A Combined Approach of Evaluation Tools for Regional Policy Innovation – The Case of Marche Region

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Acronyms

ATT: Average net effect of the intervention on the beneficiaries

CIA: Conditional Independence Assumption

DG: Directorate General

DID: Difference-in-Difference method

ERDF: European Regional Development Fund

MA: Managing Authority

NUVV: Italian Network of regional Evaluation Units

OECD: Organisation of Economic Cooperation and Development

R&D: Research and Development

RDD: Regression Discontinuity Design

RIS: Regional Innovation Scoreboard

ROP: Regional Operational Programme

RUICS: Regione Umbria Innovation & Competitiveness Scoreboard

RUIS: Regione Umbria Innovation Scoreboard

SWOT: Strengths Weaknesses Opportunities and Threats

UVAL: Italian Unit of Evaluation

Glossary of interventions

1.1.1.4.1 - Research: this intervention is financed in the framework of the law 598/94 art.11 'Ricerca'

1.1.1.4.2 - Technological networks: this intervention finances the creation of networks for high tech productions

1.1.1.4.3 - Technological transfer: this intervention promotes technological transfer through high tech investments, training and recruitment of high skilled young workers

1.2.1.5.1 - Business Innovation: this intervention is financed in the framework of the Law 598/94, the part related to business innovation

1.2.1.5.2 - Fashion sector: this intervention supports innovation in the fashion sector

1.2.1.7.1 - Technological investments: this intervention finances the acquisition of new machinery

1.3.1.7.1 - Spinoff: this intervention finances the transformation of a spinoff into a firm and the creation of start-ups.

Contents

Executive Summary

The aim of this paper is twofold: to propose an evaluation approach for regional innovation policy, able to meet the methodological challenge of combining several tools entirely and effectively; to describe the empirical (qualitative and quantitative) results of the adoption of the approach in the case of the Regional Operational Program (ROP) of Marche, a region in the eastern central part of Italy.

From a methodological point of view, the adopted approach has at least three points of interest. First, it is based on the combination of various tools that are usually separate in literature and in practice: preparatory analysis, quantitative and statistical tools, as well as qualitative tools such as case studies. Secondly, the methodological approach is an effort to put in practice the recent orientations of the European Commission in the impact assessment of Structural Funds for Cohesion Policy after 2014. The third element of interest - as a consequence of the reasons explained above - is that this approach has high transferability potential in other local or regional contexts.

The case of Marche is interesting because it is a concrete example where the evaluation approach has been used for the independent evaluation of innovation interventions implemented in the framework of the ROP. The ROP has a total budget of around €289 million for 2007-13, 39% funded by the European Regional Development Fund (ERDF). The ROP is divided into six priority axes, among which the most important in financial terms is Priority 1, which is the subject of evaluation and concerns innovation and the knowledge economy.

The independent evaluation has been an opportunity to reflect upon innovation dynamics in the region, which is experiencing a period of great change and crisis in some traditional manufacturing industries. According to the European Commission Regional Innovation Scoreboard, Marche region has a medium-low position in Europe, due to a low level of tertiary education, absorptive capacity, R&D expenditure and fewer innovative firms working together. The regional industrial model, which is mainly specialised in traditional sectors, is export-oriented and primarily composed of low-capitalised micro and small enterprises. Nonetheless, Marche has one of the highest percentages of manufacturing companies across Europe and has a dense regional network for innovation, with six public research centres (including four universities) and seven knowledge centres (including three public-private

centres).

The evaluation approach produces some interesting results. It describes a complete picture of the innovation policy by making explicit 'the theory of change' underpinning the ROP. Moreover, it allows a systematic combination and completion of various evaluation tools in order to provide a quantitative dimension of the results (how much) and to give an interpretation (why). It evaluates the accessibility to incentives; it updates the implementation progress of Priority 1 and reconstructs the logical framework of the interventions.

The combined use of statistical tools and case study allows identification of the main innovation success factors, as well as human capital and networks within the R&D/innovation system. Among the other main findings is that a positive element for a higher effectiveness of interventions is the active participation of universities in the financed projects. Universities participate in various roles in the innovation process such as: centres of technological transfer; suppliers of highly specialised workers; stable partners in innovative processes and start-up firms, in the case of spinoffs. Incentives with a more technologically-oriented perspective perform better in promoting an upgrade of human capital and in building cross-sectoral networks for innovation.

Introduction

I. BACKGROUND AND PURPOSE

The aim of this paper is twofold: to propose an evaluation approach for regional innovation policy, able to meet the methodological challenge of combining several tools entirely and effectively; to describe the empirical (qualitative and quantitative) results of the adoption of the approach in the Regional Operational Program (ROP) of Marche, a region in the eastern central part of Italy.

From a methodological point of view, the proposed evaluation approach is innovative for three main reasons. First, it is based on the combination and integration of various tools that

are usually recurring separately in literature and in practice: preparatory analysis, quantitative/counterfactual evaluation methods and the case study.

Secondly, the proposed approach is not only an original combination of various tools but also an experimental and pioneering attempt to put in practice, the recent orientations of the European Commission as regards impact assessment of Structural Funds for Cohesion Policy after 2014. The DG Regio Guidance Document proposes a similar approach for evaluation in the New Programming Period2. The first step in evaluation is the description of the logical framework of interventions primarily related to the deliberative social and political process. According to the DG Regio Guidance document, once the logical framework is defined, evaluation should focus on the results. They depend basically on financed interventions (net effect or impact) and on the contribution of other factors (external factor contribution).

The Guidance document indicates two distinctive questions useful to disentangle the impact of interventions from external factor contribution. The first question is 'Does the public intervention work / have an effect?' This question refers to the existence of a causal linkage between the intervention and an ex-post effect. The Guidance document suggests counterfactual impact evaluations as the proper tool to answer this question. The second question is 'Why and how does it work?'. This relates to an explanation of the actual (intended or / and unintended) effects. The theory-based impact evaluation tool is proposed for tackling the second question. In addition and more importantly, the Guidance document highlights that these two questions ('how much' and 'why'/'how') only seem to be separated. All the elements explained above reinforce our proposed approach, which is very interesting, because it is based on a triangulation of the three main evaluation tools and anticipates a possible evaluation model for the Programming period 2014-2020.

A third element of interest in the proposed approach - as a consequence of the reasons explained above - is its high transferability potential in other local or regional contexts. In fact it follows evaluation standards according to Commission Manuals (MEANS and EVALSED), and the main Italian references (UVAL and NUVV)3. Harmonising the methodological standards also ensures the high quality of evaluation activities.

From an empirical point of view, this paper describes the results (qualitative and quantitative) of the adoption of the approach in the ERDF Regional Operational Program

2 See Dg Regio (2011) and the Note of the High Level Group in Barca, Mc Cann (2011).

3 See DG Regio (2008) and DG Regio (2008a).

(ROP) of Marche. In particular the approach was adopted to the evaluation of Priority 1 'Innovation and Knowledge Economy', which represents approximately out of 41% of €289 million of the ROP. This case is very interesting because Marche Region represents a concrete example where the evaluation approach has been used for independent evaluation. The independent evaluation has been an opportunity at regional level to reflect upon the innovation dynamics in a period of great change and crisis, in particular for some traditional manufacturing industries. The peculiar regional industrial model is specialised in traditional, export-oriented sectors and based on low-capitalised small enterprises. According to the European Commission RIS, Marche region has a medium-low position in Europe, due to a low level of tertiary education, absorptive capacity, R&D expenditure and collaborating innovative firms. In spite of its industrial model, Marche is one of the most important manufacturing regions across Europe and has a dense regional network for innovation, with four universities as well as seven knowledge and technological centres.

II. STRUCTURE OF THE PAPER

The paper is divided into three sections and a conclusion.

The first section regards the preparatory analysis. The first paragraph describes the main features of this tool and its integration in the proposed methodological approach. The second summarises the results of the reconstruction of the theories of change of Priority 1 of the ERDF Marche Region ROP. The third describes the prioritisation of theories of change and the logical framework of the Priority.

The second section concerns counterfactual analysis. The first paragraph describes the integration of counterfactual analysis in the proposed approach. The second is about the statistical tools used for the estimation of net effect. The third paragraph describes the main quantitative effects of innovation incentives.

The third section concerns the case study analysis. The first paragraph describes the main methodological characteristics of the tool and its integration in the proposed approach. The second paragraph presents the tool box used to implement the case study. The third highlights the main results in terms of behavioral additionality for innovation at enterprise level.

The conclusion summarises the main results of the adoption of the approach.

1. Section I: Preparatory Analysis

1.1 PREPARATORY ANALYSIS IN THE COMBINED APPROACH

Preparatory analysis aims at verifying the policy implementation status. Preparatory analysis includes various tools for different purposes. The tools used in the Marche ROP Independent Evaluation are:

- a literature review to take into account different schools of thought in the field of innovation. The main references are the RIS of DG Regio, the RUICS, the Ismeri Report and the Nesta Study 4;
- analysis of implementation reports to verify progress of the procedural, financial and physical implementation of the ROP Priority 1;
- analysis of Priority 1 indicators, to provide suggestions for revision as well as to complete and update context analysis of the Marche Region in the field of innovation;
- analysis of administrative documents, to reconstruct the logical framework of interventions 5.

According to DG Regio Guidance Document, particularly interesting is the analysis of administrative documents aimed at reconstructing the logical framework of interventions 6.

4 See the following reference for: RIS, European Commission (2009); RUICS, Regione Umbria (2010), the Ismeri Report, ETEPS AISBL (2010), the Nesta study, Nesta (2009).

5 It is important to note that the preparatory analysis was carried out in the Independent evaluation using also other tools, such as interviews and focus groups (t33, 2011).

6 The DG Regio Guidance proposes a similar approach for programming, monitoring and evaluation activities in the New Programming Period 2014-2020. This is why the adoption of the approach in the Marche Region is a pioneering experience in respect to the new approach of the Cohesion Policy.

1.2 'RECONSTRUCTION' OF THE LOGICAL FRAMEWORK

Three steps are necessary for the reconstruction of the logical framework:

a) defining needs;

b) reconstructing the strategy of the interventions;

c) matching needs and strategies of interventions.

1.2.a Defining needs

Defining needs is part of the programming activity that should precede the decision-making phase. In the independent evaluation, defining needs is a re-calibration activity based on an update of the regional innovation SWOT analysis. The result of the SWOT analysis update is the identification of seven main needs concerning innovation:

- (N.1) Low tertiary education and low employment opportunity for graduate students;
- (N.2) Low R&D expenditure (both private and public);
- (N.3) Limited cooperation among innovative firms and the small size of firms;
- (N.4) Low absorptive capacity and little knowledge diffusion, which limits technological transfer;
- (N.5) Low physical capital accumulation and low-risk capital diffusion for innovation;
- (N.6) Few organisational and marketing innovations;
- (N.7) Crisis in some traditional manufacturing sectors.

These needs represent the starting point for defining objectives underpinning the strategic framework of ROP Priority 1 (DG Regio, 2011)

1.2.b Reconstructing the strategy of interventions

Reconstructing the strategy of interventions is based on the categorisation of interventions according to their industrial and productive features and on the analysis of documents

describing the regional innovation policy related to ROP Priority 1.

The categorisation of interventions is carried out in the independent evaluation according to various criteria (t33, 2011). For the sake of both simplicity and synthesis, this paper presents the main categorisation referring to the technological features of interventions. In particular, the focus is on the economic sector of the intervention and the presence/absence of cross-fertilisation between different sectors (Pavitt, 1984, Noteboom 2000, OECD, 2003, Chesbrough 2006). Some interventions focus mainly or exclusively on traditional sectors (1.1.1.4.1, 1.2.1.5.2 and 1.2.1.7.1); others more on high tech sectors (1.1.1.4.2 and 1.1.1.4.3) or on the sector of University research (1.3.1.7.1). Although the interventions 1.1.1.4.1, 1.1.1.4.2 and 1.1.1.4.3 concern various sectors (traditional, high tech, or both), all of them invest in cross-sectoral integration and fertilisation (see table 1).

Although any intervention has peculiar and different features from the others, the above categorization allows a classification of the interventions in two main categories:

- technological interventions, which assist enterprises in either high tech sectors or/and traditional sectors for the promotion of cross-sectoral integration7. The interventions of this category are: 1.1.1.4.1, 1.1.1.4.2, 1.1.1.4.3;

- traditional interventions, which assist enterprises in either traditional or manifacturing sectors without cross-sectoral integration. The interventions of this category are: 1.2.1.5.1, 1.2.1.5.2, 1.2.1.7.1.

Intervention 1.3.1.7.1 is excluded from this classification due to its particularities. This classification is useful to the comparison among the interventions (see Second Section).

7 In literature, two main types of industrial aggregations are used. The first depends on institutional features and consists of Pavitt's taxonomy (Pavitt, 1984). According to Pavitt's taxonomy there are four groups of sectors: science-based, scale intensive, specialised suppliers and supplier-dominated. The second taxonomy is based on technological intensity (OECD, 2003). According to OECD aggregation, there are four groups of sectors: high-tech, medium high-tech, medium low-tech and low-tech. In our paper we take the definition of traditional sectors given by the independent evaluation that refers to Pavitt's supplier-dominated sector. Traditional sectors are textiles, clothing, shoe manufacturing and the food industry. According to the OECD taxonomy, low-tech sectors should include: textiles, clothing, shoe manufacturing, food and other sectors such as the printing paper and furniture industries.

Table 1 Interventions, sectors and cross-sectoral integration

Intervention	***Sectors concerned***	***Cross-sectoral Integration***
1.1.1.4.1 - Research	*Traditional*	*Yes*
1.1.1.4.2 - Technological networks	*Traditional and high tech*	*Yes*
1.1.1.4.3 - Technological transfer	*Mainly high tech sectors*	*Yes*
1.2.1.5.1 - Business innovation	*Manufacturing*	*No*
1.2.1.5.2 - Fashion sector	*Traditional*	*No*
1.2.1.7.1 - Technological investments	*Mainly traditional*	*No*
1.3.1.7.1 - Spinoff	*Spinoff*	*No*

Source: t33

The analysis of regional documents is the other main activity to 'make explicit' the logical framework and the theory of change of Priority 1. This analysis allows the identification of four strategies of change:

(T.1) Strengthen technological transfer;

(T.2) Increase capitalisation in traditional sectors as a tool to support innovation;

(T.3) Invest in the innovation and research system;

(T.4) Support the transition towards a 'collaborative/open innovation' industrial organisation in the Marche Region.

Each of these strategies of change corresponds to the main theory of change, already detailed in the European Cohesion Policy Framework. Innovation policy is a pillar of a regional competitiveness and growth policy. Moreover, each of the identified strategies corresponds to a different theory of change, that is a narrative on how to modify the regional setting to increase innovation. T.1 is based on the idea that technological transfer is the best way to spur innovation, because the Marche region has an industrial model that is based more on embodied innovation rather than driven by R&D. T.2, T.3 and T.4 refer to the idea that through capitalisation, R&D and networking, it is possible to tackle the weakness of small size preventing regional firms from investing in innovation.

1.2.c Matching the needs and strategies of interventions

The last step of the reconstruction of the logical framework is matching needs (from N.1 to N.7) and theories/strategies (from T.1 to T.4) at the intervention level.

Table 2. Needs, theories and interventions

	Needs							Theories			
Intervention	N.1	N.2	N.3	N.4	N.5	N.6	N.7	T.1	T.2	T.3	T.4
1.1.1.4.1											
1.1.1.4.2											
1.1.1.4.3											
1.2.1.5.1											
1.2.1.5.2											
1.2.1.7.1											
1.3.1.7.1											

Source: t33

Table 2 shows the matching of needs and theories with various interventions. The number of matches, indicated by grey spaces in Table 2, is an effective proxy of the correspondence between the regional needs for innovation and the interventions. At the same time, matching theories (strategies) and interventions indicates a correspondence between the general objectives of the ROP, taken from administrative documents. and each intervention. The degree of matching between interventions and needs is:

- High, (6 /7 matches) for the interventions 1.1.1.4.2 Technological networks and 1.1.1.4.3 Technological transfer. They are the two best interventions to meet the regional needs in terms of innovation;

- Medium, (3/4 matches), for 1.1.1.4.1 Research, 1.2.1.5.2 Fashion Sector and 1.3.1.7.1 Spin off. In spite of the similar number of matches, they meet different needs. From a sectoral point of view, the interventions 1.1.1.4.1 and 1.2.1.5.2 concern traditional sectors and the intervention Spinoff regards the transformation of spinoffs and start-ups into firms. Furthermore, Research intervention is the only one explicitly devoted to R&D;

- Low, (1/2 matches), for the interventions 1.2.1.5.1 Business Innovation and 1.2.1.7.1 Technological innovation, which are the most traditional in Priority 1. They have a relatively low relevance for meeting regional needs.

The same analysis as above can be carried out for the degree of matching between interventions and theories, which is:

- High, (4 matches), for 1.1.1.4.2 Technological networks and 1.1.1.4.3 Technological transfer. They are the two best interventions to put in practice the theories of change for innovation;

- Medium, (3 matches), for 1.1.1.4.1 Research, 1.2.1.5.2 Fashion Sector and 1.3.1.7.1 Spin off. They have in common technological transfer and the creation of a regional system of collaborative/open innovation, but they differ in sectoral focus (see above);

- Low (2 matches), 1.2.1.5.1 Business Innovation and 1.2.1.7.1 Technological innovation. These focus mainly on technological transfer and have a relatively low relevance.

It is clear that the interventions 1.1.1.4.2 and 1.1.1.4.3 are the best to both meet regional needs and to put in practice the theories of change in innovation.

1.3 PRIORITISATION OF THEORIES OF CHANGE

The analysis of the previous table shows a tree structure of the theories of change: T.1 is the common theory to all interventions. As a consequence, the promotion of technological transfer is the main strategy in Priority 1 of the ERDF ROP to increase innovation at a regional level. All the other theories of change refer, implicitly or explicitly, to T.1. The importance of T.1 is due to the following reasons:

- the industrial model of Marche region is specialised in traditional sectors, with low technological and capital intensity, composed of micro and small firms, mainly organised in districts and productive networks. Technological transfer represents the best way to sustain R&D-driven innovation in the existing regional context;

- technological transfer is also an opportunity to establish new networks for innovation at the regional level both in traditional and high tech sectors. This is particularly so in 1.1.1.4.2 Technological networks and 1.1.1.4.3 Technological transfer but also in 1.1.1.4.1. In the first case, technological transfer takes place among firms of different sectors (both traditional and non-traditional); in the second case it depends on human capital (young researchers) and in the third case on R&D investments.

Overall, technological transfer seems to represent the best way to innovate in traditional

sectors as well as to sustain the transition towards a more innovative industrial model of production.

2. Section II: Counterfactual Analysis

2.1 THE EVALUATION TOOL IN THE COMBINED APPROACH

In theoretical econometric literature and in practice, counterfactual impact evaluation is associated to a set of statistical techniques. The purpose of counterfactual evaluation is to provide a credible answer to the question 'Does it work?' and in particular, 'How much difference does the intervention make?'. Counterfactual analysis aims at providing a plausible causal interpretation based on empirical evidence under some assumptions. The existence of data on beneficiaries and non-beneficiaries (counterfactual sample), the state of project implementation and the projects' sample size are critical preconditions for the applicability of counterfactual methods. According to the DG Regio Guidance document '*counterfactual and theory based approaches should complement each other*'. As a consequence quantitative and qualitative tools are more effective and useful if used jointly. This is our case.

2.2 THE APPROACH OF THE COUNTERFACTUAL ANALYSIS

2.2.a The sample

Counterfactual analysis is carried out on a sample, created through a survey questionnaire including 180 firms, of which 100 are beneficiaries and 80 non-beneficiaries of ROP interventions. These represent almost 15% of the total firms (beneficiaries and non-beneficiaries) applying and which were deemed eligible for the incentives. As with the total set of firms applying for funds in Priority 1, in the sample each firm participated in an average of 1.3 projects. Likewise, the sample has similar proportions of territorial (Nuts-3 level) representation to the total set: 2/5 of the firms are in Province of Ancona, 1/5 in

Macerata, 1/5 in Pesaro; 1/10 in Fermo and 1/10 in Ascoli Piceno. The main performance result variables are:

- turnover, which indicates selling capacity and business competitiveness;
- the number of total and R&D employees, which fluctuates less than turnover;
- process and product innovations, defined according to the Oslo Manual (OECD, Eurostat, 2005).

The descriptive statistical analysis of the sample has been carried out using the average and the variation of the performance result variables. Table 3 shows the average number of employees in 2007 and 2010 and the difference in time, for both beneficiaries and non beneficiaries, in the cases of both technological and traditional interventions and in the general case. According to the above categorization (see Paragraph 1.2) technological interventions are: 1.1.1.4.1, 1.1.1.4.2, 1.1.1.4.3; traditional intervention: 1.2.1.5.1, 1.2.1.5.2, 1.2.1.7.1. This classification is useful to the comparison of the interventions, otherwise not possible due to the relative small number of observations per intervention. The last column on the right of Table 3 shows the difference between the 'Δ 07-10' of beneficiaries and non-beneficiaries. 'Δ 07-10' indicates the difference between the number of employees in 2010 and 2007.

Table 3 Statistical analysis - Number of employees

Type of Intervention	***Beneficiaries***			***Non beneficiaries***			***Difference in Difference***
	2007	*2010*	*Δ 07-10*	*2007*	*2010*	*Δ 07-10*	
Technological	*40,97*	*43,17*	*2,2*	*32,02*	*33,01*	*0,99*	*1,21*
Traditional	*31*	*35,28*	*4,28*	*35,89*	*35,43*	*-0,46*	*4,74*
Intervention (all)	*32,6*	*35,5*	*2,9*	*35,98*	*35,22*	*-0,76*	*3,66*

Source: t33

It is important to notice that only through a counterfactual analysis, based on the statistical matching, it is possible to estimate the net benefit of beneficiaries. Nonetheless, the

difference in difference of the last column of table 3 is useful to say in terms of descriptive statistics which should be the sign (not the value) of the counterfactual estimation. In all three cases (technological interventions, traditional interventions and all interventions) there is a positive sign. The last column of the table can be useful to analyse the sample and give explanations of the estimates. The value of the number of employees is greater in the case of traditional interventions. In particular non-beneficiaries enterprises of traditional interventions lose employees from 2007 to 2010. This is also why the difference in difference is higher than technological interventions8.

Similar descriptive statistical analyses were carried out for the other result variables with the following results:

- product innovations and R&D employees have a positive variation from 2007 to 2010 for both beneficiaries and non-beneficiaries, but higher for the first;
- process innovations, as well as the number of total employees, have a positive variation for beneficiaries and negative for non-beneficiaries;
- turnover has a negative performance for beneficiaries from 2007 to 2010, in spite of a relative recovery compared to non-beneficiaries from 2009 to 2010.

2.2.b The estimation strategy

Counterfactual evaluation of the effect consists of estimating the difference between the observed value of the result variable after the intervention and observed value (counterfactual value) if the intervention had not been there. The counterfactual value is actually not observable as a consequence some hypotheses have to be introduced in order to estimate it and to make possible the comparison with the 'observed value'. In literature, the methods of Counterfactual analysis are three: Experimental method, mainly used in Medical Science; One group Design (i.e. Shift Share Analysis); Comparison group design based on the comparison between target group and control group (Bondonio, 2009). The most common methods of Comparison group design are: Difference-in-Difference (DID), Regression Discontinuity Design (RDD), Propensity Score Matching, Instrumental variables and randomised controlled trials. The main challenge for all the counterfactual evaluation

8 For further details on difference in difference, see De Iaco, Fantozzi, 2010.

methods is the estimate of the counterfactual. In order to do so, in particular two main obstacles have to be tackled 9.

The first obstacle in the estimation of counterfactual is the 'selection bias', which consists of the fact that target population differs from counterfactual population due to pre-intervention features. A solution is the introduction of an identification hypothesis stating that pre-intervention variables are sufficient to 'reconstruct' the control group of non-beneficiaries (counterfactual)10.

The second obstacle is the presence of spontaneous dynamics, due to the fact that target population differs from control population for the trend of the result variable. A solution is the introduction of an identification hypothesis to take in consideration the spontaneous dynamics of the result variable trend.

In our estimation strategy, the idea is to tackle the first obstacle, through the introduction of variables relevant both to influence the performance of the enterprise and to describe the pre-intervention situation. The second obstacle will be partially tackled through the use of the result variables in variation from 2007 to 2010.

The estimation strategy is developed in three main steps:

i. Identification of all variables relevant to the performance;

ii. Estimation of the propensity score;

iii. Propensity Score Matching.

<u>i) Identification of all variables relevant to the performance of the firm</u>

The variables which can influence the performance were identified according to the main references in the literature (Bondonio, 2007). The variables are divided into two groups: binary and qualitative.

Binary variables are:

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9 See Martini, Mo Costabella, Sisti (2007); Bondonio (2007); Sisti (2007); Bondonio (2009).

10 It has to be considered a partial solution because it is not possible to 'measure' exactly the counterfactual, but only to 'estimate' it.

- Size (S): is a group of binary variables referring to the size of the enterprise; 'micro' (0-9 employees), 'small'; (10-49 employees), 'medium' (50-249 employees), 'big'(over 250 employees11). Each binary variable is 1 if the firm belongs to the relevant size category, zero if not;

- Province (P): is a group of binary variables indicating the location of the firm. The reference is the province because it corresponds to both an administrative level and to the Nuts-3 level. 'PU' is the province of Pesaro Urbino, 'AN' Ancona, 'MC' Macerata, 'FM' Fermo and 'AP' is the province of Ascoli Piceno. Each binary variable is 1 if the firm is located inside the province, zero if not;

- Sector: is a group of binary variables indicating the sectors of the firms according to Pavitt's taxonomy (see Section 1); 'science-based', 'scale-intensive', 'specialised suppliers' and 'supplier-dominated' industries. Each binary variable is 1 if the firm belongs to the Pavitt's taxonomy category, zero if not;

- Group: is a binary variable which is 1 if the firm belongs to a group, zero if not;

- Other funding (OF): is a binary variable which is 1 if the firm received other public funding for innovation from 2007 to 2010, zero if not;

- Craft: is a binary variable which is 1 if the firm is a craft business, zero if not.

'Actors' is a group of qualitative variables indicating the respondents' judgment of relevance (from 1 to 4) of some actors for innovation. 'Lab' is the R&D internal lab, 'VN' a vertical productive network with other firms, 'UNIV' the relationship with the university and 'PROF' the relationship with professional associations. Each variable is 1 if the firm belongs to the the category of actors, zero if not.

ii) Estimation of the propensity score

The propensity score is the probability that the firms can receive incentives according to the variables identified above. The estimation is carried out through a logit model. The variables

11 The number of employees per enterprise is collected through the questionnaire. In the questionnaire respondents are asked to fill the annual average of employees, excluding external collaborators/ contractors.

inserted on the right-hand side of the estimation of the propensity score (independent variables) equation are the ones decided in the previous step.

$$P(T = 1 \mid X_i) = \Phi(h(X_i)) \quad \textbf{(E.1)}$$

where Φ is the normal (logistic) cumulative distribution function and h(Xi) is the starting specification which includes all the covariates without interactions or higher order terms. 'T' is a binary variable, which takes a value of zero if the firm is not a beneficiary, 1 if the firm is a beneficiary of the intervention. It is important to recall that the beneficiary and non-beneficiary are taken from a list of eligible enterprises, according to the criteria defined by the administrative procedures.

Introducing in (E.1) the covariates X_i, we obtain

$$P(T = 1) = f(S; P; Sector; Group, OF, Craft, Actors) \quad \textbf{(E.2)}$$

Being a logit model, all our estimates have been checked according to the usual parameters and tests: the Likelihood Ratio (LR) test, the pseudo R2 value12. These two tests were applied successfully in all our estimates. In order to identify and 'drop' outliers and to improve the quality of the estimate, we added the condition of common support and we made a trimming activity (see Becker, Ichino, 2002, Bondonio, 2007), so some firms with low pre-intervention variable comparability are dropped from the sample13. After estimating the propensity score, there is the identification of the optimal number of blocks. In order to reach it, the average of propensity score of beneficiaries and non-beneficiaries should not differ within each interval (block). This is a necessary condition to make the Balancing Hypothesis hold. In our case, as a consequence, other richer specification of h(Xi) are not necessary.

12 The Likelihood Ratio LR test is the test for the null hypothesis that all the coefficients of the model are equal to zero. It is the analogue of the F test in linear regression. LR statistics is distributed as a Chi-Square with a number of degrees of freedom as high as the coefficients of slope. The p-value lower than 0.05 indicates that the model is 'not completely' out of sense. The Pseudo R2 is an analogue to R2 of linear regression. In particular, the Mc Fadden's R2 version is used.

13 The level of comparability according to pre-intervention variables is summarised by the propensity score.

iii) Propensity Score Matching

Once the propensity score has been estimated, it is the turn to estimate net effect of the interventions, that consists of disentangling value of the result variable into the effect of the intervention (net effect) and the effect of exogenous factors. In order to do so, it is important to recall that the net effect on the result variables is estimated by a difference model based on the propensity score matching analysis carried out through an elimination of the fixed effects of enterprises, which are not observables, through the use of in time variation of the result variable. This is obtained through the introduction of binary independent variables related to enterprises features, which could have influenced the performance of each enterprise in the considered period . The variation of the result variable is used in absolute values following the main examples in literature (Bondonio, 2007)

Various methods and estimators have been proposed in the literature to estimate Propensity Score Matching models. Among them four are the most commons: Nearest Neighbor Matching, Radius Matching, Kernel Matching and Stratification Matching. To the elaboration of this paper, three of them (Nearest Neighbor Matching, Kernel Matching and Stratification Matching 14) have been considered in order to ensure a greater robustness of the estimates.

2.3 THE EFFECTS OF INNOVATION INCENTIVES

For the sake of synthesis, in this paper, the results of the counterfactual analysis are presented as the average of the ATT estimates using three different methods. As a consequence, the effect for each type of result variable is reported as the average of the three estimates coming from Nearest Neighbor Matching, Kernel Matching and Stratification

14 The Stratification Method consists in the division of the range of variation of the propensity score in intervals in which each of the beneficiaries and non-beneficiaries have the same propensity score in average. The average of the effect is calculated within each interval. The main weakness of this approach is that it drops some observations inside the blocks, if either the beneficiaries or the non-beneficiaries are absent. The Nearest Neighbor Method is implemented with the replacement, in the sense that a non-beneficiary can be used as a best matching for more than one beneficiary. The main weakness is the possible poverty of the matching due to the features of non-beneficiaries. With the Kernel Matching all beneficiaries are matched with a weighted average of all controls with weights that are inversely proportional to the distance between the propensity scores of beneficiaries and non-beneficiaries. The quality of the matchings can be improved with the introduction of the common support hypothesis.

Matching (see Table 4). The same is for standard errors, reported in brackets. The standard error, measuring the standard deviation of the estimates, can be considered as a proxy of both the variability and imprecision of the estimator.

Furthermore, it is important to highlight that in the case of all interventions, the non-beneficiaries are the enterprises which do not receive any contribution. On the other hand, in the case of Traditional interventions, the non-beneficiaries are exclusively those which do not receive any contribution from the following interventions: 1.2.1.5.1, 1.2.1.5.2, 1.2.1.7.1. Similarly, in the case of Technological interventions, the non-beneficiaries are exclusively those enterprises not receiving contribution from the following interventions: 1.1.1.4.1, 1.1.1.4.2, 1.1.1.4.3.

Table 4 Estimate of the net effects (2007-2010)

Result variable	***Average all interventions***	***Technological interventions (n.)***	***Traditional interventions (n.)***
Variation of the number of employees	*3.5 (1.9)*	*0.7 (0.4)*	*4.2 (2.6)*
Variation of the number of R&D employees	*1.1 (0.7)*	*1.4 (0.6)*	*0.6 (0.4)*
Variation of the number of process innovations	*0.6 (0.4)*	*0.9 (0.6)*	*0.2 (0.6)*
Variation of the number of product innovations	-	*2.5 (1.5)*	*0.9 (2.1)*
Variation of turnover (Euro)	*199442 (906333)*	*849667 (865667)*	*432000(835667)*

Source: t33 elaborations

The analysis of table 4 shows that, concerning:

- the variation of total employees, the benefits from 2007-2010 for the beneficiaries in respect to the non beneficiaries is 3.5 in average; roughly 1 (0.7) in the case of technological interventions; 4.2 in the case of traditional interventions;

- the variation of R&D employees, there are positive but limited benefits: in average around the unity, 1.4 in the case of technological interventions;

- the variation of process innovations, there are positive effects even if limited in value and to the case of Technological interventions. In the case of Traditional interventions for Process innovations, the results have a low relevance due to a standard error greater than the value of the result variable;

- the variation of product innovations, there are positive effects even if limited to the case of Technological interventions. In the case of Traditional interventions, the results have a low relevance due to a standard error greater than the value of the result variable. In the case of 'all interventions', there is a low statistical significance of the propensity score estimates;

- the variation of turnover, it is positive even if lower than the standard error. This does not mean that the intervention has not had any effect. Further analyses are required.

The 'quantitative' effects on performance variables and in particular on turnover has to be taken in account cautiously for at least four types of reasons.

The first comes from preparatory analysis. The average procedural duration, corresponding to the period of time from the call to the appearance of the list of eligible firms, corresponds to 6 /12 months. This 'level' of procedural duration reduces the expectations for each enterprise in terms of effects from the ROP contribution and, as a consequence, the additionality of interventions.

The second and more important reason also comes from preparatory analysis and concern the relatively small amount of the public contribution. Public contribution is limited in amount for Traditional interventions; it is higher for Technological interventions and for Spinoffs (see table 5).

Table 5 Interventions, expenses and average contributions

Intervention	***Eligible expenses (€)***	***Public contribution out of the eligible expenses(€)***	***Average contribution per company (€)***
1.1.1.4.1	*17310009*	*5466954*	*150220*
1.1.1.4.2	*7987659*	*7987659*	*207967*
1.1.1.4.3	*6623648*	*4427191*	*133173*
1.2.1.5.1	*20069746*	*6339410*	*59435*
1.2.1.5.2	*18435944*	*7180859*	*47621*
1.2.1.7.1	*23733753*	*8023019*	*84279*
1.3.1.7.1	*2556949*	*2556949*	*379763*

Source: t33 and Independent Evaluation

The third is the relevance of other variables which have not been deeply analysed in the counterfactual analysis. Further statistical analyses have shown also:

- a better performance of the beneficiaries respect to the non-beneficiaries in terms of equal opportunities. 42% of beneficiaries increased the number of female employees against 32% of non-beneficiaries, in particular in the cases of micro and medium enterprises and Traditional interventions;

- a better performance of the beneficiaries in terms of recruitment of graduate employees. 47% of beneficiaries increased the number of graduate employees against 26% of non-beneficiaries, in particular in the cases of micro and medium enterprises and of Technological interventions;

- a growing role of the university in the networks for innovation (horizontal networks). Responding to the questionnaire, enterprises considered the relations with the Universities and Research centres almost as important for innovation as relations with other firms. Furthermore, the University seems to exert a relevant role for the effectiveness of the networks for innovation. As a matter of fact, the beneficiaries with a structured relation with the University have the highest growth rate of turnover in the period 2007-2010 (13%) (see t33, 2011).

The three above reasons highlight that quantitative effects have to be analysed also under a 'behavioural' perspective. This is why, it is important both the quantitative and the qualitative dimension (see Section III).

The fourth reason to take in account cautiously the final results of the counterfactual analysis is methodological. Our estimates are based on an empirical model as well as in many business incentive program evaluations (Bondonio, 2007). Further studies could be directed to explore the theoretical dimension in order to provide the estimates with a sound theoretical model (Becker, Ichino, 2002, Rostirolla, Brancati, 2005). An other methodological aspect is the verification of the robustness of the matching estimate through a simulation-based sensitivity analysis, in order to check the conditions for the application of propensity score for specific failures of the Conditional Independence Assumption (CIA)15. A first sensitivity analysis on two result variables - R&D employees and total employees - for

15 The CIA is based on the idea that the selection for the interventions is only driven by factors that the researcher can observe, this is why the CIA is also called “unconfoundedness” or “selection on observables” assumption.

the estimation of the Nearest Neighbor Method, has been carried out but it is not reported, being another the object of this paper. The sensitivity analysis has largely confirmed the robustness of the matching estimates (Nannicini, 2007, Ichino et alii, 2006). Further sensitivity analyses could be carried out in order to verify and reinforce the robustness of the estimates.

3. Section III: Case Study Analysis

3.1 THE EVALUATION TOOL IN THE COMBINED APPROACH

Case study analysis helps verify 'why' and 'how' the interventions produce effects. According to the DG Regio Guidance document, verifying 'why' and 'how' is a methodological question, as relevant as 'if / how much difference was made', strictly related to estimating the added value in counterfactual analysis. The main general results of the case study analysis do not consist of a number, but a narrative.

3.2 SELECTION OF CASES AND OPERATIONAL TOOLBOX

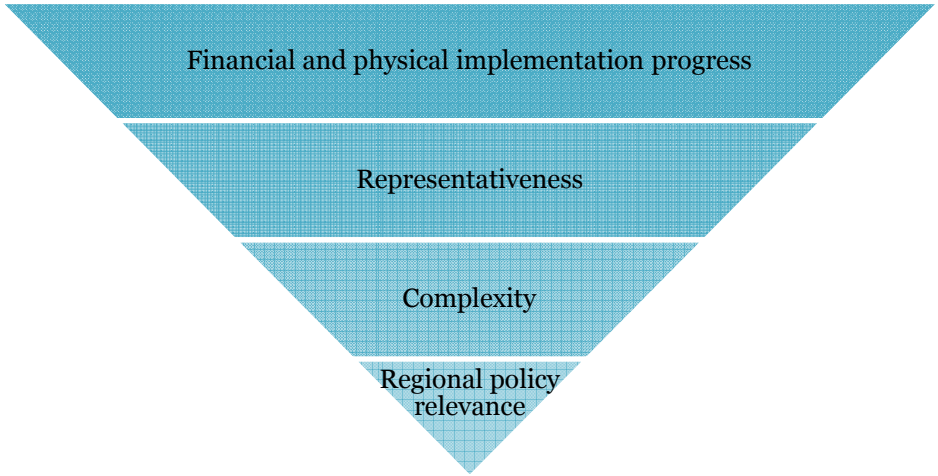
The case study methodology is defined according to the Evalsed and Means Guide and the DG Regio Guide for Case Studies16. The selection of cases has been carried out following four criteria (see Figure 1):

- 'Physical and financial implementation progress'. It aims at restricting the focus on the cases, in which the effects of the interventions could have already taken place at the moment of the evaluation;

16 See DG Regio (2008) and DG Regio (2008-a).

- 'Representativeness'. It depends on the number of cases per intervention, the geographical coverage and the firm size;
- 'Complexity level'. It regards the financial weight of the project and the number of involved actors;
- 'Regional policy relevance'. It depends on the importance of the case for the Regional Innovation Policy.

Figure 1 – Selection criteria of case study analysis



Source: t33

Starting from the outputs of preparatory analysis, case study analysis has been conducted at project level following a precise methodology. The methodology, based on DG Regio standards, was approved by the Managing Authority. The methodology ensures homogeneity across the cases through a common toolbox for case study analysis. The toolbox focused on the:

- context of the firm(s), which describes the market, industry, economic performance, project budget and the role of the firm(s) in the project;
- implementation of the project, which highlights the administrative mechanisms and obstacles, the performance of the firm(s) in the project, at each stage, from conception of the idea to the execution of the product/project;
- effects.

The evaluation of effects has been carried out at 4 levels:

- 'result analysis', which consists of the comparison between intended results corresponding to theories of change of interventions and the actual results;

- 'incidence of exogenous factors', which aims to clarify the external elements having a relevant impact on the actual results. The main exogenous are: the existence of a company innovation strategy, the existence of a network for innovation and the economic performance of both the firm and the industry before the project;

- 'performance analysis of the project', which concerns the main output variables of the firm(s): turnover, investments, market share, relations for innovation, job creation and type of innovation (organisation, production or process);

- 'analysis of other relevant parameters of performance: sustainability and transferability'. Sustainability consists of following up the main activities produced by the project. Transferability depends on the fact that the results of the project can be adopted either by the same firm in another activity (internal transferability) or by another firm (external transferability).

3.3 BEHAVIOURAL ADDITIONALITY FOR INNOVATION

This paragraph describes the behavioural additionality induced by the interventions at each level of the evaluation of effects defined above. However, for the sake of synthesis, the analysis will not be detailed case by case.

All 20 analysed projects have results consistent with their intended objectives. The projects with a higher capacity of integration of theories of changes and needs belong to 1.1.1.4.2 - Technological networks and 1.1.1.4.3 - Technological transfer. This confirms the analysis in the first section.

The existence of external positive factors widens project benefits regardless of the type of intervention. On the other hand negative exogenous factors influenced the results of the projects, in particular, the negative firm performance and the absence of a strategy for innovation. The intervention played an anti-cyclical role, in particular in some firms such as Aethra, Teuco Guzzini, Duna and the artisan enterprise Principe di Bologna.

The main outputs of the projects are:

- process and product innovations, an increase or reduced decrease in investments,

turnover and number of employees;

- the relevance of a market–oriented approach. Project success depends on an adequate mix of demand side and supply side factors. In particular, stagnating and sluggish internal demand imposes a new export-oriented commercial strategy;

- the crucial role of human resources for technological transfer and innovative projects. The creation of horizontal networks with universities takes three different forms. A university can be:

    a. an external supplier of knowledge and highly skilled workers, in particular for less innovating firms and 1.1.1.4.3 intervention;

    b. a partner of innovation. As in 1.1.1.4.2 Technological Networks, but also in Fashion 1.2.1.5.2;

    c. a partner in research, as in an intervention on Geothermic Energy production financed by 1.1.1.4.3, in which the enterprise became the research lab of the University;

Among other relevant parameters of performance, the main factors of project sustainability, regardless of the type of intervention, are:

- the presence of a university in the network (horizontal network). A university is almost a *sine qua non* condition of sustainability for innovation processes across all the projects analysed. The greater the integration of a university in the network, the greater the potential of sustainability. Horizontal networks are different from vertical. Vertical networks are based only on productive complementarity. Horizontal networks are based on: horizontal relationships, knowledge and high-tech transfer, recruitment and the training of young graduates, the presence of a university and *cross-fertilisation* between traditional and high tech sectors.

- the relevance of positive exogenous factors;

- the solidity of the network for the innovation.

The analysis of transferability is the final output of this case study analysis. It identifies best practices and interesting cases which can be 'reproduced' in other regions or fields. Concerning:

- 1.1.1.4.2 Technological Network, the 'Automa' project, is an example of the virtuous management of vertical (among firms) and horizontal (firms, university and spinoff) networks for innovation. Furthermore, two other interesting aspects emerge: the leader of the networks is a small high tech firm (less than nine workers) and the spinoff Ariellab is the network Research Centre;

- 1.1.1.4.3 Technological transfer, the Geotermotec project of Termoidraulica Sanitari, results in the transformation of the enterprise into an active lab for technological transfer. In fact, the firm becomes a sort of R&D lab of the University of Urbino for thermo-hydraulics. There are benefits arising for both the firm and the university;

- 1.2.1.5.1 Business innovation, the Distilleria Varnelli project is an example of the relevance of territorial elements as a part of the innovative product and marketing strategy. The main territorial elements are the National Sibillini Park and the technological and innovation network with the University of Camerino;

- 1.2.1.5.2 Fashion sector, the Duna project is an example of a successful mix of a highly-skilled workforce, horizontal networks and the almost handmade quality of products;

- 1.3.1.7.1 Spinoff, the Erydel project is the only one that represents a reference management model for the transformation of a high tech spinoff into an enterprise.

Conclusions

The evaluation approach produces some interesting results, from a methodological point of view and for the production of local knowledge useful to sustain local development, in particular in the field of innovation.

From a methodological perspective, the adoption of the proposed approach is a successful example of the systematic combination and completion of various evaluation tools. In particular, preparatory analysis is useful for: monitoring the accessibility to incentives, updating the progress of Priority 1 implementation through the use of output and result

indicators and reconstructing the logical framework of the interventions. The combination of documental analysis and the use of a mix of institutional paradigms on innovation mean that the region can be 'located' in the European context according to various scoreboards.

Assessment of the effectiveness of incentives uses quantitative tools and case studies. Counterfactual analysis is used to provide a quantitative dimension of the results ('how much'), case studies contribute to interpretation of the effects of the interventions in terms of theory of change ('why') and to detection of the presence of behavioral additionality and intangibles at firm level in the implementation of the financed project ('how').

The adoption of the proposed approach also provides interesting 'local results'. The first relevant result is that the adopted approach gives the opportunity to detail and describe the logical framework of innovation policy underpinning the ROP. The combined use of statistical tools and case studies helps identify the main success factors of the intervention, as well as human capital and networks within the R&D/innovation system. Among the other main findings the active participation of universities in the financed projects leads to higher intervention effectiveness. Universities exert various roles in the innovation process as a centre of technological transfer; a supplier of highly specialised workers; a stable partner in innovative processes and as start-up firms for spinoffs. Furthermore, comparing the interventions, the incentives with a more technological oriented and cross-sectoral perspective perform better in promoting an upgrade of human capital and in building cross-sectoral networks for innovation. Finally, the results of the adoption of this model have started an interesting policy path to an innovation plan for smart specialisation.

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