, as well as the e) fruits and vegetables sector. Programme support under Measure 1 had the form of a capital grant covering up to 50 percent of costs to investments in the above sectors. The major beneficiaries of programme support (received approximately 67 percent of funds available under this measure) were large agricultural companies located in relatively well developed regions of West Slovakia (Nitra, Trnava and Bratislava). In our example all selected programme beneficiaries received programme

Observations	GVA/company in SKK 1,000		
	Before SAPARD programme (T0)	After SAPARD programme (T1)	DID
SAPARD participants (P=1)	17,727	18,478	751
SAPARD non-participants (P=0)	9,950	9,680	-270
Average Ø	11,660	11,614	-46
Difference (1-0)	7,777	8,798	1,021
Difference (1- Ø)	6,067	6,864	797
Matched SAPARD participants (M= 1)	11,082	9,610	-1,472
Matched SAPARD non-participants (M=0)	9,367	9,701	334
Average Treatment Effect on Treated (ATT)	1,715	-90	-1,805

Table 15.1.: Slovakia: Estimation of the effect of the SAPARD programme on agricultural companies (comparison of various methods)

support in the year 2004. Assessment of the impact of the programme on agricultural companies was carried out on the basis of Slovak FADN data in the years 2003 (prior to 2003 and 2005 (after programme implementation).

The assessment of the micro-economic effects of a given RD programme on programme beneficiaries was carried out using seven result indicators available from a standard FADN system:

- Gross value added per company
- Profit per company
- Profit per ha
- Profit per person employed
- Employment per company
- Employment per company
- Employment per company
- Labour productivity (Gross value added per employed)
- Land productivity (Gross value added per ha)

The results showed that traditional estimates of programme effects can be highly misleading, whereas application of advanced evaluation methodologies can lead to quite different, yet more reliable results. This issue can be illustrated on the basis of the table below.

The analysis of the table above shows that:

1. If a naïve "before-after" estimator was applied, the effect of the programme would have been assessed as very positive (in the group of programme beneficiaries "SAPARD participants (P=1)" an average GVA per company increased in the examined period from 17,727 thousand SKK in T0 to 18,478 thousand SKK in T1 (i.e. GVA per company increased by +751 thousand SKK). But this estimator is statistically biased.

2. If SAPARD participants were compared with **all** SAPARD non-participants (i.e. **no matched control group**) and the DID estimator was applied "Difference (1-0)", the effect of the programme would also have been assessed as very positive (the initial positive difference measured in terms of GVA per company between programme participants and all non-participants = + 7,777 thousand SKK in year T0 increased in the examined period to + 8,798 thousand SKK in year T1 , i.e. GVA increased by +1,021 thousand SKK). But this estimator is also statistically biased.

3. If effects observed for SAPARD participants were compared with **a country's average** calculated for all farms (e.g. **national performance standards**), including SAPARD participants **as well as** non-participants and a DID estimator was applied "Difference (1- Ø)", the effect of the programme would also have been assessed as positive (the initial positive difference measured in terms of GVA per company between programme participants and the country's average = + 6,067 thousand SKK in year T0 increased in the examined period to +6,864 thousand SKK in year T1 , i.e. GVA increased by + 797 thousand SKK). Yet, similar as in (1) and (2) this estimator is statistically biased.

4. Above conclusions have to be revised if programme effects are measured using statistically similar groups (participants vs. matched non-participants). In this case the estimated programme effect (DID in ATT) was found to be **negative** (difference between both groups (ATT) decreased from = 1,715 thousand SKK in period T0 to -90 thousand SKK in T1 , i.e. it dropped by 1,805 thousand SKK). The reason is a much higher growth in GVA per company in the matched group of SAPARD non-participants (average change in GVA = +334 thousand SKK) compared with the matched SAPARD participants (average change in GVA = -1,472 thousand SKK). Thus, it is suggested that PSM-DID largely eliminated selection bias, leading to more reliable comparisons between supported and control groups.

Also in other cases the estimated effects of the SAPARD programme (Measure 1) on supported agricultural companies obtained by applying PSM-DID methodology differed significantly from those obtained by using naive approaches (i.e. before-after, comparisons with all non-beneficiaries or comparisons with national averages), irrespectively in the

	Profit/company 1000 SKK			Profit/person employed 1000 SKK			Profit/ha 1000 SKK		
	2003	2005	DID (2003 -2005)	2003	2005	DID (2003 -2005)	2003	2005	DID (2003 -2005)
Participants (1)	-880	1589	2496	-11	23.6	34.6	-0.456	0.91	1.366
Non-participants (0)	-3338	-839	2499	-42	-11	31	-2.32	-0.51	1.81
Country Average Ø	-2798	-305	2493	-35	-3.9	31.1	-1.91	-0.19	1.72
Difference (1-0)	2458	2428	-30	31	35	4	1.86	1.42	-0.44
Difference (1- Ø)	1918	1894	-24	24	27.5	3.5	1.454	1.1	-0.354
Matched participants (1)	-1705	131	1836	-30.8	7.8	38.6	-1.112	0.21	1.322
Matched control group (0)	-1264	815	2079	-19.3	19	38.3	-1.128	0.54	1.668
ATT	-440	-683	-243	-11.5	-11.2	0.3	0.016	-0.33	0.346

Table 15.2.: Slovakia: Effect of SAPARD (Measure 1) on supported agricultural companies using profit as result indicator (PSM-DID method)

selected result indicator. Further examples involving various result indicators (provided below) confirm this supposition.

For instance, an application of a **naive "before-after" estimator** to the assessment of effects of the SAPARD programme using as a result indicator **profits per company** would lead to a conclusion that the impact of the programme was very *positive* (+ 2,496 thousand SKK per company). Conversely, estimated effects of the same programme derived on the basis of **other naive estimators**, i.e. **comparisons of programme beneficiaries with all non-beneficiaries or comparison of programme beneficiaries with a country's average** would indicate small but *negative* effects (i.e. -30 and -24 thousand SKK per company, respectively). Interestingly, also the latter results were found to be *overstated*. Indeed, the results obtained by applying the PSM-DID (matched comparisons) show that profit per company in the *matched* **non-supported** group of similar agricultural companies increased in the examined period from -1,264 thousand SKK in 2003 to 815 thousand SKK in 2005 (that is by +2,079 thousand SKK), i.e. they grew much stronger than in the group of programme beneficiaries (+1,836 thousand SKK). Consequently, the estimated effect of the SAPARD programme on profits per company derived from applying advanced evaluation methods (-243 thousand SKK per company) was found to be significantly different from results obtained by using traditional evaluation methods.

Similar effects were found in case of other result indicators: i.e. profits per person employed, profits per ha, gross value added per company, gross value added per employed person and gross value added per ha (Table 15.2 and Table 15.3). Indeed, while in the control group (i.e. matched **non-supported** agricultural companies) gross value added

	GVA/company 1000 SKK			Labour productivity (GVA/employed) 1000 SKK			Land productivity (GVA/ha) 1000 SKK		
	2003	2005	DID (2003 -2005)	2003	2005	DID (2003 -2005)	2003	2005	DID (2003 -2005)
Participants (1)	17727	18478	751	222	216	-6	10.6	11.5	0.9
Non-participants (0)	9950	9680	-270	130	150	20	7.2	6.6	-0.6
Country Average Ø	11660	11614	-46	151	164	13	7.9	7.7	0.2
Difference (1-0)	7777	8798	1021	92	66	-26	3.4	4.9	1.5
Difference (1- Ø)	6067	6864	797	71	52	-19	2.7	3.8	1.1
Matched participants (1)	11082	9610	-1472	206	147	-59	7.31	7.41	0.1
Matched control group (0)	9367	9701	334	164	168	4	6.85	7.13	0.28
ATT	1715	-90	-1805	41.4	-21.3	-62.7	0.46	0.28	0.18

Table 15.3.: Slovakia: Effect of SAPARD (Measure 1) on supported agricultural companies using GVA as result indicator (PSM-DID method)

per company, GVA per person employed and GVA per ha **increased** between 2003 and 2005, in the group of **programme beneficiaries** the above indicators either **decreased** (e.g. GVA per company, labour productivity) or increased but at lower rate compared with controls (e.g. land productivity).

Consequently, in all above cases programme results obtained from the PSM-DID methodology differ from those derived on the basis of traditional evaluation techniques.

Analogous conclusions can be drawn from comparison of results obtained by using various methodologies to the assessment of the effect of the SAPARD programme on employment (see Table 15.4). Indeed, also in this case, results obtained from advanced methods considerably differed from those obtained by using traditional techniques.

Example B. Assessment of micro-economic effects of the Agrarinvestitions-förderungsprogramm (AFP) 2000-2006 in Schleswig-Holstein Confirmation of above trends can also be found from another example, i.e. the estimation of effects of the Agrarinvestitionsförderungsprogramm (AFP) in Schleswig-Holstein, Germany.

The evaluation of the AFP programme (Measure: Investments in milk and beef sectors) was carried out on the basis of data of bookkeeping farms (AFP participants and non-participants) specialized in milk production, using a panel for the years 2001-2007. Applying the PSM-DID method to the assessment of programme results at the farm-level showed a positive effect of the AFP programme on programme beneficiaries (average change of profit per farm + 9,285 EUR). Yet this result was much smaller in comparison to the results obtained from using traditional methods (i.e. +62,148 EUR in case of before and after approach, + 19,682 if an unmatched 1-0 approach was applied, and + 17,219

Calculation basis	Employment total (per company) 2003	2005	D I D (2003) -2005)
Unmatched P=1	85	82	-3
Unmatched P=0	68	57	-11
Ø	84	62	-22
Difference (1-0)	17	25	8
Difference (1- Ø)	1	20	19
Matched M= 1	53	53	0
Matched M= 0	59	56	-3
ATT	-5.53	-3.32	2.21

Table 15.4.: Slovakia: Effect of SAPARD (Measure 1) on supported agricultural companies using employment as result indicator (PSM-DID method)

Calculation basis	Profits per farm in EUR 2001	2007	D I D (2007 -2001)
Unmatched P=1 (101)	54,629	116,777	62,148
Unmatched P=0 (706)	40,518	82,983	42,465
Average Ø (807)	42,284	87,213	44,929
Difference (1-0)	14,111	33,793	19,682
Difference (1- Ø)	12,345	29,564	17,219
Matched M=1 (99)	54,634	115,908	61,274
Matched M=0 (662)	52,292	104,281	51,989
ATT	2,341	11,626	9,285

Table 15.5.: Schleswig-Holstein: Effect of the AFP programme on profit per farm

EUR if an unmatched (1- Ø) approach was used, see Table 15.5).

Also in case of leverage effects of the AFP programme on milk production, farm employment and labour productivity, the programme results estimated on the basis of advanced evaluation methods were found to be *systematically lower compared with those obtained by using traditional (naive methods).*

15.1.2. Generalized propensity score matching approach

A systematic difference between results obtained on the basis of the advanced methods (e.g. PSM-DID) in comparison to traditional evaluation techniques was also found in case of the assessment of **macro-/regional** effects of RD programmes.

In Michalek 2009 (D12) the overall net impact of EU RD programmes on rural regions (aggregated effects of a given RD programme at regional levels) was estimated using the Rural Development Index (RDI) - a proxy describing the overall quality of life in individual

Calculation basis	RDI			Unemployment (absolute)			Unemployment (per capita)		
	2002	2005	D I D (2005 -2002)	2002	2005	D I D (2005 -2002)	2002	2005	D I D (2005 -2002)
Unmatched 1	0.00627	0.0910252	0.00847552	7136	4664	-2472	0.100763	0.068188	-0.032575
Unmatched 0	-0.12417	-0.020165	0.104005	6806	4587	-2219	0.101956	0.070347	-0.031609
Difference 1-0	0.130444	0.1111904	-0.019254	329	76	-253	-0.00119	-0.00215	-0.00096
Matched M 1	-0.088289	-0.001828	0.086461	6889	4890	-1999	0.10065	0.071229	-0.029421
Matched M 0	-0.104754	0.0306261	0.1353801	6406	4279	-2127	0.1033	0.069738	-0.033562
ATT	0.016464	-0.032455	-0.048919	483	610	127	-0.00264	0.00149	0.00413

Table 15.6.: Slovakia: Estimated policy evaluation parameters (per capita basis)

rural areas. The weights of economic, social and environmental domains entering the RDI index (a composite indicator) were derived empirically from an econometrically estimated intra- and inter-regional migration function. The impacts of individual RD measures were analysed by means of a counterfactual analysis by applying a combination of the Propensity Score Matching (PSM) and difference-in-differences (DID) methods using the RDI Index, unemployment ratios, etc. as impact indicators. Furthermore, given information on the regional intensity to programme exposure (financial input flows by regions) the overall impact of obtained support via a given RD programme was estimated by means of a dose-response function and derivative dose-response function within the framework of a generalized propensity score matching (GPS). Above methodologies were empirically applied to the evaluation of the impact of the SAPARD programme in Poland and Slovakia during the years 2002-2005 at NUTS-4 level. While obtained results show the full applicability of this approach to the measurement of the impact of rural development and structural programmes, they also confirmed a presence of significant differences between macro-economic results based on advanced methodologies in comparison to traditional evaluation techniques. For example, in case of the SAPARD programme in Slovakia, results obtained on the basis of traditional evaluation techniques would suggest a positive effect of the programme on employment (i.e. reduction of unemployment - this applies to both, the before-after method as well as to the unmatched method comparing programme beneficiaries with non-beneficiaries 1-0) and an unclear effect on the overall quality of life (the before-after method suggests here positive effects while according to the unmatched 1-0 method effects of the SAPARD programme on the RDI index were negative). The results from applying traditional techniques could not be confirmed when the assessment of the programme impact was carried out on the basis of advanced evaluation methodologies (PSM-DID and the generalized propensity score matching). Applying the conditional DID estimator to the assessment of the programme impact at the regional level showed that the overall impact of the SAPARD programme in Slovakia for regional development and rural unemployment were negative or negligible (see Table 15.6).

Application of the GPS matching and the dose-response function to the assessment of the impact of the SAPARD programme in Slovakia primarily confirms the results obtained by using the binary PSM method, i.e. it suggests that the impact of SAPARD measures (total funds) on the overall level of rural development (measured in terms of the RDI) across Slovak regions was generally negligible (or negative), except for those regions which received programme support between 260-780 SKK per capita (positive dose-response function). More positive impacts of all SAPARD measures were found on the reduction of rural unemployment (though, the latter only applies to specific programme intensity intervals).

15.1.3. Conclusions

Overall, the more strategic nature of evaluations from the programming period 2007-2013 onwards is positive. The Member States needed to work out broad National Strategy Plans consistent with EU policy priorities (Lisbon and Göteborg strategies for growth, jobs and sustainable development) and add their national and regional priorities. Based on these, the programming authorities develop rural development programmes by focusing on specific strengths, weaknesses and opportunities of the individual programming areas. Which rural development measures are then included in the programmes is (in some countries, should be as we now know from the ex-ante meta evaluation) a direct result of the SWOT analyses. A stronger focus on the quality of baseline indicators and structured monitoring systems promises to facilitate an increased possibility to use quantitative methods for mid-term and ex-post evaluations. Still, the text of the CMEF concerning the monitoring system and concrete evaluation methods applicable stays at a general level, which will still result in a multitude of methods being applied for the current programming period. This will likely result (again) in a wide variety of qualities of evaluation reports to facilitate policy learning from the local to the European levels and hamper the scaling up of results of impact assessments at European level.

When looking at the past programming period (2000-2006), in most mid-term evaluations quantitative benchmarking studies have not been implemented because data on counterfactuals and sometimes also baseline data at the start of the programming period were missing and because ex-post data for the calculation of impacts is by its very nature mostly available only later in the process. Naturally, quantitative methods have increasingly been used at the ex-post stage. But still, advanced quantitative methods have often not been implemented presumably because of data, skills, and budget constraints available for the evaluation. Simple before-after comparisons were implemented quite widely for the socio-economic and environmental impact indicators, the few comparisons with counterfactual groups were only done in the socio-economic domain. The reason is probably that natural scientists do not see the possibility to apply with-without comparisons because nature is just too complex for being able to control for variations between localities and external influences.

When it comes to identifying and describing concrete methods/techniques applied in RDP evaluations and checking for the reliability of results, the information presented in evaluation reports vary, but are rather general. This might partly be the case because consultants do not want to describe their methods in much detail because this could compromise their competitiveness for funding in the future, and partly because transparency opens oneself up to criticism. Plus, the guidelines for the RDP are somewhat vague in terms of how detailed the methodological part needs to be, which leaves ample room for evaluators to display their methods used in as much detail as they prefer. But transparency is an important aspect of quality assurance. This is not only true for quantitative methods (this is intuitively so because many technical details need to be decided by the evaluator as they go along in treating the data and implementing the estimation), but this is also true when applying qualitative methods, for which measures to ensure quality standards are just as important. This calls for a rather detailed description of the process and standards of the individual evaluation exercise in appendices of evaluation reports, which should be enclosed to the reports sent to the European Commission.

There is no single best method for impact evaluation, which is very much influenced by data availability, the scale where the programme is implemented, but also the range of evaluation questions that need to be answered (Blundell and Costa Dias 2000). Because of the complexity of the programmes, the institutional settings and specific situation on data availability in different institutional settings, good evaluations always apply a mix of methods that, taken together, try to answer the range of evaluation questions. For being able to deliver such an evaluation, evaluators need to have a comprehensive overview and partly also in-depth knowledge of qualitative and quantitative methods. This is why a scaling up of evaluation competences across the European Union could be a well invested effort. A simplifying aspect in the EU rural development context is that evaluators are dealing with the same evaluation questions and the programmes at the same scales, which gives a window of opportunity for narrowing down suitable methods for particular evaluation questions.

Although the advantages of ex ante evaluation are quite intuitive, and although the European Commission requires an obligatory ex ante evaluation for EU policies, an adequate methodology is not yet fully developed. This was the starting point for the analyses in the Advanced Eval project, which analyzed to what extent current practice, i.e. ex ante evaluations of RD policies mostly applying only qualitative methods can be improved by applying quantitative approaches. In particular, we simulated data in a micro-macro linked ABM-CGE modelling framework and a non-parametric matching approach. The comparison of these results with results from applying qualitative methods shows that the quantitative approach applied can significantly enhance evaluation results, especially because indirect feedback mechanisms can be estimated which is not done in qualitative analyses on their own. Overall, this suggests again a mixed-method approach, where qualitative methods are a first step towards an efficient ex ante evaluation of RD policies. However, compared to an ideal ex ante evaluation framework, we identified a considerable potential to improve currently applied qualitative methods with quantitative methods where qualitative methods have the role to substantiate the evaluation framework and intervention logic, inform the quantitative analysis, and can also be used to substantiate the results of the quantitative analysis and bridge a potential interpretation gap. But there are strong indications that quantitative methods are necessary to receive less biased estimates about effects. Qualitative evaluation methods normally provide static or comparative static policy effects, e.g. a detailed development of policy impacts over time is not possible. In particular, it is not possible to separate short or medium term policy impacts, e.g. demand side effects resulting from simple income transfers that vanish once the programme has been terminated, from long-term supply side effects that persist even after the programme has been phased out.

The ex post impact evaluation method applied in this project for the micro level, the combination of propensity score matching with difference in difference (PSM-DID) in assessing programme results at the farm-level also shows that applying simple methods results in biased conclusions. Simple before-after comparisons, or comparing participants with non-participants where the latter comprise either all non-participants or country averages produce in our case relatively more positive assessments in comparison with the matched samples applying PSM-DID, although, basically, results could also be biased in the other direction. To capture macro level effects, very similar results are reported when applying generalized propensity score matching (GPS) using, above others, a rural development index as predictor, the latter being developed within Advanced Eval.

It is important to note that no immediate policy relevant conclusions can be taken from the above results because they only report snapshots of particular measures in specific localities (ex-ante) and/or specific years. They are implanted in this project to show that (1) it is possible to implement them, and (2) that they produce significantly different results. An encompassing evaluation would cover the whole programming period and several measures.

As a word of caution, one needs to emphasis that no method is infallible. Thus, the combination of qualitative and quantitative methods in a triangulate fashion is recommended to ensure a high quality of impact evaluations in the future. But quantitative methods, as discussed here, are clearly advantageous to capture the magnitude and direction of effects.

15.2. Comparison of quantitative and qualitative (current practice) ex ante evaluation methods

- Qualitative current practice methods are certainly a first step towards an efficient ex ante evaluation of RD policies. However, compared to an ideal ex ante evaluation framework, we identified a considerable potential to improve currently applied qualitative methods with quantitative evaluation methods where qualitative methods have the role to substantiate the evaluation framework and intervention logic, inform the quantitative analysis, and can also be used to substantiate the results of the quantitative analysis and bridge a potential interpretation gap.
- But implementing only qualitative analyses are not appropriate because qualitative evaluation measures cannot:
  - give a forecast on implied developments of rural development indicators, e.g. percentage of income increase, unemployment decrease, etc.
  - really compare different policies or policy measures because qualitative comparisons will likely produce biases, at least because they do not incorporate feedback mechanisms in their assessment. Also a consistent ranking cannot be derived based on qualitative evaluation measures. Note that even if qualitatively Axis 1 measures lead to a higher allocation of budget resources for income, while Axis 3 measures imply a higher allocation of budget resources for employment, this does by no means allow the conclusion that Axis 3 policies will have a higher impact on employment, while Axis 1 measures have a higher impact on income. It still could be the case that, for example, Axis 3 measures have in absolute terms a higher impact on both, employment and income.
  - derive cost efficiency measures and an optimal policy mix.
  - calculate heterogeneous treatment effects depending on specific characteristics of treated units at the micro (individual farms) or macro level (individual regions). It would be only possible to drive qualitative differences, e.g. programme participation works better for one unit when compared to another. However, as long as for each unit at least one measure exists that compares favourably when compared to any other unit, it follows that no general assessment of heterogeneous treatment effects of complete policy programmes can be made.
  - provide a thorough assessment of how different policy implementation designs influence overall policy impacts. The latter is a direct consequence of point e. For example, it is hardly conceivable to assess how different selection criteria determining the eligibility of the participation in policy programmes affect

overall impacts of a policy using only qualitative evaluation methods.

- Qualitative evaluation methods normally provide static or comparative static policy effects, e.g. a detailed development of policy impacts over time is not possible. In particular, it is not possible to separate short or medium term policy impacts, e.g. demand side effects resulting from simple income transfers that vanish once the programme has been terminated, from long-term supply side effects that persist even after the programme has been phased out.
- Although qualitative methods basically allow the derivation of impact indicators at all levels, i.e. micro, meso and macro. Current practice mainly focuses on the micro level, while policy impacts at meso and macro levels are only vaguely described, based on ad hoc projections of micro impacts. The latter follows from the fact that qualitative measurement of policy impacts based on experiences is generally much easier at micro level when compared to meso or macro level. Meso and macro level policy impacts are much harder to derive since these include complex market and non-market interactions which can hardly be understood without applying a quantitative model.
- Analogously, qualitative evaluations hardly take into account specific framework conditions of certain regions. The latter follows from the fact that first relationships between policy and result indicators are normally derived applying stylized facts from standard microeconomic theory, while relationships between result and impact indicators are derived applying stylized facts from macro theory, e.g. multiplier concept of general equilibrium theory. Other aspects, i.e. policy response due to non-market interactions like new economic geography effects are often not explicitly used.
- Although it is generally conceivable that qualitative methods offer an in-depth-explanation of a specific intervention logic relevant for a specific region, this is currently hardly offered in existing ex ante evaluation reports. One reason for this observation is that behavioural responses of the village economy are rather complex and therefore it is practically impossible to understand these complex processes without applying quantitative models. However, the derivation of logical framework matrices hardly goes beyond standard economic theory. For example, often existing ex post analyses indicate some evidence for a positive impact of a RD measure on labour productivity or profits at the micro level, i.e. for individual farms. This positive impact is then directly transformed to the meso level, i.e. it is assumed that these RD measures also have a positive impact on labour productivity and profits at the sectoral level. However, as we show in detail with our ABM-CGE approach, by taking spillover effects e.g. via land markets and farm exit decisions into account it is easy conceivable

that although there is a clear positive treatment effect of a RD measure at the micro level, the overall effect at the meso level can be still negative. This can for example be the case because of the positive treatment effect less efficient treated farms do not exit the farm sector and hence slowing down structural change to an overall more efficient farm structure.

- The micro-macro linked ABM-CGE approach developed in the ADVANCED EVAL project offers a flexible model-based ex ante evaluation tool, which is able to improve qualitative evaluation results in the following way:
  - The micro-macro-linked ABM-CGE model provides a full set of quantitative evaluation indicators at all levels, i.e. the micro, meso and macro level. Moreover, due to its sequential structure the development of policy impacts can be explicitly analyzed over time.
  - In contrast to qualitative methods as well as non-parametric matching, the ABM-CGE approach allows the calculation of short, medium and long-term policy impacts. In particular, short term policy effects operating through Keynesian income effects that vanish after a programme has been phased, out can be separated from long-term policy impacts which operate through supply side factors and sustain even after a programme has been terminated.
  - The ABM-CGE approach provides a rather flexible model framework that is generally able to include a wide range of behavioural responses and market and non-market interactions induced by RD polices. Accordingly, complex rural development processes are more realistically modeled which not only allows a better understanding of the intervention logic of existing RD programmes, but this also allows the identification of innovative RD-policy measures. A case in point is innovative RD policy programmes that aim to improve large-scale network structures in rural communities.
  - Due to its interlinked micro-macro structure the model is able to identify counterintuitive policy impacts like for example the possibility that investment subsidies have a strong positive impact on technological progress at the individual farm level of programme beneficiaries, but these positive impacts are reversed at the sectoral level due to the fact that subsidies impede the exit of inefficient farms.
  - In contrast to most existing macro models, which are applied to Nuts 2 level corresponding to larger economies comprising of more than 100,000 people, this approach is applied at the village level with a population ranging from 2000 up to 8000 people. This is useful given the fact that especially structural measures like most Axis 3 policies have only a measurable impact at village

level, which would be watered down at a higher regional level like Nuts 2.

  - Overall, one can conclude that the ABM-CGE model approach certainly provides a very flexible ex ante evaluation tool that not only allows the derivation of a complete set of quantitative evaluation indicators, but beyond this provides a suitable tool to better understand the complex and often counterintuitive intervention logic of certain policies and hence facilitates policy learning.

- Besides these positive aspects, the ABM-CGE model has also the following drawbacks:
  - It is extremely time consuming and data intensive to calibrate or estimate model parameters for specific cases.
  - Moreover, even if the model is empirically estimated or calibrated based on detailed survey data for a specific rural community, it is still fair to conclude that specific model modules can only be roughly calibrated and hence do only to a limited extend reflect true empirical behavioural responses. Accordingly, simulated model results have to be interpreted with caution.
  - For example, simulated policy impacts crucially depend on assumed effects of specific RD measures on technological progress. While impacts of exogenously shifted technological progress parameters (at the macro, meso and micro levels) are endogenously derived, the policy induced shift of technological progress is exogenous. Here, more realistic policy impacts on result indicators can be derived applying statistical methods of ex post analysis like matching.
  - Accordingly, regional differences of policy impacts mainly result from differences in central economic or demographic structures of analyzed communities, while more interesting institutional variances like local government institutions are not yet explicitly considered. This is especially regrettable since empirically, these institutional factors seem to be crucial in determining why some policies work in some communities but not in others. Partly, local government institutions have been taken explicitly into account via the integration of a political economy module (see RR5-1). This topic is certainly a very worthwhile field for future research.

- A second quantitative approach corresponds to non-parametric matching methods that have already been proven to be very suitable tools for ex post evaluation analyses. For applying matching methods as complementary methods for ex ante evaluation, we can summarize the following:
  - Both, micro- and macro econometric matching methods can be suitable tools for ex ante evaluation studies.

- Especially, to estimate impacts of specific RD policy measures on relevant result indicators at the micro level, standard ex post matching methods can be applied to estimate possible policy impacts in ex ante evaluation studies. For example, the impact of training on technological progress realized at farm level could be empirically estimated using ex post matching techniques, which can then be used as inputs of model-based approaches to estimate policy impacts in corresponding ex ante evaluation studies.
- Additionally, generalized micro econometric matching techniques exist that allow the evaluation of a policy measure prior to its implementation.
- While micro-econometric matching approaches can be applied for RD policy measures that intervene at the individual farm level, like many Axis 1 measures, many RD measures like most Axis 3 measures intervene at the macro level which makes it generally not possible to apply microeconometric matching methods to evaluate these policies (neither ex ante nor ex post).
- Furthermore, estimated treatment effects at the micro level can be extremely biased. This is especially true, when micro data from other regions is used, which results from a regional selection bias.
- In this case macroeconometric matching methods could be applied. For example, within ADVANCED-EVAL macroeconometric matching procedures have been developed and applied for ex post analysis, where rural regions at Nuts 3 level have been matched (see RR3-2).
- But, it is not straightforward to use these macroeconometric methods also for ex ante evaluation.
- Moreover, matching rural regions is often limited due to the fact that the total number of regions available is rather low. Thus, matching delivers often extremely biased results.
- Finally, given existing ex post evaluation analyses, it is commonly accepted that the impact of RD policies is often negligible at higher regional levels, i.e. Nuts 3 or higher levels, while it is often not possible to get sufficient statistical data for regional levels below Nuts 3.

15.3. Publications of WP6

Deliverables

[D25] Comparison of derived ex post and ex ante evaluation tools with ad hoc tools commonly used in RD-programmes : Thematic Report (TR6-1)

Part VII.

Summary and outlook on future work

by Christian Henning and Peter Kaufmann

Evaluations of rural development programmes (RDP) need to answer a range of evaluation questions against the background of different institutional settings, varying data availability at different levels, heterogeneity between the units of analysis (be on the firm level or regional level) that all have an influence on which evaluation methods are more likely applicable in particular situations. This said, one needs to warn from staying completely open in terms of which methods can be applied because evaluators will often choose the designs and methods they feel most comfortable with, which might in many cases not be the optimal method. The range of ex-ante and ex-post evaluations produced so far under the rural development regulation (RDR) give a telling overview on how diverse these designs and implementations can be where it is very difficult to get a clear picture and to scale up results to give policy makers an answer on what worked well in which circumstances. The main evaluation questions, (1) To what extent does the policy work? and (2) How does the policy work?, need to be answered with different, thus complementary approaches. As the results of the ADVANCED EVAL project show clearly, quantitative ex-ante and ex-post evaluation methods, underpinned by theory, are clearly advantageous in giving indications on the magnitude and direction of effects. This needs to be complemented by qualitative and/or other quantitative approaches aiming to give an answer on the causal chain of effects to answer the 'how' question and to implement essential sensitivity analyses to test for potential biases of the earlier results.

Applied to the Rural Development Regulation (RDR), such a combined approach could be implemented the following way: The intervention logic sets the frame for the evaluation of singular measures on the micro level by conceptualising the causal chain from inputs to impacts. One can argue that putting the intervention logic to a serious test requires quantitative and qualitative methods. Qualitative methods are necessary to put the theoretical construct on firm footings through covering background knowledge to formulate correct quantitative models and also potential alternative conceptualisations/modifications to the intervention logic. Quantitative methods are advantageous for estimating and comparing the magnitude of net-impacts. Qualitative methods can again be used to gain a deeper understanding of why the quantitative effects played out the way they did and which role heterogeneity in implementation and context plays in determining the success of policy measures. Because all methods have their advantages and disadvantages, a way forward could be to agree on some kind of ranking for which methods to apply in which circumstances. A simplifying aspect in the EU rural development context is that evaluators are dealing with the same evaluation questions and the programmes at the same scales, which gives a window of opportunity for narrowing down suitable methods for particular evaluation questions. Aggregation of outcomes is otherwise not possible because different methods will produce somewhat differing results on the same indicator using the same data.

UNDERSTANDING AND MEASURING THE COMPLEX PROCESS OF RURAL DEVELOPMENT

A prerequisite of a comprehensive policy evaluation is certainly a sound understanding of the complex process of rural development. Based on this a intervention logic of applied RD-policies can be derived. In this regard ADVANCED-EVAL contributed to existing theory via analysing the role of social networks in rural development.

Motivated by earlier studies on the impact of networks on regional development (Bryden, 2001; Courtney et al., 2001; Atterton, 2003) ADVANCED-EVAL focused it theoretical and empirical work on the following three aspects: (1) The impact of network structure on knowledge spillovers and regional economic growth, (2) The impact of network structure on belief formation and economic performance and (3) The impact of network structure on firm's transaction costs.

Main theoretical and empirical are the following:

1. Social network structure significantly differ across high and low performing rural regions

2. At the macro level especially the local and global network size as well as clustering and centrality of business networks have significant impact on the speed of knowledge diffusion and hence realized technical progress in rural regions.

3. Analogously, at micro level large business networks of individual farms increase technical efficiency and hence productivity of farm production.

4. Communication network can function as an information aggregation device, which determines firm's beliefs on future states of the economic environment triggering farm's investment, exit and diversification decisions. Favorable communication structures allow an efficient aggregation on available information which leads to rational investment decisions. Vice-versa unfavorable communication network structures can lead to overoptimistic or extremely pessimistic beliefs implying a over- or under-investment in corresponding farm activities.

5. Social networks also determine significantly transaction costs occurring on agricultural commodity markets as well as on rural labor markets. Accordingly, EGO-centric social network structure determine economic performance of farm-households on off-farm labor and agricultural commodity markets as well as labor market performance of non-farm households.

6. Elite network structure in rural communities have a significant impact on local government performance, i.e. favorable structure imply the the implementation of efficient RD-policies inducing a sustainable rural development mainly via supply

side factors. In contrast, unfavorable elite network structures biased towards special local interest groups imply the implementation of less efficient RD-policies mainly focussed on short-term income redistribution to politically favored local groups.

7. Understanding the emergence and dynamics of rural network structures organising both economic and political life in rural communities will be a key factor to achieve a sustainable rural development process characterized by increasing quality of life in rural regions. In this regard applied econometric MCMC procedures allowing a empirical estimation of large scale networks based on sample network data are certainly a very promising tool facilitating future empirical network studies at the macro level.

8. Although undertaken empirical and theoretical network studies clearly deliver new and interesting results, it is still fair to conclude that research on the role of networks as determinants of rural development is still in its infancy and especially more theoretical, but especially comprehensive empirical studies are needed in the future to fully understand the role of networks in rural development.

Beyond network studies the project constructed a multi-dimensional Rural Development Index (RDI) as a proxy indicator describing an overall level of regional development in individual regions. The RDI was also used together with other relevant indicators to estimate the net effect of a given RD programme, i.e. to disentangle the effect of programme support from exogenously determined factors at the regional level (substitution, displacement, multiplier effects). An important objective for developing the RDI was to learn more about the magnitude and major trends in the overall welfare of individual rural areas. It was also used to identify key factors fostering growth (economic, social and environmental) and convergence of rural regions in a given EU country.

The main methodological and policy conclusions from applying the RDI as an impact indicator to the evaluation of RD programmes are as follows:

1. It needs a rich dataset for capturing all relevant dimensions (economic, social, environmental, etc.) of rural development. This means in practice using the regional databases provided by statistical offices and further indicators provided by ministries and alike to fill potential gaps;

2. This way, a RDI allows for a comprehensive analysis of various rural development domains (aggregated or separated by programme measures) and their impact on the overall quality of life in rural regions. It can be implemented at NUTS 2-5, thus even village levels providing data availability;

3. The index is not constant over time, easily adjustable and allows for an easy inclusion of additional relevant variables/coefficients representing various aspects of the overall quality of life/rural development;

5. However, in its present form the RDI index is an applied concept, while future research is certainly needed to establish a more comprehensive theoretical foundation of the RDI index.

EX-ANTE EVALUATION METHODS

Although the advantages of ex ante evaluation are quite intuitive, and although the European Commission requires an obligatory ex ante evaluation for EU policies, an adequate methodology is not yet fully developed. This was a starting point for the ADVANCED EVAL project that analyzed to what extent current practice, i.e. ex ante evaluations of RD policies mostly applying only qualitative methods can be improved by applying quantitative approaches. In particular, we simulated data in a micro-macro linked ABM-CGE modelling framework and a non-parametric matching approach. The comparison of these results with results from applying qualitative methods shows that the quantitative approach applied can significantly enhance evaluation results because:

1. The micro-macro linked ABM-CGE approach provides a rather flexible model framework that is able to include a wide range of behavioural responses and market and non-market interactions (structures of social networks) induced by RD polices.

2. It provides a full set of quantitative evaluation indicators at all levels, i.e. the micro, meso and macro level.

3. The development of policy impacts can be explicitly analyzed over time.

4. Indirect feedback mechanisms can be captured that sometimes influence estimates decisively and produce counterintuitive results.

5. It is possible to separate short- and medium-term policy impacts, i.e. demand side effects resulting from simple income transfers that vanish once the programme has been terminated, from long-term supply side effects that persist even after the programme has been phased out.

6. The level of analysis has also proven to be decisive: The micro-macro linked ABM-CGE model at village level (i.e. NUTS 4/LAU 1) could still capture effects of RD spending, but this has proven to be increasingly difficult at higher levels, like already at NUTS 3 level, because the amounts spend for RD per person get very small. The main drawback of this approach is that it is very time consuming and rather complicated to implement, which makes it prohibitive for an immediate implementation by RD evaluators. Thus, the further development of the approach includes simplifying applications by providing templates for different, characteristic types of regions, which can then be used and potentially adapted by evaluators.

EX-POST EVALUATION METHODS

Because the basic evaluation problem means that the state of 'no intervention' (the counterfactual baseline) for the same unit of analysis cannot be observed, evaluators need to simulate counterfactuals that are as similar as possible, but did not receive the support, for making comparisons and estimate effects with minimised biases. For the micro level, ADVANCED EVAL suggests as ex post impact evaluation method to apply a combination of propensity score matching with a difference in difference approach (PSM-DID). This approach aims to disentangle programme effects from exogenously determined effects and also includes indirect programme effects (e.g. leverage and deadweight loss effects) to arrive at a programme's net effect. The comparison of results from PSM-DID with results from qualitative methods shows that using simple methods results in biased conclusions. Simple before-after comparisons of beneficiaries, or comparing beneficiaries with non-beneficiaries where the latter comprise either all non-beneficiaries or country averages produce in our case more positive assessments in comparison with the matched samples applying PSM-DID, although, basically, results could also be biased in the other direction. Thus, PSM-DID is successful to minimise different kinds of biases, and so can lead to substantially different assessments in comparison to applying only qualitative methods on their own. This very fact should make it a strong candidate to consider for impact evaluations as long as some preconditions are fulfilled:

1. PSM-DID is data hungry in terms of sample sizes necessary and availability of data for several points of time. Matching is per se sensitive to smallish sample sizes, i.e. lower than 300. what; beneficiaries and non-beneficiaries combined?

2. Whenever possible, it should be implemented including a time series of a few years (because the true ATT vary over the years).

3. No method is infallible. Thus, results need always to be tested for their sensitivity, e.g. with bootstrapping, bounding, the response of estimated effects from programme participation to small changes, or comparisons of results with alternative matching techniques.

4. Matching does not differentiate between effects caused by the programme design and policy effects. For capturing this, one needs to complement this approach with qualitative analyses. Encompassing modelling approaches like some CGEs would also suitable, but might be prohibitive because of the effort to set them up.

5. A further advantage of PSM-DID is that it is a method that can be learned by evaluators with some medium effort. This is in contrast to an encompassing modelling approach like CGEs or structural economic models, which need highly specialised econometric skills.

To estimate macro effects, a generalized propensity score (GPS) matching and a dose-response function approach has been applied using, above others, the RDI as a predictor. This approach enables us to estimate indirect macro-level effects.

It is also applicable if the majority of regions, or all regions, are subject to support from the programme.

The conclusions regarding the applicability of the generalized propensity score matching approach are:

1. The GPS extends and improves the quality of the analysis of programme effects compared to a binary PSM-DID method;

2. Especially promising is the possibility of the estimation of the average and marginal potential outcomes that correspond to specific values of continuous programme doses (i.e. for each level of programme support) by means of a dose-response and derivative dose-response functions. Here, programme impacts are linked to the level of programme intensity.

3. The method is fully applicable to the measurement of the macro-economic impact of RD and structural programmes in the EU.

4. The approach allows to incorporate general equilibrium effects of a programme, e.g. multiplier effects, substitution effects, into the analysis.

Overall, we conclude that improvements of the mostly qualitative methods of ex ante and ex post evaluations of EU RD policy programmes could be realized through innovative quantitative methods. These methods should considerably lesson biases of evaluations because exogenous factors and indirect programme effects are taken into account and estimated quantitatively. Still, one needs to emphasize that no method is infallible. Thus, the combination of qualitative and quantitative methods in a triangulate fashion is recommended to ensure a high quality of impact evaluations in the future. But quantitative methods, as discussed here, are clearly advantageous to capture the magnitude and direction of effects. It is then the role of essential sensitivity analyses as well as qualitative methods to test and correct for potential biases and present the results in a suitable context.

Finally, it is important to note that no immediate policy relevant conclusions can be taken from the above results because they only report snapshots of particular measures in specific localities (ex-ante) and/or specific years.

They are implemented in this project to show that (1) it is possible to implement them, and (2) that they produce significantly different results from the current practice. An encompassing evaluation would cover the whole programming period and several measures.

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