ESPON Workshop

Scenarios and modelling in the framework of exploring Territorial Cohesion

RHOMOLO

Brussels, 4 September 2014

Philippe Monfort
EUROPEAN COMMISSION, DG for Regional Policy and Urban Policy
D'Artis Kancs
EUROPEAN COMMISSION, JRC-IPTS

Background

- DG REGIO has used economic models for a long time:
  - Analysis of the impact of cohesion policy programmes;
  - Simulation of policy scenario;
  - Contribution to impact assessment;

- DG REGIO mainly relied on two macroeconomic models: HERMIN and QUEST.

- HERMIN and QUEST produce results at the national level.

Background

- It was felt that DG REGIO should extend its analytical capacity to also cover regional level.
- None of the existing models could fully respond to the needs of DG REGIO.
- It was hence decided that it would develop its own regional model.
- Prototype elaborated by TNO.
- Based on prototype JRC-IPTS, developed the RHOMOLO model.
- Work continues in collaboration with DG REGIO.

Note

- RHOMOLO is a Dynamic Spatial General Equilibrium Model
- **Designed to simulate policy scenario…**
- **… not for projections or forecasting**.
- Results are expressed as deviation from baseline…
- … which means that the baseline is not the most interesting part of the model.

Main features

- Economy consists of R regions included into M countries.
- Each region is inhabited by H_r households.
- Industry: S different sectors, monopolistic competition. Goods consumed by households or used by other firms as intermediate inputs or as investment goods.
- Trade between and within regions is costly (distance separating regions, transport infrastructure, national borders…).

Main features

- Technological change directly follows Romer (1990) and Jones (1995).
  - Final goods firms use durable goods. Each variety of durable goods is produced by a durable goods firm.
  - Each durable goods firm must acquire a design from a R&D sector which uses human capital and existing knowledge to produce new designs.
- National public sectors:
  - Levy taxes on consumption and on income of domestic households.
  - Provide public capital necessary for the operation of firms.
  - Subsidises the private sector and influences the capacity of the educational system to produce human capital.

Households

- Households make decisions about consumption, savings and labour supply.

- Budget constraint: $$P_q^c C_{h,q} \leq (1-s)\, YC_{h,q}$$

- With:
  - $$YC_{h,q} = \sum_e (1-t_m^w)\, w_{h,e,q}\, l_{h,e,q} - \Gamma_w(w_{h,e,q}) + (1-t_m^\pi)\, KI_{h,q} + \frac{TR_{H,m}}{\sum_{r=1}^{R_m} H_r}$$
  - $$KI_{h,q} = \sum_{r=1}^{R-1} \sum_{v=1}^{A_r} r_{v,r}^k B_{h,q}^{k,v,r} + \sum_{m=1}^{M} r_m^G B_{h,q}^{G,m} + r^F B_{h,q}^F + \sum_{r=1}^{R-1} \sum_{v=1}^{A_r} s_{h,q}^{k,v,r} \pi_{v,r} + \frac{1}{H} \pi^{FG}$$

Households

- Preferences: $$C_{h,q} = \left(\sum_{r=1}^{R} \sum_{s=1}^{S} \sum_{i=1}^{N_{s,r}} \left(c_{h,q}^{i,s,r} \right)^{\theta} \right)^{\frac{1}{\theta}}$$

- Demand: $$c_{h,q}^{i,s,r} = \left(\frac{\tau_{s,r,q} \left(1 + t_{s,m}^{c}\right) p_{i,s,r}}{\beta_s P_q^c} \right)^{\frac{1}{\theta-1}} \frac{(1-s)\, YC_{h,q}}{P_q^c}$$

- Human capital: $$\Delta b_{h,e,q} = b_{h,e,q}(e_{h,e,q}^{\Lambda} - 1) - \delta_{HC}\, b_{h,e,q}$$

Firms

- Production functions
  - Final goods: $$y_{i,s,r} = Z_{i,s,r}^{\alpha_s} L_{i,s,r}^{1-\alpha_s} KG_r^{\alpha_G} - FC_{i,s,r}$$
  - R&D sector: $$\Delta J_m = (J^*)^{\omega} \cdot J_m^{\zeta} \cdot L_{R\&D,m}^{hi}$$
  - Durable goods: $$z_{v,r} = K_{v,r}$$
$$K_{v,r} = \left(\sum_{q=1}^{R} \sum_{s=1}^{S} \sum_{i=1}^{N_{s,q}} (k_{v,r}^{i,s,q})^{\theta} \right)^{\frac{1}{\theta}}$$
- Implies that $$y_{i,s,r} = A_r^{\alpha_s/\rho} K_{i,s,r}^{\alpha_s} L_{i,s,r}^{1-\alpha_s} KG_r^{\alpha_G} - FC_{i,s,r}$$

Innovation

- Transforming designs into a new production process is uncertain.

- Probability to succeed in using a new design depends on regional technological level and human capital (see for instance Rodriguez-Pose and Crescenzi, 2010):

$$\phi_r = \left(\frac{A_r}{\sum_{r=1}^{R_m} A_r} \right)^{\nu} \left(\frac{HC_r}{\sum_{r=1}^{R_m} HC_r} \right)^{1-\nu}$$

Public sector

- Public deficit:

$$D_m = \sum_{q=1}^{Rm} P_q^c G_q + TR_{H,m} + TR_{m,EU} + r_m^G B_{G,m} + Sub_m - T_m - \sum_{q=1}^{R_m} TR_{EU,q}$$

- With:

$$\begin{aligned} T_m &= \sum_{q=1}^{R_m} H_q \sum_{r=1}^{R} \sum_{s=1}^{S} t_{s,m}^c N_{s,r} p_{i,s,r} \tau_{r,q,s} c_{h,q}^{i,s,r} \\ &+ t_m^w \left(\sum_{q=1}^{Rm} \sum_{e=lo,me,hi} \sum_{h=1}^{H_q} w_{h,e,q} l_{h,e,q} \right) \\ &+ t_m^\pi \sum_{q=1}^{Rm} H_q KI_{h,q} \end{aligned}$$

Dynamics

- No intertemporal choices in RHOMOLO
- Physical capital
  - Private sector (endogenous): $I_{v,r} = \Delta K_{v,r} + \delta_K \, K_{v,r}$
  - Public sector (exogenous): $\Delta KG_q = GI_q - \delta_K \, KG_q$
- Human capital (exogenous): $\Delta b_{h,e,q} = b_{h,e,q}(e^{\Lambda}_{h,e,q} - 1) - \delta_{HC} \, b_{h,e,q}$
- Technology (endogenous): $J^r_m = \sum_{r=1}^{Rm} \frac{A_r}{\phi_r}$

Spatial equilibrium

- Free entry/exit on the final goods and durable goods market exhaust pure profit.

- This determines the number of final goods and durable goods firms in region *r*.

- Agglomeration forces:
  - Access to a large market;
  - Lower price/costs in a large market;
  - Local technological externalities.

- Dispersion force
  - Competition fiercer in large market (for goods and labour).

Policy interventions

- European cohesion policy interventions are regrouped into 5 broader categories of policy instruments:

Field	Implementation in Rhomolo	Variables
RTD	Reduction of fixed costs in R&D sector	$Sub_{EU,q}^{R\&D}$
Human resources	Education investment in skill-specific human capital	Λ_e, $TR_{EU,q}$
Infrastructure	Reduction of trade costs	$\tau_{s,q,r}$, $TR_{EU,q}$
	Increase of the stock of public capital	KG_q, $TR_{EU,q}$
Industry and services	Reduction of fixed costs in final goods sector	$FC_{i,s,q}$, $Sub_{EU,q}^{FG}$
	Reduction of fixed costs in durable goods sector	$FC_{v,q}$, $Sub_{EU,q}^{z}$
Technical assistance	Increase in public consumption	$TR_{EU,q}$

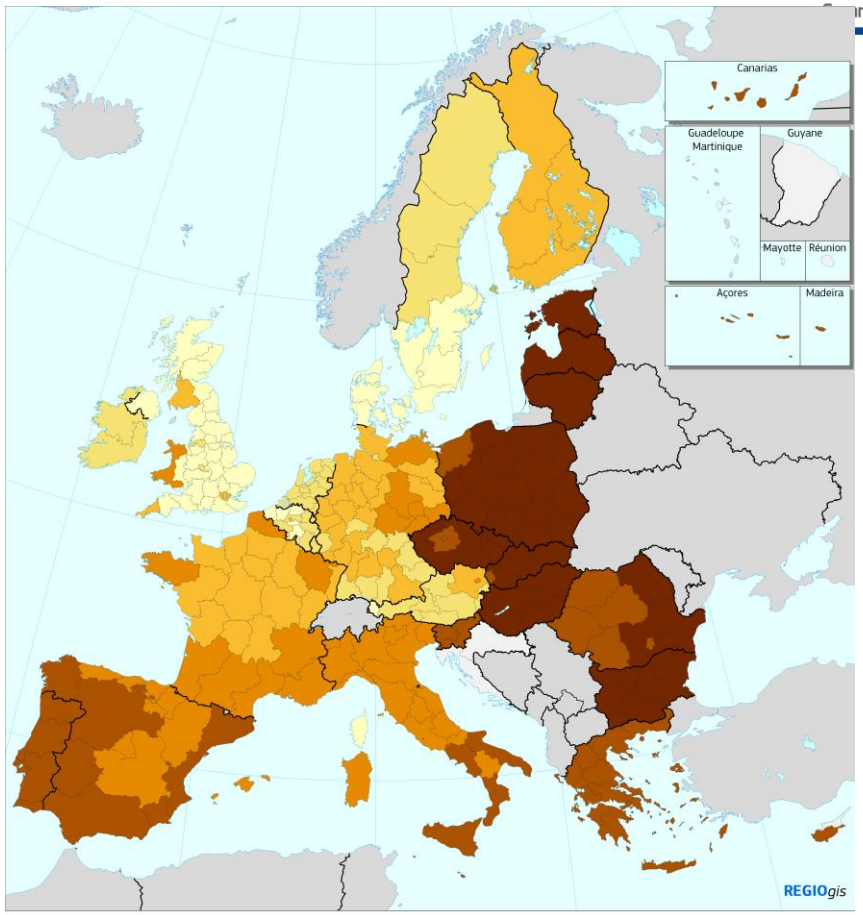
Calibration and baseline

- The current version of RHOMOLO is calibrated to 2007 data.
- Within the next months the base year will be updated to 2010.
- Calibrated values are all shift and share parameters based on the base year data in Social Accounting Matrices (SAMs).
- Behavioural parameters, such as elasticities of substitution, are estimated econometrically or borrowed from the literature.
- In the baseline, GDP and population are assumed to grow at an exogenous rate.

Simulations – ECP 2014-2020

1. Infrastructure

- Investment in infrastructure represents an important part of cohesion policy funding.
- Expenditure on infrastructure is considerably higher in less developed regions.
- Expenditure in euros are 'translated' into reduction in transport costs.
- Per euro, impact is bigger in regions where transport infrastructure is lacking while it is smaller in more developed regions where the quality of the transport network is already high.



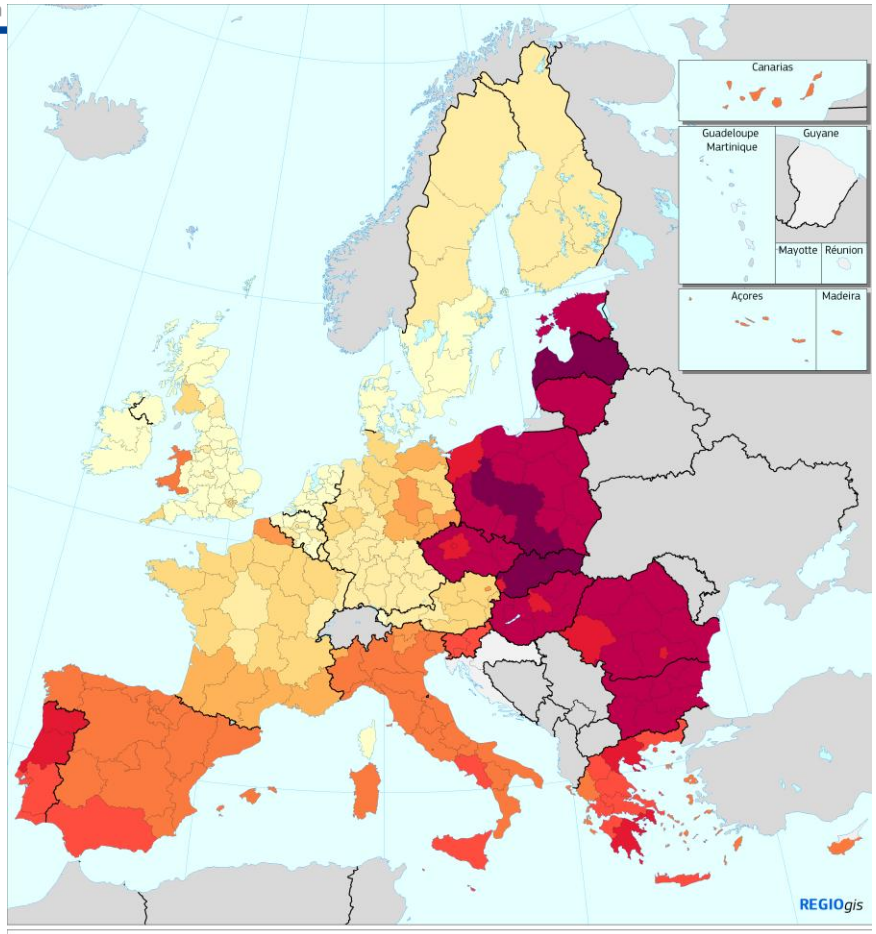
Impact of interventions in the field of infrastructure GDP, yearly average 2014-2023

% above baseline

- < 0.019
- 0.019 - 0.029
- 0.029 - 0.054
- 0.054 - 0.228
- 0.228 - 1.590
- >= 1.590

Source: RHOMOLO

0 500 Km



Impact of transport infrastructure interventions on GDP, 2030

% above baseline

- <0.020
- 0.020 - 0.040
- 0.040 - 0.060
- 0.060 - 0.080
- 0.080 - 0.10
- 0.10 - 0.50
- 0.50 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- >2.0

Source: RHOMOLO

0 500 Km

Simulations – ECP 2014-2020

1. Infrastructure

- The impact of investment in the field of infrastructure does not only materialise in the region where the investment takes place.

- A region benefiting from enhanced accessibility increases its imports of goods from the other regions which in turn also experience an increase in their exports and hence their GDP.

- The impact of local intervention therefore has a tendency to progressively disseminate in space through the numerous trade links existing between the EU regions.

Simulations – ECP 2014-2020

1. Infrastructure

- Illustration: Reduction of transport costs between five Polish regions: Łódzkie (PL1), Mazowieckie (PL12), Śląskie (PL22), Kujawsko-Pomorskie (PL61) and Pomorskie (PL63).

- In fact, these regions are those directly affected by two TEN-T priority projects: TEN-T 23: Railway axis Gdansk-Warszawa-Brno-Bratislava-Wien, and TEN-T 25: Motorway axis Gdansk-Brno-Bratislava-Wien.

Poland

Short run impact on GDP of a reduction in transport costs in five Polish regions

% above baseline

- < 0.02
- 0.02 - 0.03
- 0.03 - 0.06
- 0.06 - 0.25
- 0.25 - 1.54
- >= 1.54

0 120 Km

Poland

Long run impact on GDP of a reduction in transport costs in five Polish regions

% above baseline

- < 0.02
- 0.02 - 0.03
- 0.03 - 0.06
- 0.06 - 0.25
- 0.25 - 1.54
- >= 1.54

0 120 Km

Simulations – ECP 2014-2020

2. Human capital

- Cohesion expenditure on human capital is assumed to increase labour productivity, however at the cost of a temporal decrease in the regional labour supply.

- Formally, a cohesion expenditure on human capital of 1% relative to local education expenditures is assumed to increase local labour productivity by 0.3% (see for instance Sianesi B. and J. Van Reenen, 2003).

- Per euro, impact is bigger in regions where the level of local expenditure on education is low and in regions where the industrial fabric incorporates a larger proportion of labour intensive industries (such as for instance manufacturing).

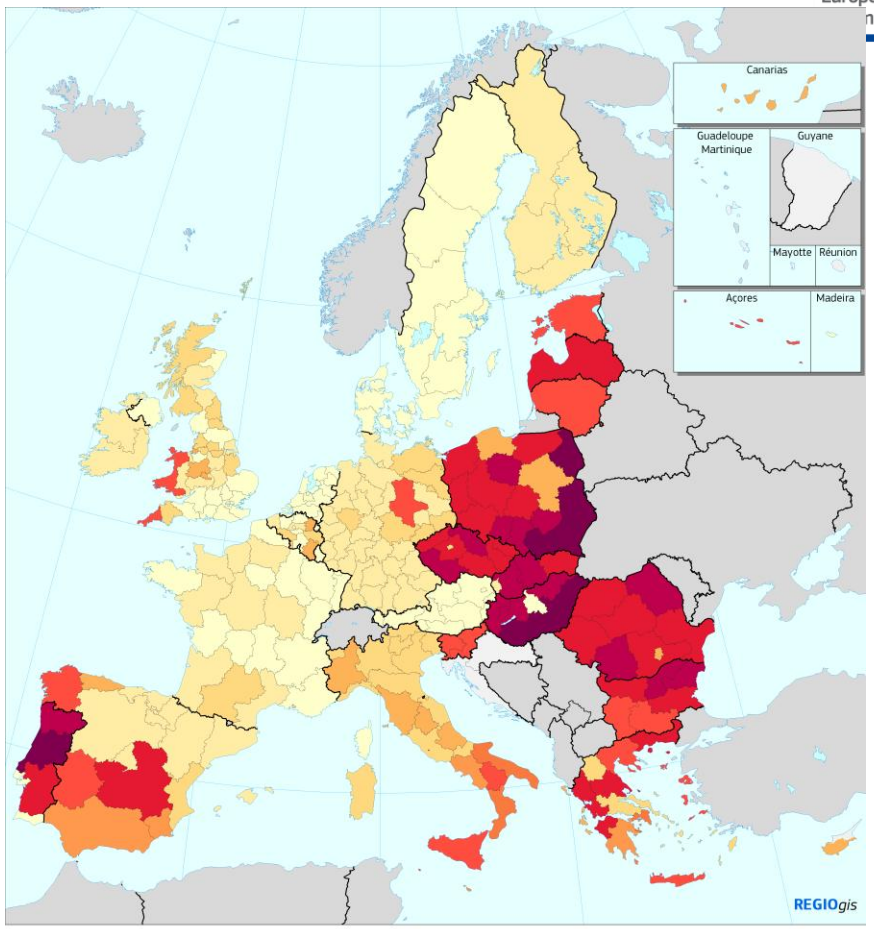
Simulations – ECP 2014-2020

2. Human capital

- Investment in human resources also generates spatial spill-overs.

- Increase in GDP in the regions receiving support for investment in human resources benefit to the other regions due to interregional trade links.

- Investment in human resources tends to increase the wage level in the beneficiary region which makes it more attractive for workers. This triggers migration flows out of the other regions which are then negatively affected by the intervention.



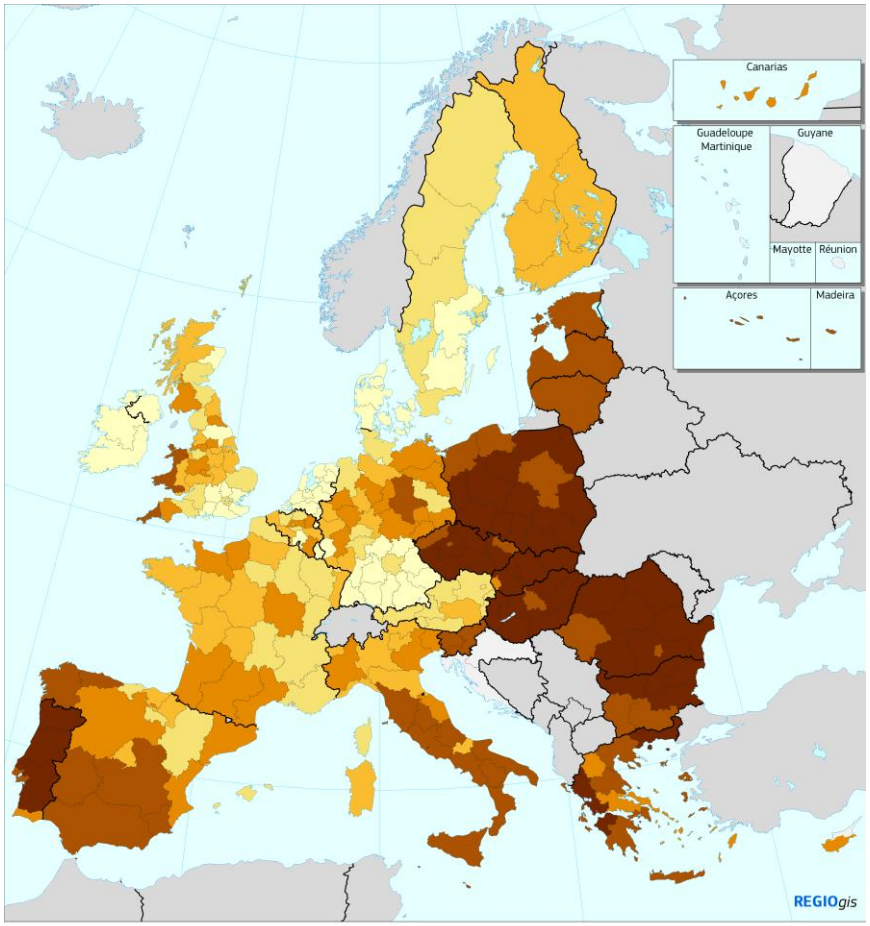
Impact of interventions in the field of human resources on GDP, yearly average 2014-2023

% above baseline

- <0.005
- 0.005 - 0.01
- 0.01 - 0.02
- 0.02 - 0.03
- 0.03 - 0.04
- 0.04 - 0.05
- 0.05 - 0.10
- 0.10 - 0.20
- 0.20 - 0.30
- >0.30

Source: RHOMOLO

0 500 Km



Impact of interventions in the field of human resources on GDP, 2030

% above baseline

- < 0.03
- 0.03 - 0.03
- 0.03 - 0.05
- 0.05 - 0.10
- 0.10 - 0.40
- >= 0.40

Source: RHOMOLO

0 500 Km

Simulations – ECP 2014-2020

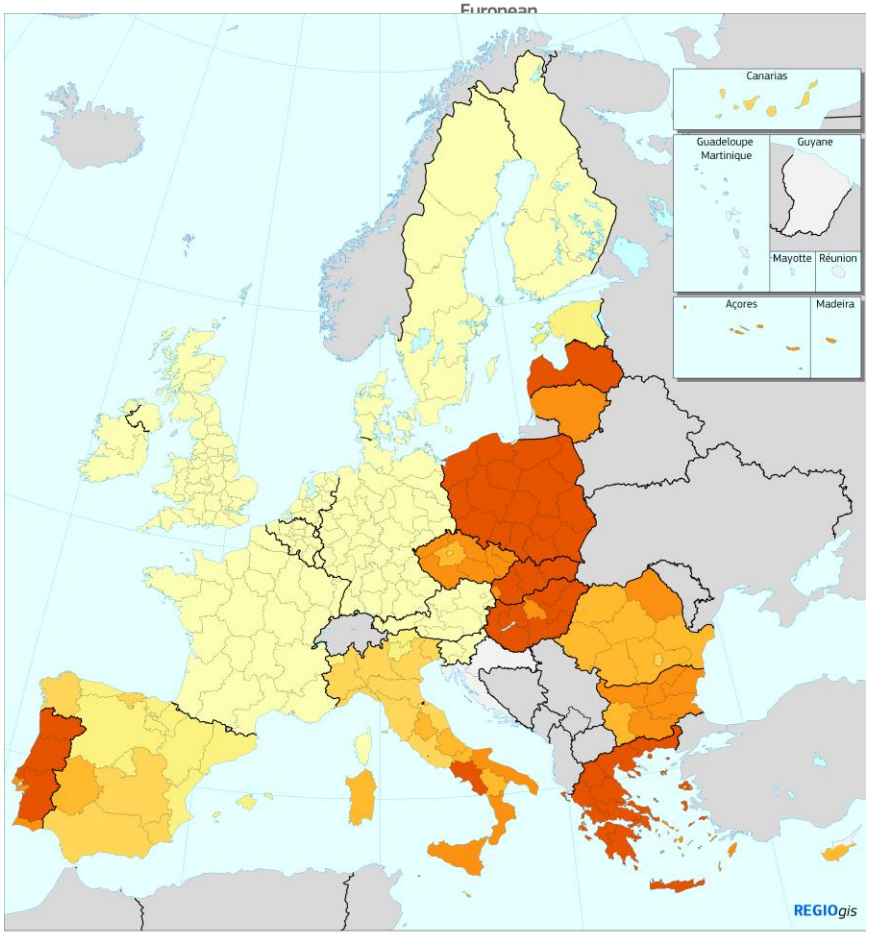
3. RTDI

- RTDI increases total factor productivity (TFP).
- Expenditure in this field is first expressed as an increase in R&D intensity compared to the baseline.
- The extent to which increases in R&D affects productivity is borrowed from empirical literature for the EU (see for instance Belderbos, R. and P. Mohnen, 2013).

Simulations – ECP 2014-2020

3. RTDI

- R&D increases competitiveness by lowering production cost.
- Other regions benefit from increase in GDP in the region receiving RTDI support but loose market shares.
- In general, the impact is smaller in more developed than in less developed regions:
  - Less fund received under Cohesion Policy;
  - Smaller effect on factor productivity since they lag less behind in terms of technology.



Impact of interventions in the field of R&D on NUTS 2 regions GDP, yearly average 2014-2023

% above baseline

- < 0.005
- 0.005 - 0.015
- 0.015 - 0.025
- 0.025 - 0.050
- 0.050 - 0.100
- >= 0.100

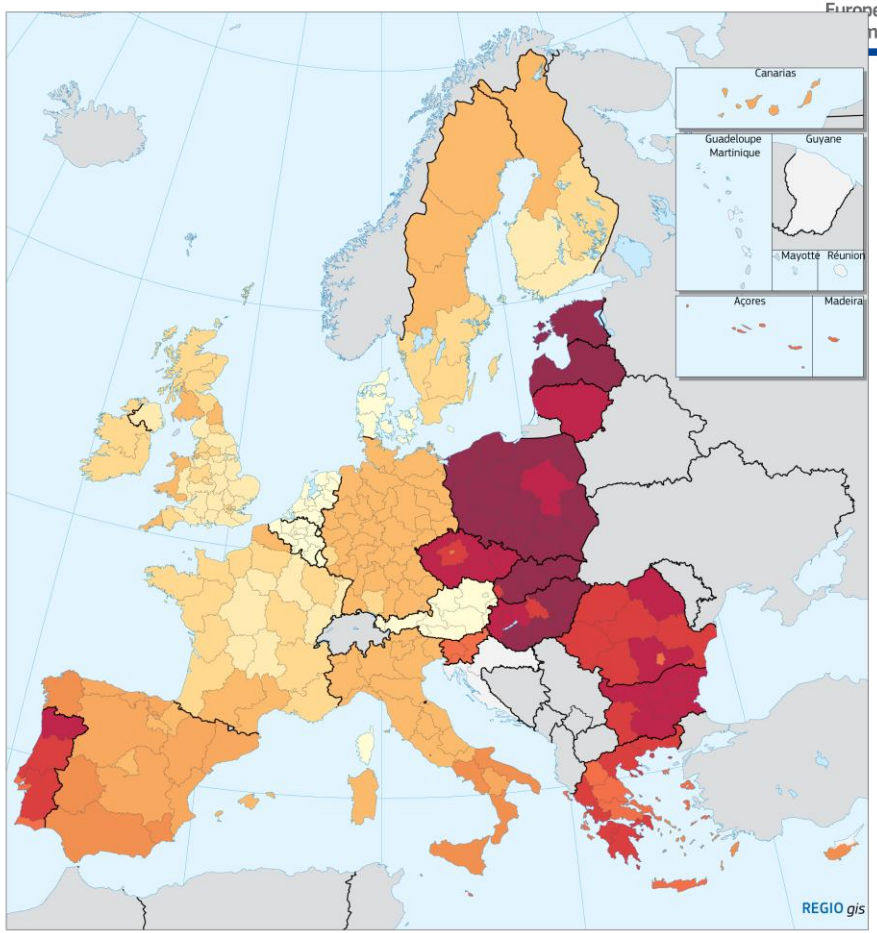
Source: RHOMOLO database

0 500 Km

Simulations – ECP 2014-2020

4. Total impact

- Impact particularly large for regions located in Eastern and Central Europe.
- Highest in Polish regions (Śląskie, Podkarpackie, Małopolskie and Lubelskie) as well as Slovakia (Východné Slovensko) where cohesion policy is expected to increase GDP by more than 3% per year on average between 2014 and 2023.
- Some regions in Southern Europe also benefit from a large positive impact of cohesion policy on their GDP.
- For instance, GDP is expected to increase on average by 1.7% per year in Norte (Portugal) and by 1.5% per year in Kentriki Makedonia (Greece).



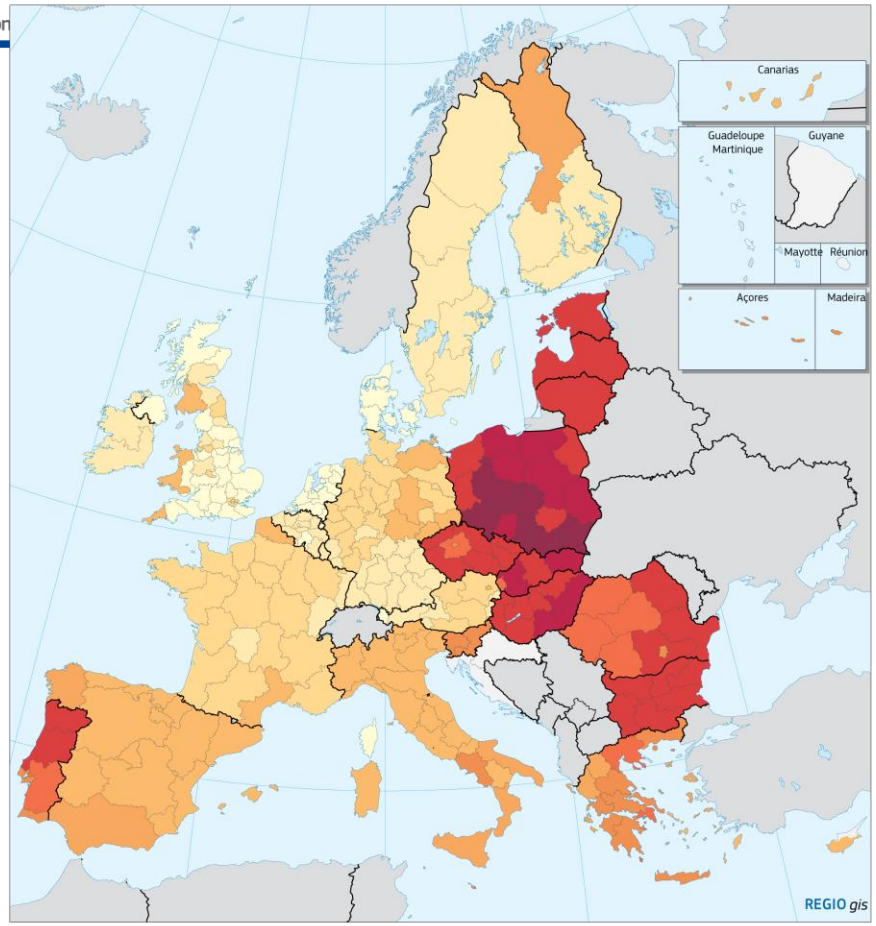
Impact of the 2014-2020 cohesion policy programmes GDP, yearly average 2014-2023

% above baseline

- <0
- 0.0 - 0.005
- 0.005 - 0.01
- 0.01 - 0.15
- 0.15 - 0.30
- 0.30 - 0.60
- 0.60 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- >2.0

Source: RHOMOLO

0 500 Km



Impact of the 2014-2020 cohesion policy programmes on GDP, 2030

% above baseline

- <0.02
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.5 - 3.0
- 3.0 - 3.5
- >3.5

Source: RHOMOLO

0 500 Km

Simulations – ECP 2014-2020

4. Total impact

- Impact generally smaller in more developed regions (allocation more modest, already largely endowed in infrastructure and human capital and technology).

- However, these regions still benefit from their own cohesion policy programmes and from those implemented in less developed regions.

- Impact of the policy remains significant in a number of more developed regions.

- GDP is expected to increase on average by 0.11% per year in Lazio or by 0.12% per year in West Wales and The Valleys during the implementation period.

Simulations – ECP 2014-2020

4. Total impact

- Impact generally smaller in more developed regions (allocation more modest, already largely endowed in infrastructure and human capital and technology).

- However, these regions still benefit from their own cohesion policy programmes and from those implemented in less developed regions.

- Impact of the policy remains significant in a number of more developed regions.

- GDP is expected to increase on average by 0.11% per year in Lazio or by 0.12% per year in West Wales and The Valleys during the implementation period.

Simulations – ECP 2014-2020

4. Total impact

- Impact in the long run is generally higher than in the short run.
- Highlights the fact that cohesion policy effects are expected to progressively build up in time and continue to increase after the termination of the programmes.
- The long run the impact has generally increased much more in developed regions compared to less developed regions.
- Dissemination of the impact in space is not immediate and is hence likely to become more prominent in the long run.

Thank you for your attention