STAREBEI Sapienza project:
"The European Investment Bank and geographic divergence in the EU"

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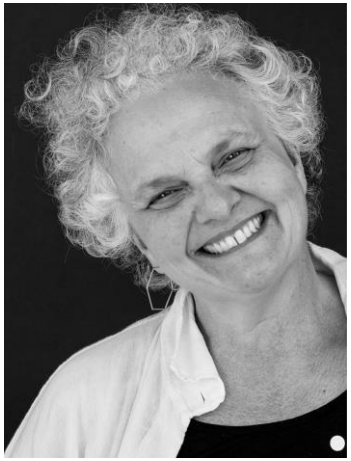
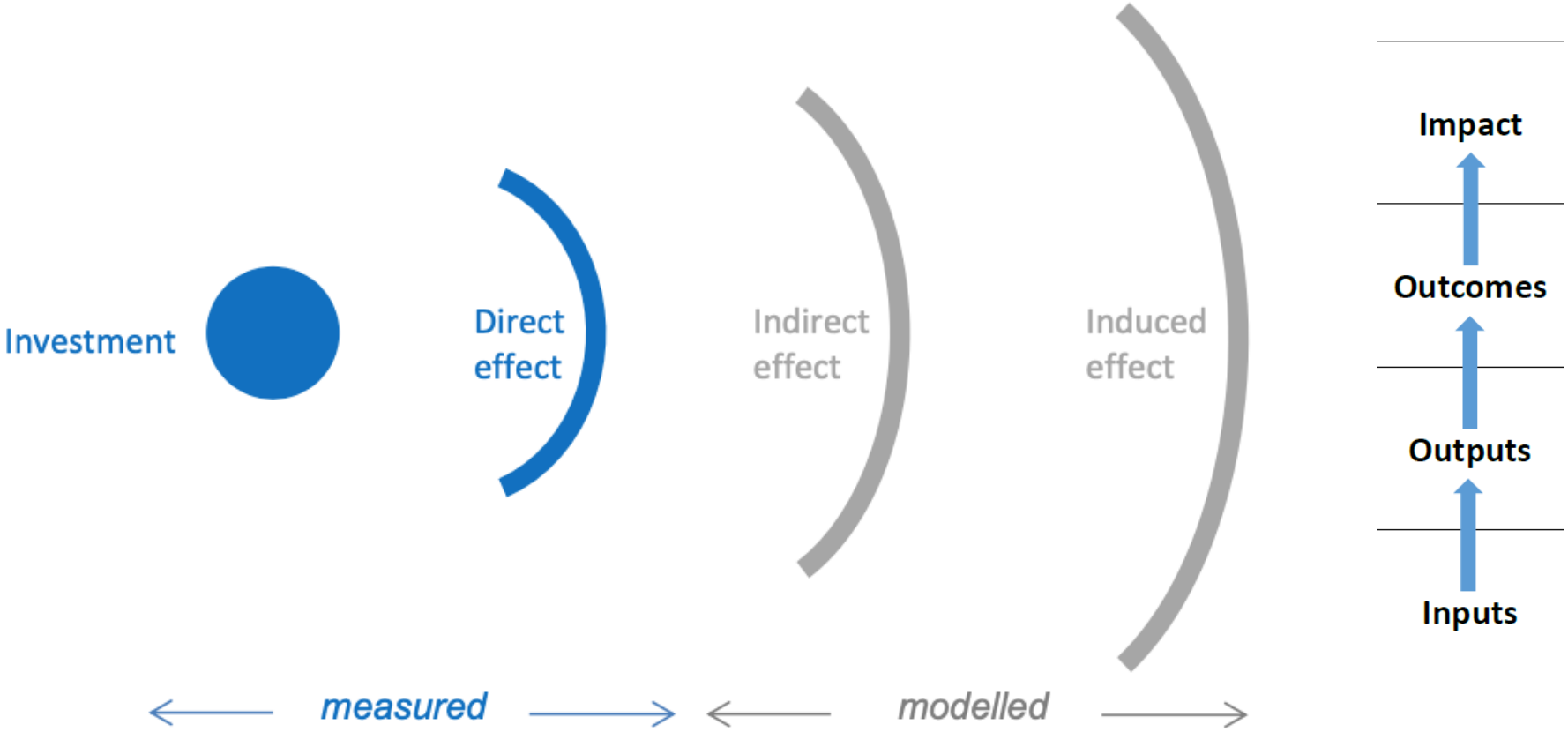


Marcella Corsi
Project member

The EIB and geographic divergence in the EU: PROJECT AIMS

1. To verify if and to what extent the EIB generated economic growth and reduced geographical divergence across European regions
2. To estimate the economic impact of EIB lending at the regional level
3. To look into differences across regions

Previous EIB work



Main project characteristics

1. Creation of a complete dataset of EIB lending at the regional and sectoral level for the 2012-2020 period

2. Analysis of the causal nexus, beyond mere correlation (“counterfactual techniques”)

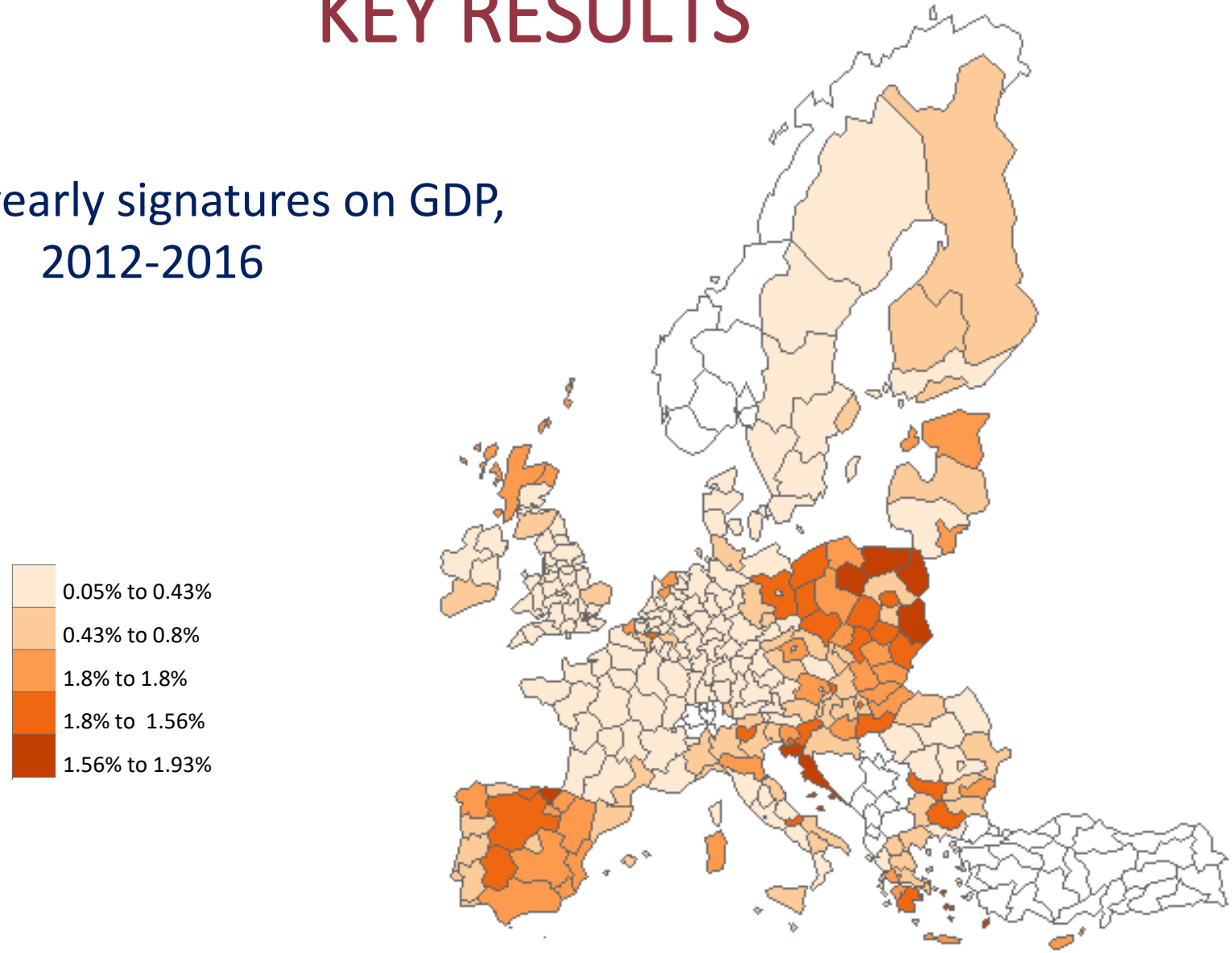
3. Consideration of a possible indirect impact (“spillover effect”)

KEY RESULTS

- EIB lending has a **positive impact** on the GDP growth of Europe's regions (the "EIB multiplier").
- Such impact is heterogeneous: it is higher in the less developed regions than in the more developed ones. So, **EIB lending positively contributes to reducing GDP gaps between regions.**
- **1€ of EIB lending translates into 0.76€/1.75€ of additional GDP in the region in the same period.**
  - Additional signatures for 1% of a region's GDP increase GDP growth in the less developed and transition regions by 0.91%-1.75%, and in the more developed ones by 0.76%-0.84%.
- There is an indirect effect. **Lending in one region significantly impacts on the GDP of other regions**: those with which the region trades ("spillover effect").
  - Additional demand from «neighbouring» regions due to EIB lending for 0.5% of a less developed region's GDP increases its growth by 2%; and in a more developed region by 0.14%.

KEY RESULTS

Average yearly signatures on GDP, 2012-2016

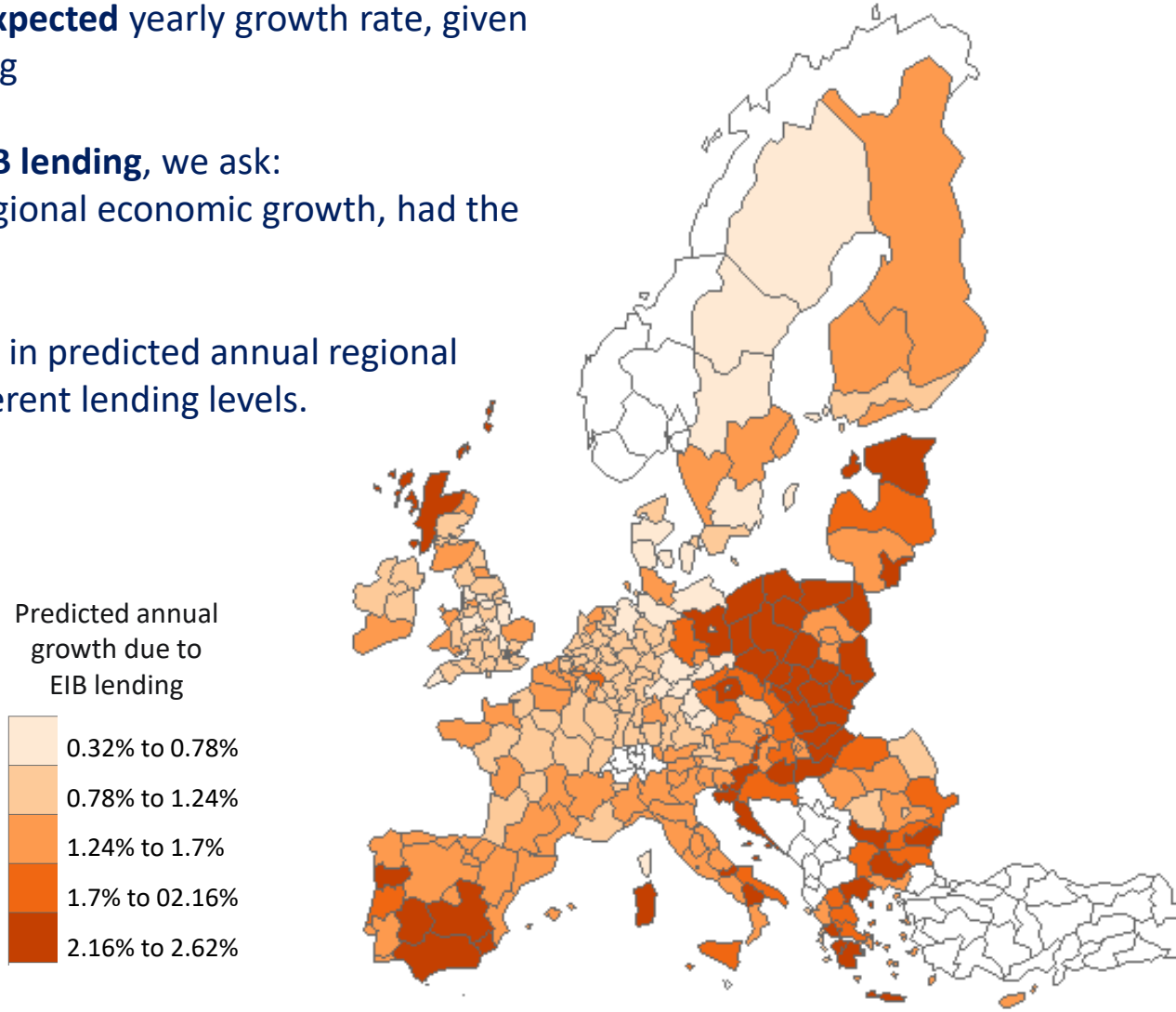


KEY RESULTS

- The map shows each region's **expected** yearly growth rate, given the observed level of EIB lending

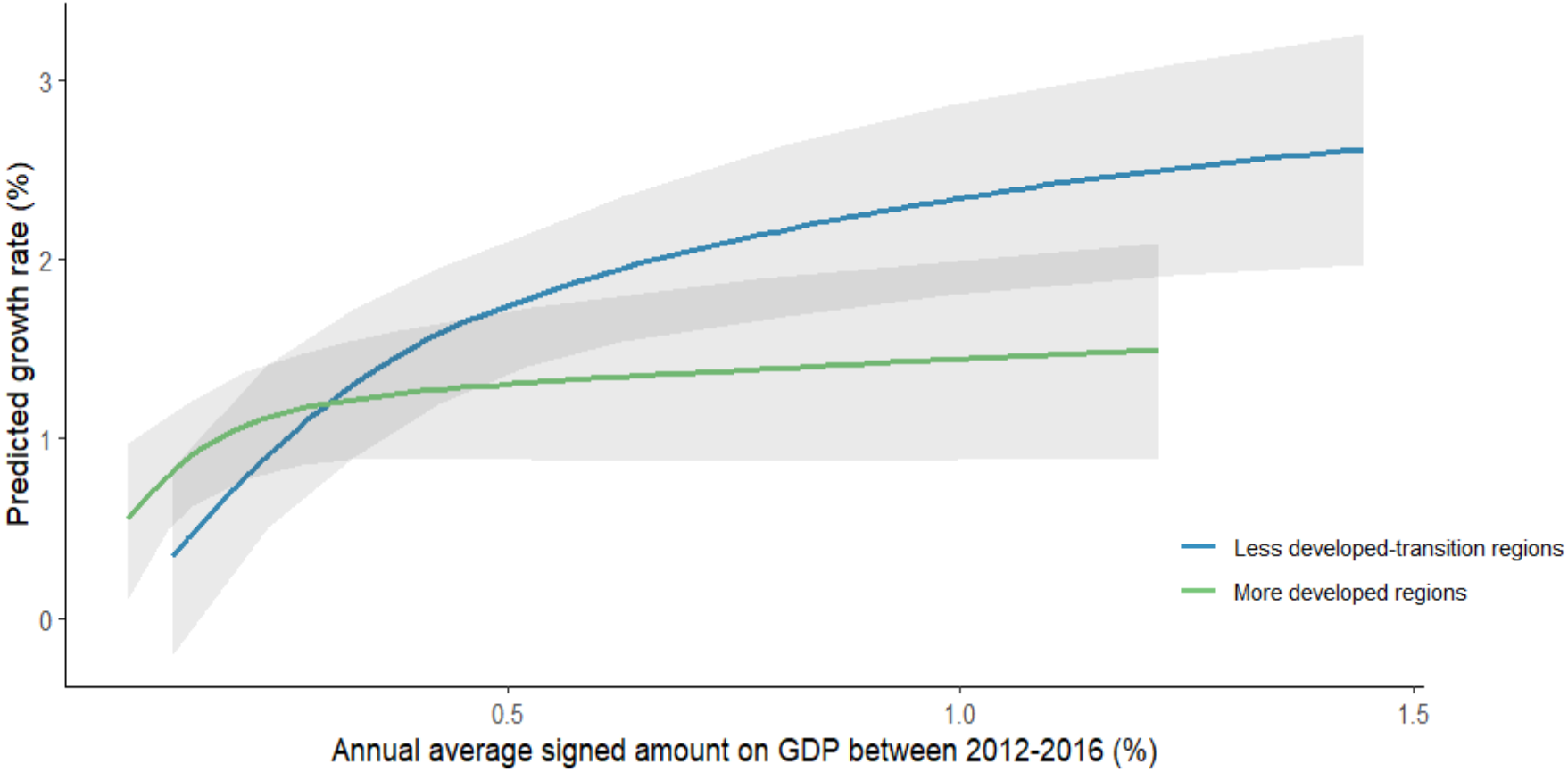
To understand a **causal effect of EIB lending**, we ask:
"What would have happened to regional economic growth, had the EIB invested more/less?"

To answer, we compare differences in predicted annual regional growth rates corresponding to different lending levels.



KEY RESULTS

Relationship between the expected growth rate and the EIB lending.



To verify if and to what extent the EIB generated economic growth and reduced geographical divergence across European regions

1

IS THERE ECONOMIC CONVERGENCE IN EUROPE?

1. Convergence in economics
2. Empirical evidence on regional convergence in Europe

1. LITERATURE ON REGIONAL CONVERGENCE

Traditional economic theory

(Solow, 1956)

Growth depends on technology, demography, and the accumulation of capital.

- *Stimulus policies can only have a transitory impact*
- *Poorer countries/regions grow faster than richer ones (hence, in the long run they "converge" to similar levels of income)*

Regional economics

(Isaard, 1960)

Introduction of space in the model changes the results.

- *A core-periphery pattern might emerge; initial higher accumulation of capital is perpetuated*

More recent theories

«Endogenous growth» theory

(Romer 1986; Grossman and Helpman 1991)

Technological progress depends on observable variables, such as education, R&D expenditure, economies of scale, externalities (e.g., imitation), etc.

New Economic Geography

(Krugman 1991; Krugman & Venables 1995; Fujita et al. 1999)

The uneven geography of economic activities drives the localization of investments.

Demand-led Growth Models

(Kaldor, 1970; Thirlwall, 2014)

The growth of (autonomous) demand induces greater capacity utilization and new investments, which increase productivity

- *Active policy can affect long-term growth: e.g., by encouraging the accumulation of physical and human capital, by promoting innovation, etc.*

2. EMPIRICAL EVIDENCE ON REGIONAL CONVERGENCE

The most used metrics derive from neoclassical growth theory:

- **β convergence** concerns differences in growth rates across economies with different starting income levels.
  (recall the assumption that poorer regions will grow faster)

- **σ convergence** concerns the overall reduction of income disparities over time. It is usually measured by the variance of regional incomes, or with the coefficient of variation: the ratio between the standard deviation and the mean
  (this is arguably the real policy goal)

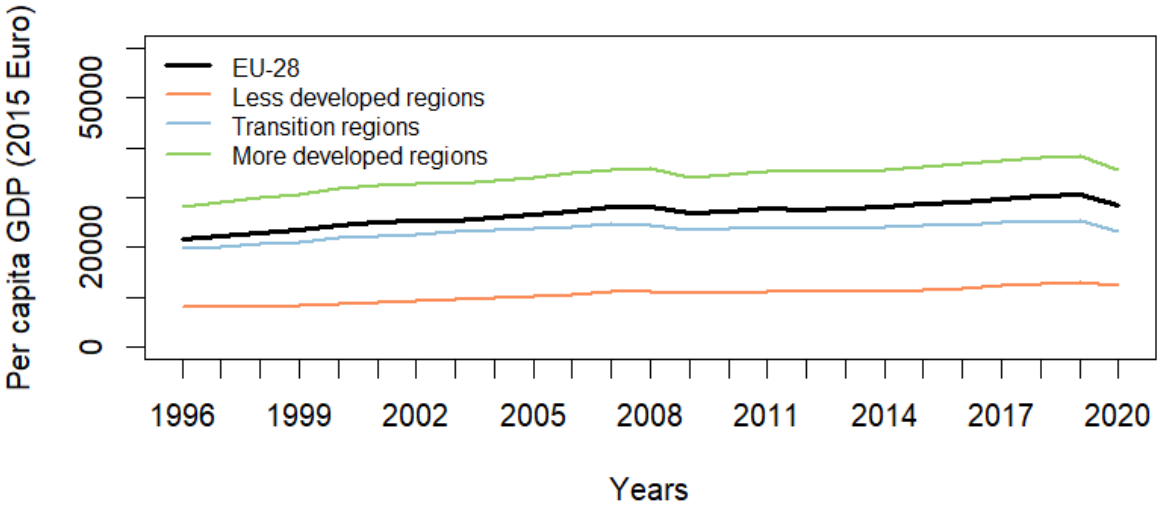
! β-convergence is **necessary but not sufficient** to guarantee σ-convergence.

Empirical evidence shows that there is **no regional convergence** at the European level.

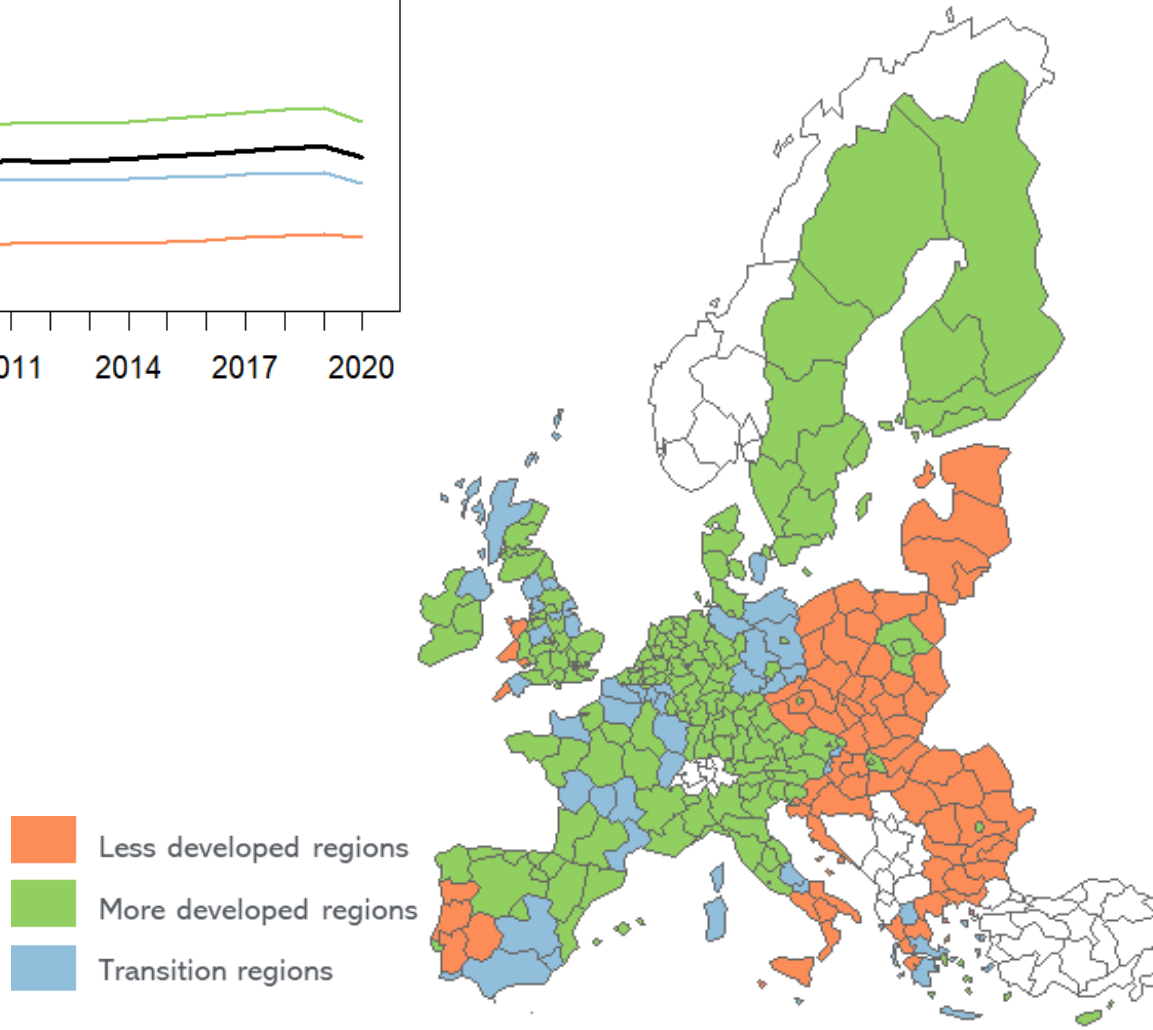
Even analyzing regions with similar economic structures, still we do not obtain consistent evidence of convergence

2. EMPIRICAL EVIDENCE ON REGIONAL CONVERGENCE

Population-weighted average per capita GDP

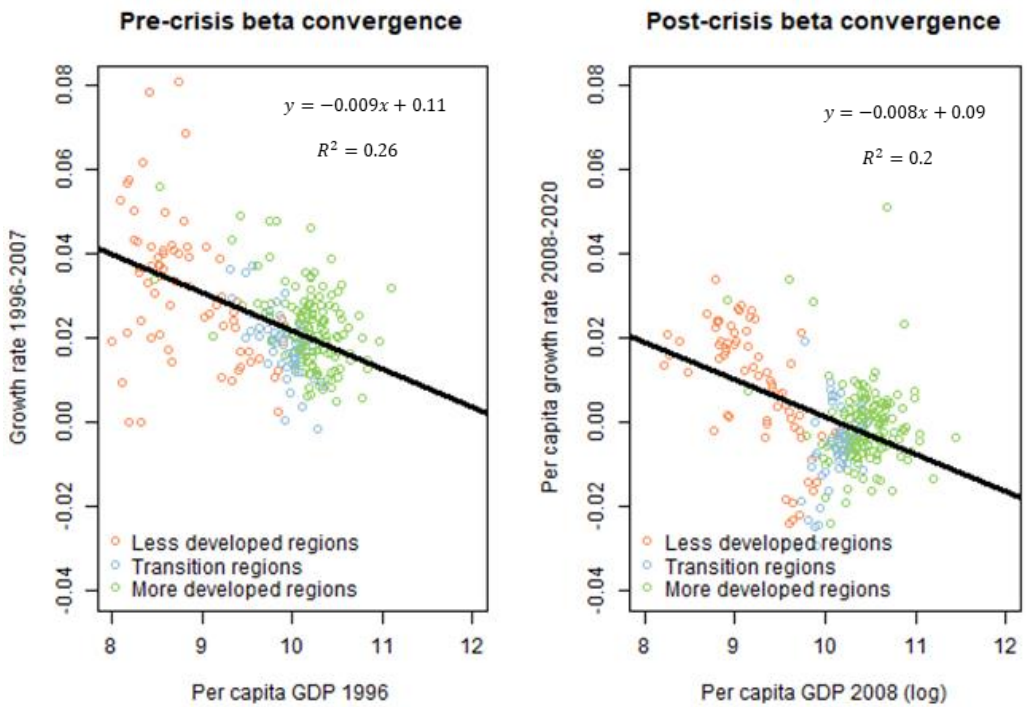


EU Programming Period 2014-2020



2. EMPIRICAL EVIDENCE ON REGIONAL CONVERGENCE

Beta-convergence



Poorer regions seem to grow a little faster than the richer ones.

2. EMPIRICAL EVIDENCE OF REGIONAL CONVERGENCE

Empirical research focused on convergence across groups with a similar economic structure, i.e., "club convergence".

Given the lack of clear evidence of convergence,
we investigate if at least convergence in this narrower sense might have happened.

The **idea** is to create clusters of regions with a similar economic, social and demographic structure in an initial period, and then we ask if regions similar in such initial conditions at least converge among themselves.

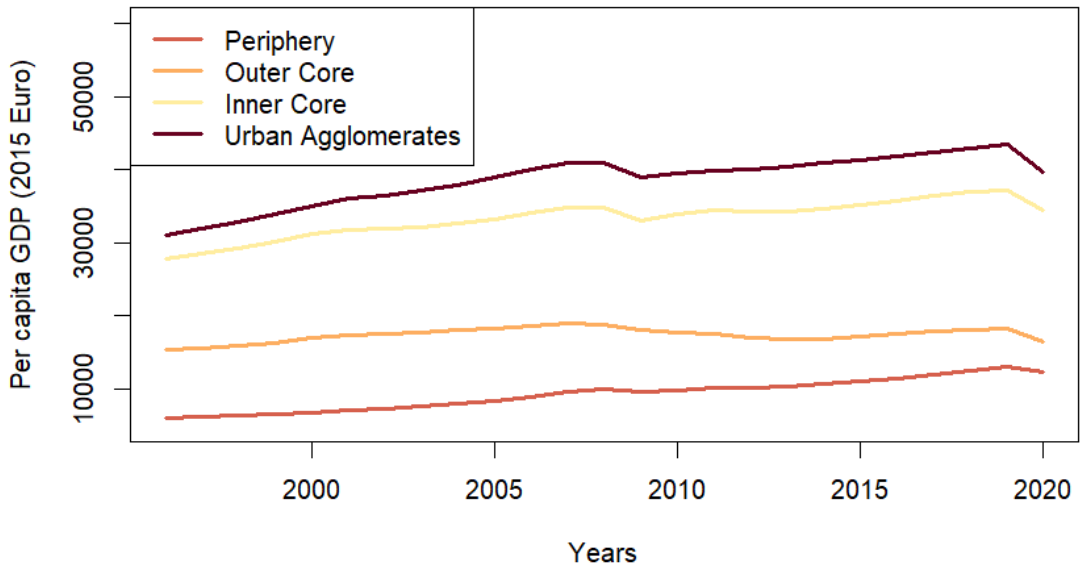
We use:

- *agglomerative hierarchical clustering*;
- *a large set of regional variables*:

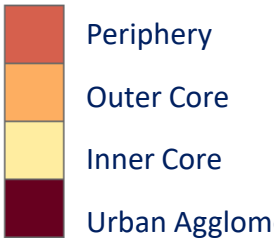
the share of GVA in agriculture
the share of GVA in industry
the labor productivity
the total investment per GDP
the public investment
the capital-labor ratio
the population density
the tertiary education
the female employment
the European Quality of Government Index

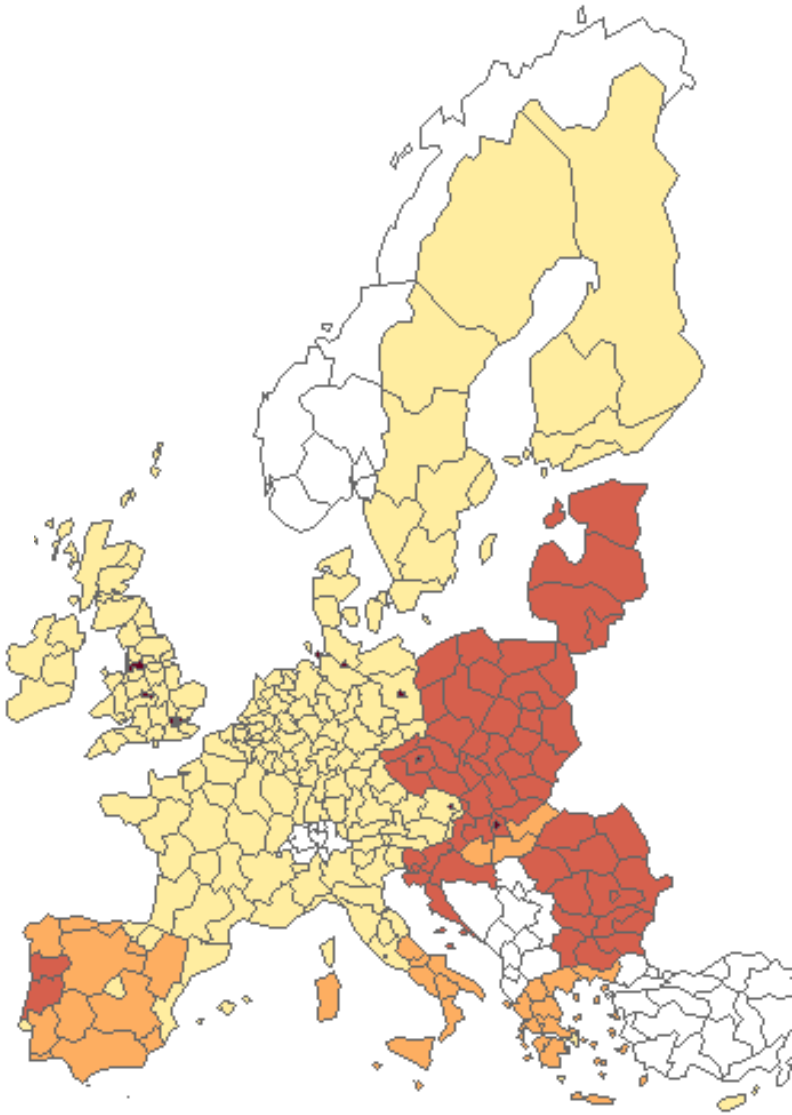
2. EMPIRICAL EVIDENCE ON REGIONAL CONVERGENCE

Population-weighted average per capita GDP



Club of regions with similar economic structure

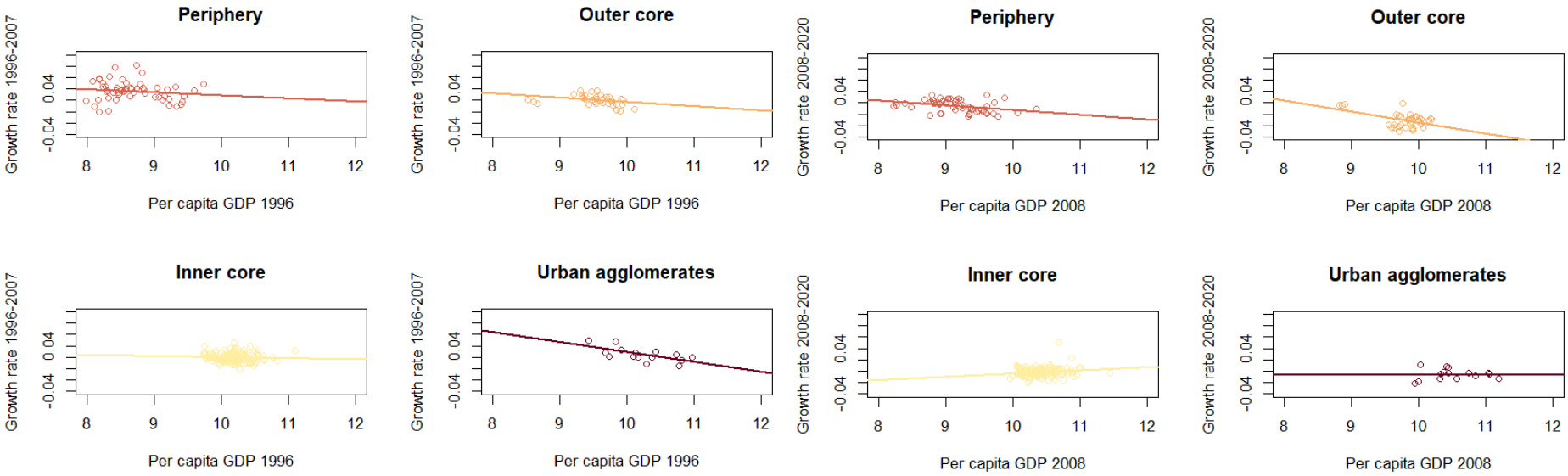




2. EMPIRICAL EVIDENCE ON REGIONAL CONVERGENCE

Beta-convergence

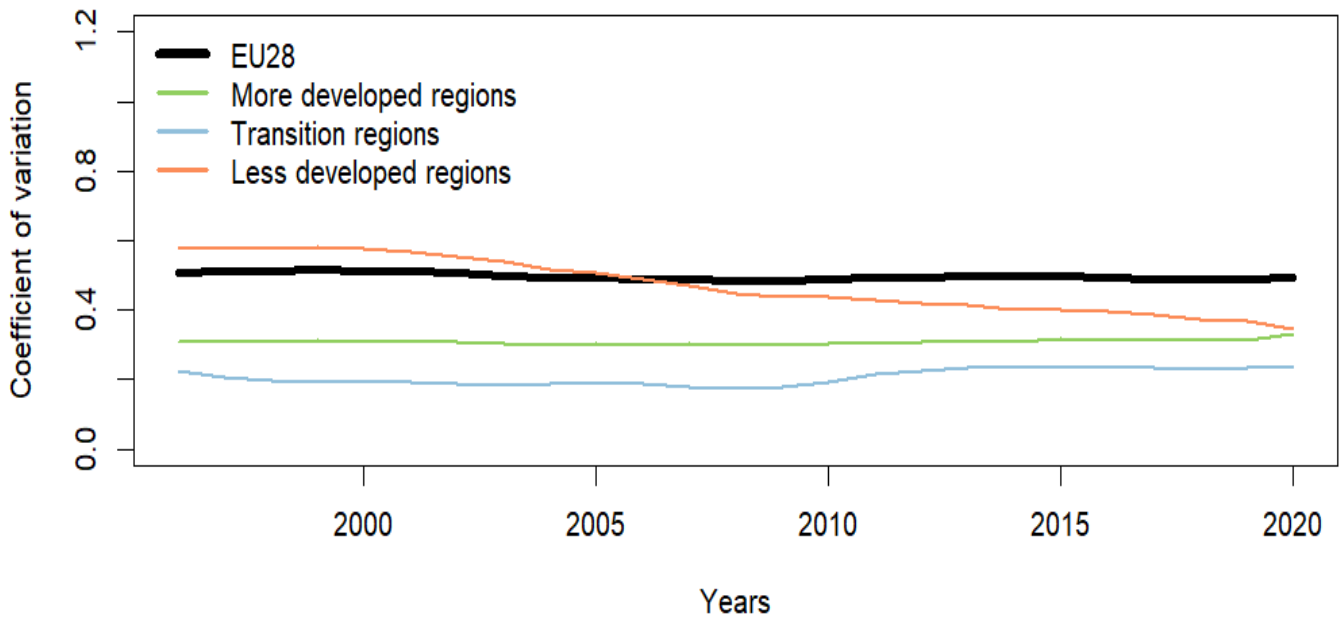
Before 2008 financial crisis ***After 2008 financial crisis***



It is difficult to affirm beta-convergence.

2. EMPIRICAL EVIDENCE ON REGIONAL CONVERGENCE

Sigma-convergence



In conclusion, even if in some cases we observe that poorer regions grew faster than the richer ones, this has not been sufficient to reduce disparities over time.

However, even if **we do not observe regional convergence**, it does not mean that the EIB “has not delivered” on this front.

We do not know **what would have happened in the absence of EIB lending**.

This is what we investigated with counterfactual statistical techniques

What would have happened to regional economic growth, had the EIB invested more or less?

To estimate the regional economic impact of EIB lending, we need:

1. **A new dataset on EIB lending at the regional level;**
2. An appropriate estimation strategy.

1. A new dataset on EIB lending at the regional level

- We considered the portfolio of all signatures (projects) by the EIB in the European Union in the **2012-2020** period.
  - We considered **all 27 EU countries as well as the United Kingdom**, which for part of the period was an EU Member State.
  - Our signature dataset encompasses projects for **€515.6 bn** (in 2015 € prices), of which €155.79 bn (in 2015 € prices) MBILs and €359.78 bn (in 2015 € prices) of other products.

- The EIB does not have detailed information yet, on the regional and time distribution of signatures for all signatures.

- Within the project, we created a dataset of the **total amounts of EIB signatures in each region and sector in a given year**.

1. A new dataset on EIB lending at the regional level

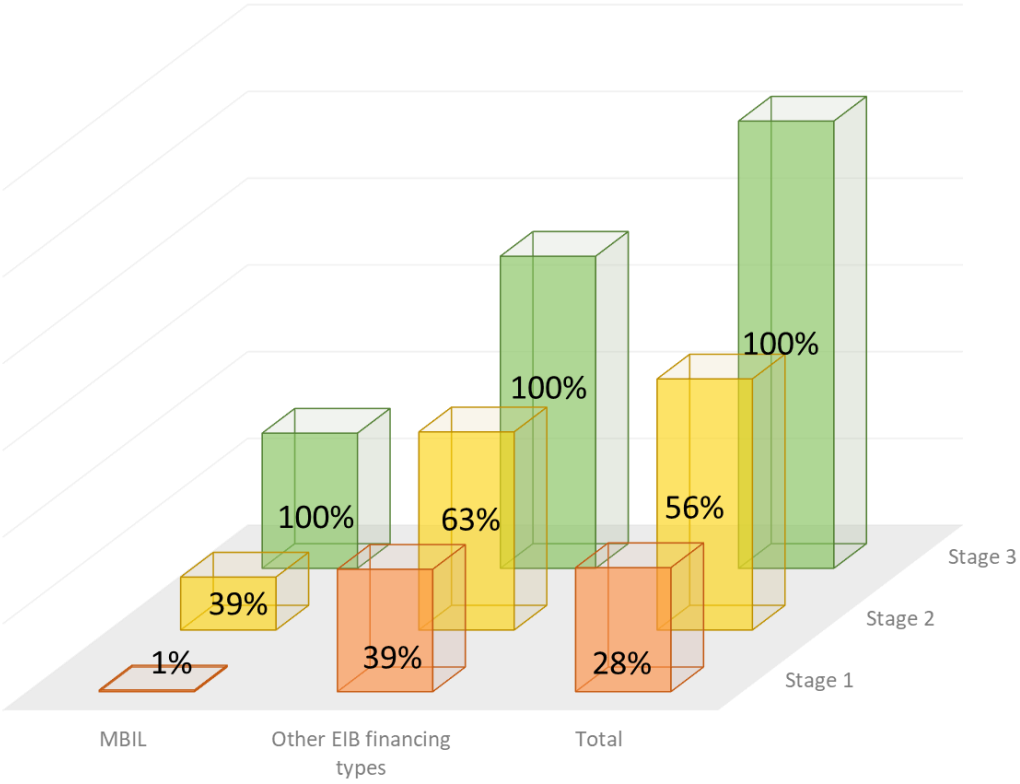
3-STAGES PROCEDURE

1. Exclude from the dataset all projects cancelled after signature, and rectify typos and errors (e.g. on NUTS codes information).

2. Data cleaning and textual analysis.
   a. For the MBILs, we use information on allocations between 2012-2020, after preparing and cleaning it.

3. Data imputation techniques.

Regional and sectoral information in the dataset



1. A new dataset on EIB lending at the regional level

Because of the uncertainty about the regional localization of projects on which there is no data, as well as about multi-regional projects, we take a conservative approach and consider a variety of assumptions for data imputation.

i. To allocate information available at the national level to the single regions and sectors, we select 6 main disaggregation criteria:

a. 3 criteria consider the ***regional economic structure***: **(i) GDP, (ii) GVA, (iii) POPULATION.**

ASSUMPTION: regions' socio-economic characteristics affect the regional allocation of EIB projects.

b. 3 criteria based on the ***observed distribution*** of projects for which information on the regional breakdown is available by: **(i) Sector of activity, (ii) EIB objectives, (iii) EIB financing types/products.**

ASSUMPTION: the projects of which the regional allocation is unknown might be allocated with similar criteria as those of which the regional allocation is known to the EIB.

ii. We consider several possible syntheses of these criteria, which can be synthetized by a weighted mean.

1. A new dataset on EIB lending at the regional level

ii. We consider 6 approaches to synthesize the six criteria, by taking the weighted average of the resulting regional allocations:

A. Based on **regional characteristics**: assigning equal weight (1/3) to the three regional criteria of GDP, population, and sectoral GVA shares, and weight equal to zero for the three project-based criteria.

B. Based on **project characteristics:** assigning equal weight (1/3) to the (the regional shares of the) three project criteria of EIB objectives, EIB sectors, and EIB financing types/products, and zero to the regional characteristics-based criteria.

C. Based on **all criteria**: assigning equal weight (1/6) to all criteria, i.e., GDP, population, sectoral GVA shares, EIB objectives, EIB sectors, and EIB financing types/products.

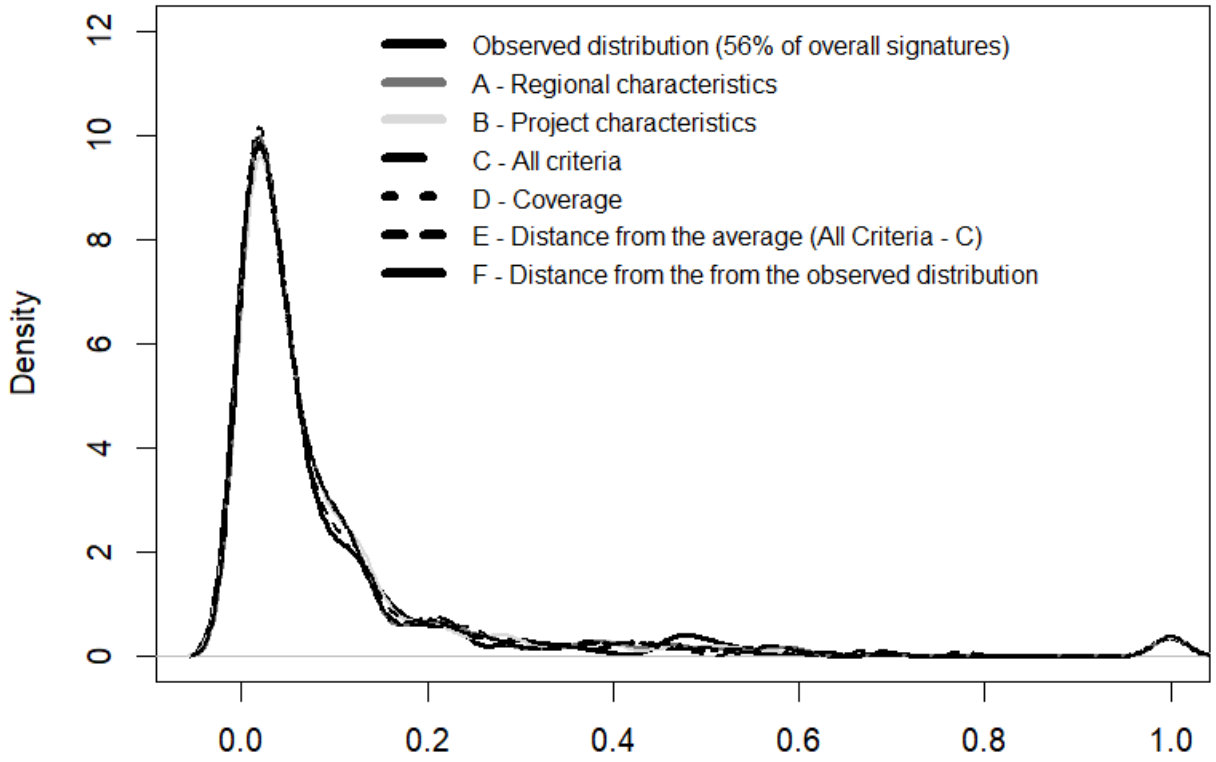
D. Weighting based **on coverage**: attributing to each of the six criteria a weight proportional to the extent to which, for each country, that criterion contains information on regional amounts in the original dataset.

E. Weighting based **on the distance from the average**: the weights of each criterion are computed as the inverse of the distance between the distribution of amounts resulting from that criterion and the distribution resulting from the average of all criteria.

F. Weighting based **on the distance from the observed distribution**: the weights of each criterion are computed as the inverse of the distance between the distribution of amounts resulting from that criterion and the observed distribution of projects for which there is information at the regional level.

1. A new dataset on EIB lending at the regional level

In the aggregate, these six approaches result in six distributions of amounts at the regional level that do not seem very different from each other (indeed, we test for their similarity)



Distribution of regional shares of amounts, resulting from the six approaches, and observed distribution of the projects on which there are regional disaggregated data

What would have happened to regional economic growth, had the EIB invested differently or less?

To estimate the regional economic impact of EIB lending, we need:

1. A new dataset on EIB lending at the regional level;
2. **An appropriate estimation strategy.**

2. Estimation strategy

- We do not compare observed levels of lending and of GDP growth across EU regions, because the resulting estimates could be biased.
  - The decision to lend reflects a policy evaluation process that also depends on regional characteristics, so the determinants of lending must be taken into account: they could have an impact on growth, separately from the effects of lending.

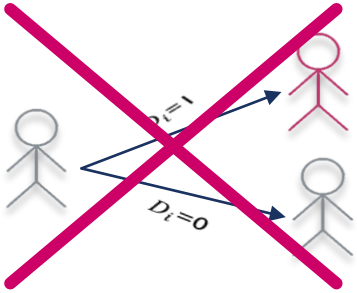
- We draw inspiration on recent literature on the economic impact of the EU Structural and Cohesion Funds, which uses **counterfactual approaches** (Becker et al., 2012; Dall'Erba and Fang, 2017 and others).
  - The consideration of causality in a counterfactual perspective (Rubin, 1974) aims to improve the reliability of empirical economics, providing statistical and data-driven techniques to gather evidence.

- **The idea of the counterfactual approach is to create a counterfactual scenario, i.e., to ask what would have happened in the absence of policy, even in non-randomized policy contexts.**

2. Estimation strategy

Most works on policy impact evaluation consider policy in a binary context, i.e., a situation in which policy exists compared with one in which it does not exist

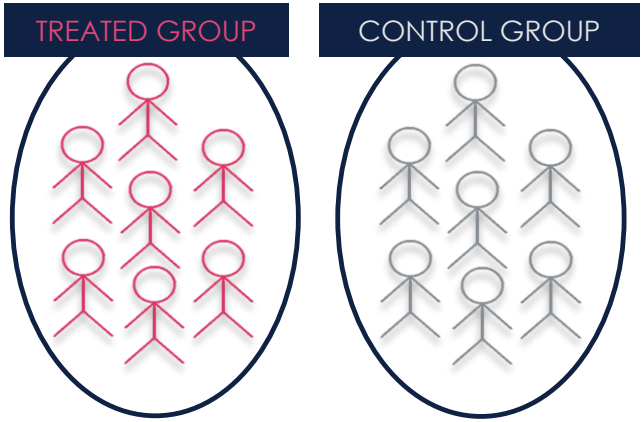
Causality



THE CAUSAL INFERENCE PROBLEM

missing data problem

Solution



Estimate the **average effect of the treatment** for the population: compare the difference in means between the **treated group** and a **control group** that has a similar distribution of observed and unobserved characteristics.

This works in randomized experiments.

In **observational studies**, we would like to evaluate **ex-post** an effect.
The first empirical threat to face is the **selection bias:** because treated and control groups have no similar characteristics, the potential outcomes may depend on the selection of the treated units.

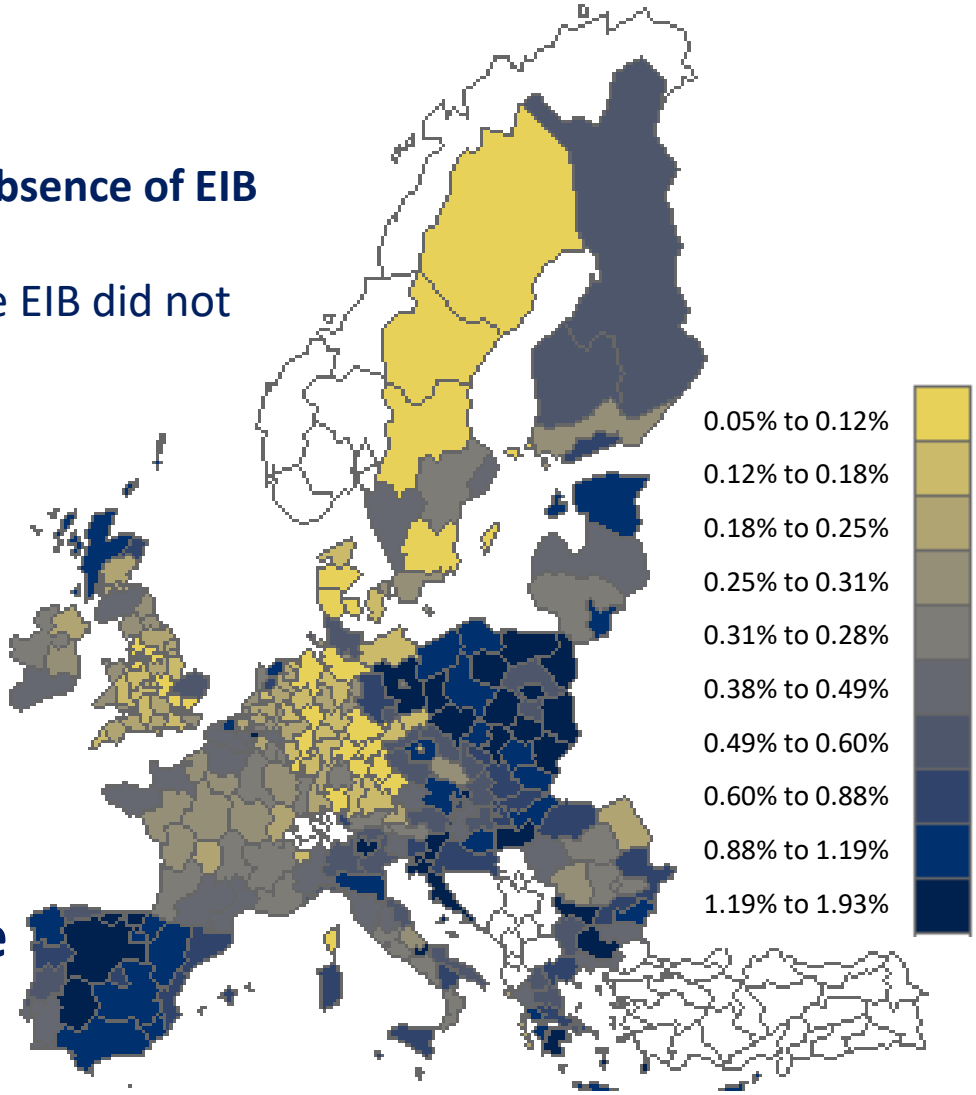
2. Estimation strategy

To estimate **the hypothetical scenario in the absence of EIB lending**,
we would need data about regions where the EIB did not invest.

(Fortunately) The EIB does not concentrate its investments in some regions only.

Instead, the value of regional projects is **heterogeneous**, so we can ask:

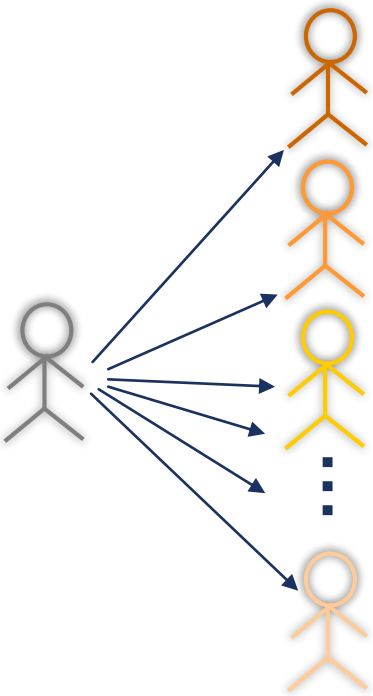
What would have happened to regional economic growth, had the EIB invested *more or less*?



Annual average amounts of signatures between 2012-2016 on the GDP

2. Estimation strategy

Causality with continous treatment



- In this **continuous variable context**, the framework of potential outcomes becomes more complicated: **potentially each region could have been exposed to any treatment level.**
- But we only observe one level for each region.
- Under certain conditions, we may be able to build a **dose-response function (DRF):** the relationship between the treatment and the outcome variable.
- Thus, for any potential level of treatment we can estimate the average potential outcome.

2. Estimation strategy

What would have happened to regional economic growth, had the EIB invested more and less?

We investigate the **regional** (NUTS-2 level) impact of

annual average amounts of EIB signatures between 2012-2016 as a share of GDP

("treatment")

on

the yearly per capita GDP growth rate in 2013-2018

("outcome" variable).

We do so separately for the **less developed and transition regions,**

and for the **more developed** regions.

2. Estimation strategy

What would have happened to regional economic growth, had the EIB invested differently?

Generalized Propensity Score (Hirano and Imbens, 2004) gives us the answer.

The **idea** is to compare regions with sufficiently similar characteristics but different treatment intensity, estimating a possible outcome at different levels of treatment.

The **key assumption** is that the **outcome variable is independent of treatment given a vector of observable factors** ("unconfoundedness" assumption). This way, we correct for selection bias.

2. Estimation strategy

The first step is to estimate the generalized propensity score.

It represents the probability that the region receives that level of lending, given the observed regional characteristics, i.e., the probability density function for an observed level of treatment.

REGIONAL CHARACTERISTICS CONSIDERED

tertiary education,
share of gross value added in agriculture,
share of gross value added in industry,
average labor productivity,
female employment,
total investment on GDP,
public investment on GDP,
population density,
European quality of institution index,
Krugman specialization index,
share of European Structural funds on GDP,
per capita GDP in the previous period,
country fixed effects.

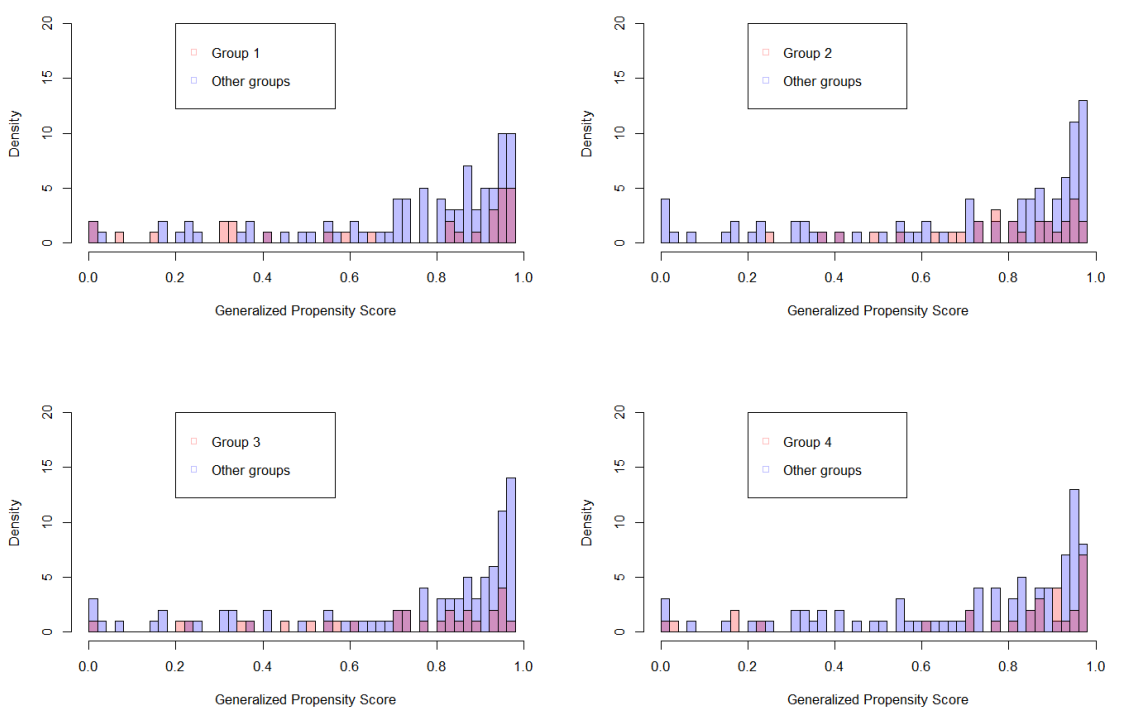
2. Estimation strategy

The idea of counterfactual analysis is to find regions with similar GPS (similar characteristics) but different treatment intensity.

We verified that there are regions with the same probability to receive a certain amount of lending but that did receive different levels of lending.

For few regions we cannot find a suitable counterpart, and we have to remove them from the sample.

We apply tests for the **common support condition** and the **covariates balancing**.



2. Estimation strategy

- **The second step** consists in the estimation of the expected value of economic growth, given a certain treatment intensity and the GPS:

$$E[growth_i | treat_i, gps_i] = \alpha_0 + \alpha_1 treat_i + \alpha_2 gps_i$$

- We thus estimate the **dose response function**, i.e., the relationship between EIB signatures and economic growth. However, these estimated parameters **do not have a causal interpretation**.
- We must estimate the average **potential outcome at each level of treatment intensity**.

- **The third step** consists of defining the potential outcomes.
  - We chose the treatment intensity levels that we are interested in (in our case, deciles of the observed distribution), and for each region we impute the potential outcome associated with each of these levels.
  - We must consider: the treatment intensity we chose, the correspond GPS, and the parameters estimated before.
- To obtain the potential outcomes, we take the average of the potential regional outcomes for each level of lending:

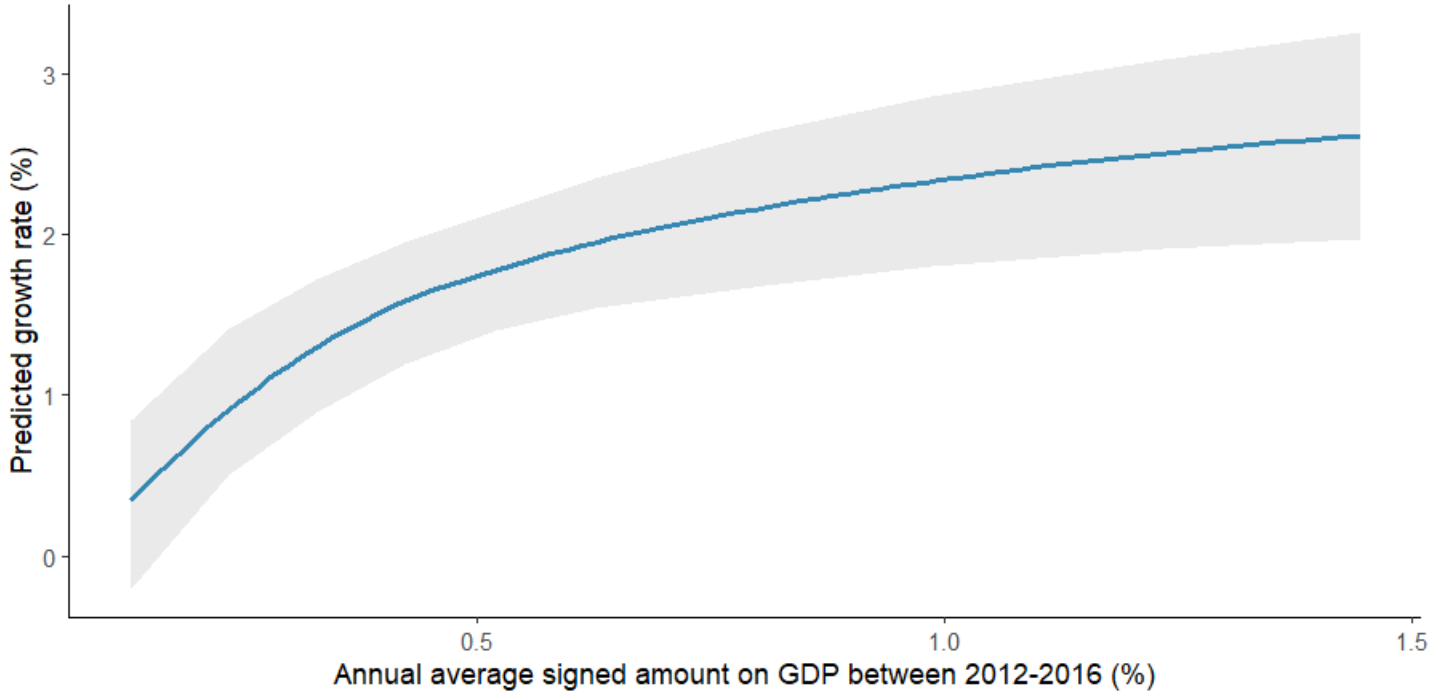
$$E[\widehat{growth}_\tau] = \frac{1}{N}[\widehat{\alpha_0} + \widehat{\alpha_1} treat\_lev + \widehat{\alpha_2}\widehat{gps}(treat\_lev, reg\_var_i)]$$

To estimate the economic impact of EIB lending at the regional level

2

DRF for the less developed and transition regions

What would have happened to the regional economic growth of LESS DEVELOPED-TRANSITION REGIONS, had the EIB invested differently?

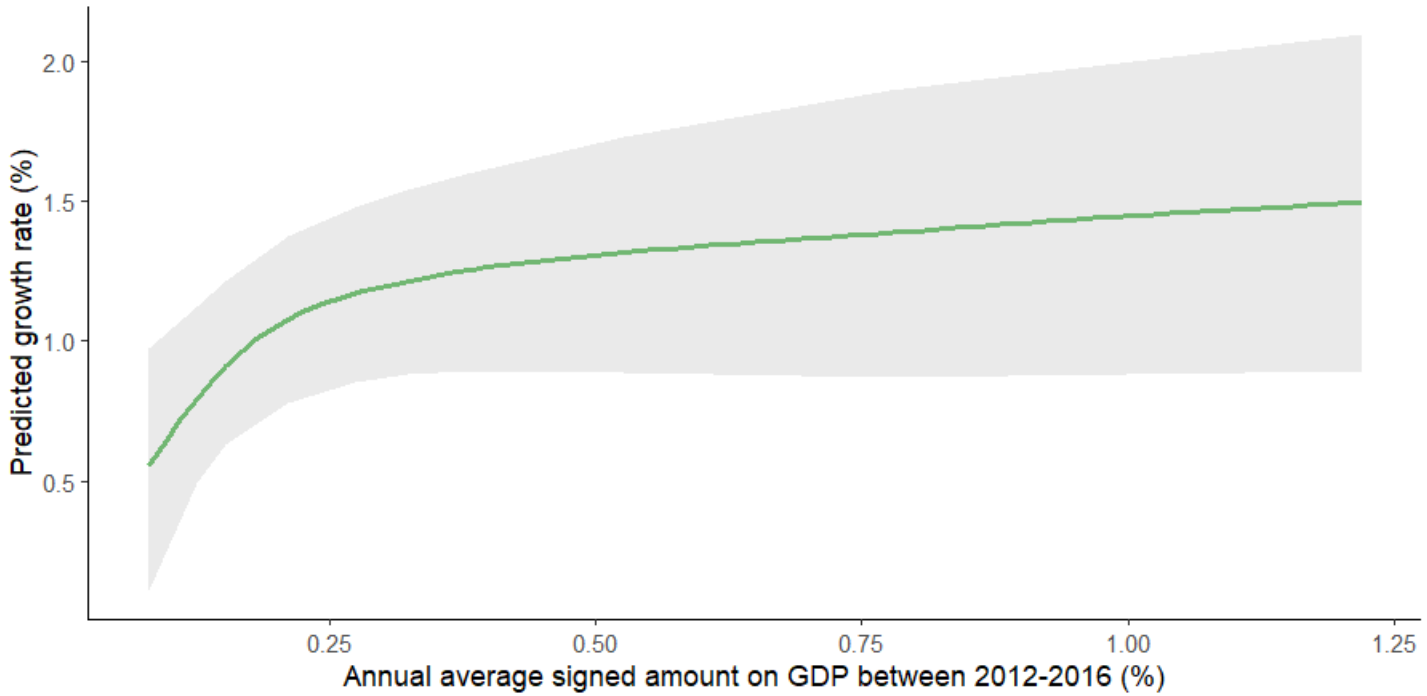


To estimate the economic impact of EIB lending at the regional level

2

DRF for the more developed regions

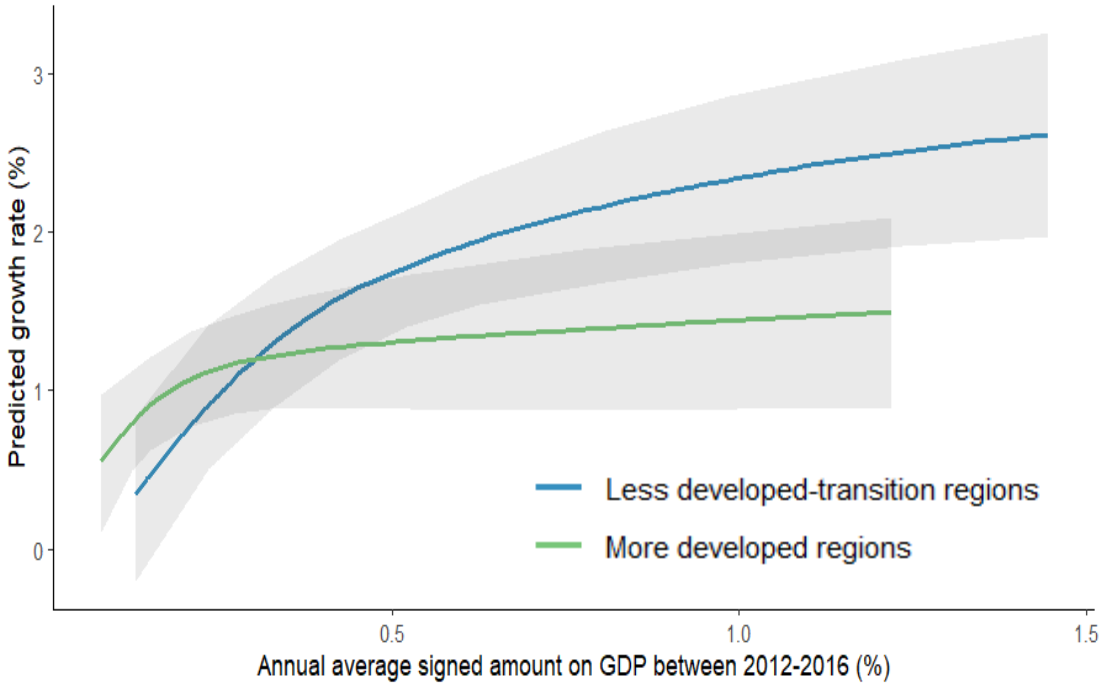
What would have happened to the regional economic growth of MORE DEVELOPED REGIONS, had the EIB invested differently?



To estimate the economic impact of EIB lending at the regional level

2

Comparing DRFs



- **The more the EIB invests, the more we expect to region to grow**, both for more developed regions and for less developed-transition regions;
- for medium to high amounts of signatures on GDP, we predict **a greater growth rate** for the less developed-transition regions **than** for the more developed regions;
- the difference between the two groups of regions grows with the level of lending on GDP.

To estimate the economic impact of EIB lending at the regional level

2

The multiplier

The **multiplier** measures the impact that a change in economic activity—such as new investments or spending—will have on total economic output.

In our framework, we do not consider observed changes in time, but rather differences in the levels of treatment intensity (signatures on GDP).
With some algebraic manipulations, we can calculate the multiplier as the ratio between the change in GDP and the change in levels of EIB lending.

For example, comparing the scenario in which the EIB invests the maximum value of signatures/GDP observed for that group of regions, to that in which it invests the minimum, the estimated regional multipliers are:

LESS-DEVELOPED TRANSITION REGIONS

1.75

MORE-DEVELOPED REGIONS

0.84

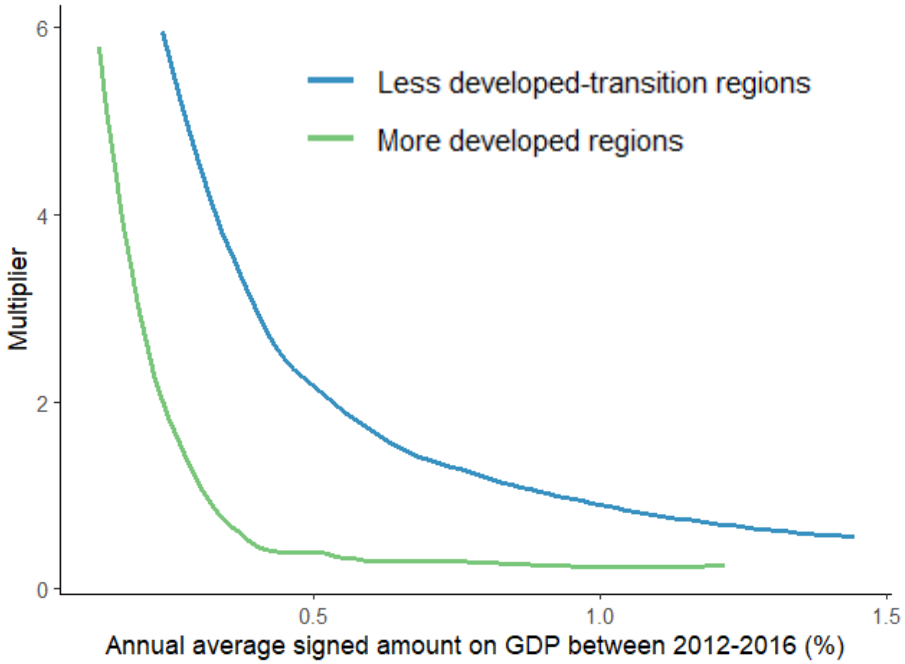
To estimate the economic impact of EIB lending at the regional level

2

The multiplier

- The EIB multiplier is always **positive**
- It **decreases** as a function of the level of signatures on GDP.

- For the same potential signed amounts on GDP, the **multiplier is larger for the less developed-transition regions than for more developed regions.**



Results: comparison

- **Possible reasons for the our positive results:** investments have a larger multiplier effect than current expenditure (Deleidi, 2022); and financial leverage of EIB-financed projects («additionality» of EIB lending)

- **Previous EIB reports use macroeconomic (theoretical) models to estimate the prospective impact of EIB lending. Our results are in line with theirs.**
  - EIB (2021a) considers a portfolio of projects financed under cohesion and finds an increase of regional GDP growth up to **1.3%** on average (with respect to their baseline scenario). EIB (2021b) estimates, on average across all EU regions, an impact of **0.8%** with respect to their baseline scenario for 2020-2025.

- **Our results are in line with previous literature on the income multiplier that focuses on European Structural Funds** (typically using instrumental variables approaches).
  - Coelho (2019) identifies a regional multiplier in the poorest European regions of **1.8**, which grows to **4.1** after three years. Durand and Espinoza (2021) find that an increase in European Structural Funds disbursements of 1 percent of GDP has a multiplier of **1.2** on impact, and **1.8** after 1 year.

- **Literature on empirical estimation of the multiplier in Europe** (that uses VAR models) generally finds similar values too.
  - Estimated instantaneous multipliers: Blanchard and Perotti (2002) and Burriel (2010) **0.75-0.84**; Beetsma et al. (2008) **1.17-1.50**; Deleidi et al. (2020) **1**, and **3.4** at peak; Bénétrix and Lane (2010) and Tenhofen et al. (2010): **3.5**; Piacentini et al. (2016) **1.45** (in Northern Italian regions) and **1.37** (in Southern Italian regions)

To look into differences across regions

3

The total impact of EIB lending on a region *i*'s income growth can be disaggregated between a **direct** and an **indirect effect**.

Up to now, we neglected spillovers coming from the EIB signatures in "neighbouring" regions (those with which a region trades most), with the risk of under- or over-estimating the effect (if the spillover is negative or positive, respectively)

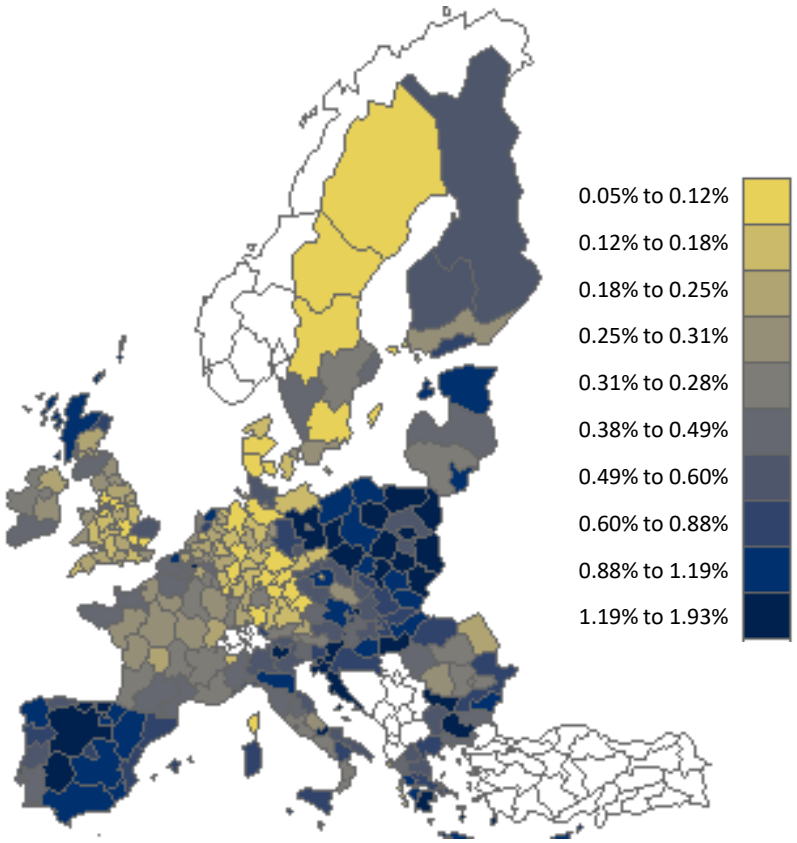
Again, we conduct separate analyses for the less developed and transition, and the more developed regions.

The direct and the indirect impact

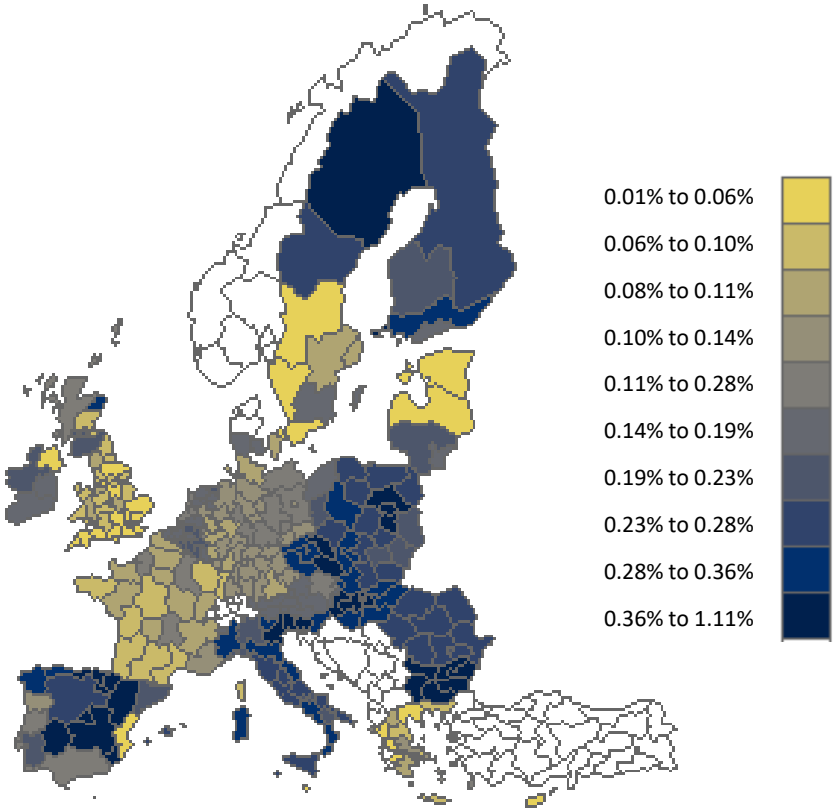
The **idea** is that each region is affected by a *direct treatment* and by an *indirect treatment* received by network connections.

- The **direct effect** measures the increase (or, potentially, decrease) in growth associated with EIB signatures in the region itself.
- The **indirect effect** captures the increase in the income of region *i* occasioned by EIB signatures in other regions (denoted by *j*), which might spill over in the form of demand for goods and services produced by region *i*, caused by the increase in income in region(s) *j*.

The direct and indirect treatment



EIB signatures on GDP



Demand from neighbouring regions due to EIB signatures

$$\frac{\sum\left(Imports_j/GDP_j\right) \times (EIB\ signatures\ in\ region\ j)}{GDP\ of\ region\ i}$$

Estimation strategy

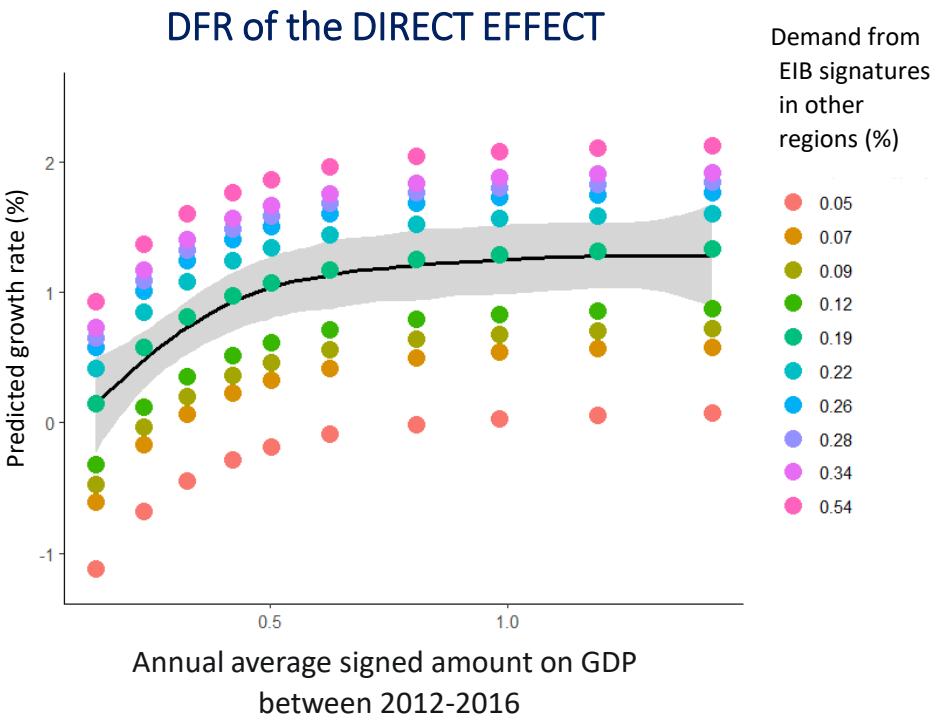
We use a GPS approach considering spillover effects (Del Prete et al., 2021).

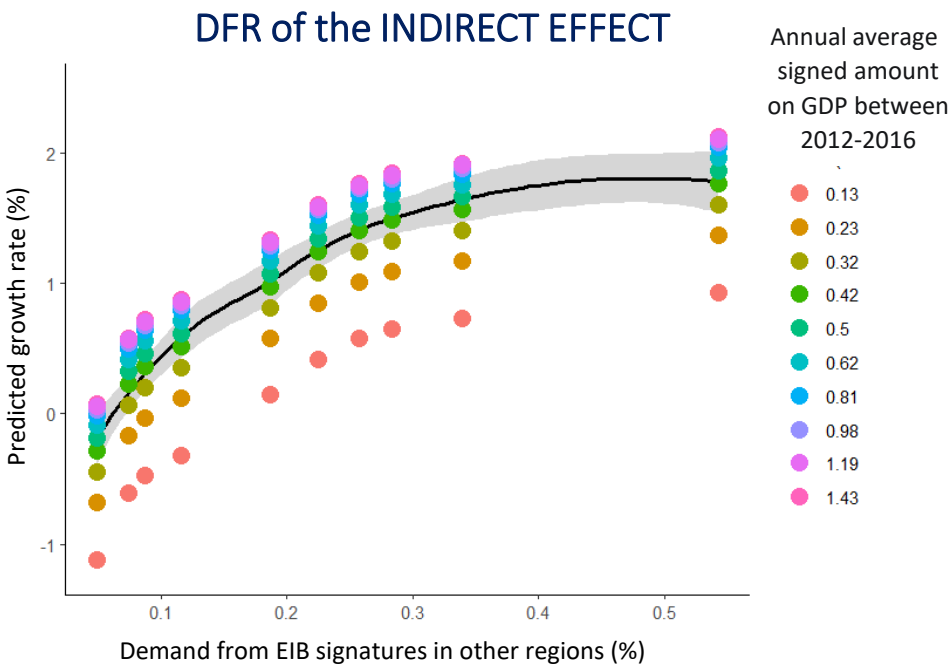
The idea is that the potential outcomes are a bivariate dose-response, i.e., an outcome potentially observed for a given level of treatment and a given level of exposure to neighborhood treatment.

In practice:

- we estimate the individual GPS and the neighborhood GPS (that depends on neighborhood treatment).
- We estimate the expected dose-response, i.e., the relationship between the outcome variable, the treatment, the neighbor treatment, and the individual and neighboring propensity scores.
- We choose levels of signed amounts on GDP we are interested in (in our case, deciles).
- We chose levels of demand from EIB signatures in other regions we are interested in (in our case, deciles).
- For each region we impute the potential outcome associated with each of these levels (we have 100 potential outcomes for each region: 10 deciles x 10 deciles).

The univariates DRFs for the less developed-transition regions

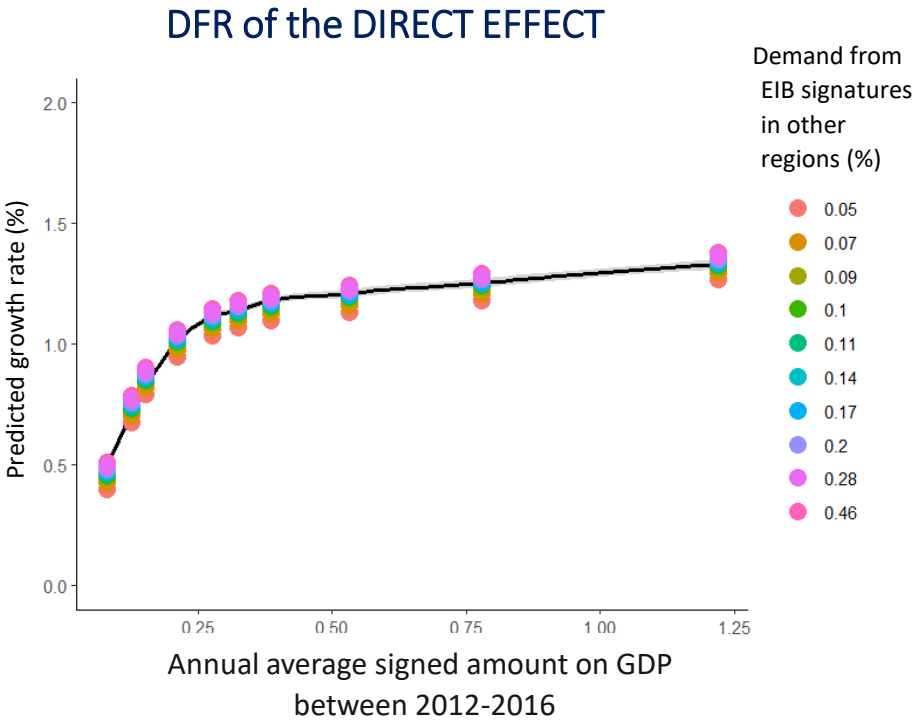


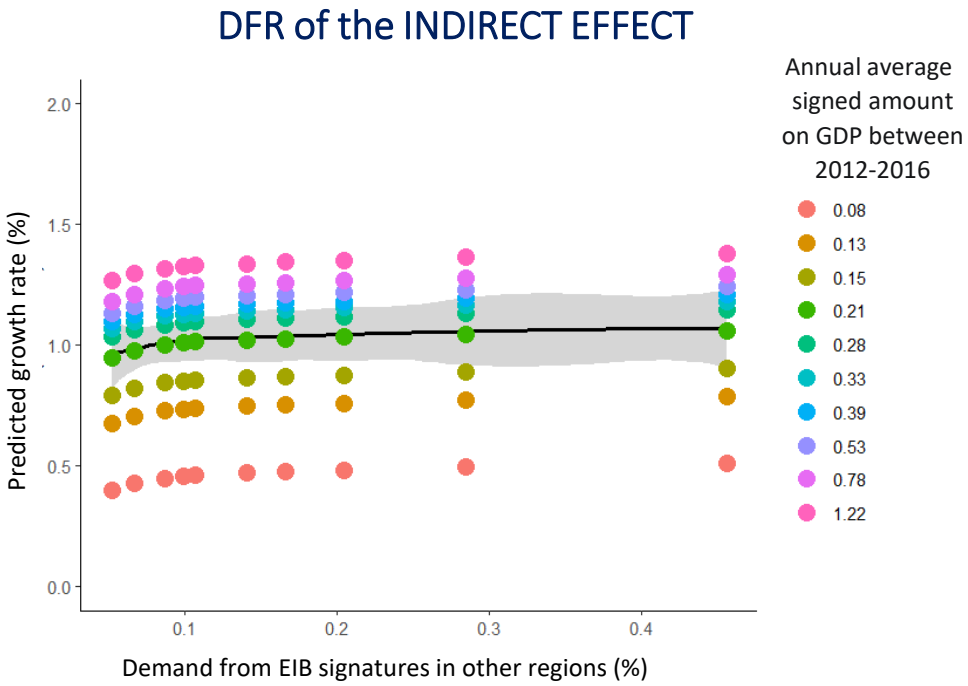


The univariate average dose-response function is obtained by averaging over the marginal densities.
The direct and indirect impact will depend on how much is lent in each region or how much is lent in neighboring regions.
More results are possible according to the hypothesis we make.

We predict a positive relationship between growth rate and demand from EIB signatures in other regions, that increases quickly (large positive spillover effect).

The univariates DRFs for the more developed regions

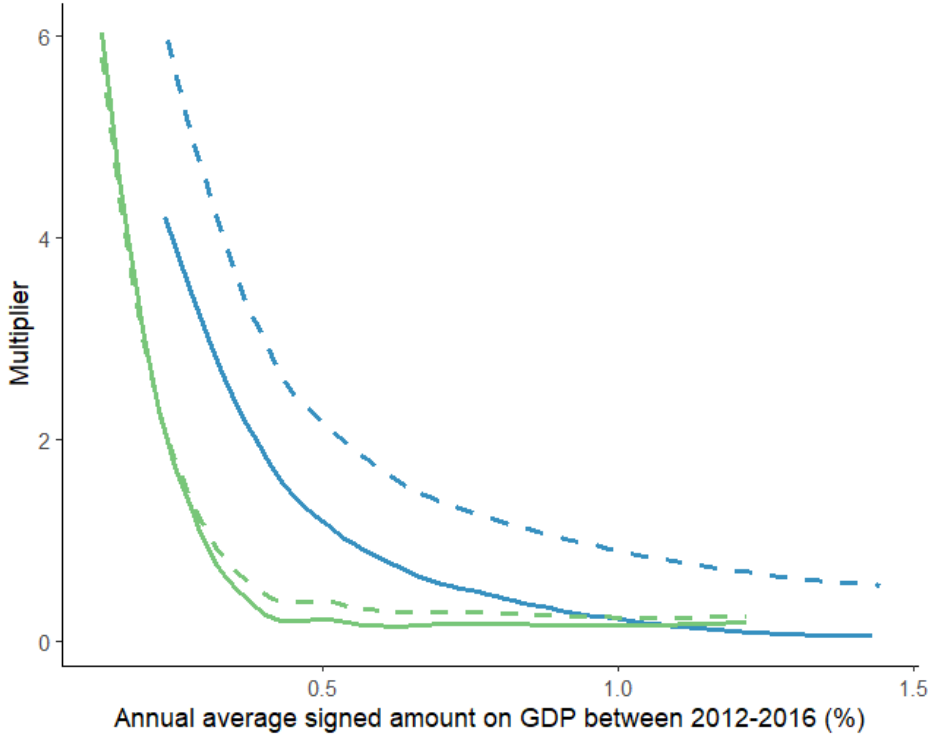




The univariate average dose-response function is those obtained by averaging over the marginal densities. The direct and indirect impact will depend on how much each region is lent or how much is lent to neighboring regions. More results are possible according to the hypothesis we make.

We predict a slightly positive spillover effect.

The multipliers of the direct effect



Note: *The dashed lines indicate the results when we do not distinguish spillover effects*

0.91

LESS-DEVELOPED TRANSITION REGIONS

0.76

MORE-DEVELOPED REGIONS

Given that we estimate a positive spillover effect, especially for the less developed and transition regions, the multipliers we previously overestimated the direct effect.

CONCLUSIONS

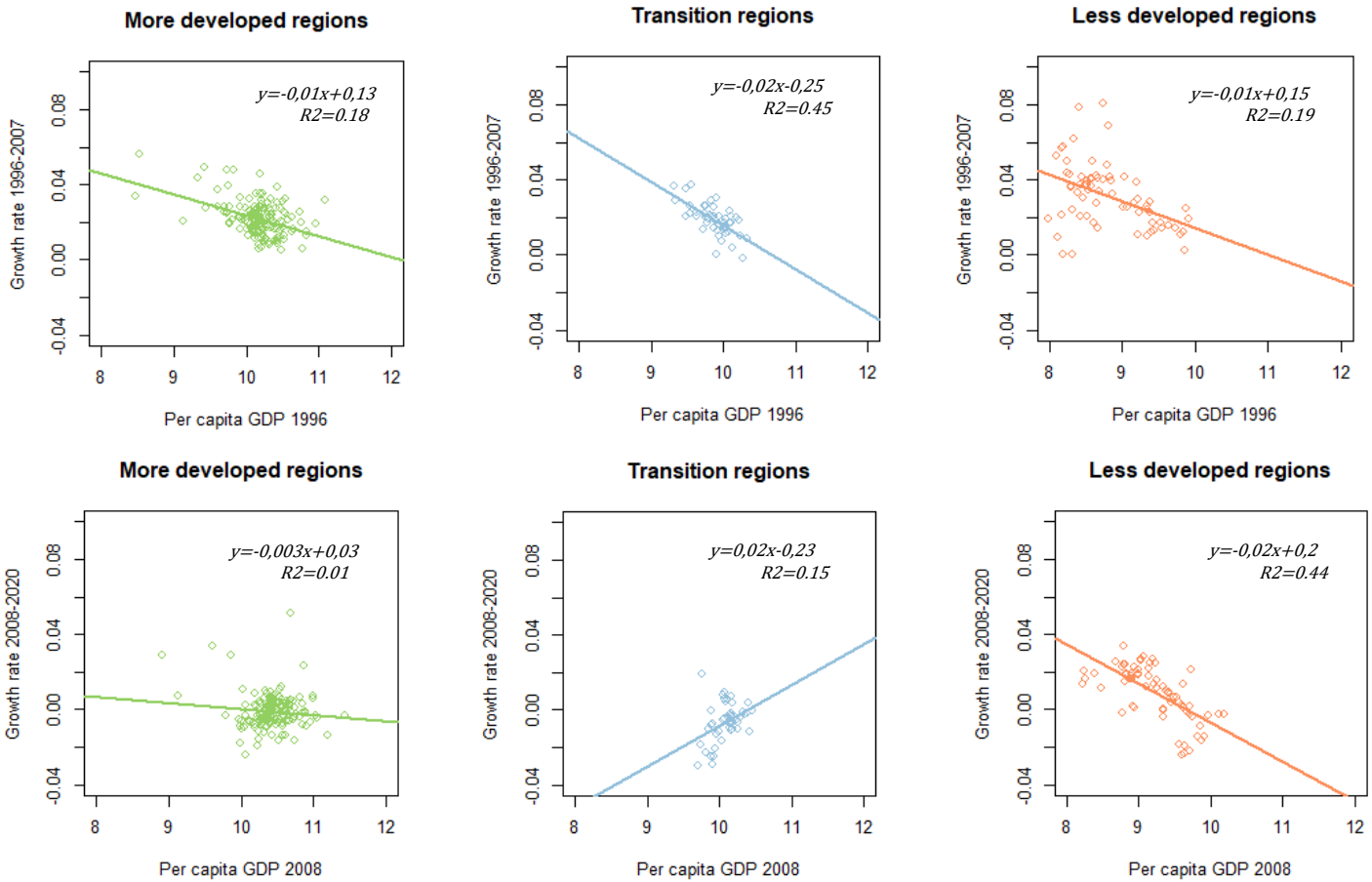
- More precise information is needed on the regional allocation of projects; until then, our database of imputed EIB signatures at the regional and sectoral level is a genuine output of the project.
- We adopt rigorous statistical techniques to retrospectively investigate the impact of EIB lending on regional GDP and geographic inequality in Europe.
- Our results (in line with recent EIB projections of the future impact of its lending) show that the EIB has a positive impact on regions' economies, and this impact larger in the less developed and transition regions than in the more developed ones.
- Always within six years, and often even within a year, it pays to lend in Europe's regions, especially in those where so far signatures have totaled a relatively low share of regional GDP.
- Had EIB lending not been there, regional divergence in Europe would have been even worse.

THANK YOU for your attention

Appendix

2. EMPIRICAL EVIDENCE ON REGIONAL CONVERGENCE

Beta-convergence



Regions with similar income levels seem to slightly converge before the financial crisis, and only less developed regions continue to converge thereafter.

3 criteria consider the *regional economic structure*

Concerning the regional economic structure, we considered the following criteria for the regional allocation of the signed amounts:

1. the regional share of **GDP** on the nation's total, using the average value for the 2012-2020 period;
2. the regional share of **population** on the nation's total, using the average for the 2012-2020 period; and
3. the regional share of the **gross value added** of sector of the project, using the average for the 2012-2018 period (data for 2019-2020 was lacking at the time of our dataset construction). To this aim, we considered the six aggregated NACE sectors reported in table 3.1, separately.

Criteria 1 and 2: we multiplied the national signed amount for each year and sector by the regional GDP and population shares of the country's **GDP** and **population**, respectively. Accordingly, unlike all other criteria, these first two result in yearly aggregate regional amounts that are not disaggregated by sector of activity.

Criterion 3: for the regions' **shares of sectoral GVA**, we aggregated national data by sector and year, and we multiplied this value by the corresponding region's share of the national GVA in that sector.

3 criteria are based on the *observed distribution*

Concerning the project characteristics, we considered the following variables:

1. **Sector of activity**, using the six macro-sectors. For the disaggregation of funds to regions, for each country we consider each region's share of projects in a certain sector.
2. **EIB objectives**. Since projects often have more than one objective, for each project the signatures dataset contains an amount to which the project is estimated by the EIB to contribute to each objective. To disaggregate project amounts to the single regions, for each project we consider the project's share of signed amount in each objective, and then for each country we consider each region's share of projects with a certain objective.
3. **EIB financing types** (not used for the MBIL projects) or **EIB financing products** (for the MBIL projects). For each country, we consider each region's share of projects of a certain type or implemented through a certain product.

EIB CODE DESCRIPTION	*NACE CODE*	*NACE DESCRIPTION*
Agriculture; Fisheries; and Forestry	*A*	*Agriculture, Forestry, and Fishing*
Energy; Industry; Water; Sewerage; Solid waste	*B-E*	*Industry (excluding Construction)*
Urban development; Composite infrastructure	*F*	*Construction*
Transport; Telecommunications	*G-J*	*Wholesale, Retail, Transport, Accommodation & Food Services, Information and Communication*
Credit lines	*K-N*	*Financial & Business Services*
Health; Education; Services	*O-U*	*Non-market Services*

3 criteria are based on the *observed distribution*

Criterion 4: we aggregated the single project amounts for each **EIB objective** by country, year, and sector. Separately, only for the projects for which disaggregated information at the regional level is available, we computed each region's share of financing in the country for each EIB objective. We then multiplied the regional share by the national amount for each objective; and for each region, sector, and year, we summed up all resulting regional amounts for all objectives.

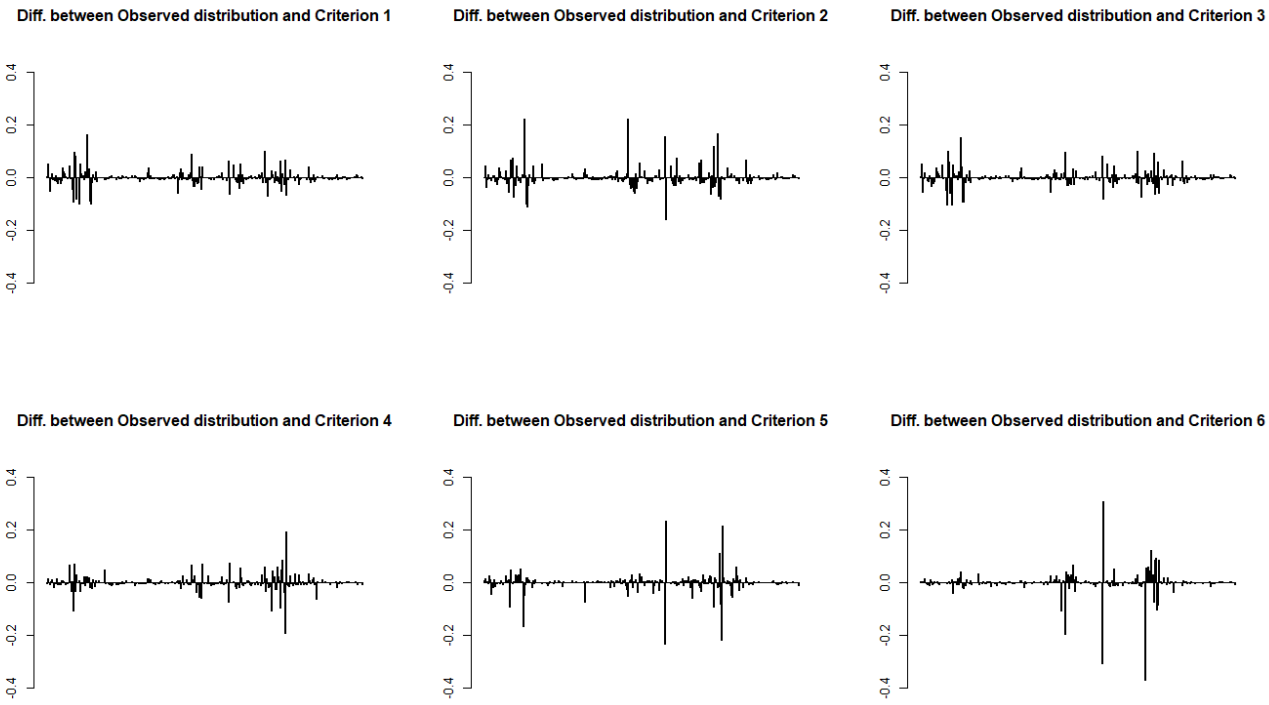
Criterion 5: for **EIB sectors**, similarly to the method adopted for the previous criterion, we aggregated the national amounts of EIB financing by sector and year, and then multiplied those for the corresponding regional sector shares calculated on the basis of those projects for which information is available.

Criterion 6: for **EIB financing type / EIB financing products**, similarly to the two previous criteria, we aggregated national amounts of EIB financing by type/product, year, and sector, and we multiplied these values by the corresponding regional shares of type/product calculated on the projects for which there is information. Total EIB financing was then obtained by summing up total financing by type/product for each region, sector, and year.

6 main disaggregation criteria

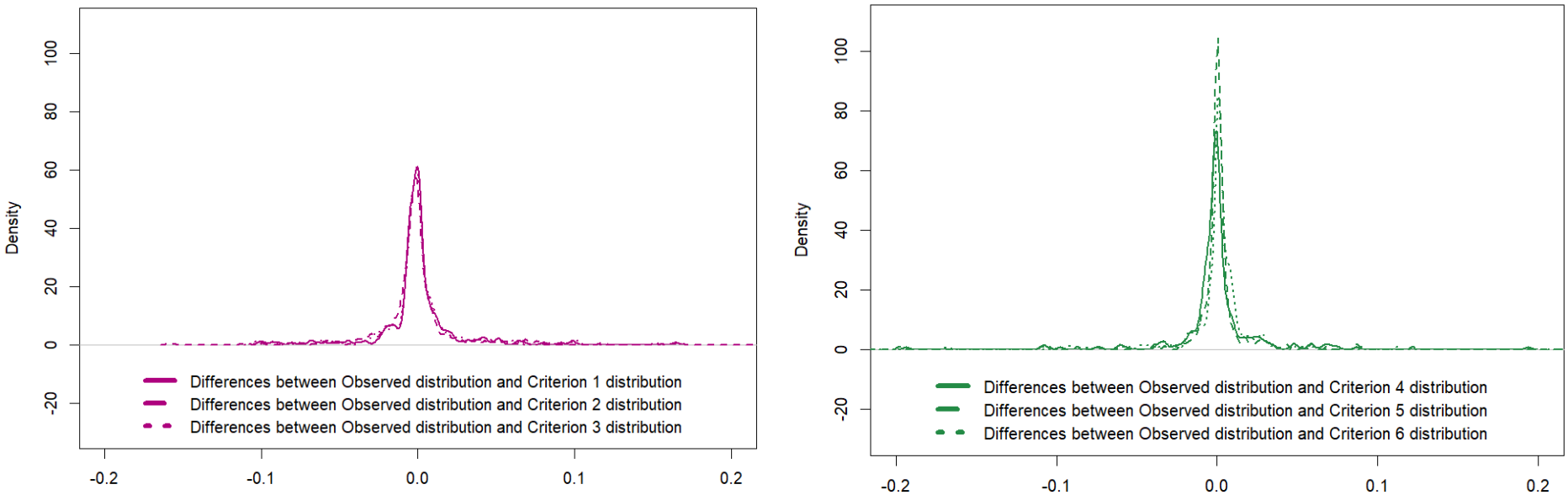
In general most differences in the regional shares of amounts seem rather low, which implies that – provided the distribution of projects on which there is information is indeed informative about the total distribution of signatures

Differences between the regional shares of the national amounts, for which there is information, and the distribution of regional shares of the national amounts, obtained with each of the six disaggregation criteria (in percentage points)



6 main disaggregation criteria

Differences in the regional shares of signature amounts: Kernel distributions



Notes: by "Observed distribution" we mean the observed distribution of projects on which there is regionally disaggregated data.

Figure 3.3. Differences in the regional shares of signature amounts: Kernel distributions

Kolmogorov-Smirnov tests

	Approach	Distance	*p*-value
A.	All criteria	0.05	0.89
B.	Coverage	0.05	0.89
C.	Distance from the average	0.05	0.83
D.	Distance from the observed distribution	0.05	0.83
E.	Project characteristics	0.03	1
F.	Region characteristics	0.07	0.56

Notes: the tests measure the probability that two samples are drawn from the same theoretical distribution, i.e., that they are not different for systematic reasons. The Distance statistics measures the maximum distance between the empirical distribution function (EDF) of a univariate dataset (i.e., one of the six approaches) and the cumulative distribution function of a second dataset (i.e., the benchmark distribution of projects on which there is regional information). The null hypothesis is that the two distributions are different; high *p*-values, such as those obtained here, imply that one cannot reject the hypothesis that the two distributions are the same.

Causal inference vs regression for continous treatment

- **Causal effects** are comparisons among potential outcomes in the **same population of units**, but the regression curve may represent different populations at different values of t.
- In other words, we **need to re-balance the sample** over the observable confounders and then estimate the DRF.

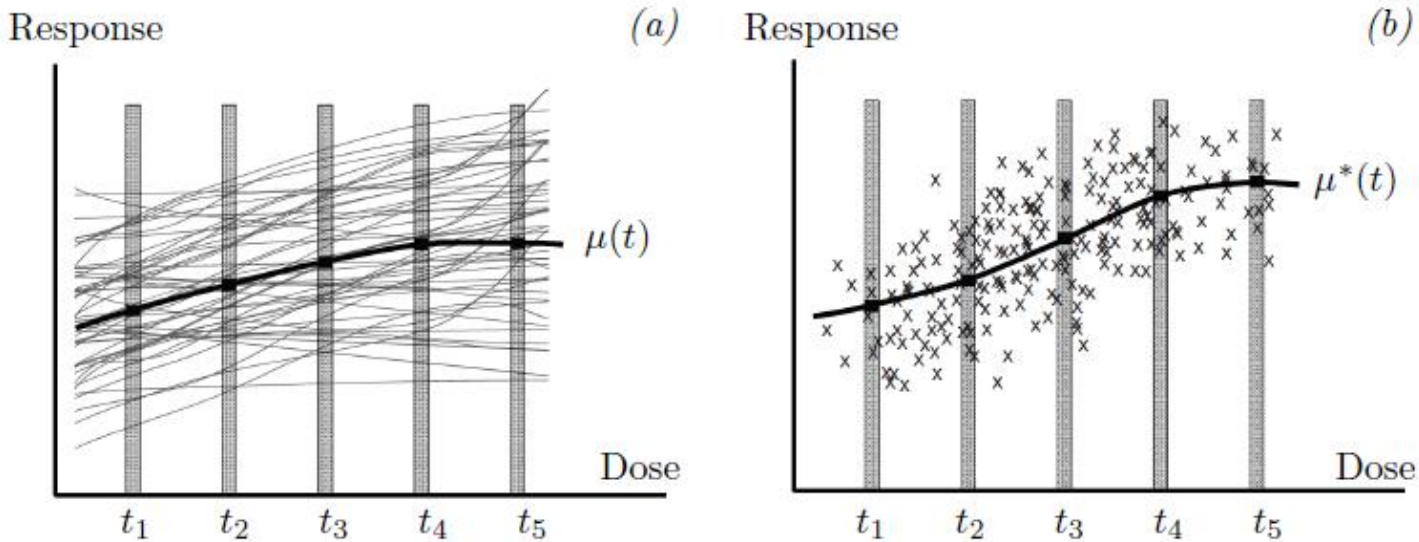
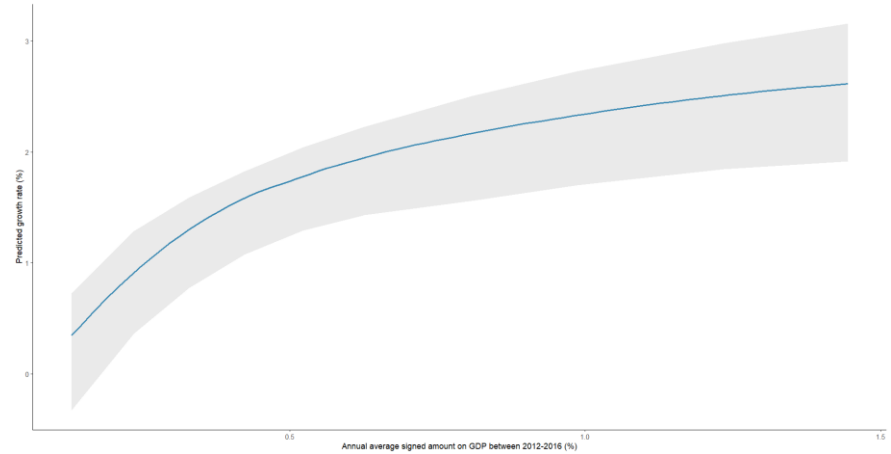
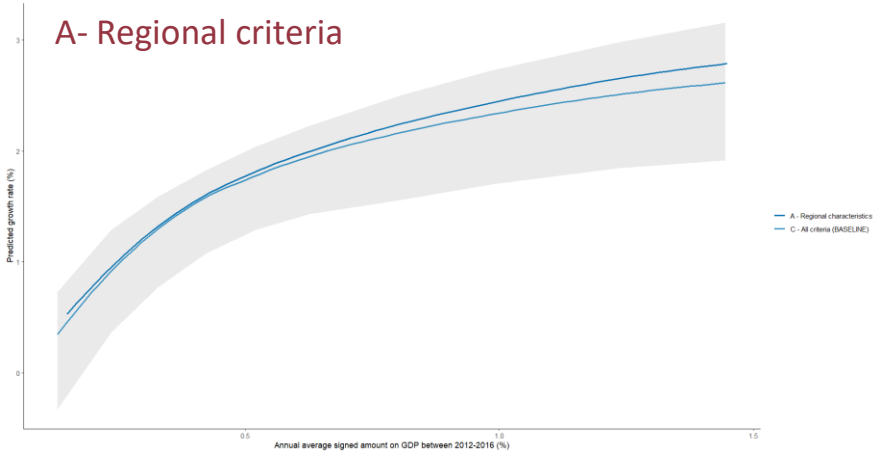
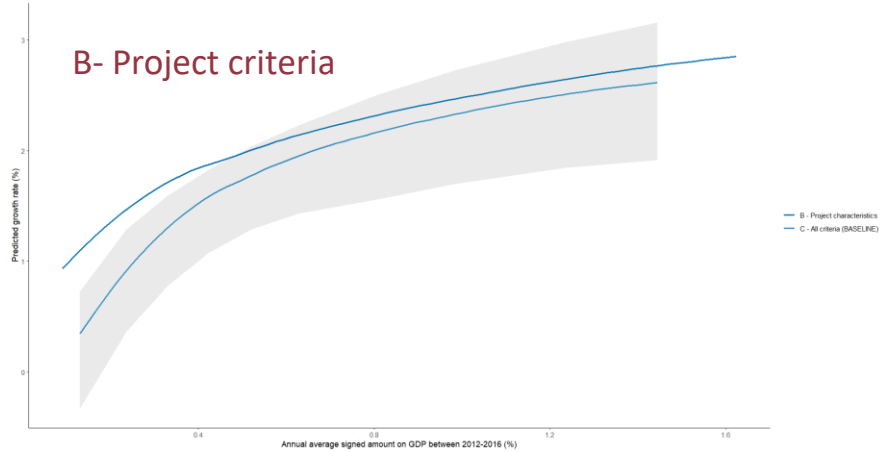
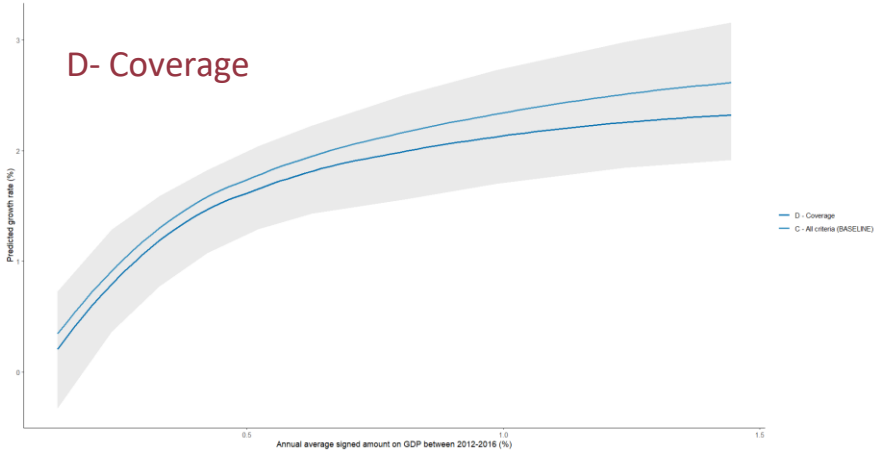


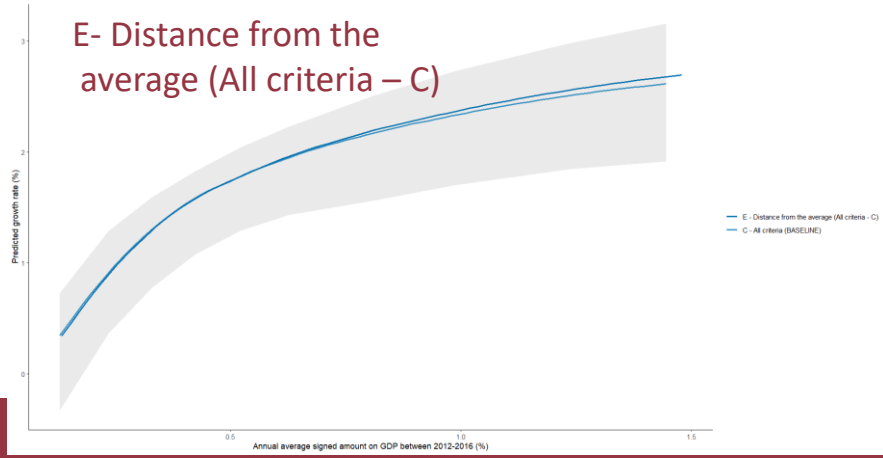
Figure 1.4: (a) Average dose-response function, $\mu(t) = E(Y_i(t))$, and (b) regression relationship between treatment and observed outcomes, $\mu^*(t) = E(Y_i(t) \mid T_i = t)$.

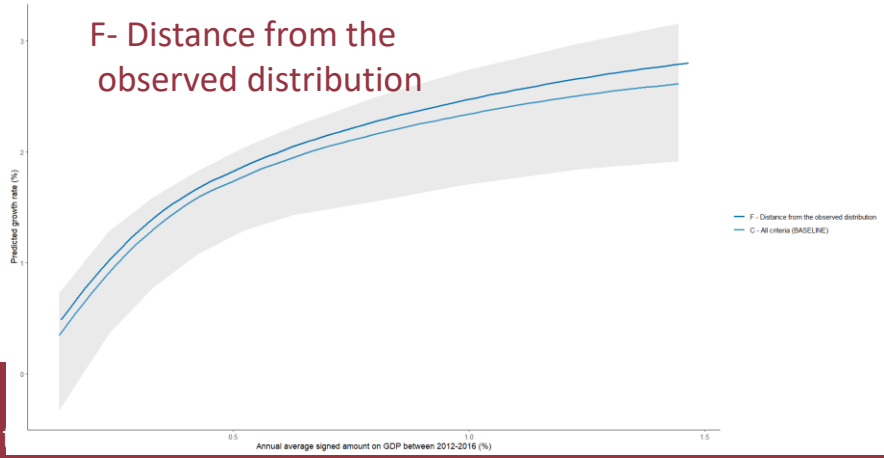

Predicted growth rate (%)
Annual average signed amount on GDP between 2012-2016 (%)


A- Regional criteria
Predicted growth rate (%)
Annual average signed amount on GDP between 2012-2016 (%)
A - Regional characteristics
C - All criteria (BASELINE)


B- Project criteria
Predicted growth rate (%)
Annual average signed amount on GDP between 2012-2016 (%)
B - Project characteristics
C - All criteria (BASELINE)


D- Coverage
Predicted growth rate (%)
Annual average signed amount on GDP between 2012-2016 (%)
D - Coverage
C - All criteria (BASELINE)


E- Distance from the average (All criteria – C)
Predicted growth rate (%)
Annual average signed amount on GDP between 2012-2016 (%)
E - Distance from the average (All criteria - C)
C - All criteria (BASELINE)


F- Distance from the observed distribution
Predicted growth rate (%)
Annual average signed amount on GDP between 2012-2016 (%)
F - Distance from the observed distribution
C - All criteria (BASELINE)

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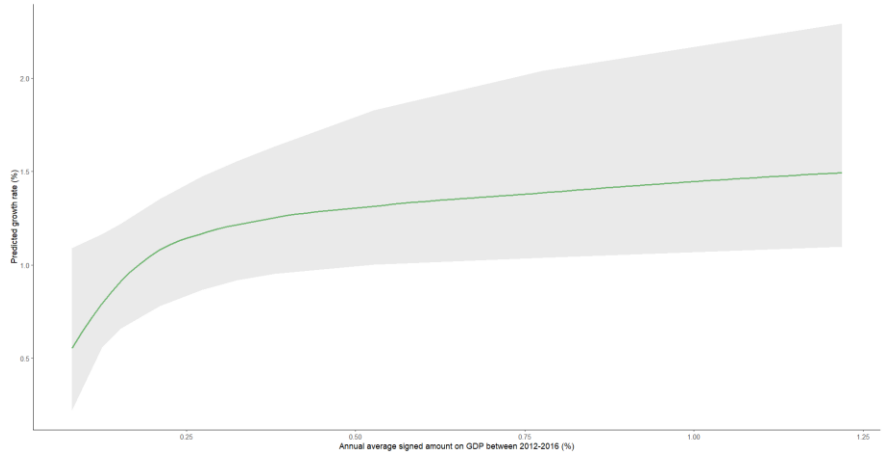
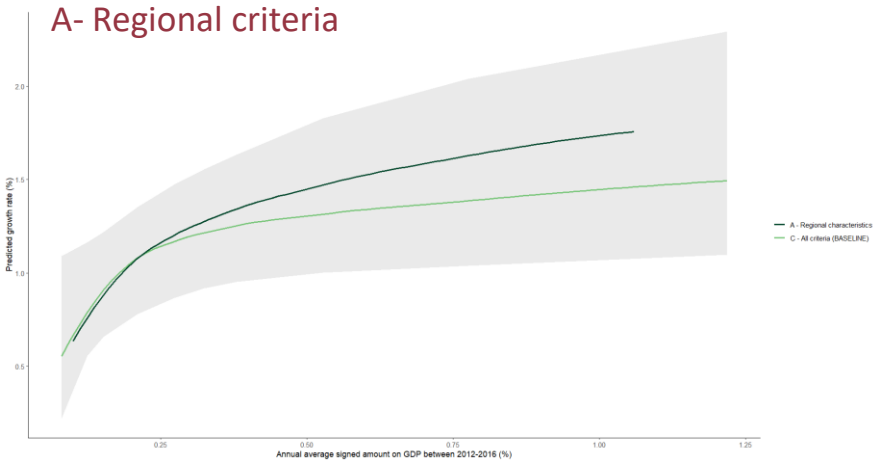
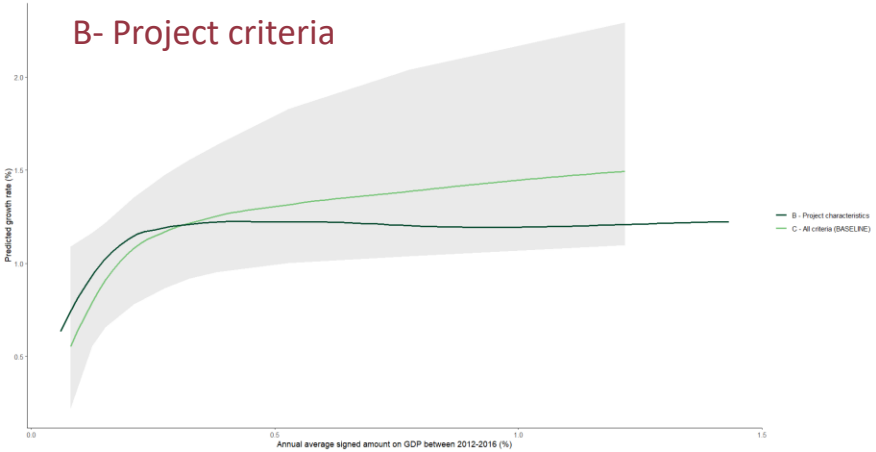


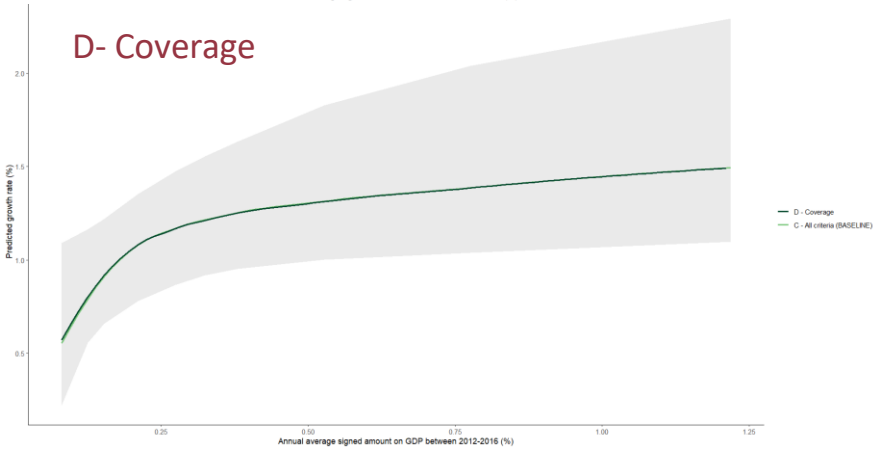
A- Regional criteria



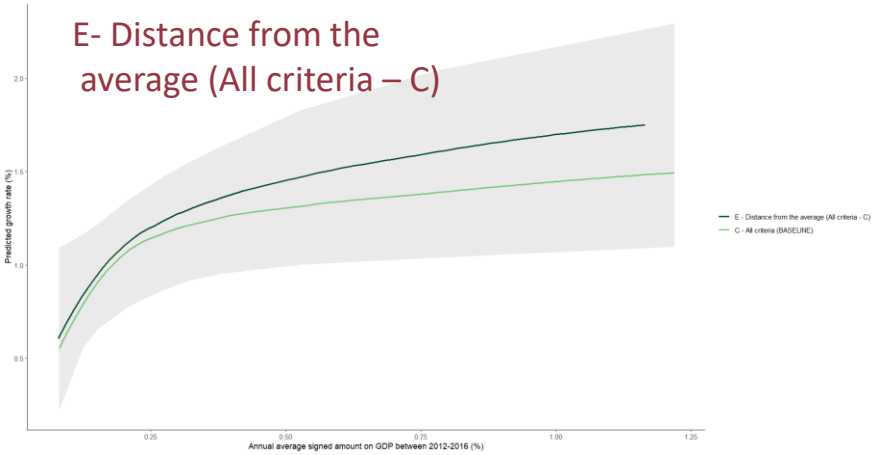
B- Project criteria



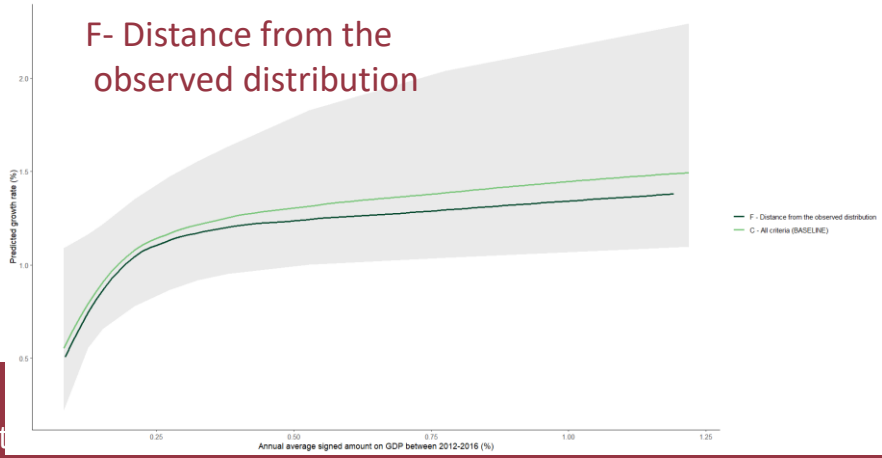
D- Coverage



E- Distance from the average (All criteria – C)



F- Distance from the observed distribution



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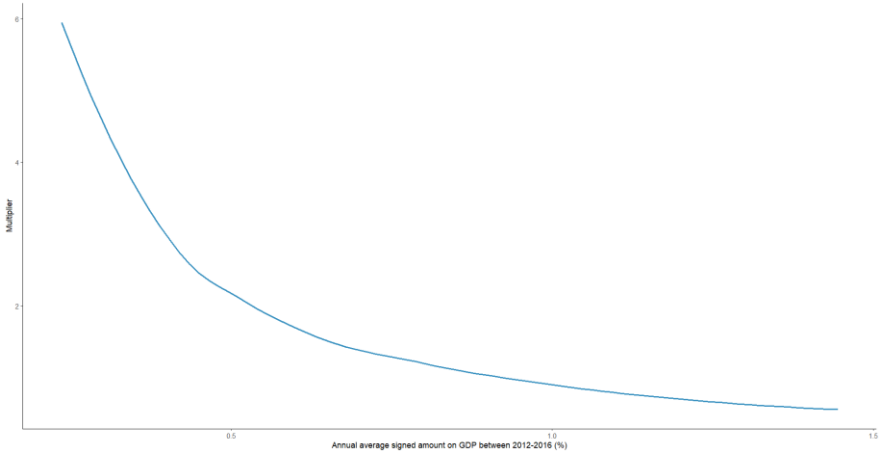
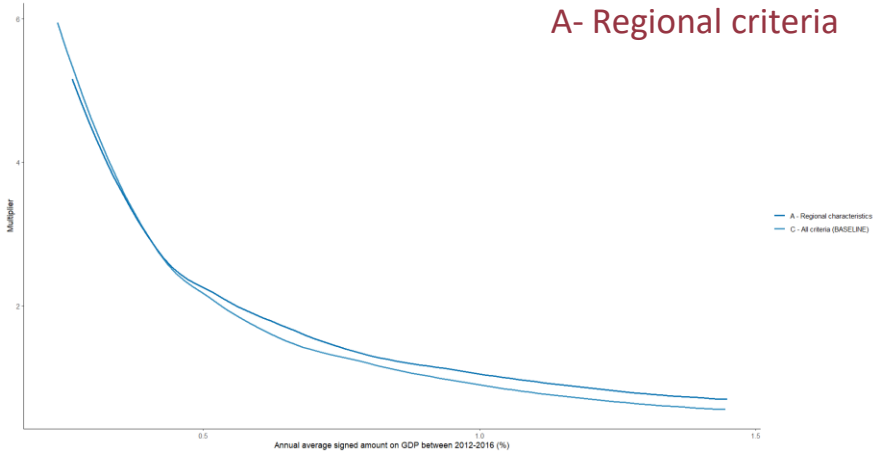
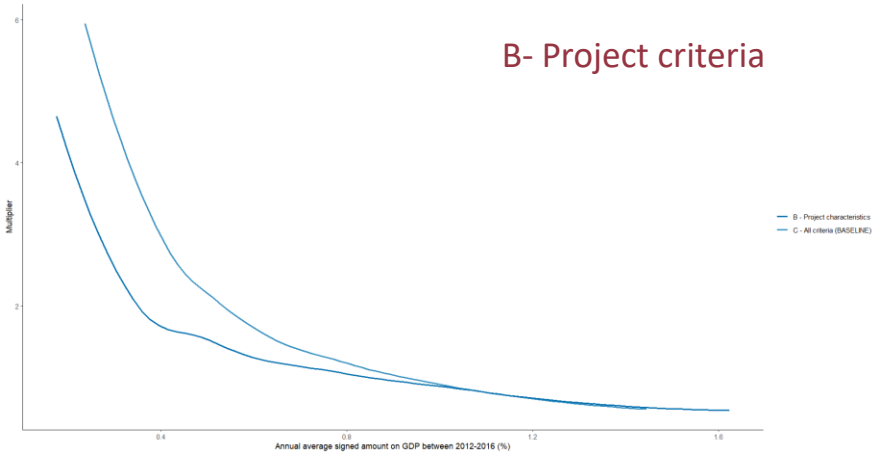
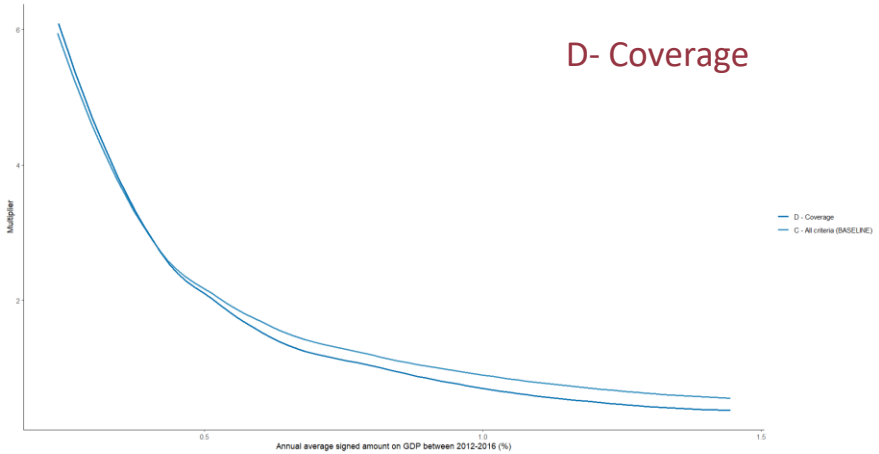
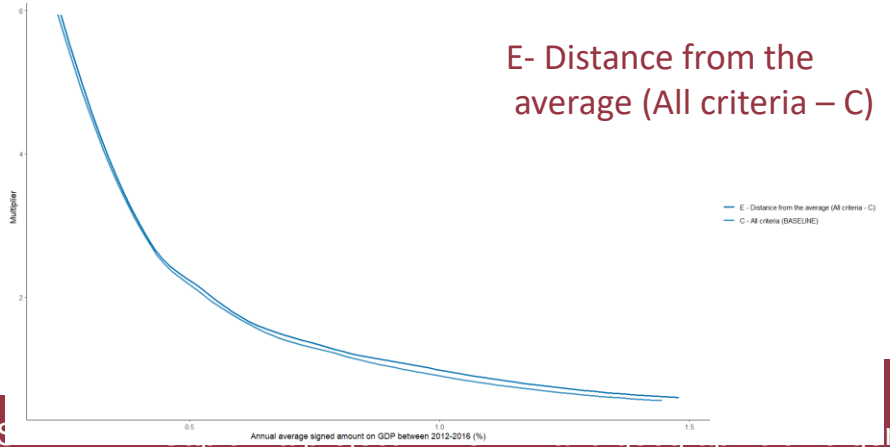
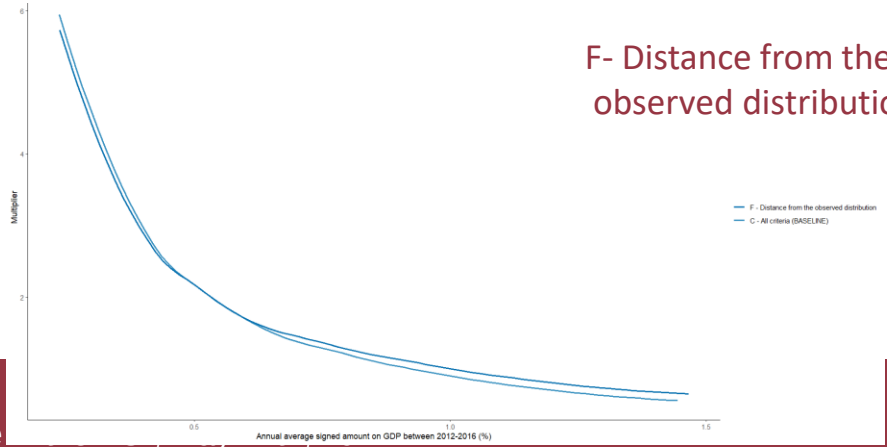

Multiplier
Annual average signed amount on GDP between 2012-2016 (%)

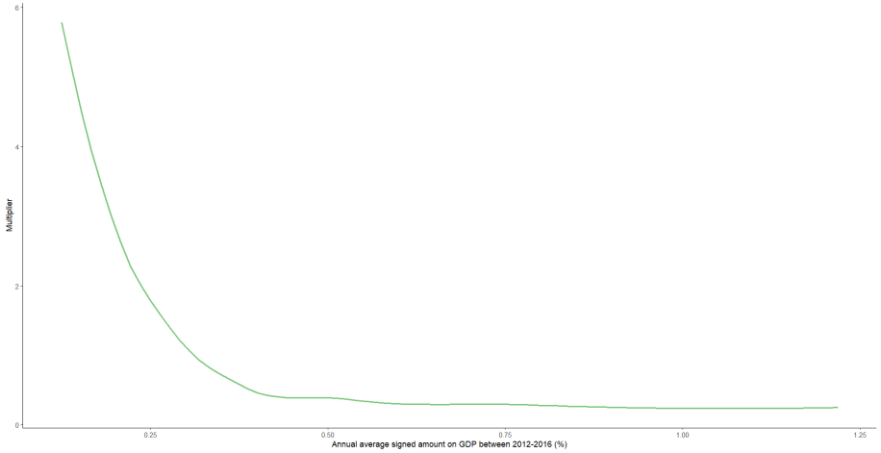

A- Regional criteria
Multiplier
A - Regional characteristics
C - All criteria (BASELINE)
Annual average signed amount on GDP between 2012-2016 (%)


B- Project criteria
Multiplier
B - Project characteristics
C - All criteria (BASELINE)
Annual average signed amount on GDP between 2012-2016 (%)

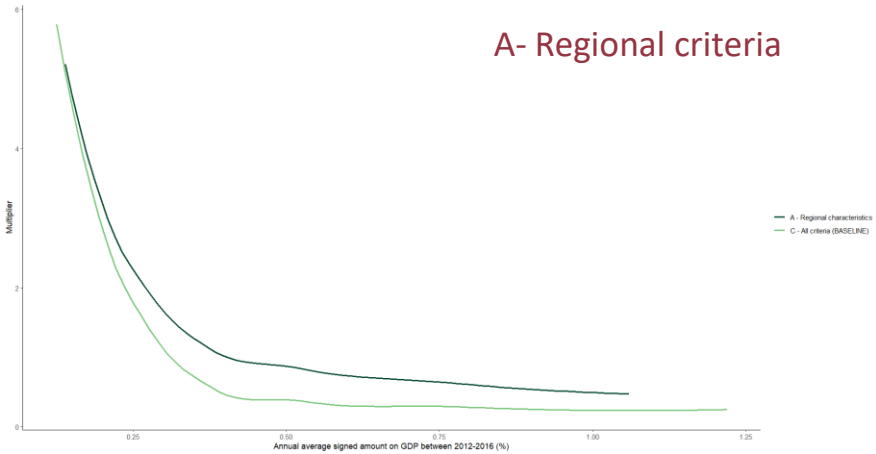

D- Coverage
Multiplier
D - Coverage
C - All criteria (BASELINE)
Annual average signed amount on GDP between 2012-2016 (%)


E- Distance from the average (All criteria – C)
Multiplier
E - Distance from the average (All criteria - C)
C - All criteria (BASELINE)
Annual average signed amount on GDP between 2012-2016 (%)

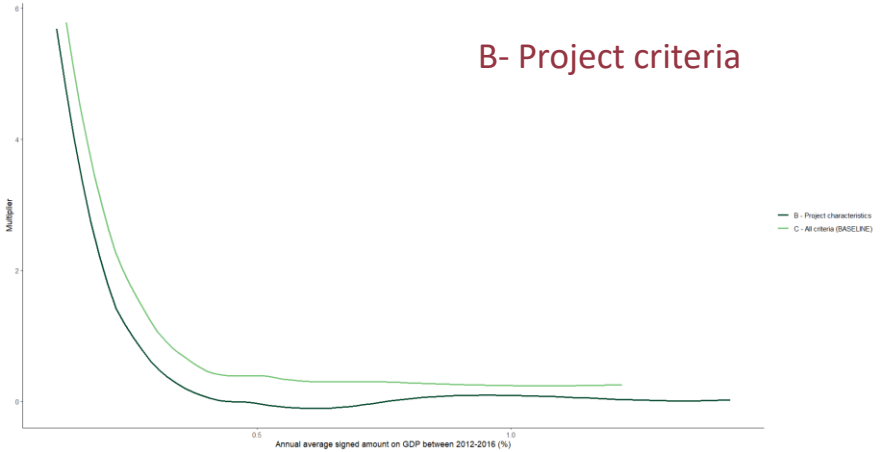

F- Distance from the observed distribution
Multiplier
F - Distance from the observed distribution
C - All criteria (BASELINE)
Annual average signed amount on GDP between 2012-2016 (%)



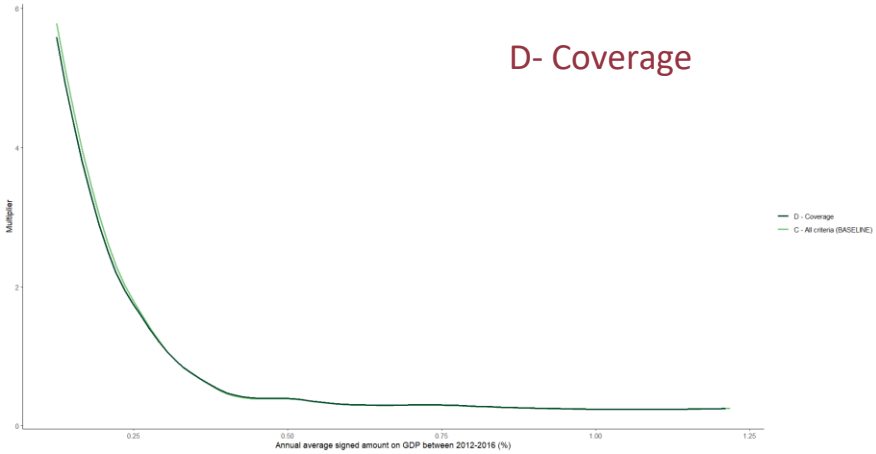
A- Regional criteria



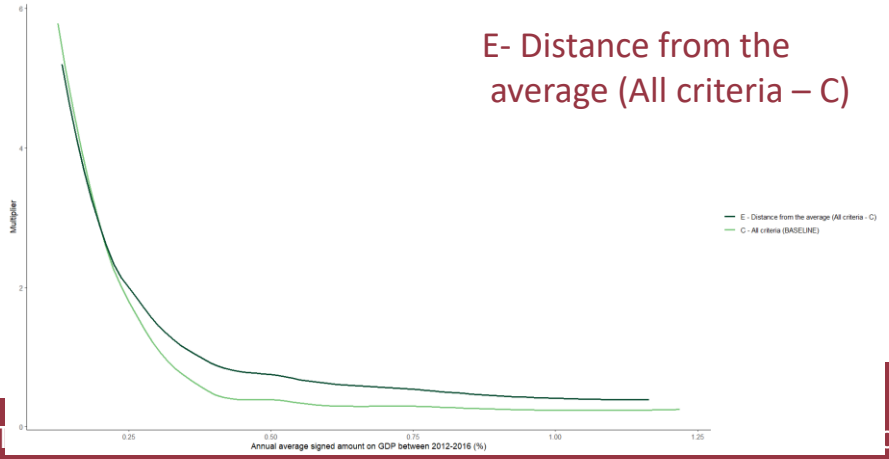
B- Project criteria



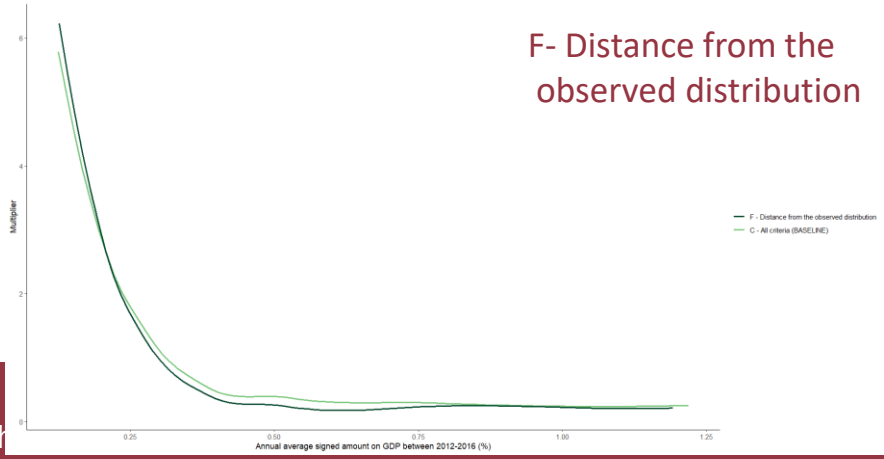
D- Coverage



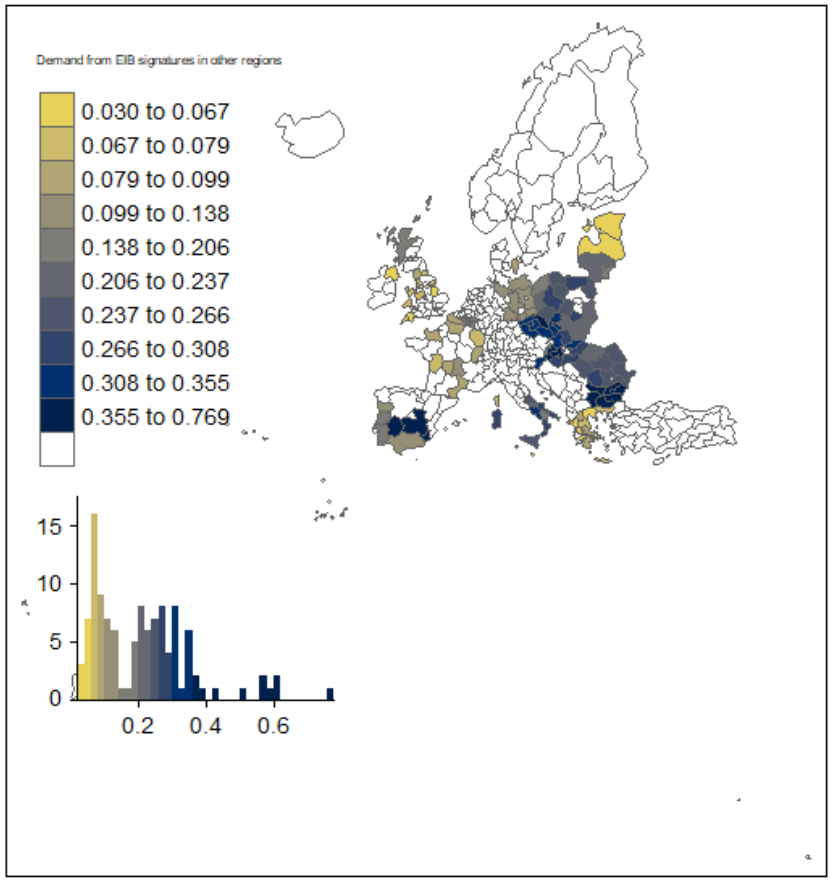
E- Distance from the average (All criteria – C)

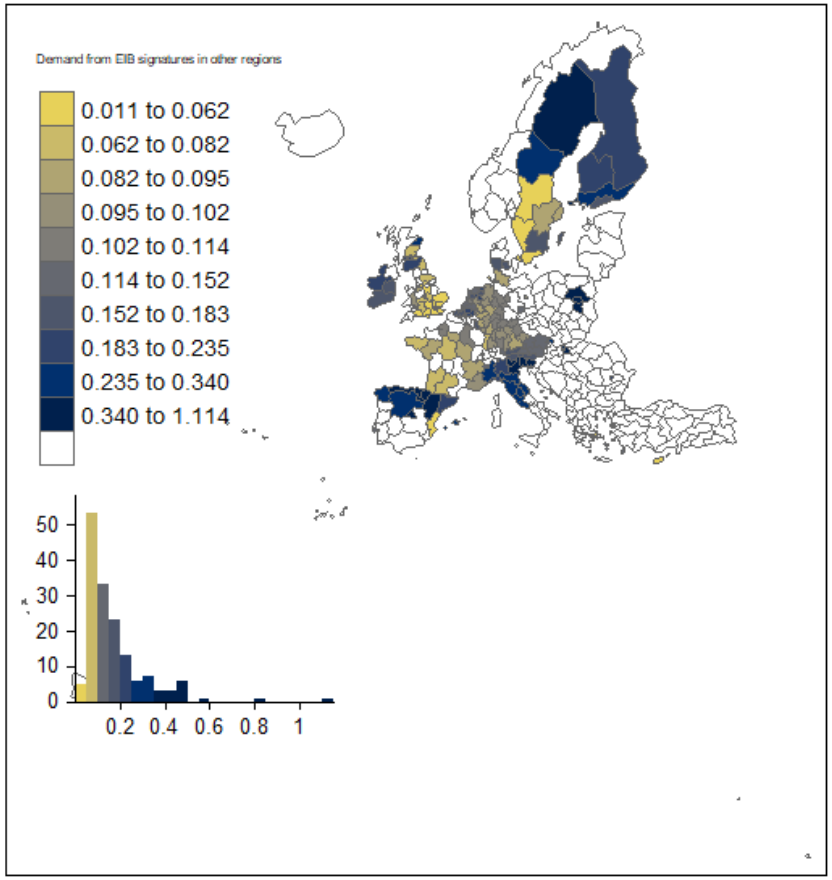


F- Distance from the observed distribution

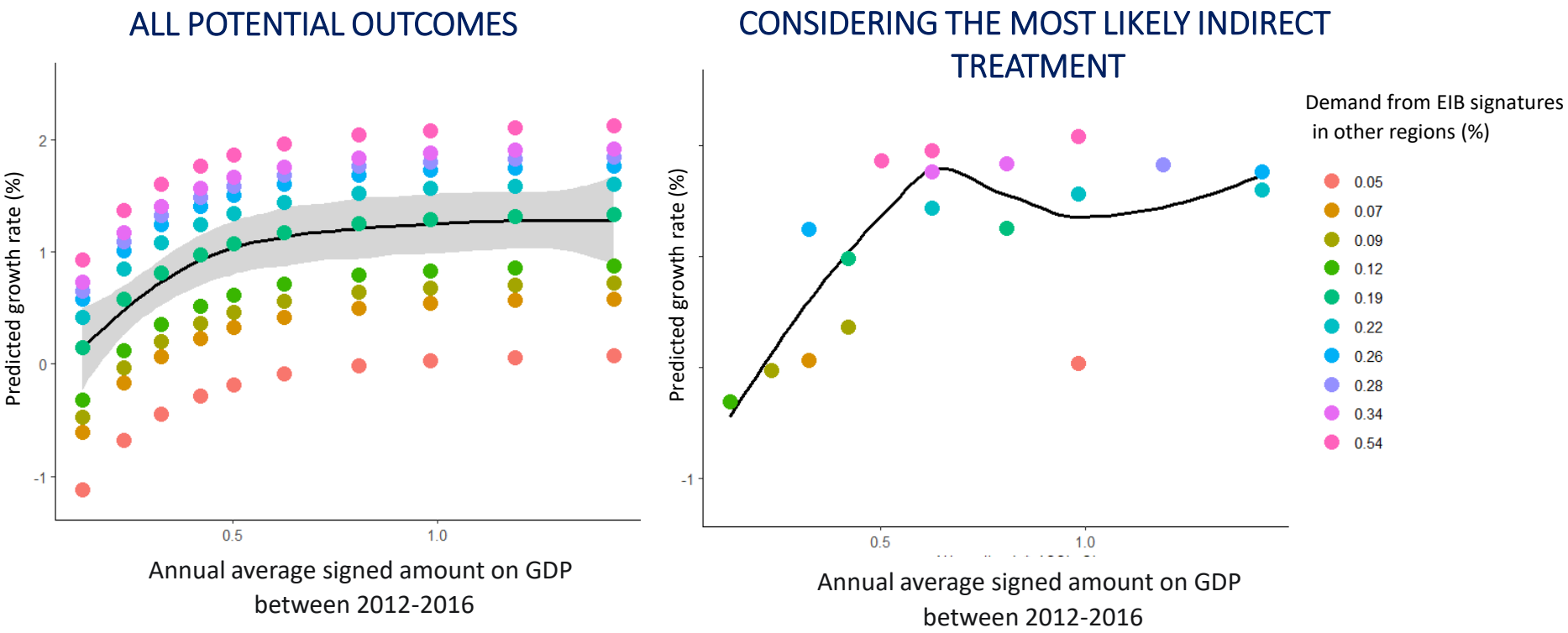


Indirect treatment



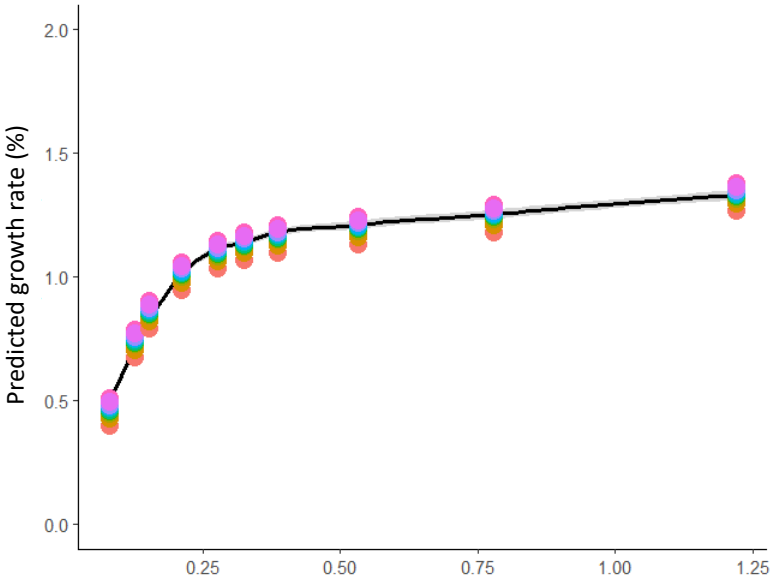


The DRF of the direct effect less developed-transition regions



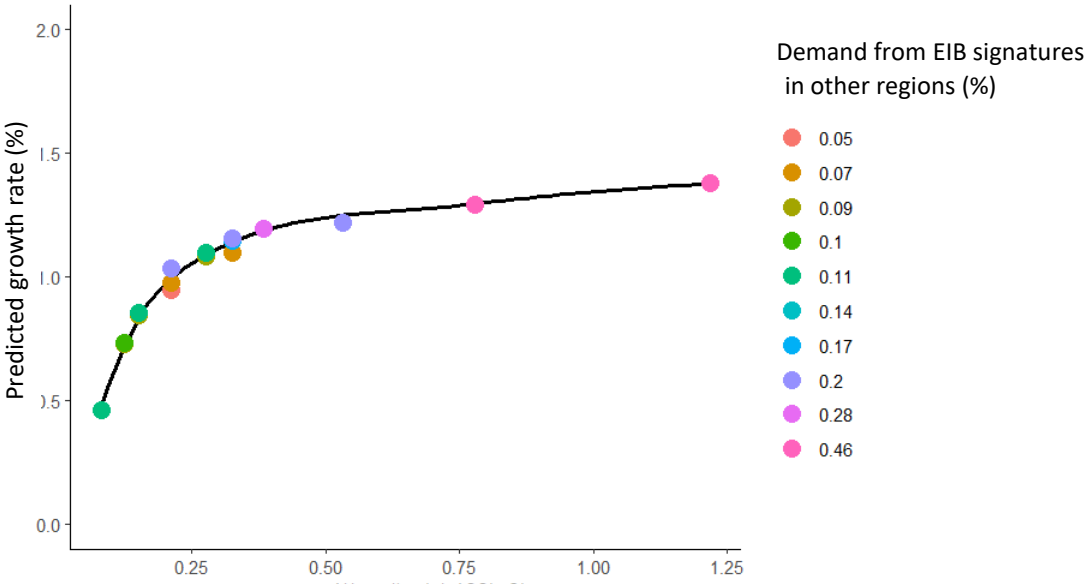
The DRF of the direct effect more developed regions

ALL POTENTIAL OUTCOMES



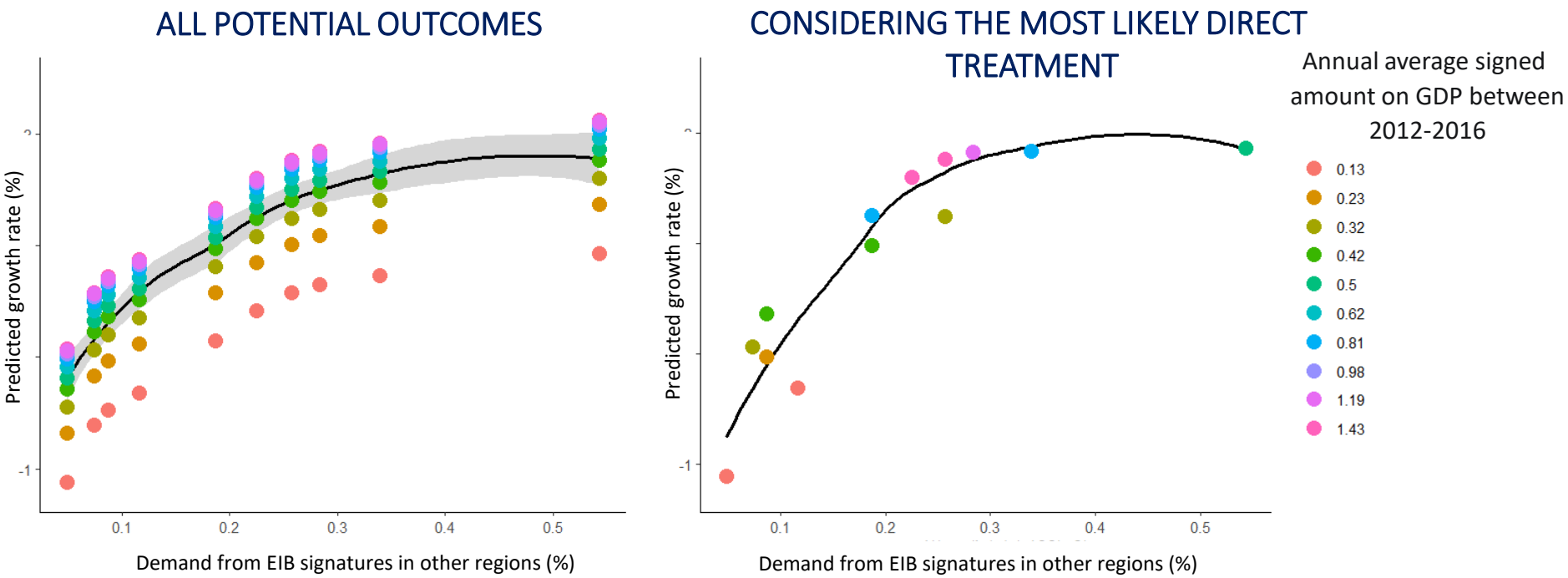
Annual average signed amount on GDP between 2012-2016

CONSIDERING THE MOST LIKELY INDIRECT TREATMENT

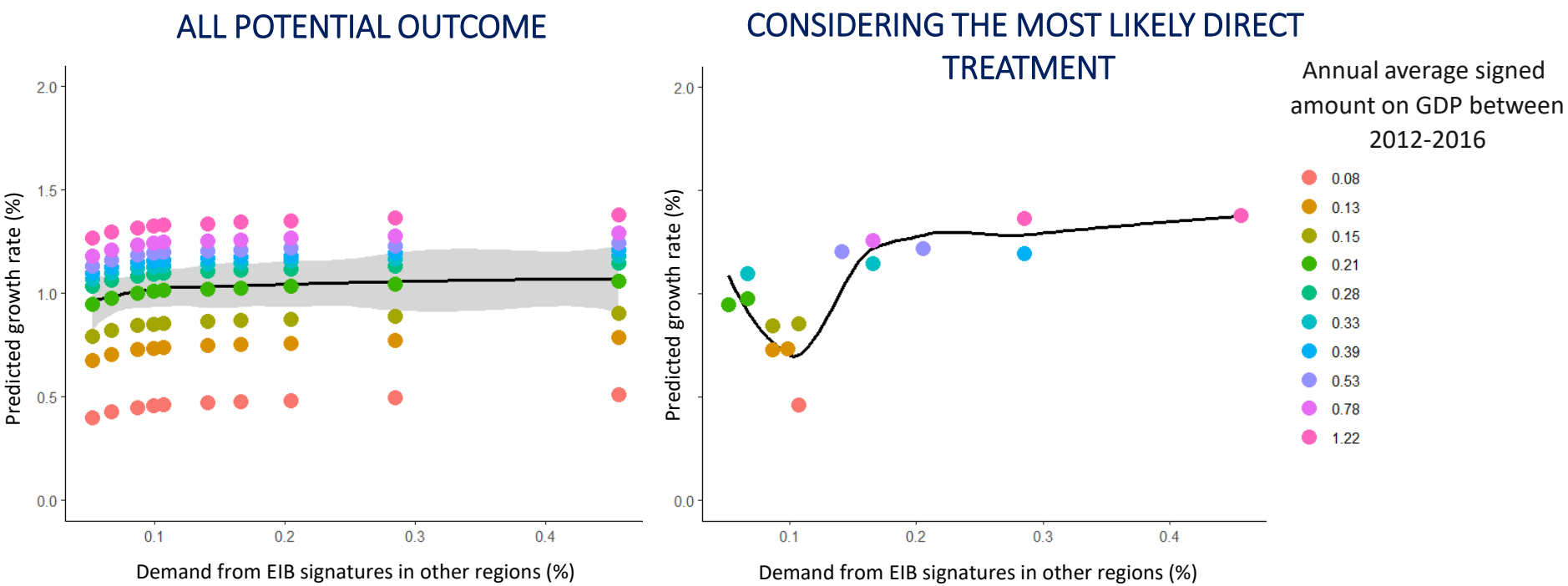


Annual average signed amount on GDP between 2012-2016

The DRF of the indirect effect less developed-transition regions

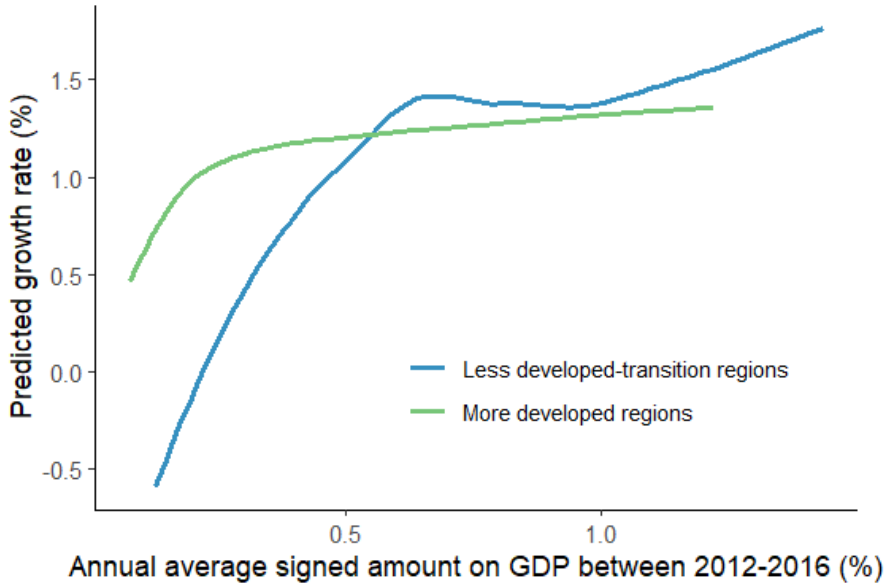


The DRF of the indirect effect more developed regions



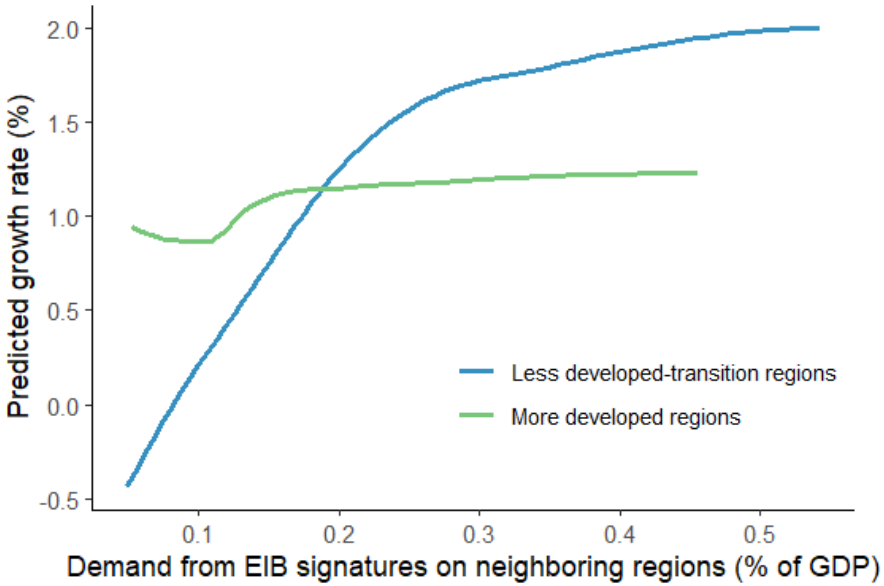
Compare DRFs

THE DRF OF THE DIRECT EFFECT



CONSIDERING THE WEIGHTED AVERAGE OF THE MOST LIKELY INDIRECT TREATMENT

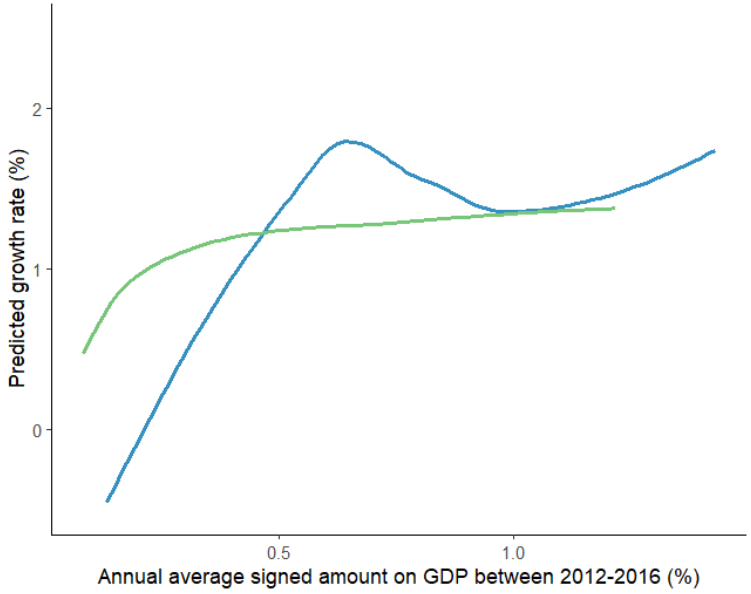
THE DRF OF THE INDIRECT EFFECT



CONSIDERING THE WEIGHTED AVERAGE OF THE MOST LIKELY DIRECT TREATMENT

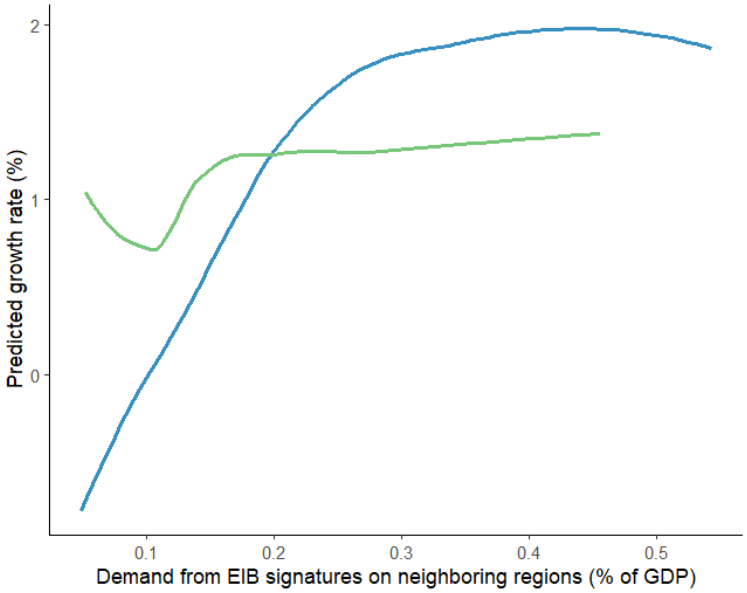
Compare DRF

CONSIDERING THE MOST LIKELY INDIRECT TREATMENT



THE DRF OF THE DIRECT EFFECT

CONSIDERING THE MOST LIKELY DIRECT TREATMENT



THE DRF OF THE INDIRECT EFFECT