#TerritorialAgenda
A future for all places

Territorial Impact Assessment (TIA) Manual

Appendix

European Funds
Technical Assistance

Republic of Poland

European Union
Cohesion Fund

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A1.1 Tools and methodologies used for ex-ante TIA

A1.1.1 ESPON TIA TOOL - ESPON QUICK CHECK

A1.1.1.1 Methodological framework

The ESPON TIA Tool is an interactive web-based tool[1] developed by ESPON[2]. Its prototype was the TIA Quick Check[3], also designed by ESPON, allowing ex-ante assessment of proposed policies' territorial impact. The TIA Quick Check is a spreadsheet-based method that enables any data modification. At the same time, the TIA Tool is a web-based tool configured and ready to use without additional data.

The methodological concept used in the ESPON TIA Tool is an extension of the methodological framework used in the TIA Quick Check. The idea of sensitivity[4], used in this methodology, assumes that it combines the effects of a given policy measure and regional characteristics, which generate the potential territorial impact. The two dimensions used in the TIA Quick Check and the ESPON TIA Tool are:

- **Territorial sensitivity** describes a given territory's susceptibility to a policy's impact due to specific regional characteristics, such as social, economic or geographical features. It represents the baseline situation of a territory and is described by statistical indicators.
- **Exposure** describes the intensity with which a policy potentially affects a territory, distinguishing between regional exposure (affecting specific types of regions) and domain exposure (affecting particular domains, such as surface water quality, emissions, etc.). It shows the intensity and direction of the potential impact of a policy on a specific indicator. Expert opinion is used to describe it.[5]

Territorial impact, which describes the ultimate expected impact of a policy, is the result of the interaction between exposure and territorial sensitivity. Assessing exposure and territorial sensitivity requires a hybrid approach combining participatory, qualitative and quantitative evaluation methods.

The ESPON TIA Tool approach requires the organisation of a workshop (such a workshop can also be performed online, see the latest moderator guide, ESPON, 2021), the results of which are entered into a tool that generates a set of maps showing the potential territorial impact of the policy on NUTS 3 level regions, while the ESPON TIA Quick Check uses spreadsheet templates for NUTS 2 level regions, into which the data obtained from experts has to be entered, for the same purpose, while the mapping phase is carried out using external software (e.g. R, QGIS).

The workshop follows a step-by-step procedure, in which the most essential points are:

1. **Preparing a policy intervention logic** - a conceptual model that translates the policy text into a cause-and-effect relationship, defining the fields of exposure on which the policy is expected to have a visible impact. The areas of influence considered include the economy, society, environment and governance.
2. **Defining the typology of regions, which are shown to be impacted by the policy** - in this step, it is decided whether the following steps will also analyse the territorial impact in terms of regional typology, selecting specific types of regions, such as coastal, peripheral, urban, etc. The ESPON TIA Tool has a built-in list of region types, with the possibility to add others, while in the case of the TIA Quick Check, the choice is left to the study team. The ESPON TIA Tool also permits "fuzzy" typologies, which show to what extent a region belongs to a specific type (the scale used is 0-100%).
3. **Identifying the exposure fields and relevant indicators** - indicators which reflect the systemic relationships appropriate for each exposure field identified in the previous step are selected. The ESPON TIA Tool provides a list of indicators available at the NUTS 3 level that can be used[6], with the

[1] The ESPON TIA Tool is available at: https://www.espon.eu/tools-maps/espon-tia-tool. Anyone can try out a demo version of the tool.

[2] ESPON has been developing the TIA Tool in the following projects: ESPON TIA Tool Upgrade (2017-2020) available: https://www.espon.eu/tia-tool-upgrade, ESPON TIA Tool (2020-2022) available: https://www.espon.eu/tia-tool-2022

[3] The TIA Quick Check tool was developed as part of the ESPON ARTS project (see: https://www.espon.eu/programme/projects/espon-2013/applied-research/arts-assessment-regional-and-territorial-sensitivity).

[4] The concept of sensitivity was developed by the Intergovernmental Panel on Climate Change.

[5] A more detailed description of the methodology can be found in: ESPON and ÖIR, BEST, OTB, PBL (2011)

[6] The general TIA indicators cover several thematic areas - accessibility, demography, education and skills, environment, governance, health, infrastructure, innovation, natural disasters, economic development, social disparities and social well-being. Examples of

possibility to add others. At the same time, the TIA Quick Check requires the preparation of statistical indicators by the survey team.

4. **Expert voting** - the experts attending the workshop estimate the intensity of exposure caused by implementing the proposed policy. Such an assessment is made for each type of region and each indicator. This step is based on the experts' knowledge. The voting is carried out according to a 5-point scale. [7]

5. **Mapping** - based on quantitative data (indicators) and expert knowledge (voting), the ESPON TIA Tool generates maps showing potential territorial impact. In the case of the TIA Quick Check, the maps have to be developed using external software. Based on normalisation, the territorial impact is calculated as the product of the numerical value of exposure intensity, estimated by the experts (converted into numerical values), and the normalised values of regional sensitivity (defined by an indicator). The final results are continuous and range from -1.875 to +1.875. Finally, the results are assigned to one of four positive or negative classes (or class 0, indicating no exposure). [8]

Thus prepared maps show the territorial impact. The ESPON TIA Tool also allows the generation of additional charts and diagrams. The maps, combined with the intervention logic, are used in the final part of the work to formulate conclusions and recommendations for the policy analysed.

A1.1.1.2 Applications

In the *Better Regulation "Toolbox"* (European Commission, 2021, p. 301), the European Commission recommends the ESPON TIA Tool as one of the tools to support the quantitative analysis of the territorial impact of legislative proposals. It is recommended to be used in both the "call for comments" and the impact assessment phase. The ESPON tool is used extensively by the Committee of the Regions to analyse the potential territorial impact of EU legislative proposals. It is also used in the evaluation activities of DG REGIO and INTERACT[9] . Recent applications include the territorial impact assessment of legislative proposals for zero-emission road transport (CoR, 2021d) and EU decarbonisation initiatives (CoR, 2021b), and EU climate targets (CoR, 2021a) and cross-border health risks (CoR, 2021c). [10]

A1.1.1.3 Recommendations, advantages and disadvantages

The ESPON TIA Tool is designed for use in a workshop environment using both quantitative data and expert involvement. As highlighted in the official ESPON materials, "the maps are the product of a one-day workshop, the exposition is based on the expert assessment by a small group of experts, while tentative indicators often describe the regional sensitivity. This very general model helps steer the discussion but cannot replace a sound assessment of policy proposals' relevant and specific territorial impacts". The specificity of the approach adopted means that the results of policy impact assessments can vary considerably depending on the experience of the experts. Because of its limitations, it is sometimes called "quick and dirty" TIA.

In a workshop conducted during the pilot action *Understanding how sector policies* shape *spatial (im)balances: region-focused Territorial Impact Assessment,* both the ESPON TIA Tool and the TIA Quick Check were applied to territorial impact assessment.

The ESPON TIA Tool was used to analyse the territorial impact of the organic farming support policy, which is part of the Common Agricultural Policy, in NUTS 3 units located in the Polish-German area of connections covering, on the Polish side, four voivodeships: Dolnośląskie, Lubuskie, Zachodniopomorskie and Wielkopolskie, and, on the German side, the territory of four federal states: Mecklenburg-Vorpommern, Brandenburg, Berlin and Saxony.[11]

The experience of the test workshop was very good, and the method proved useful for the policy under consideration. On the one hand, the method and the interface save a considerable amount of time compared

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indicators in the area of demography: population density, economically active population per km^2 , dependency ratio, working-age population ratio, population outflow. A full list of indicators can be found in the ESPON TIA Tool. Moderator's Guide, pp. 38-42. It is also possible to add your own indicator.

[7] Options available: strong positive impact on territorial well-being, weak positive impact on territorial well-being, slight impact/varying types of impact, weak negative impact on territorial well-being, strong negative impact on territorial well-being.

[8] The impact classes are as follows: low impact (|i| ∈ [0;1]), moderate impact (|i| ∈ [1;1,2]), high impact (|i| ∈ [1.2;1.5]) and very high impact (|i| ∈ [1,5;1,875]).

[9] A list of TIA workshops held between 2017 and 2020 can be found at: https://www.espon.eu/tia-tool-upgrade.

[10] The CoR website on territorial assessments contains more examples of the application of TIA. See: https://cor.europa.eu/en/our-work/Pages/Territorial-Impact-Assessment.aspx.

[11] Detailed results are available in the report *Territorial Impact Assessment. A report on the implementation of existing TIA methods into national and pan-European policies*.

to other available methods, as it not only provides a ready-made database but also relieves the researchers from the need to perform any calculations and create visualisations. Moreover, the “fuzzy” regions proved very useful for analysing a very economically diversified territory. However, the easiness-to-use comes at the cost of reduced flexibility (compared, e.g., to the “manual” version of the tool, see later). For example, its inability to include an expert assessment of regional sensitivity[12] to the policy means that the tool may lead to conclusions contrary to the researchers’ intentions and the experts’ preferences in the workshop. The sensitivity assessment could either be entirely subjective (individually determined by experts for each region) or assessed based on a multidimensional analysis of the characteristics of a given area. However, this option is not provided by the ESPON TIA Tool. It should be mentioned that the tool is being actively improved so that new features can be added. Currently, it involves a meagre cost of entry into the TIA analysis compared to other tools, which is undoubtedly its huge advantage.

TIA Quick Check was used in a workshop environment to analyse the territorial impact of policies aimed at eliminating digital exclusion. The subject of the analysis was priority I – “Increasing access to ultra-fast broadband Internet through the creation of infrastructure to achieve bandwidth parameters of min. 100 Mbps”[13] – of the programme European Funds for Digital Development 2021-2027 on the territory of counties located in the part of the Polish-German area of connections covering the Lubuskie Voivodeship (on the Polish side) and part of Brandenburg in the strip extending from the Polish-German border up to and including Berlin and Berlin (on the German side).[14]

An essential part of the workshop participants’ discussion on the results of the trial evaluation of the territorial impact of the European Funds for Digital Development programme was the usefulness of the TIA Quick Check tool. Among the advantages mentioned were the relatively simple design and the possibility of adapting the tool to the needs of a specific policy evaluation within a particular territory. This is because the necessary calculations can easily be made using a spreadsheet. However, visualisations require extra tools, e.g. R package or any GIS package. TIA Quick Check also has the advantage of allowing one to carry out territorial impact assessments at any level of territorial aggregation for which statistical data are available (e.g. municipalities, districts). This sets apart the TIA Quick Check from some other tools, which only allow for a thorough analysis at the NUTS 3 aggregation level and above.

One limitation of the TIA Quick Check (as well as other TIA tools) is that it does not consider the spatial diffusion mechanisms of the effects of the intervention. It assumes that the territorial sensitivity to an intervention results from the characteristics of the territorial units where the intervention occurs. It does not, however, consider that the policy analysed can carry both beneficial and adverse effects in areas which are functionally linked to the place of intervention. Finally, a significant challenge of the TIA Quick Check method is defining the time horizon that the assessment covers. Workshop participants pointed out that treating the immediate effects of a policy and its long-term impact equally introduces confusion and can lead to incorrect conclusions.

Despite the above imperfections, TIA Quick Check appears to be an effective TIA method. This is due to the great flexibility of the tool, which allows one to freely shape both the fields of policy exposure, the types of territorial units assessed, the dimensions of regional sensitivity and, importantly, the level of territorial aggregation of the analysis. However, carrying out the procedure requires a relatively large amount of work (recreating calculations in a spreadsheet, creating maps), so using this method instead of the more accessible TIA Tool should be considered when such flexibility is required by the policy being analyzed.

[12] Sensitivity is predefined on the basis of the statistical indicators available in the tool, using an algorithm that cannot be modified by the workshop team.

[13] https://www.gov.pl/documents/31305/436699/Narodowy_Plan_Szerokopasmowy_-_aktualizacja.pdf/e81fa8de-363d-1dbf-fa25-a85dcde702a1

[14] Detailed results are available in the report *Territorial Impact Assessment. A report on the implementation of existing TIA methods into national and pan-European policies.*

A1.1.2 EATIA

A1.1.2.1 Methodological framework

The EATIA project (ESPON and Territorial Impact Assessment)[15] developed an ex-ante TIA procedure for the territorial impact assessment of European directives and other EU and national policy proposals. Unlike the quantitative TIA techniques developed by the EU institutions (e.g. RHOMOLO, LOUISA, see further below), this method assumes a purely participatory implementation. It is based more on stakeholder involvement than on collecting costly data sets and quantitative methods.

The methodological framework was developed around three components: (i) a procedural component - dealing with the successive stages of the TIA process, namely: verification, scoping, assessment and evaluation; (ii) a technical component - concerning the methods and approaches used at each stage of the TIA process; and (iii) governance - relating to the involvement of different levels of government at each stage of the TIA process, and the involvement of stakeholders.

The next steps in the TIA process are as follows (ESPON, 2012b):

1. **Verification** - the primary purpose of this stage is to determine whether a TIA should be carried out for a given policy proposal. It is a kind of necessity check carried out within various impact assessment techniques. The decision is made based on the anticipated type of potential impact. Namely, if a policy proposal can be expected to have undesirable or unintended consequences with significant impacts that vary from region to region, a TIA will be recommended. Methods recommended for use at this stage include: (i) the preparation of a logic chain/conceptual model - drawing up a list of all possible direct and indirect effects of the policy, which helps to identify causal relationships arising from the policy proposal; (ii) preparation of a checklist - selection of criteria against which territorial impacts will be assessed; it should be broad enough to cover a wide range of territorial characteristics. The verification phase should be coordinated by national governments with the support of a subject matter expert, considering the policy impact areas under review and the spatial planning sector.
2. **Definition of scope** - if the verification phase concludes with a decision to carry out a TIA, the second step is to define the scope of the TIA and identify the major territorial impact of the proposed policy, its nature and geographical area. The three actions envisaged in this step are: (i) completing the checklist - the policy is analysed and its impact is identified against each of the criteria previously defined; the assessor should check whether the impact exists (yes/no/uncertain), the location or type of territory affected (e.g. coastal, urban, rural, but also what types of activities are being carried out and what natural resources are available in the area), the nature of the impact (written comment on e.g. the anticipated strength of the impact, its duration, or its likelihood), and finally complete the assessment, along with a justification for the decision (also a written comment); (ii) the development of an impact assessment matrix (IAM)[16] - filling in the IAM template using the criteria used in the previous step; (iii) identification of the geographical area - using the types of territories identified in the previous step, the specific regions most likely to be affected by the policy and sharing the same identified territorial characteristics, should be recognised and qualified to participate in the subsequent TIA steps. As in the first step, scoping should be coordinated by national governments, with the support of a multidisciplinary team of experts.
3. **Impact assessment** - in this step, evaluators complete the IAM developed in the previous step, considering the impact of the policy proposal on the territory in question regarding the territorial characteristics used in scoping and possibly other local characteristics. Three impact characteristics should be assessed: (i) magnitude - expected size/scale of impact (0,1,2)[17] ; (ii) direction - impact in relation to the baseline scenario (decrease/increase); (iii) temporal distribution -

[15] EATIA - ESPON and territorial impact assessment. The project website is available at: https://www.espon.eu/programme/projects/espon-2013/targeted-analyses/eatia-espon-and-territorial-impact-assessment.

[16] Impact Assessment Matrix templates, checklists for verification and area definition, and tables for impact assessment are available from ESPON (2012b).

[17] Size is rated according to the following scale: 0 (no impact), 1 (some impact), 2 (high impact).

duration of impact (short/medium/long term)[18] . Assessors should also consider the policy's potential indirect and spillover effects on adjacent territories. The results of quantitative modelling/research projects or databases on the topic of the assessed policy proposal may assist the assessment. Regional or local authorities, particularly spatial planning teams, should carry out this step.

4. **Impact evaluation** - the main objective of this step is to determine whether the potential impact identified in the previous step is significant, both positively and negatively, and to decide how any undesirable effects can be prevented or mitigated, e.g. by changing the content of a proposal for a directive or changing the approach to its transposition. The impacts identified in the IAM are assessed against compliance with relevant national policy objectives (for example, the national-territorial cohesion strategy) using assessment tables. The assessment using tables can be supported by creating thematic maps showing the spatial variation of the expected impact. For each objective, the materiality of the effect is determined on a 5-point scale[19], reflecting whether the potential impact will be positive or negative and the degree of significance of that impact. Each assessment should be justified by adding an appropriate written comment (which may include recommendations to decision-makers for changes to policy proposals that reduce the identified negative impact). This step should be carried out by ministers from the central government responsible for negotiating or transposing the policy in cooperation with the department responsible for spatial planning and with other departments (Fischer et al., 2014).

At the end of all four steps, a written summary of the process should be prepared, including the TIA results and any suggested changes to the policy proposal. The authors of the method recommend preparing impact matrices, impact maps or radar charts to present the results in a fashion that is clear and easy to understand.

A1.1.2.2 Applications

To date, the TIA methodology developed within the EATIA project has only been tested during its pilot projects. It has been tested on sample draft directives (treating already implemented directives as proposals) with the participation of local, regional and national administrative bodies and stakeholders in Portugal, Slovenia and the UK. The directives analysed[20] covered various topics: natural habitats, renewable energy and marine environmental policy. The pilot applications aimed to identify the method's strengths, weaknesses and limitations, with different levels of involvement of the project team and national/local stakeholders at different stages of the assessment. Detailed reports summarising the application of the method can be found in the final report of the EATIA project.[21] No applications beyond the initial draft have yet been reported. The impact assessment matrix and the overall qualitative approach have been used as inspiration in other ESPON projects developing TIA for cross-border cooperation.[22]

A1.1.2.3 Recommendations, advantages and disadvantages

The geographical scope of the method allows it to be applied to any type of territorial unit because, unlike quantitative modelling, no statistical data is required.

The relatively simple procedure can improve the promotion of this method among administrative bodies. Using a bottom-up participatory approach instead of top-down quantitative methods allows less advanced users to employ it. Gaugitsch and co-authors emphasise that "the participatory approach provides policymakers with a sense of ownership of the results, which can facilitate further action to minimise negative or enhance positive effects" (Gaugitsch et al., 2020, p. 9). Guidelines to support the application of the developed TIA methodology and templates for subsequent assessment steps are publicly available[23], so national/regional/local authorities can easily apply the method.

[18] The methodological framework does not explain what is meant by a short/medium/long term impact, however, it gives examples: short term up to 5 years, medium term up to 10 years, long term over 10 years.

[19] The scale used is as follows: -2,-1,0,+1,+2.

[20] Directives analysed included: Directive 92/43/EEC on the conservation of natural habitats and wild fauna and flora, Directive 2009/28/EC on the promotion of the use of energy from renewable sources, Directive 2010/31/EU on the energy performance of buildings, Directive 2009/72/EC concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC, the proposal for a directive on the control of major-accident hazards involving dangerous substances COM(2010) 781 final SEC(2010) 1591 final, 2008/56/EC the Marine Strategy Framework Directive.

[21] EATIA - ESPON and territorial impact assessment. The project website is available at: https://www.espon.eu/programme/projects/espon-2013/targeted-analyses/eatia-espon-and-territorial-impact-assessment.

[22] Detailed information on the project can be found at: https://www.espon.eu/TIA-CBC.

[23] The guidelines and other materials are available on the project website: https://www.espon.eu/programme/projects/espon-2013/targeted-analyses/eatia-espon-and-territorial-impact-assessment.

The authors of the method emphasise that “tests conducted during the project have shown that an experienced evaluator is likely to find the TIA methodology simple and easy to apply, while less experienced evaluators may need some time if they are participating in the TIA process for the first time” (Marot et al., 2020, p. 94). Participants in the pilot confirmed that the method “is a simple procedure that does not require much human capacity and advanced evaluation knowledge, neither from public administrators (to carry it out) nor from stakeholders (to participate in it)” (Marot et al., 2020, p. 94).

However, as the authors point out, “testing of the EATIA procedure has been conducted as an exercise, meaning that to demonstrate its true benefits and value, the procedure would need to be tested in real-time policy development and on draft directives (of those tested, all have already been adopted and are in the process of being implemented)” (Marot et al., 2020, p. 96).

In addition, the approach used in the EATIA project relies on the collaboration of people from different departments with diverse backgrounds and expertise, which can sometimes pose a significant challenge - especially if the national evaluation culture takes a more quantitative approach and collaboration between departments is not common (Fischer et al., 2014).

A disadvantage of this method is the lack of detailed statistical evidence from the assessment, which may make the methodology less reliable than other TIA methods. Assessment results may also be less comparable.

A1.1.3 TEQUILA

A1.1.3.1 Methodological framework

The model of multi-criteria evaluation of efficiency, quality and territorial identity (TEQUILA), developed within the framework of the ESPON 3 Project[24] by a team supervised by Roberto Camagni, is described by the author as a tailor-made version of a consolidated methodology, namely multi-criteria analysis (MCA) in its simplest form, which can produce in both analytical and synthetic (“summative”) form an ex-ante territorial impact assessment of EU policies, programmes, measures and integrated projects on European regions (Camagni, 2020).

The methodology aims to assess the effectiveness of European policies, programmes and measures to increase territorial cohesion, chosen as a policy objective of each EU act or measure analysed. The TEQUILA model allows for an overall assessment of the potential impact of EU policies on the European territory as a whole (the so-called first layer), as well as an assessment of the territorial impact, through a model built to assess the impact on individual regions (the second layer) (ESPON, 2006).

In the TEQUILA model, territorial cohesion is divided into three dimensions, namely territorial efficiency, territorial quality and territorial identity, measured using a series of sub-criteria[25] (Camagni, 2006) with assigned weights[26] . These three macro-criteria are obtained in several steps. The territorial impact formula is derived from the risk assessment procedure where risk = hazard (potential risk) x sensitivity; analogously: territorial impact is the product of potential impact x sensitivity index. In this case, the sensitivity index is understood as a set of regional characteristics, combining the desirability of a dimension/criteria in individual regions (technically: the territorial “utility function” defining local preferences, measured by socio-economic indicators) and the susceptibility to impact (mainly geographical indicators, Camagni, 2009). As impact can be defined according to quantitative or qualitative assessments, the formula for potential impact differs slightly for qualitative assessments, but the main idea remains the same.

The Interactive Simulation Package, TEQUILA SIP, supports the TEQUILA model. Spreadsheets of the model include (Camagni, 2020):

[24] Detailed information on the project can be found at: https://www.espon.eu/programme/projects/espon-2006/coordinating-cross-thematic-projects/spatial-scenarios-relation-esdp.

[25] The initial list of sub-criteria presented in Camagni, 2006 included: (i) for territorial efficiency: resource efficiency; general accessibility, infrastructure subsidies; competitiveness; sustainable transport; intensity of urban networks; compact city form, no urban sprawl; reduction of technological and environmental risks, (ii) for territorial quality: protection and creative management of natural resources; access to services of general interest; quality of life and working conditions; quality of transport and communication services; reduction of emissions; health; safety; attractiveness for external companies; reduction of poverty, unemployment, exclusion; multi-ethnic solidarity and integration, (iii) for territorial identity: preservation and creative management of cultural heritage; quality of urban and rural landscapes; urban-rural cooperation; development of know-how and knowledge for the region; degree of access to global knowledge and creative “blending” with local knowledge; development of territorial “directions”; development of territorial visions through strategic planning practices; social capital, increasing trust and creating common rules of behavior.

[26] According to Camagni (2020), the weights assigned to a criterion can be defined in a number of ways: through internal expert discussions, through open discussions with decision-makers and stakeholders, or through Delphi procedures.

- a complete list of the criteria and sub-criteria used, together with the weights in the current and previous runs (to check sensitivity);
- the result of the quantitative assessment (expressed in scores ranging from -5 to +5) for the three dimensions of territorial cohesion and the summative assessment, for both the current and the previous launch, in figures and histograms.

Two series of graphs are also produced for the overall territorial impact by a single criterion (each dimension of territorial cohesion) and sub-criterion, the aggregate score and all the impact indicators by sub-criterion. Scores are calculated for both each individual NUTS 3 region and the territory as a whole (ESPON, 2006).

A1.1.3.2 Applications

To date, the TEQUILA model has been applied to agricultural and transport policy, both within ESPON projects.

The experimental application concerned the territorial impact of Trans-European Networks (TEN) policies on NUTS 3 regions. The individual impacts and the variables for calculating a specific impact or vulnerability were derived from previous studies carried out at earlier ESPON projects (ESPON, 2006). The selected sub-criteria were as follows: (i) for territorial efficiency: internal connectivity, external accessibility, economic growth; (ii) for territorial quality: traffic density, emissions, transport services density; (iii) for territorial identity, cultural heritage, landscape quality.[27] Each criterion was given equal weight. The study calculated three macro-criteria (territorial impact on efficiency, quality and territorial identity) and one overall territorial impact indicator.

In the second ESPON project, which applied the TEQUILA model, the focus was on assessing the territorial impacts of the Common Agricultural Policy (on NUTS 2 units due to the limited availability of more detailed data) and Trans-European Transport Networks (on NUTS 3 regions). Unlike the pilot project, the weighting system was changed to take into account the preferences for different policy priorities and objectives expressed by both policymakers and sectoral policy experts (ESPON, 2009), adding a bit of a participatory approach to the assessment and differentiating the importance of the three dimensions (efficiency, identity and territorial quality). In addition, a flagging system was introduced to consider that some very negative impacts (e.g. on the environment) cannot be compensated by other positive effects, for example, on the economy (ESPON, 2009). In the CAP evaluation, expert knowledge was also indispensable to identifying logical cause-effect relationships between a policy measure and its impact, as no previous studies were available, as was the case for the TEN policy in the pilot project.

The methodology of the TEQUILA model was later also applied in the ESPON-ARTS project. Part of the TEQUILA methodology also had a follow-up in the form of a research project carried out in Slovenia to develop an alternative TIA method piloted on Slovenian energy policy. [28]

A1.1.3.3 Recommendations, advantages and disadvantages

The evaluation is comprehensive, not focusing on one specific area but on the environment, economy, society and people. Therefore, it may consider aspects such as cultural heritage when evaluating agricultural policy.

However, identifying potential territorial impacts may be a significant obstacle to applying the TEQUILA model to policies for which no extensive theoretical studies determine cause-effect relationships. Moreover, data requirements may limit the application of TEQUILA only to policies for which statistical offices collect significant amounts of sufficiently detailed data.

Although the TEQUILA model produces detailed results, these are not always easy to interpret for decision-makers due to the use of standardised scales and macro-criteria (Gaugisch et al., 2020).

TEQUILA is a very sophisticated impact assessment tool that needs enormous data, as the instrument is mainly designed for EU-wide surveys. Therefore, whether TEQUILA meets the requirement of an easy-to-use tool can be questioned. However, some parts of it can be simplified to allow non-experts to work with it (Zonneveld and Waterhout, 2009).

A1.1.4 LUISA

A1.1.4.1 Methodological framework

The LUISA (*Land Use-based Integrated Sustainability Assessment*) territorial modelling platform is an analytical tool developed by the Joint Research Centre to assess EC policies' direct and indirect spatial impacts. It is based on the concept of "land functions" for cross-sectoral integration and representation of complex system dynamics.[29] The interconnected models that comprise the LUISA platform enable ex-ante assessment of EU policies. The platform attributes resource demand and supply, accounting for socio-economic activities and infrastructure.

[27] For a full list of variables (and relevant sources) through which impacts on these sub-criteria are measured, see ESPON (2006, p. 90).

[28] A detailed description of this research project can be found in Golobič and Marot (2011)

[29] https://ec.europa.eu/jrc/en/luisa

Inputs from various models[30] and datasets[31] are used to prepare a baseline scenario called the "Territorial Reference Scenario", which is later used to estimate the potential territorial impact of policies. The latest 2018 LUISA base map (used in modelling the baseline map) provides very high precision (available working cell sizes are 50 m and 100 m). It covers 39 countries, including the EU27 and EFTA countries, the UK and the Western Balkans.[32] At the modelling stage, the regionalisation and allocation modules allow LUISA to model the change in terrain function for each grid cell over time, based on several input factors, and then calculate secondary effects based on the resulting terrain functions. The land uses are then allocated to the land units.[33] The territorial impact is identified by comparing the baseline and policy scenarios. The share of land that changes its functions as a result of the analysed policy reflects the territorial implications of the policy. The final output of LUISA modelling includes gridded land use patterns, which are derived from a series of indicators (more than 50 indicators[34] are projected, typically to 2030 or 2050) grouped into specific themes called land function (economic, social, product provision, settlements and infrastructure, regulatory services by [natural] physical structures and processes, ecosystems and biodiversity).[35] LUISA modelling results' demographic and economic projections can also be presented at an aggregated regional level (NUTS 2 and 3).

As highlighted by those involved in the development of the LUISA platform: it offers the possibility to define scenarios based on policy options, collect and analyse data at the appropriate level of thematic and spatial detail, and exchange and discuss alternatives and possible forecasts with relevant stakeholders, based on a combination of advanced analytical tools and dissemination platforms (Lavalle, C. et al., 2020, p. 192).

A1.1.4.2 Applications

The application of the LUISA territorial modelling platform primarily covers the impact assessment of EU-wide policies. In the Better Regulation Toolbox prepared by the EC (European Commission, 2021, p. 301), which guides on, among other things, impact assessment, the LUISA model is recommended as one of several tools to support the quantitative assessment of territorial impacts, especially for policies with effects expected at the regional level or when policies cross regional boundaries without impacting entire regions. By 2022, the LUISA land use model had been applied to policies dedicated to issues such as Integrated Coastal Zone Management (European level), Common Agricultural Policy (European level), Energy (national, regional and European level), Environment and Climate (regional and European level) and Urban and Regional Policy (national and European level).[36] The following paragraph describes an example of one study in the energy sector to demonstrate for which aspects of impact assessment the LUISA territorial modelling platform can be used.

The application of LUISA concerned the assessment of potential impacts on land and water resources associated with shale gas development scenarios for the Lower Palaeozoic Baltic-Podlasie-Lublin Basin in Poland and Germany.[37] Four scenarios of possible shale gas development were created, and spatial implications were considered for each scenario. The simulation period covered three 5-year periods from 2013 to 2028. The results of the LUISA modelling (then called the European Land Use Modelling Platform (LUMP)) enabled the estimation of land for shale gas extraction as a percentage of all land converted to industrial use across the country during the analysis period and the potentially exposed population.

LUISA-simulated projections are also used in studies on territorial cohesion. Jacobs-Crisioni et al. (2016) studied the impact of predictable population changes on the accessibility improvements offered by large-scale transport infrastructure investments in Austria, the Czech Republic, Germany and Poland. The added value of the study provided by using the LUISA model came from the possibility of considering dynamic population changes instead of static population levels, as in previous studies. The LUISA estimation provided population projections at the municipal level (for approximately 22,000 units in the study area) and enabled the modelling of improvements in accessibility levels at the same territorial level. It was possible to assess the territorial impact of known and unknown network improvements.

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[30] The variables used in the LUISA platform come from specific sectoral models, for example: EUROPOP for demographic projections and CAPRI for agriculture. The full list of policy models included in LUISA is available at: https://ec.europa.eu/jrc/en/luisa/technical-description.
[31] The 2018 LUISA Base Map integrates datasets such as CORINE Land Cover maps, Copernicus Earth Observation programme products, TomTom Multinet and OpenStreetMap. Full details of the data and methods used can be found in Pigaiani and Batista e Silva (2021).
[32] Pigaiani and Batista e Silva (2021)
[33] A more detailed description of the regionalisation and allocation modules can be found in Lavalle et al. (2020).
[34] The indicators are publicly available on Urban Data Platform Plus and can be used extensively for other research purposes. Available at: https://urban.jrc.ec.europa.eu/en.
[35] A more detailed description of the thematic breakdown is available at: https://ec.europa.eu/jrc/en/luisa/technical-description.
[36] A detailed list of studies carried out using the LUISA territorial modelling platform can be found in: Lavalle, et al. (2020).
[37] Lavalle et al. (2013).

A1.1.4.3 Recommendations, advantages and disadvantages

The strengths of the LUISA territorial modelling platform include, in particular, the detail of the results generated and their grid format, which is not typical for other TIA methods and tools. The results can be obtained at both the regional and local levels. The quantitative approach of this platform also allows for the creation of long-term forecasts. The available public territorial indicators covering the most diverse thematic areas can also be used as input statistics in qualitative and participatory TIA methods.

As the JRC, responsible for developing the LUISA platform, is the only institution that carries out analyses using it, the availability of this tool for national/regional/local authorities is limited. Although the *Better Regulation Toolbox* encourages contacting the JRC for support with impact assessments using the LUISA land use platform, no information on such cooperation was found. The chances of the LUISA platform becoming a publicly available tool, like the ESPON TIA Tool, are low, so its user group may remain limited to JRC researchers.

A1.1.5 Rural proofing

A1.1.5.1 Methodological framework

Rural proofing is a tool for assessing the territorial impact of policies targeting rural areas. The EC defines rural proofing as a mechanism that systematically verifies policies through a "rural prism", considering the possible effects on rural communities (European Commission Communication, 2017). As the EC emphasises in the *Better Regulation Toolbox*, "through territorial impact assessments (TIA) and *rural proofing,* the needs and specificities of different EU territories (for example, urban/rural areas, cross-border areas and outermost regions of the Union) can be better taken into account to improve cohesion across the Union" (European Commission, 2021, p. 297). Given the broader scope of the assessment, TIA tools such as the ESPON TIA Quick Check or TARGET_TIA can enhance rural proofing assessments. The possibility of paying more attention to rural territories through rural proofing is linked to implementing the EU Rural Action Plan[38] , which foresees systematic monitoring of the extent to which rural areas are integrated into EU policies. The Commission encourages the EU Member States to consider implementing rural proofing methods at the national, regional and local levels (European Commission Communication, 2021).

A1.1.5.2 Applications

A unique method for assessing the impact of policies on rural areas has not yet been developed. National bodies using rural proofing in their policy-making process use qualitative and participatory methods tailored to the needs of a given country, most often checklists or guidelines. The most robust method in terms of recognition by policymakers and the number of policy proposals assessed is probably the one used in the UK; rural proofing became a mandatory procedure in England in 2000[39] and is also used in Northern Ireland, Scotland and Wales. The four-stage process is based on some key questions that need to be answered:

- **Stage 1** - What is the direct and indirect impact of the policy on rural areas?
- **Stage 2** - What is the scale of this impact?
- **Stage 3** - What actions can you take to adjust your policies to work better in rural areas?
- **Stage 4** - What impact has your policy had on rural areas, and how can it be further adapted?

Guidance[40] prepared by the UK Department for Environment, Food and Rural Affairs (2017) provides examples of issues to be considered and recommended methods to be used at each stage. For instance, at the first stage (impact identification), assessors should consider the impacts of the policy, including, but not limited to, issues relating to access to services and infrastructure; living and working in rural areas; the environment; distribution, equity, devolution and funding. Methods recommended at this stage include a literature review and consultation with experts and local rural stakeholders. Notably, the methods proposed at each stage are complemented by extensive lists of additional resources (e.g. data sets, newsletters, statistical indicators) and identified rural stakeholders.

A similar approach to rural proofing has been adopted in Finland, where the Rural Policy Council promotes the use of voluntary rural impact assessment for policy proposals[41] through several methods such as checklists, participatory workshops, relevant data and

[38] More information on the EU Rural Action Plan is available on the EC website: https://ec.europa.eu/info/strategy/priorities-2019-2024/new-push-european-democracy/long-term-vision-rural-areas_en.

[39] A mandatory rural proofing mechanism was introduced by the White Paper for rural areas in 2000.

[40] The guidelines are available at: https://www.gov.uk/government/publications/rural-proofing.

[41] More information on rural proofing can be found at: https://www.maaseutupolitiikka.fi/paatoksenteontueksi/tietoa/mva.

questionnaires. The checklist is used as a kind of necessity check to determine whether a more in-depth impact assessment should be carried out. The types of impacts analysed include but are not limited to living conditions, transport, environment and social integration. Representatives from the Finnish Ministry of Agriculture and Forestry assure that rural proofing will be part of the new impact assessment guidelines for government legislative proposals, and a new rural proofing method will be developed in 2022.[42]

Rural proofing has been implemented outside the UK and Finland in New Zealand[43] , Sweden[44] and Estonia[45]. In Spain, a nationwide pilot project was carried out to obtain many recommendations for implementing rural proofing.[46]

The European Network for Rural Development has undertaken the most recent activities on rural proofing. It launched a new Thematic Group on Rural Proofing[47] in 2022 to share experience and develop recommendations on the design and implementation of rural proofing in the EU Member States at different administrative levels (national, regional and local).

A comprehensive overview of rural verification methods is provided by the study[48] prepared by the Committee of the Regions, which presents both the available methods and guidelines for a better assessment procedure.

Taking into account the research work carried out by the EU Member States and thematic associations and the recognition of the importance of rural proofing by the European Commission in relevant documents, it can be expected that new methodologies for rural proofing will emerge in the future and their application will accompany the territorial impact assessment of policy proposals.

A1.1.6 Urban proofing and assessments focusing on urban areas

A1.1.6.1 Methodological framework

The concept of urban proofing is similar to that of rural proofing but focuses on urban areas and includes all assessment methods that pay special attention to urban areas or functional urban areas. The Urban Agenda for the EU[49] highlights the importance of urban proofing tools, which ensure better coherence in EU policies with a focus on urban areas. Currently available tools include:

- **The Urban TIA tool**[50] , an extended ESPON TIA Quick Check tool based on functional urban areas, allows territorial impact assessment like the ESPON TIA Quick Check, but with a focus on urban areas and with specific indicators to assess these areas.
- **Urban Data Platform Plus**[51] , a joint initiative of the Joint Research Centre and DG REGIO, combines databases and tools that can help policy-making in one place.
- **Guidelines for a metropolitan planning approach, results of the ESPON SPIMA project** - Spatial dynamics and strategic planning in metropolitan areas[52] , provide several general recommendations for applying a metropolitan planning approach in the context of the broader scope of European territorial cohesion policy.

[42] Source: Presentation of the Finnish experience with rural proofing by Antonia Husberg and Sanna Sihvola, Finnish Ministry of Agriculture and Forestry, at the 1st meeting of the ENRD Thematic Group on rural proofing. Available at: https://enrd.ec.europa.eu/news-events/events/1st-meeting-enrd-thematic-group-rural-proofing_en.

[43] The rural verification policy was implemented in New Zealand in 2018. More information available at: https://www.mpi.govt.nz/legal/rural-proofing-guidance-for-policymakers/.

[44] The Swedish Agency for Economic and Regional Development is responsible for activities in the area of rural proofing. More information available at: https://enrd.ec.europa.eu/sites/default/files/tg1-rp_a_stronger_rural_perspective_how_we_work_with_rural_proofing_in_sweden_selander.pdf.

[45] In Estonia, the national impact assessment guidelines have been supplemented with parts of rural proofing in 2021. More information available at: https://enrd.ec.europa.eu/sites/default/files/tg1-rp_how_to_make_the_regional_impact_assessment_rural_proofing_a_routine_part_of_the_decision-_making_process_of_officials_across_the_government_in_all_ministries_kasemetskurvits.pdf.

[46] The results of the project “Rural proofing. Mecanismo Rural de Garantía” are available at: https://ruralproofing.com/.

[47] More details about the Rural Proofing Thematic Group and its work are available at: https://enrd.ec.europa.eu/enrd-thematic-work/long-term-rural-vision/TG-rural-proofing_en_en.

[48] Gaugitsch et al. (2022)

[49] More information on the Urban Agenda for the EU available at: https://ec.europa.eu/regional_policy/sources/docgener/brochure/urban_agenda_eu_en.pdf.

[50] More information on the Urban TIA tool is available at: https://www.espon.eu/sites/default/files/attachments/TIA-Tool_report-on-work.pdf.

[51] Urban Data Platform Plus is available at: https://urban.jrc.ec.europa.eu/?lng=en&ctx=udp.

[52] More information about the SPIMA project can be found at: https://www.espon.eu/metropolitan-areas.

- **The URBANPROOF Toolkit[53], developed under the LIFE URBANPROOF project "Climate Proofing Urban Municipalities"**, consists of 5 modules, including impact assessments, to support policy-making for climate change adaptation planning in urban areas. The toolkit is currently only available for urban municipalities in Italy, Greece and Cyprus. It offers information on the potential impacts of floods, heat waves, suburban fires, electricity cuts, water availability and drought, and ozone exceedances in urban areas.

In addition to assessment methods focusing on urban areas being developed internationally, there are also national initiatives to build their own tools. The UK Department for International Development, together with Atkins and UCL[54], has proposed a policy framework for a decision-support tool to assist urban actors in policy-making.

Methods supporting urban proofing in combination with rural proofing methods provide evaluators with tools that offer a particular focus on urban and rural areas, respectively. In contrast, other TIA methods sometimes fail to sufficiently capture the differences between these types of regions. In light of increasing urbanisation, such support is particularly indispensable to ensure that no resident is overlooked regardless of where they live.

A1.1.6.2 Applications

Applications to date include the Urban TIA tool at the EU level to assess the impact of the UN Sustainable Development Goal number 11.3 ("by 2030, increase inclusive and sustainable urbanisation and the capacity for participatory, integrated and sustainable planning and management of human settlements in all countries") on urban development through spatial planning and the URBANPROOF toolkit at the regional level in Italian, Greek and Cypriot municipalities, to support mitigation policy-making.

A1.1.7 Territorial foresight

A1.1.7.1 Methodological framework

Territorial foresight combines territorial impact assessment and foresight approaches to enable structured forward thinking for decision-makers on territorial development. Compared to other TIA tools, territorial foresight focuses more on forward-thinking, which is generally lacking in TIA tools and methods. However, the territorial focus present in territorial *foresight* develops concepts used in territorial impact assessment, such as exposure (to what extent a region/territory is likely to be affected by a change) and sensitivity (to what extent regional development will be affected and what is the intensity of impact due to specific characteristics, ESPON, 2018).

The ESPON project "Possible European Territorial Futures" developed the most recent territorial foresight method. As defined by the project, territorial foresight is a future-oriented approach characterised by: (a) critical lateral thinking about long-term changes and their impact on territorial development, (b) broader participatory engagement, and (c) support for public and/or private decision-making (ESPON, 2018, p. 3).

The basis of the method is a participatory process that involves stakeholders from different backgrounds (for example, scholars, NGOs, public bodies at different levels, and policymakers) supported by qualitative and quantitative research methods. Territorial analyses, computational foresight models, expert assessments, documents, and interviews are used to improve the discussion and enrich participants' knowledge of the policy objective/vision/trend subject of territorial foresight.

The process of territorial foresight involves several steps, starting with formulating a research question, which most often takes the form of "What if topic X became a reality/single source/base of the economy in territory Y by year Z?". For example, in the ESPON project "Possible European Territorial Futures", one of the research questions was "What if a renewable energy source became the only energy source in the European territory by 2030?". The following steps are used to conduct a preliminary study employing these qualitative and quantitative methods to gather data and information to identify key impact factors and territories affected, and to answer questions of exposure and sensitivity. The material collected is then used in a workshop with participants, which is the most critical part of the whole process, during which the territorial implications of the foresight theme are defined. The process leads to a sketch of the future situation (illustrating its territorial dimension) and a foresight narrative (completes the sketch and details the rationale for the future position) (ESPON, 2019). Additional qualitative and quantitative research should resolve any uncertainties arising during the participatory process. Once the final foresight report has been written and maps depicting the impact have been produced, the results should be shared with participants at a debriefing event to ensure the participatory nature of the process until the very end (ESPON, 2018).

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[53] More information on the URBANPROOF toolkit is available at: https://tool.urbanproof.eu/.

[54] More information on the decision support tool is available at: https://assets.publishing.service.gov.uk/media/57a08a67e5274a31e00005ae/FPC_Report_FINAL.pdf.

A1.1.7.2 Applications

Territorial foresight applies to any geographical area and various documents, such as vision statements, policy strategies or general observable trends (e.g. the transition to green energy).

To date, the method has been tested in many projects, such as initiatives at the European level, such as the ESPON projects *Possible European Territorial Futures*[55] and BT2050 - *Territorial Scenarios for the Baltic Sea Region*[56] , and at the national level, for example, in Luxembourg[57] . A comprehensive assessment prepared by the European Committee of the Regions (2011) identified more than 200 examples of territorial foresight applications at European, cross-border, national, regional and local levels. The authors also highlighted the potential usefulness of territorial foresight for local and regional authorities in the EU Member States, who are responsible for implementing European law after it has been transposed into national law. Using foresight methods can help local and regional authorities increase their active participation in the European legislative process (European Committee of the Regions et al., 2011, p. 19).

As the experts developing territorial foresight highlighted, this method "can be recommended to decision-makers who (1) are uncertain about the future territorial dimension of visions, trends or policy goals, (2) are looking for tools with which to anticipate or discuss the territorial dimension of future situations, and (3) want to build ownership among a wider group of stakeholders" (ESPON, 2019, p. 80).

The Polish Ministry of Development Funds and Regional Policy is expanding territorial foresight in developing the Concept for National Development 2050. Territorial foresight should be considered a complementary tool to carrying out ex-ante TIA, which can be used to assess policies with expected impacts in the distant future.

A1.1.8 Territorial keys

A1.1.8.1 Methodological framework

The Territorial Keys were proposed as a tool to translate the EU 2020 Territorial Agenda into a series of concrete actions, the execution of which was crucial for the successful implementation of the Europe 2020 strategy (Boehme et al., 2011). The concept of territorial keys emerges from the observation that territory characteristics influence development and, simultaneously, that policies pursued have an increasingly visible territorial dimension. Thus, territorial keys are spatial determinants of development. In the available studies, the territorial keys analysed are accessibility, services of general economic interest, territorial opportunities/resources/assets, urban networking and functional regions (Zaucha et al., 2014). The main objective of the territorial keys concept is to improve the analysis of territorial impacts in development policies. Territorial keys organise the picture of the territorial dimension of policies at the design and implementation stage.

The concept of analysing the impact of policies in areas similar to the keys mentioned above have also been used in previously described TIA methods, including, for example, the TARGET_TIA method. Thus, the set of keys presented in the available literature can help select policy impact areas to be examined using other TIA methods.

The keys make it possible to systematise the impact of the different instruments within various policies on specific areas of territorial implications. The concept of territorial keys implies that they are much narrower than the priorities of the policies they aim to implement (especially concerning broad strategies such as the Europe 2020 mentioned above). Analysing an implemented strategy through the prism of territorial keys makes it possible to identify strategy elements that need to be refined or coordinated with other policies to increase the effectiveness of territorial impact and improve territorial cohesion (Zaucha et al., 2014).

A1.1.8.2 Applications

The pilot application of territorial keys included the EU 2020 Territorial Agenda and the Europe 2020 Strategy. The analysis of these keys reflects the existing disparities and different needs of the countries under study, thus contributing to policy territorialisation. The territorial key "accessibility" was tested in a case study for Poland, allowing the identification of several types of territorial units for which specific policy recommendations were made in the context of Europe 2020.

Territorial keys, which combine both institutional and spatial planning approaches to policy territorialisation, can be handy to ensure territory-based programming for all policies at all levels of governance. As Zaucha et al. (2014) highlighted, territorial keys can be used to tailor policy interventions to the characteristics of different territories, in order to strengthen the territorial dimension of a policy, thus complementing territorial

[55] More information on the "Possible European Territorial Futures" project is available at: https://www.espon.eu/territorial-futures.

[56] More information on the project BT2050 - Territorial Scenarios for the Baltic Sea Reion is available at: https://www.espon.eu/BT%202050.

[57] Implementing territorial foresight in Luxembourg: Böhme et al. (2018).

impact assessment and acting as a soft TIA. Territorial keys can be applied at any stage of policy implementation, but the greatest added value is generated when they are used as an ex-ante tool to ensure the territorial dimension of a policy and raise the territorial awareness of policy-makers.

A1.2 Tools and methodologies used for ex-ante and ex-post TIA

A1.2.1 TARGET_TIA

A1.2.1.1 Methodological framework

TARGET_TIA is a territorial impact assessment methodology developed by Eduardo Medeiros (Medeiros, 2014b), which can be used in both ex-ante and ex-post territorial impact assessments of projects, programmes and policies. The methodological approach differs slightly for ex-ante and ex-post evaluations. The ex-post evaluation allows the inclusion of quantitative indices to consider the changes that have occurred during the period under analysis, while the ex-ante evaluation is based solely on estimated impacts. As the author points out, this method is the most suitable tool for evaluating programmes and policies with potential socio-economic, environmental, governance and spatial planning impacts (Medeiros, 2020).

The basis of this method derives from the EU cohesion policy defining territorial cohesion, the dimensions and components of which are the aspects assessed in the TARGET_TIA method. Depending on the policy being analysed, the primary evaluation dimensions and their respective components must be defined in the first step. Once the dimensions and their components are determined, a decision has to be taken on the positive/negative impact of the analysed policy in each component - the scale used ranges from -4 (very significant negative impact) to +4 (very significant positive impact), with 0 indicating a neutral impact. [58]

To get a complete picture of the estimated impact of the analysed policy, it is recommended to identify three additional vectors (on the same scale from -4 to +4) representing the counterfactual[59] , namely the endogenous-exogenous vector (assessing the impact of the policy concerning the analysed territory and external territories, for example, the impact on the investigated region and the effect on the rest of the country) the sustainability-short-term vector (assessing the impact of the policy in relation to the sustainability of change); and the multiplier-substance vector (assessing the impact of the policy concerning possible effects in other dimensions/components or the replacement of an already existing positive result). Once all four vectors have been defined, their arithmetic mean determines the impact assessment in each component analysed.[60] In addition, the average of the components for each impact type and for each dimension is calculated, representing the impact score of each dimension to each impact type and, finally, the overall average for all impact types (average of mean dimensional impacts) is calculated, representing the overall impact of every kind on the policy.

Two additional assessment elements include policy intensity and regional sensitivity. Policy intensity, rated on a scale of 0 (zero intensity) to 1 (maximum intensity)[61] , represents the degree to which a component is funded by a policy/the extent to which the policy under analysis focuses on it. In the case of investment, the more funding allocated to a component, the more significant the expected impact of the policy in that area. Regional sensitivity, rated on the same scale as policy intensity, represents the needs of the assessed territory to the analysed component: the higher the needs of the territory, the higher the score to be given. Dimensional and overall averages are calculated similarly to the averages for impact types.

The final indicator attributed to each component is the Territorial Cohesion Aggregate Statistical Index (TCI) or another aggregate statistical index relevant to the analysed policy, which is only used in the ex-post evaluation. The TCI is calculated on the basis of the statistical index corresponding to the component under analysis (for example, GDP per capita can be used for the “income” component of the “economy” dimension[62]), using standardisation and normalisation processes to obtain an index that ranges from 0 to 1. The territorial cohesion index should be calculated twice, in the initial year of policy implementation (starting point) and 2-3

[58] Significance of individual impact scores: -4 (very significant negative impact), -3 (significant negative impact), -2 (moderate negative impact), -1 (weak negative impact), 0 (zero impact), 1 (weak positive impact), 2 (moderate positive impact), 3 (significant positive impact), 4 (very significant positive impact). Source: Medeiros (2014b, pp. 56-57).

[59] The TARGET_TIA author recommends using only one impact vector (positive - negative impact vector) if the other three vectors are difficult to assess due to low data availability or gaps in expertise.

[60] If the evaluator decides not to evaluate the alternative vectors, it is recommended to enter the same value of positive - negative impact in the three alternative evaluation vectors, so that the overall average in this evaluation parameter is not affected. Source: Medeiros (2020, p. 17)

[61] Values may range from 0 to 1.

[62] Example from Table 3.7 in Medeiros (2014b).

years[63] after implementation. Dimensional and overall averages are calculated similarly to the type of impact.

The overall impact indicator is obtained using the following formulas (Medeiros, 2017a):

Ex-post: $\boldsymbol{TIM_r} = \left(\boldsymbol{EIM_p} \times \boldsymbol{I_p}\right) \times \boldsymbol{S_p}$

Ex-ante: $\boldsymbol{TIM_r} = \left(\boldsymbol{EIM_{ql}} \times \boldsymbol{EI_p}\right) \times \boldsymbol{S_p}$

Where:

TIM$_r$	Territorial impact of policy/programme/project ***p*** in region ***r***	
EIM$_p$	Estimated Impacts of policy ***p*** for each dimension ***d***	$EIM = \frac{EIM_{ql}+EIM_{qt}}{2}$
EIM$_{ql}$	Estimated Qualitative Impacts of policy ***p*** for each dimension ***d***	$-4 \leq EIM_{ql} \leq 4$
EIM$_{qt}$	Estimated Quantitative Impacts of policy ***p*** for each dimension ***d***	*EIM_{qt} = QSI × 4/0.25, where QSI is the synthetic quantitative indicator*
I$_p$	Intensity of policy ***p*** for each dimension ***d***	$0 \leq I \leq 1$
EI$_p$	Estimated Intensity of policy ***p*** for each dimension ***d***,	$0 \leq EI \leq 1$
S$_p$	Regional Sensitivity to policy ***p*** for each dimension ***d***,	$0 \leq S \leq 1$

A1.2.1.2 Applications

So far, the TARGET_TIA method has been applied by the author to ex-post evaluations of the territorial impact of the EU Cohesion Policy in Portugal (Medeiros, 2014a), Spain (Medeiros, 2017b) and Sweden (Medeiros, 2016), the cross-border cooperation programme in Portugal and Spain (Medeiros, 2015), and the territorial impact of the Swedish-Norwegian INTERREG-A sub-programme (Medeiros, 2017a).

In the case of the EU Cohesion Policy, whose main objective is to achieve territorial cohesion, the analysis consisted of four dimensions[64] and their respective territorial cohesion components. The resulting overall indicator made it possible to determine the impact of the policy in a given region/country. The ability to calculate overall indicators for different types of territories (region/country) also made it possible to compare regional and national impact.

In the case of the application of TARGET_TIA to ex-post evaluations of cross-border programmes (Medeiros, 2015), the evaluation aimed to provide information on whether the barrier effect (in this case, a border is considered a barrier) was reduced as a result of the implementation of the cross-border programme. The evaluation was conducted with two objectives (reducing the barrier effect and valorising territorial capital), with five defined dimensions[65] and components.

A1.2.1.3 Recommendations, advantages and disadvantages

In a workshop conducted during the pilot action *Understanding how sector policies shape spatial (im)balances: Region-focused Territorial Impact*

[63] 2-3 years is the period recommended by the author of the method, however, the impact of some policies may only become apparent over a longer period of time, particularly for policies that address long-term changes, i.e. innovation and research, education.

[64] The four dimensions analysed in the study are socio-economic cohesion, environmental sustainability, governance/collaboration/institutions and morphological polycentricity.

[65] The five dimensions analysed in the study are accessibility, environmental issues and heritage, the economic-technological dimension, the institutional-urban dimension and the cultural-social dimension.

Assessment, the TARGET_TIA method was applied to assess the territorial impact of Polish minimum wage policy in districts located in a part of the Polish-German cross-border area, encompassing the Lubuskie Voivodeship on the Polish side, and part of Brandenburg, up to and including Berlin, on the German side.66 Applying the method to national policies and the selection of counties as the unit of analysis made it possible to test the suitability of TARGET_TIA for territorial impact assessment at a higher level of territorial detail and with the participation of local and regional stakeholders.

The results of the territorial impact analysis using the TARGET_TIA method obtained during the workshop should be considered interesting. Among the main advantages of this method are its high flexibility and the possibility to adapt the study framework to the specific case of the policy analysed. The initial framework defining the analytical dimensions is quite extensive. Still, it is possible to pre-define some of the analysis dimensions, which allows the workshop time to be reduced without compromising the result. Territorial sensitivity and policy intensity can be predefined by the workshop preparation team or selected during the expert discussion at the workshop. A cumulative or detailed analysis of successive impact dimensions and individual components is possible.

The main limitation of this method is the lack of prepared tools for result aggregation and visual presentation. It is necessary to prepare a spreadsheet with functions to aggregate the result independently, a tool for expert discussion and voting on individual components, and to map the results (within the research team) using external software (e.g. R, QGIS). The results are interpreted mainly in a comparative sense. From the results, it is possible to determine whether the impact is positive or negative (according to the value of the final indicator) and its relative strength.67 However, these results do not translate into a quantitative measure of impact, i.e. the quantitative impact of the policy on the key indicators.

When TARGET_TIA is applied to programmes/strategies for which either extensive qualitative studies of overall/sectoral impact have not yet been carried out or for which the statistical data on the subject of the study is not collected at a sufficiently low level, the identification of sectoral impact can be a problematic process.

Moreover, although this method is advertised as enabling ex-post evaluation, it does not offer a reliable way to identify the causal impact of a policy. It is essential to mention that the performance indicators in a particular region improve after introducing a policy cannot be conclusively linked to that policy if there is no solid evidence of such an impact. These evaluations have to be carried out outside the TARGET_TIA tool, and the quality of the supporting ex-post analyses determines the quality of the results obtained by this method. The same consideration applies to ex-ante assessments; the quality of the expertise and desk research used as input in this method determines the quality of the TIA. The TARGET_TIA tool can be seen as a way to aggregate and present expertise, but it does not explain how to identify causal relationships.

A1.2.2 STeMA-TIA

A1.2.2.1 Methodological framework

The STeMA-TIA tool was created by Maria Prezioso68 in 1983 and has been developed over the years to support policy-making processes by applying the Sustainable Territorial Approach to Environmental/Economic Management (STeMA).[69] The method is based on a multidisciplinary approach that combines assessment tools, econometric models, techniques and processes linked to creating indicators and concepts such as resilience, chaos and fractal theory (Prezioso, 2020).

The STeMA-TIA tool builds on 10 hypotheses and the original qualitative-quantitative methodological approach, built on 9 logical steps, using interactive coaxial matrices (indicators-policies-impacts). The method refers to socio-economic indicators with territorial impacts presented in 7 systemic territorial functional typologies (STFT). These typologies assume that a geographical, economic region represents its territorial systems' quality, efficiency, identity, and interconnectedness (Prezioso, 2019b).

STFTs enable the identification of regional uniqueness and can strengthen the territorial capital of the area. They can support the assessment of territorial cohesion at the time of policy initiation/pre-implementation, influencing spending opportunities and aligning local needs and policy objectives (Prezioso, 2020). The final

[66] Detailed results are available in the report *Territorial Impact Assessment. A report on the implementation of existing TIA methods into national and pan-European policies*.

[67] Due to the limitations of the workshop and the low availability of data, only the positive-negative vector of the territorial impact of minimum wage policy was assessed during the workshop, and the endogenous-exogenous, sustainability-short-term and multiplier-substitution vectors were not assessed.

[68] STeMA-TIA is a tool copyrighted by Maria Prezioso © (all rights reserved); copyright no. 0602007/2006.

[69] STeMA-TIA is developed under the supervision of Maria Prezioso by the STeMA Laboratory at the Faculty of Management and Law of the University of Rome "Tor Vergata" (Università degli Studi di Roma "Tor Vergata"). More information can be found at: https://economia.uniroma2.it/dmd/STeMA-lab/.

result of the assessment is presented in the form of ex-ante and ex-post maps that provide quickly interpretable results.

Following the author of the STeMA tool (Prezioso, 2020), the ten hypotheses underlying this method are as follows:

1. The territory includes biotic and abiotic elements. It combines systems and subsystems, such as society, politics, environment and economy.
2. The territory can be analysed individually or in relation to the system of policies that govern it. It can be interpreted according to the administrative and sectoral criteria that define it or its interaction with other actors or existing policies.
3. Regardless of the approach chosen to analyse the territory (individually/referentially), the territory remains a synthesis of the biotic and abiotic elements of which it is composed.
4. The territory is unique and different from all other territories.
5. To assess the territory, it is necessary to identify and understand the processes that link all the elements that shape the region.
6. When the TIA starts (when the analysis is initiated), the territory is considered partially balanced. Its characteristics define the initial state[70] of the entire territorial system, which can be measured and assessed.
7. The territorial system can be divided into sublevels (e.g. NUTS 2, NUTS 3). Each sublevel corresponds to a geographical scale and can be assessed using indicators and indices that can be compared to others.
8. Policy impacts can be positive, neutral or negative. A neutral or negative impact may limit the acceptable development potential of the system, both in terms of timing and means of implementation (the "sustainability paradox").
9. Acceptable development potential can be considered as the threshold for sustainable development of a territorial system and is derived from its initial sustainability (or vulnerability).
10. The term carrying capacity (∂) is used to define the difference between the initial equilibrium of the system (ITV) and the final tolerance level (FTV)[71] or sustainable development of the territorial system. Carrying capacity describes how supply matches demand according to what is specified in the policy; it means that a new partial equilibrium will likely result from continued growth and improvement of the territory.

The above hypotheses are the starting point for the operational assessment procedure of STeMA-TIA. The process consists of 9 steps, during which an analysis of the available data is conducted, appropriate indicators are selected, a territorialisation of the determinants is carried out, ex-ante scenarios are created, policy impacts are identified, and, finally, the ex-post situation is presented.[72] Techniques used in the 9-step procedure include scientific analysis (for example, the pairwise comparisons method used for "weighted positioning" of determinants) and participatory methods based on expertise (for example, the Delphi method used in the territorialisation process - relating each indicator to a determinant).

An essential component of the STeMA TIA tool that distinguishes it from other territorial impact assessment methods is the 7 systematic territorial functional typologies implemented in the latest version of the tool, STeMA TIA 3.0. The typologies are as follows:

MEGA and metropolitan systems with high-impact urban features and transnational/national functions can enhance cooperation between cities (or parts of cities) at regional, national and transnational levels.

- Systems with high-impact urban features and transnational/national specialised functions, which can enhance urban-rural cooperation between authorities in interconnected areas at regional, national and transnational levels.
- Systems with a high impact of urban features without specialised functions and with several transnational/national functions, which can enhance urban-rural cooperation between authorities in interconnected areas at regional, national and transnational levels.
- Systems with a high impact of urban features without specialised functions and transnational/national functions, therefore unable to improve urban-rural cooperation between authorities in interconnected areas at regional, national and transnational levels.
- Systems with low-impact urban features and regional/local specialised functions, which can enhance urban-rural cooperation between authorities in interconnected areas at regional, national and transnational levels.
- Systems with low-impact urban features and regional/local functions, which can enhance urban-rural cooperation between interconnected areas at regional and local levels.

[70] The initial scenario is called the initial territorial value.

[71] FTV stands for final territorial value, which writes off the final situation in the territory.

[72] A full description of the methodology is available in: Prezioso (2020, pp. 60-71).

- Systems with low-impact urban features without specialised functions and transnational/national functions, which are therefore unable to improve urban-rural cooperation.

According to Prezioso, "these typologies assume that a geographical, economic region represents the quality, efficiency and identity of its territorial systems and their interconnectedness. The ability of a region to pool existing resources and valorise their efficiency reflects its initial (ex-ante) environment; in other words, a region can create socio-territorial and governance models through shared principles" (Prezioso, 2020, p. 70).

The mapping function in the STeMA-TIA tool makes it possible to represent the STFT in a given country (see the STFT for Italy in Prezioso (2019 b) for an example).

A1.2.2.2 Application

So far, the STeMA-TIA tool has been applied in several projects in both regional and international contexts. Among others, it has been used in the ESPON project "Territorial dimension of the Lisbon-Gothenburg Strategy"[73] , among other things, to assess development potential and territorial imbalances in different transnational/national territories and types of regions in relation to the Lisbon/Gothenburg Strategy objective[74] .

The method has been used extensively by Maria Prezioso and her team in analyses of Italy and its national policies, for example, the development of the green economy (Prezioso et al., 2016), the spending review of Italian regions (Prezioso 2019a), territorial cohesion (Prezioso, 2018), social housing (Prezioso et al., 2021).

In line with the EU framework, the theoretical and applied results propose STeMA-TIA to support an integrated strategic and territorial vision for general and sectoral policies at all decision-making levels. (Prezioso, 2019b).

A1.2.2.3 Recommendations, advantages and disadvantages

Unlike other TIA methods, the STeMA-TIA tool focuses heavily on the distinctive characteristics of the territory under analysis and their process of shaping the ultimate impact of a given policy. The method allows for both ex-ante and ex-post evaluations, and application at any territorial level (the territorialisation procedure makes this possible) and specific regions, thanks to the original systemic territorial functional typologies that reflect concepts used at the EU level (for example, FUA or marginalised territories/communities). The method considers different dimensions (social, political, environmental and economic), allowing for an in-depth assessment of territorial impact. The credibility gained from the broad application to Italian policies (not only as pilot projects or artificial implementations) allows us to conclude that, with the support of national research teams, other EU Member States will also be able to apply the method in their policy-making processes.

However, a nine-step procedure involving several more complex steps may prevent non-expert users from using this method and discourage decision-makers without sufficient scientific support.

A1.2.3 RHOMOLO

A1.2.3.1 Methodological framework

RHOMOLO is the spatial computational general equilibrium model of the European Commission, developed by the JRC in collaboration with DG REGIO. It is intended to support EU policy makers by providing sectoral, regional and temporal simulations of investment policies and structural reforms (Lecca et al., 2018).

The theoretical methodology of the model is similar to other computational general equilibrium models - it models the decision-making processes of various economic agents. The model considers all monetary transactions in the economy, resulting from optimisation decisions made by the actors. Goods and services are consumed by households, governments and firms and are produced in markets that may be perfectly or imperfectly competitive. The actors' behaviour is constrained by assumptions derived from economic theory on computational general equilibrium modelling. Spatial interactions between regions are captured through trade cost matrices of goods and services and the mobility of agents through migration and investment.[75] The economy is divided into 267 EU regions (NUTS 2 level)[76] and one region representing the rest of the

[73] More information about this project can be found at: https://www.espon.eu/programme/projects/espon-2006/coordinating-cross-thematic-projects/territorial-dimension.

[74] More information on the Lisbon Strategy can be found at: https://portal.cor.europa.eu/europe2020/Profiles/Pages/TheLisbonStrategyinshort.aspx.

[75] https://web.jrc.ec.europa.eu/policy-model-inventory/explore/models/model-rhomolo.

[76] NUTS 2 refers to the basic regions for the application of regional policies. In the case of Poland, this breakdown corresponds to the administrative division into voivodeships (with one exception of the Mazowieckie voivodeship, which is divided into two NUTS units). More information on the NUTS breakdown can be found at: https://ec.europa.eu/eurostat/web/nuts/background.

world. The economic sectors modelled in RHOMOLO include economic sectors according to NACE rev.2 classification 10 (such as agriculture, forestry and fishing, manufacturing or construction, for example).[77] The high dimensionality of RHOMOLO implies that the number of (non-linear) equations that must be solved simultaneously is very large, in the order of hundreds of thousands (Barbero and Salotti, 2021).

Within the RHOMOLO model, a scenario analysis is conducted. The policy to be analysed is entered into the model as a shock to the baseline scenario, estimating its impact on key indicators (for example, total factor productivity, labour productivity or public capital) and identifying the transmission mechanisms and channels for the intervention when simulating policy impact. The final outcome of the modelling is a quantitative estimate of the impact at the NUTS 2 level, expressed as relative changes to the baseline scenario, e.g. % GDP growth by region, which can also be expressed in absolute terms (e.g. millions of euros or thousands of employed people) (Gaugitsch et al., 2020).

The methodology used in RHOMOLO allows for ex-post and ex-ante assessments with short, medium and long-term projections and impacts on economies. As a general rule, while the use of CGE models relates primarily to ex-ante assessments, CGE models have in the past also been used for ex-post assessments[78] , especially in cases where it is too early for the full impact of a policy change to become apparent. It must be stressed that the models offer information about the modelled response to a policy change, and the extent to which such a response reflects the actual response depends on both the quality of the model and the detail with which the model reflects reality, and also the extent to which the policy shocks used in the model reflect actual policies. Some policies are easier to assess, particularly those easily expressed in model terms, e.g. taxes, subsidies, capital investment, and some are more difficult, e.g. specific legal changes that must first be quantified and translated into variables present in the model.

A full methodological description of the RHOMOLO model can be found in Lecca et al. (2018).

A1.2.3.2 Applications

The EC lists the RHOMOLO model as one of the tools supporting quantitative analysis of territorial impacts in the Better Regulation Toolbox (European Commission, 2021, p. 301). It recommends using RHOMOLO to analyse the territorial impacts on economic outcomes such as GDP, exports or wages at the regional level. By 2022, RHOMOLO had been applied to various policies, including employment and social change, investment policies, plans and programmes, cohesion policy, energy policy and research and development. Most of the RHOMOLO model analyses are carried out by the Territorial Data Analysis and Modelling (TEDAM) team as part of its scientific support to EU-wide policies for the EC Directorates-General. However, national analyses are also carried out. The following paragraphs describe examples of analyses to show which aspects of territorial impact assessment the RHOMOLO model can be used for.

In one study for DG REGIO, the RHOMOLO model was applied to the ex-post evaluation of cohesion policy investments in the EU for the period 2007-2013. The impact of the policy in the short and long term was assessed. To bring cohesion policy into the model, the authors grouped 86 categories of expenditure from programmes funded by the European Regional Development Fund, the Cohesion Fund and the European Social Fund into the following areas of intervention: investment in transport infrastructure; other infrastructure; investment in human capital; investment in research and innovation; aid to the private sector; and technical support. Model shocks were then applied to simulate each category with an appropriate economic transmission mechanism (for example, an increase in government consumption in the short term and a decrease in transport costs for transport infrastructure investment). The modelling results were expressed as deviations from a hypothetical (baseline) scenario in which cohesion policy is not implemented, allowing the authors to interpret the results as a “pure” policy impact, both at Member State and regional level (Monfort and Salotti, 2021).

Ex-ante evaluations were also carried out using the RHOMOLO model. One of these was part of the impact assessment accompanying the European Parliament’s and the Council’s proposal to establish the Horizon Europe research and innovation programme. In all cases, three different policy proposals were analysed using the RHOMOLO model compared with a baseline scenario that assumed the end of the European research and innovation programme. RHOMOLO considers two channels, namely the demand channel and the productivity channel. The former assesses the effects of increased public spending to support research and innovation, with private and public investment implications. On the other hand, the productivity channel refers to the accumulation of knowledge generated from investments in research and innovation, which has long-term consequences for economic growth (Christensen et al., 2019). Simulation results provided regional employment and GDP projections in 2040 under different

[77] The sectoral classification used in RHOMOLO can be found in Lecca et al., 2018).

[78] An example can be found on the European Commission website, with assessments of free trade areas where the use of CGE models is common https://ec.europa.eu/trade/policy/policy-making/analysis/policy-evaluation/ex-post-evaluations/.

policy scenarios. Policy impacts were assessed at the aggregate EU and regional levels (Christensen, 2018).

As of 2018, all analyses conducted by the TEDAM team are published in the JRC Working Papers on Territorial Modelling and Analyses[79], where further examples of the application of the RHOMOLO model can be found.

A1.2.3.3 Recommendations, advantages and disadvantages

The TEDAM team has made the tool available for all interested parties to run sample simulations based on a simplified version of the RHOMOLO model. The web tool now covers innovation-related policies, the labour market and transport infrastructure improvements. The web tool was prepared to familiarise interested parties with how the model works.

The unquestionable advantage of the regional CGE model is that it is based on sound economic theory. It models the economic linkages between the different regions of the analysed economy. Therefore, the results of the model simulations are economically consistent and can explain and quantify the spillover effects of policy impacts. However, not all policies can be modelled using a general equilibrium model; for example, it is relatively easy to model the impact of changes in tax and subsidy levels or the effects of productivity improvements and other measurable economic actions. Conversely, for policies that may be difficult to quantify and translate into the variables and parameters used by the model, the quality of the results depends mainly on the quality of the initial input data.

The inclusion of the RHOMOLO model by the EC in the Better Regulation Toolbox makes this impact assessment method widely accepted. Many impact assessments carried out using this methodology indicate that the results obtained are reliable for policy-making processes at a general level.

The full version of the model is only available to the TEDAM team, making the application of the RHOMOLO model for TIA at the regional level limited. A relatively high level of expertise, which may not be available to regional authorities, is required to conduct analyses using CGE models. However, national/regional authorities may request an external assessment by the TEDAM team to receive support in analysing the impact of draft plans/policies using the RHOMOLO model.

A disadvantage of the RHOMOLO model is its territorial coverage. The low spatial resolution precludes a distinction between rural and urban areas or assessments focused on a cross-border area, which may be particularly interesting to policymakers.

[79] Available online: https://ideas.repec.org/s/ipt/termod.html [accessed 29/07/2022].

A1.3 Statistical tools and methods to support ex-post analysis

Ex-post analysis can combine expert knowledge and consultation results with statistical data analysis. This analysis, on the one hand, uses statistical data collected for the territories under study in earlier periods and, on the other hand, uses econometric models to explore the relationships between the data. Both the data and the methods used must be well chosen for the analysis - their inappropriate use can lead to erroneous conclusions. This analysis identifies causal relationships between policies and the resulting statistics. It, therefore, allows the actual impact of policies on the observed statistics (isolated from the impact of other factors present in reality) to be shown. Thus, statistical methods are a handy tool that can provide the TIA team (as well as experts and stakeholders) with key information on the impact of policies on the variables analysed. Statistical methods can therefore be used in conjunction with the participatory methods described earlier to increase the precision of the analysis.

The diversity of modelling approaches is due to the different determinants of the processes under study, additional information in the data and other research questions posed by TIA. Econometric methods have developed significantly in recent years, and using the simplest models is most often misguided, as reported in many specialist publications. This chapter presents the most essential econometric methods that can be used in TIA analysis. Their usefulness is confirmed by extensive applications worldwide.

A vital element of the econometric modelling process is data, available in varying temporal, spatial and thematic ranges and varies in its degree of aggregation. As a rule of thumb, more aggregated data (e.g. at NUTS 2 level) is characterised by a higher degree of averaging and, therefore, lower variation. It also obscures information on variation at lower levels of aggregation (e.g. LAU1) and may consequently distort the accurate picture of policy impact processes. Generally, the fresher the data and the less aggregated, the better – analyses on such data are significantly more sensitive to local conditions and more timely.

The key model concepts are outlined below.

A1.3.1 The concept of counterfactual analysis

The counterfactual analysis involves examining the effects of policy/programme impacts at the individual level. It asks, “what would have happened if there had been no impact?". Its essence is to compare the outcome under and without impact for a specific unit. This is, of course, not possible directly, as these are mutually exclusive scenarios for a given unit. Hence, sophisticated statistical methods are used to find "twins" - units which are very similar but differ in whether or not they were impacted. Similarity can be sought at the level of units, which is a challenging and often unfeasible task. It is somewhat easier to treat units as a group - to isolate similar (on average) groups, impacted and unaffected. Many studies show that if the groups are statistically similar, the method still works very well even if the units are not identical 1:1.

In the treatment group, the level of the phenomenon analysed is examined and compared with that in the control group, which was unaffected by the programme or policy. The difference in results in the two groups is the effect of the programme/policy impact. The concept of counterfactual analysis is simple, but its implementation is often challenging. The essence is to find units that are components of the two groups - on the one hand, differing due to the impact/lack of impact of the effect, and on the other hand, similar due to characteristics. Formally, the observed outcome depends on whether the unit has been influenced. In formal notation, this takes the form:

$$Y_i = D_i \cdot Y_1 + (1 - D_i) \cdot Y_0 \qquad (1)$$

where Yi is the observed outcome, Y1 is the outcome if the intervention is implemented, Y0 is the outcome if there is no intervention, and Di is a zero-one variable taking the value 1 for intervention and 0 for no intervention.

Counterfactual analysis is the flagship method for assessing the impact of policies. An excellent explanation of how to proceed in this analysis can be found in the World Bank manual Impact Evaluation in Practice (Gertler et al., 2016). Under this broad heading, several econometric methods are used, which differ due to application situations, model assumptions and equation specifications. These are the synthetic control method (propensity score matching), the difference-in-differences method and the regression discontinuity design model, which will be discussed below.

However, there are several problems with counterfactual analysis methods. Firstly, there is the assumption of the policy itself. Two basic approaches can be found: the redistribution of resources and the pursuit of change, which assumes that an intervention will have a specific effect on one particular group. Counterfactual methods are useless when the policy assumes a simple redistribution of resources and no specific impact of the policy intervention is expected, as they cannot pick out a non-existent effect. The second is the replicability of public interventions. This is important at the data collection stage - a successful counterfactual analysis should be conducted on units that have been subjected to the same impact. When interventions are conducted differently, it is difficult to expect a unified effect. This is also important for the purposefulness of the analysis. The result of a counterfactual analysis shows how a specific intervention affects units, and only to that extent can it serve as an approximation of the effects of the subsequent intervention. Changing the principles of intervention means changing the impact. The third is the homogeneity of the intervention. This is crucial for data collection and the comparability of results. Fourth is the availability of data. A well-designed intervention that can be evaluated ex-post, ex-ante must include a plan for collecting information - evaluating effects in the affected group and monitoring a control group that is de facto unaffected by the intervention.

A1.3.2 Synthetic control method (synthetic controls and Propensity Score Matching)

The synthetic control method is similar to propensity score matching - in both cases, it serves as a statistical tool for finding "twins" in the sample for observation. The technique is only used at the study and control group construction stage. The study group usually includes all observations exposed to the intervention. The control group must consist of units with similar characteristics to the study group, but with the difference that they have not been exposed to the intervention.

The basic solution of propensity score matching is the simplest 1:1 matching, which is not always possible - mainly in situations with many characteristics. In those cases, group similarity is sought. In propensity score matching, pairing is done by selecting, duplicating and deleting observations due to characteristics, while synthetic controls use an observation weighting procedure. Most commonly, the multivariate distance between observations is assessed (based on the characteristics of the observations) - the aim is to minimise this distance. In the case of group similarity, based on the assumption that the distributions of characteristics in the test and control groups should be similar, an artificial (synthetic) comparison unit is created. Then, one does not compare the unit (territory) affected by the policy with a group of unaffected units (territories) but assesses the similarity between the affected and synthetic units. To do this, the method requires weighing each unaffected unit so that the synthetic comparison resembles the policy-affected unit as closely as possible (Gertler et al., 2016). The synthetic control method is based on the premise that a combination of units from a control group (synthetic control group) often is better at reproducing the characteristics of a policy-affected unit than any single comparison unit. The synthetic control methodology formalises the selection of comparison units using a data-driven procedure (Abadie, 2021). The contribution of each comparison group (unaffected territories) to the synthetic control group allows quantitative and qualitative techniques to analyse similarities and differences between the unit representing the object of interest and the synthetic control group (Abadie et al., 2015).

The proposed methodological framework can be translated and implemented in a spatial analysis in which the study group coincides with the region/country affected by the policy and the synthetic control group with a combination of neighbouring regions unaffected by the policy. So far, this method has been used to, among other things, evaluate health policies in the UK (Kreif et al., 2016) to assess the economic impact of the reunification of Germany in 1990 on West Germany (Abadie et al., 2015) or the impact of research universities on regional economies and growth in Swedish regions (Bonander et al., 2016).

The study by Abadie et al. (2015) on integrating East and West Germany is a good illustration of the synthetic control method. The authors show how to conduct such analyses by selecting different combinations of countries and weights to create a suitable comparison object. The researchers used 5 other countries (Austria, USA, Japan, Switzerland, Netherlands) to replicate the behaviour of West Germany. The result is quite promising and shows that such pairings are valid.

Combined with DID (difference-in-differences), the synthetic control method can be successfully used to analyse health policy effectiveness. Kreif et al. (2016) studied the impact of introducing P4P (pay-for-performance) as a pro-quality policy. As part of a mortality reduction programme, "priority" diseases were selected, against which hospitals were expected to take special care of patients to avoid deaths. Using these methods, it was discovered that introducing P4P did not reduce mortality in the "priority" areas but increased mortality for other diseases outside the priority list.

A1.3.3 Difference-in-differences method

The difference-in-differences (*DID*) is derived from a quasi-experimental approach to assessing group characteristics at the beginning and end of the study period. By design, it is a dynamic method. It compares changes in the performance of study units over time between the units covered by the policy/programme (the study group) and units not covered by it (the control group). It allows for correcting any differences between the test and control groups that are constant over time (Gertler et al., 2016). The name "difference-in-differences" comes from the methodological framework that underpins this method - differences between groups and, over time, are compared.

The effect of the policy is estimated as the difference in the mean score of the study group before, at the beginning and the end of the study period, minus the difference in the mean score of the control group at the beginning and the end of the study period. Formally, the policy impact effect, DID, can be expressed as:

$$\text{DID}=(\bar{y}_{T,A}-\bar{y}_{C,A}) - (\bar{y}_{T,B}-\bar{y}_{C,B}) \quad (2)$$

where the indices A and B denote the moments: A (*after*) post-intervention and B (*before*) pre-intervention, the indices C and T denote the groups: C (*control*) control group and T (*treatment*) coarse study group, $\bar{y}$ denotes the mean value of the dependent variable (which is an expression of the impact of the policy). The individual components of this formula should be interpreted as:

$\bar{y}_{T,A}$ - mean of responses, study group, post-intervention

$\bar{y}_{T,B}$ - mean of responses, study group, before intervention

$\bar{y}_{C,A}$ - mean of responses, control group, post-intervention

$\bar{y}_{C,B}$ - mean of responses, control group, before intervention

It is worth noting that by subtracting the score at the beginning of the study period from the score at the end of the period, this method offsets the impact of all characteristics that are unique to that particular unit (e.g. person, group, territory) and that do not change over time. The impact of observed and unobserved time-invariant characteristics is therefore controlled for (Gertler et al., 2016) and does not interfere with assessing the impact of the policy on the outcome variables under study.

The regression model is usually of the form:

$$Y=\beta_0+\beta_1\cdot time+\ \beta_2\cdot intervention+\beta_3\cdot time\cdot intervention+u \quad (3)$$

where time is a binary variable taking the value 0 before and 1 after the intervention. Intervention is a binary variable that distinguishes between the intervention groups, taking the value 0 for the control group and the value 1 for the study group; the variable time·intervention is an interaction variable taking a value of 1 for the post-intervention study group and a value of 0 otherwise - the coefficient β_3 is interpreted as DID.

The method has been successfully applied in various policy or programme impact assessments. It can be applied to individuals (persons, firms) and can also be successfully implemented in spatial analysis, where the study group (firms, persons or territorial units) overlaps with regions affected by the policy and the control group with neighbouring areas not affected by the policy. The difference-in-differences approach has been used, among others, to assess the regional impact of Common Agricultural Policy measures on employment in three Länder in eastern Germany (Petrick and Zier, 2010), the nationwide impact of labour market policies: employment protection legislation, minimum wages, parental leave and unemployment benefits (Bassanini and Venn, 2007), and the spatial effects of the construction of new rail freight networks in Singapore (Diao et al., 2017).

A study by Petrick and Zier (2010) analyses in detail the impact of the Common Agricultural Policy on agricultural employment in Brandenburg, Saxony and Saxony-Anhalt. It uses a difference-in-differences approach to panel data on investment, direct payments, modern technology and employment. The results of this comprehensive analysis, conducted for multiple factors simultaneously, showed that investment support and transfers to economically weaker areas did not affect employment in agriculture. On the contrary, the decoupling of direct payments from production resulted in job losses, as did investments in agricultural technology and marketing.

The impact of labour market policies on productivity, studied by Bassanini and Venn (2007), remains inconclusive. The researchers used the difference-in-differences method, but their results do not allow for clear conclusions. One conclusion is that fixed employment contracts may inhibit productivity growth by limiting flexibility and flow to emerging and high-productivity industries. However, the mechanism by which flexible forms of employment raise productivity could not be confirmed. A weak link between higher minimum wages and higher productivity levels was also detected. Still, it was impossible to investigate whether the transmission channel is an investment in worker training or the substitution of skilled workers by unskilled workers. There are also somewhat uncertain results on the association of longer parental leave with higher average productivity.

Difference-in-differences methods can also be applied in a spatial context. A study by Diao et al. (2017) analyses housing prices in Singapore due to the new urban Circle Line (CCL) railway. The authors examine the impact of transport policy by analysing housing prices at two points in time - before and after the opening of the railway line, and in two types of locations - close to the railway line, i.e. up to 600 m, and outside close proximity to the railway line, i.e. located further than 600 m. It was possible to conclude unequivocally that the new line raised housing prices near the railway by approximately 8.6%. In addition to the difference-in-differences method, the model also took into account the spatial autocorrelation of housing prices.

A1.3.4 Geographic Regression Discontinuity Design

Another econometric approach that uses the concept of studied (policy-affected) and non-studied (non-policy-affected) units and can be used to assess the territorial impact of policies is the geographic regression discontinuity design (GRD), derived from the quasi-experimental method of discontinuous regression. GRD develops an approach in which a geographical or administrative boundary separates units into study and control areas. The analysts prove that the separation between study and control areas occurs in a random, “what if” manner. The method allows heterogeneous policy effects to be mapped to specific geographical locations to observe whether the study impact varies along the geographical boundary of interest (Keele and Titiunik, 2015).

Applications of the method can be found, among others, in the evaluation of EU regional policies implemented in Italian regions (Crescenzi and Giua, 2016), and in the analysis of the impact of European Structural Funds on regional performance (Becker et al., 2010) and the impact of EU Cohesion Policy on growth (Berkowitz et al., 2019), which highlight the usefulness of GRD at the aggregate level and the moderate usefulness of the method at lower levels of analysis.

A discontinuous regression model requires a clear cut-off point for assessing policy effects. In the study by Becker et al. (2010), this point was 75% of EU GDP at the NUTS 2 level as the threshold for cohesion policy Objective 1 funding. The authors used different versions of RDD modelling - sharp and fuzzy - which treat the cut-off threshold more or less restrictively. The modelling as a whole leads to the conclusion that support under Objective 1 raised the regional GDP by around 1.6%, but had no impact on regional employment. The analysis found a “spillover effect” of the policy within a radius of about 200 km.

A1.3.5 Spatial regressions

A key element of spatial regressions is the inclusion of neighbourhood information. This distinguishes spatial models from all others, which treat territories as autonomous units that do not interact with one another. Spatial interactions are most often evident in the similarity of regions - similar indicators of economic and social development and are often apparent in regions’ similar economic and social development rates. Many factors can be the sources of interactions: mobility of capital and people, manifested by investing in the neighbouring areas and commuting; the influence of higher-level territorial units (e.g. the impact of regional policy on municipalities); a similar economic and social structure (e.g. concentration on tourism in the coastal band) or even a similar culture, resulting from similar values. Spatial interactions are an inherent feature of most territories, and neglecting this factor generates systematic estimation error.

For more than 70 years (since the development of the Moran I statistics (Moran, 1950)), the way to take neighbourhood information into account was to determine who the neighbours of a given territory are and what their relative geographic proximity is, and, further, to determine a weighted average of the neighbouring regions - this information becomes an additional explanatory variable in the modelling. The neighbourhood structure is expressed in a matrix of spatial weights. This is a $n \times n$ matrix (for n observations) which, at the intersection of two territorial units, determines the degree of importance of a given neighbour for a specific region. Most often, the weights are equal for all neighbouring areas, although this can be modified. The neighbourhood criterion is most often the existence of a common border, although there are also measures based on selected nearest neighbours or distances between neighbours.

The use of this information in modelling - the neighbourhood average (for a well-defined neighbourhood criterion) - has two advantages over other spatially-based models: firstly, it allows the similarity of neighbours (so-called spatial autocorrelation) to be controlled for and, secondly, it enables the spillover effect within the neighbourhood structure to be modelled. This significantly improves the modelling quality and allows new questions to be asked, among others, about the degree to which policy effects are internalised, i.e. to what extent policy effects remain in the territory and to what extent they spill over into neighbouring areas.

A generalised equation of the spatial regression model is of the form:

$$Y = \beta_0 + \boldsymbol{\rho} WY + X\beta + WX\boldsymbol{\theta} + u \qquad (4)$$

i $u = \boldsymbol{\lambda} Wu + e$

where Y is the explained variable, X the explanatory variable, W the spatial weights matrix expressing the neighbourhood structure, β the non-spatial regression coefficients, and ρ, θ and λ the spatial regression coefficients. The component ρWY is called the spatial lag of the dependent variable and expresses the average of the Y variable in neighbourhood regions. Similarly, the component $WX\theta$, the so-called Durbin component, expresses the neighbourhood averages of the explanatory variables X, while the λWu is the autoregressive error factor and expresses the spatial autocorrelation of the regression residuals.

The above-generalised equation, containing three spatial components, most often contains too much information (over-specification) and is reduced by selected spatial components. Each of these reduced models has its name and properties. Details on spatial estimation and its implementation in R can be found in Kopczewska (2020).

An interesting study using spatial methods to analyse the minimum wage policy in Poland is found in an article by Majchrowska and Strawinski (2021). The authors examine the spatial relationship between employment and the relative minimum wage in counties in 2006-2018. They observe considerable variations in the relationship between minimum and average wages within counties. An increase in the minimum wage increases the decline in employment in low-wage regions. Moreover, there are clear local labour market interactions between neighbouring counties. The authors see a rationale for sub-regional differentiation of the minimum wage to equalise this relationship.

Significant spatial relationships in the innovative development of municipalities and social entrepreneurship are demonstrated by Okrasa and Kober (2021). The authors show an apparent clustering between municipalities with high and low potential for innovative development, while an important factor explaining this effect is a relative location (distance from large cities), which negatively affects local potential.

Interregional interactions need not always be spatial. The concept of proximity can have a geographical dimension, expressed by proximity and an immediate common border or distance. Proximity can also be seen in economic terms. A matrix of spatial weights then defines neighbourhood relations by the similarity of development indicators - e.g. the level of GDP, while the distance so measured is called economic. In Flisikowski (2017), cross-sectoral wage and employment mobility are explained by socio-economic variables, such as the wage inequality index, the average wage level, the unemployment rate or the measure of institutionalism, with a matrix of economic distance weights. The study shows that economic proximity is a significant factor explaining inter-sectoral shifts in the labour market.

A1.3.6 Econometric approach based on NPV

The NPV econometric approach is an econometric modelling method that examines policy uptake, the saturation of policy impact and its changes in a given territory, assessing the increasing/decreasing impact of a chosen policy. It is based on the concept of net present value (NPV), in which the sum of inputs is compared to the sum of outputs. The proposed econometric model relates local authorities' own revenues to their investments and allows reporting on the marginal investment multiplier and saturation effect of the local economy. When analysing the impact of policy, the discounted (inflation-adjusted) financial flows to and from (local) government and businesses are treated as cash flows from the NPV model. Accumulating the flows from the initial period allows profitability to be assessed annually. Such a cumulative model gives a complete picture of the local communities' situation and makes it possible to see which factors influence the whole "design" of the public intervention, which gives a perspective on the cause-effect relationships of the intervention policy. It also detects the point in time (year) when trends and patterns change, usually resulting in a decrease in the significance of a variable (Kopczewska, 2016).

The formal form of the equation is expressed as:

$$\sum_{t=1}^{t=k} y_t = \beta_0 + \sum_{t=1}^{t=k} x_t\, \beta + \cdots + u_n \qquad (5)$$

where t expresses the year from the beginning of the time horizon (t=1) to the end (t=k), y_t is the explained variable, x_t is the set of explanatory variables, β is the regression coefficients and u_n is the residual component for territorial units n. The method of cumulating the variables is shown below:

In the model for year 1: y1 is explained by x1

In the model for year 2: y1 + y2 is explained by x1 + x2

In the model for year 3: y1 + y2 + y3 is explained by x1 + x2 + x3

In the model for year k: y1 + y2 + y3 + ... + yk is explained by x1 + x2 + x3 + ... + xk

The model itself considers three categories of variables: 1) financial flow variables – cumulative variables, these are financial variables like income or expenditure, 2) resource variables - that change every year, usually expressing the state at the end of the year (e.g. unemployment rate, number of employees, number of companies), 3) control variables - information that does not change significantly over time, e.g. share of the area covered by forest, type of municipality, the existence of tourist attractions. These variables help understand the context of financial flows and explain their determinants.

The NPV-based regression method is relatively easy to implement. The method can easily be used to evaluate investment policies at the local and regional level in any country, thus enabling estimates of how investment outflows need to be covered by future inflows (e.g. tax increases). This approach has several important properties. First, it smooths out cash flows reported at different times, often randomly. Second, it reduces the problem of arbitrary selection of time lags that usually occurs in typical models. Third, we interpret the regression results - coefficients with monetary variables - as multipliers, e.g. investment multipliers or income multipliers (i.e. the effects of a unit change in the intervention on the unit of the outcome variable). Fourth, the change from period to period in coefficients interpreted as multipliers allows us to assess the saturation, e.g. of the local economy with investment, as it shows the marginal response of the dependent variable. Typical time lag models do not have these properties.

An interesting application of the NPV-based modelling method is the ex-post evaluation of local public investment of Polish municipalities (LAU2) between 1995 and 2012 (Kopczewska, 2016). The study takes the year 1995 as the starting point for accumulating financial flows of local government units (LAUs). Eighteen individual models were estimated for increasingly long periods (1995, ...1995-1999, ... , 1995-2012) on the financial flows accumulated in these periods. The analysis showed a favourable investment multiplier (about 30-50%) interpreted as the return on investment, where the investment is the municipalities' capital expenditures, and the return is the own income of the territorial self-government units. Investment saturation increased towards the end of the period under study, resulting in a declining investment multiplier. The analysis was conducted using spatial methods and revealed strong inter-municipal linkages. An interesting element of the study was the importance of Special Economic Zones (SEZs) in a municipality - their impact on own revenues was negative, and the municipalities with SEZs observed lower own revenues than municipalities without SEZs.