

OPERATIONS EVALUATION

Evaluation of EIB  
Cohesion financing (2007 to 2018)

**Macroeconomic impact  
of EIB financing  
on the EU-28 regions**

October 2020



European  
Investment  
Bank

*The EU bank* 



# Operations Evaluation

Evaluation of EIB cohesion financing (2007-2018)  
– Macroeconomic impact of EIB financing  
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## **Evaluation of EIB cohesion financing (2007 to 2018) – Macroeconomic impact of EIB financing on the EU-28 regions**

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This publication is related to the following ancillary publications:

- [Evaluation of EIB cohesion financing \(2007 to 2018\) – Thematic report](#)
- [Evaluation of EIB cohesion financing \(2007-2018\) – Synthesis of project evaluations](#)

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## ABBREVIATIONS AND ACRONYMS

<b>CES</b>	Constant Elasticity of Substitution
<b>CGE</b>	Computable General Equilibrium
<b>EFSI</b>	European Fund for Strategic Investments
<b>EIB</b>	European Investment Bank
<b>EIF</b>	European Investment Fund
<b>EU</b>	European Union
<b>EU-13</b>	The European Union's newer entrants (the 13 countries which have joined since 2004 — Bulgaria, Croatia, Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Slovenia)
<b>EU-15</b>	The European Union's earlier entrants (the 15 countries which joined before 2004 — Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom)
<b>EU-28</b>	All the Member States of the European Union (before Brexit)
<b>EU-EMS</b>	European Economic Modelling System (EU-EMS), the Dynamic Spatial General Equilibrium Model for EU Regions and Sectors developed by the PBL Netherlands Environmental Assessment Agency
<b>GDP</b>	Gross Domestic Product
<b>ICT</b>	Information and Communication Technologies
<b>IG</b>	Inspectorate General of the European Investment Bank
<b>IG/EV</b>	Operations Evaluation Division of the European Investment Bank
<b>JRC</b>	Joint Research Centre of the European Commission
<b>MBILs</b>	Multiple Beneficiary Intermediated Loans
<b>MRIO</b>	Multi-Regional Input-Output database
<b>NACE</b>	Nomenclature des Activités Économiques dans la Communauté Européenne
<b>NUTS</b>	Nomenclature of Territorial Units for Statistics
<b>OECD</b>	Organisation for Economic Co-operation and Development
<b>PBL</b>	Netherlands Environmental Assessment Agency
<b>R&amp;D</b>	Research and Development
<b>SCGE</b>	Spatial Computable General Equilibrium
<b>SMEs</b>	Small and Medium-Sized Enterprises

## KEY TERMS

<b>Cohesion regions</b>	In the present report, cohesion regions encompass NUTS 2 regions that are eligible for EIB financing under Article 309(a) of the Treaty on the Functioning of the European Union, and hence under the EIB's cohesion objective. For the period 2007-2013, they included convergence regions (regions where per capita GDP was below 75% of the EU-25 average), phasing-in regions (regions that have developed significantly over the last few years to graduate out of Objective 1 support under the 2000-2006 EU multiannual financial framework, but got priority status within the Regional Competitiveness and Employment objective under the 2007-2013 multiannual financial framework), and phasing-out regions (regions that would have been eligible for funding under convergence if the threshold of 75% of GDP per capita had been calculated for the EU-15 and not the EU-25). For the period 2014-2020, they include regions with a GDP per capita below 90% of the EU average: less developed regions (GDP per capita below 75% of the EU average) and transition regions (GDP per capita below 90% of the EU average), and programme countries.
<b>Financial intermediaries</b>	Banks or other financial vehicles (such as funds) through which the EIB Group undertakes its intermediated financing operations.
<b>Market failure</b>	Situation in which markets fail to reach the socially optimal outcome because of their inability to internalise social costs or benefits through the price system. The most common market failures are public goods, market power, externalities, information asymmetries and coordination failures.
<b>Multiannual financial framework</b>	The framework that establishes the spending priorities and maximum amounts that the European Union may spend in particular areas over a fixed period of several years.
<b>Non-cohesion regions</b>	In the definition of the EIB and the present report, non-cohesion regions are EU regions with a GDP per capita above 90% of the EU average.
<b>Signature</b>	Event upon which the EIB Group signs a finance contract.

## EXECUTIVE SUMMARY

This report was prepared jointly by the Operations Evaluation Division (IG/EV) of the European Investment Bank (EIB) and the PBL Netherlands Environmental Assessment Agency.

The report builds on the work carried out within the context of the evaluation of EIB cohesion financing and extends it to assess the macroeconomic impact of investments supported by EIB financing in all regions of the EU-28.<sup>1</sup> The impact is assessed at the regional level for the 271 regions of the European Union as per the NUTS 2 classification. The assessment focuses on the impact on GDP and employment, but also takes into account the effects in terms of aggregate investment and productivity.

### Key messages

- *The investments supported by EIB financing have a substantial impact for the vast majority of EU regions. On average across all EU regions, the highest impact occurs by 2020-2025, where GDP increases by 0.8% with respect to the baseline scenario.<sup>2</sup> The impact on employment is positive, in line with the impact on GDP.*
- *Cohesion regions gain, on average, more than non-cohesion regions with respect to their GDP in the baseline scenario. On average across cohesion regions, by 2020-2025 (when the highest impact occurs), the EIB-supported investments add up to 1.2% to GDP with respect to the baseline scenario. For some cohesion regions, by 2020-2025, the impact on GDP reaches 7.2% with respect to the baseline scenario.*
- *For non-cohesion regions, by 2020-2025 (when the highest impact occurs), the EIB-supported investments add, on average, up to 0.6% to GDP with respect to the baseline scenario. For some non-cohesion regions, by 2020-2025, the impact reaches 3.1% of GDP over the baseline.*
- *The results are robust to changes in the specifications of the model (the value of Armington elasticity for international and inter-regional trade, and the change in the value of the elasticity of substitution between capital and labour).*

### Background and purpose

As the EU bank, the EIB's mission is to support the economic development of the European Union, strengthen its economic growth and enhance job creation by supporting investment across the Union. Furthermore, the Bank is tasked with contributing to EU cohesion by supporting the convergence of the least developed regions within the European Union with the rest of the Union. The objective of the present study is to assess the impact of the EIB's contribution on both objectives.

For this purpose, this study undertakes a model-based and simulation analysis of the impact of investments supported by EIB financing on the GDP and employment level of the EU regions, with a specific distinction between cohesion and non-cohesion regions. The study also takes into account the impact on aggregate investment and productivity given the importance of these variables as engines of economic growth.

The scope of the study covers 271 EU NUTS 2 regions, of which 136 are considered for the purpose of this analysis as cohesion regions and 135 as non-cohesion regions. The assessment is based on investments supported by EIB financing contracts signed in 2007-2018, and the effects of these investments are modelled over the period 2010-2050.

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1 The United Kingdom is included in the study as in 2007-2018, the period of the investments supported by the EIB, the country was an EU Member State. Thus, the scope of the study is the EU-28 including the United Kingdom.

2 The EU-EMS model uses five-yearly time periods for all its variables, which means that it calculates five-year GDP and employment levels instead of annual ones. The impact of the investments supported by EIB financing on the GDP of each region is computed as a percentage change with respect to the baseline scenario for an average representative year for each of the periods 2010-2015, 2015-2020, 2020-2025, 2025-2030, 2030-2035, 2035-2040, 2040-2045 and 2045-2050. An impact of 1% with respect to the baseline GDP for a region by 2020-2025 means that by the period 2020-2025, its GDP is 1% higher in the policy scenario with the EIB-backed investments than it would have been without them. Similarly, the average impact across EU regions of 0.8% by 2020-2025 means that their GDPs are, on average, 0.8% higher in comparison to their respective baselines than in the scenario without the EIB investments.

The analysis was undertaken in the context of the evaluation of EIB cohesion financing conducted by the Operations Evaluation Division (IG/EV) of the EIB. Within the scope of the evaluation, the Thematic Evaluation report focused strictly on EIB *cohesion* financing and assessed whether investments supported by EIB cohesion financing serve their purpose of benefiting cohesion regions. The present report goes a bit beyond the central scope of the evaluation and assesses whether the investments supported by EIB financing *as a whole* contribute to reducing disparities between the cohesion regions and the rest of the European Union.

## Data and modelling

The analysis is carried out on a total volume of EIB financing of €658 billion, of which €224 billion was dedicated to cohesion regions and €434 billion to non-cohesion regions. The total volume of investment mobilised by the EIB amounts to €2 342 billion, of which €1 001 billion for cohesion regions and €1 341 billion for non-cohesion regions.<sup>3</sup>

The macroeconomic modelling of the impact of the investments supported by the EIB uses the European Economic Modelling System (EU-EMS), a Dynamic Spatial General Equilibrium Model for EU Regions and Sectors developed by the PBL Netherlands Environmental Assessment Agency.

The model assesses two scenarios. First, a baseline scenario simulates the evolution of the economy until 2050 without EIB financing. Second, an EIB policy scenario adds the data on investments supported by EIB financing. Considering that the two scenarios differ only in the implementation of EIB financing, the comparison of the macroeconomic aggregates across the two scenarios provides a model-based estimate of the impact of EIB-backed investment.

## Results

The investments supported by EIB financing have a sizeable positive impact for the vast majority of EU regions throughout 2010-2050 (except for the period 2010-2015). On average across all EU regions, the highest impact occurs by 2020-2025: GDP increases by 0.8% compared to the baseline scenario. However, this average hides significant heterogeneity between regions: the impact ranges from near zero for some regions (with respect to GDP in the baseline scenario) to very strong for other regions (up to 7.2% with respect to GDP in the baseline scenario). When comparing effects between categories of regions, cohesion regions gain, on average, more with respect to the baseline scenario than non-cohesion regions. Furthermore, the cohesion regions which experience the highest increase in GDP with respect to the baseline scenario gain more than the non-cohesion regions with the highest impact. Consequently, the EU regions with relatively lower GDP per capita gain the most, while the richer regions gain relatively less. In the longer run — by 2045-2050 — cohesion regions appear to gain more than non-cohesion regions even in absolute terms. In other words, by 2045-2050 the total gain in euro for cohesion regions exceeds the total gain for non-cohesion regions. This result is all the more remarkable given that the share of EIB financing going to cohesion regions represents 34.0% of total EIB financing and the volume of investment supported by EIB financing in cohesion regions is 42.7% of the total volume of investment supported by EIB financing across the European Union. Thus, the EIB contributes to the reduction of disparities in terms of GDP between the cohesion regions and the rest of the European Union throughout 2010-2050 in relative terms and, in the longer run, even in absolute terms. This finding is particularly significant in the context of the overall trend of increasing regional disparities across the European Union, which the EIB investment support thus helps to reduce.

The impact on employment is more limited than the impact on GDP, but still quite sizeable. The regions that experience the largest increase in employment add up to 0.7% to the number of persons employed with respect to the baseline scenario at the peak of the impact of investments supported by EIB financing (by 2020-2025). The effects on employment being relatively more moderate than the effects on GDP is in line with literature findings, as productivity growth may not always be associated with job creation.

The robustness checks show that these results are robust to changes in the model specifications (traded goods substitution elasticity, and the elasticity of substitution of capital to labour).

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3 The total volume of investment mobilised is measured by the total project investment cost.

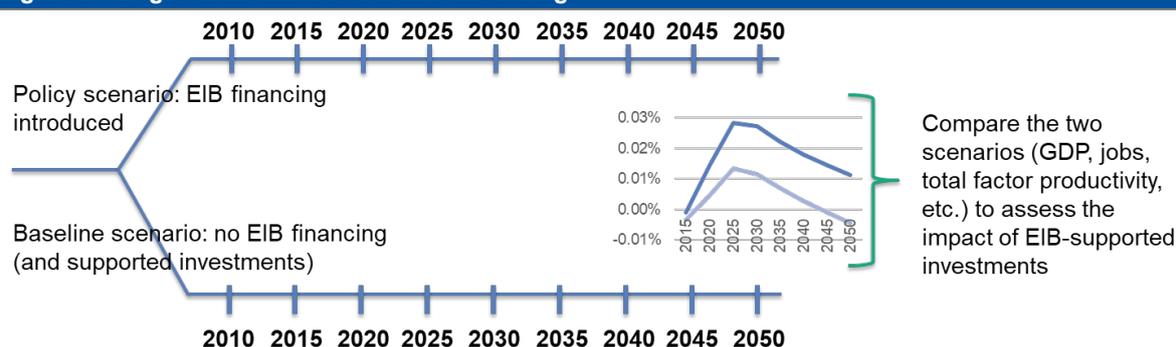
## 1. BACKGROUND AND RATIONALE OF THE STUDY

**Contributing to economic convergence within the European Union is one of the *raison d'être* of the European Investment Bank (EIB).** Alongside its microeconomic role of addressing market failures, the EIB also has a macroeconomic role, based on the sheer size of the overall investment it supports each year. As the EU bank, the EIB contributes to the achievement of EU policy goals. One such goal is the economic development of the European Union, strengthening its economic growth and enhancing job creation by supporting investment across Europe. Another is cohesion, supporting the catch-up of less developed regions within the European Union. The objective of the present study is to assess the EIB's contribution to both objectives by assessing the macroeconomic impact of EIB-supported investments.

**The paper was produced in the context of the evaluation of EIB cohesion financing conducted by the Operations Evaluation Division (IG/EV) of the EIB.** While the paper relies on the same methodology as was used in the Thematic Evaluation report, it provides a more extensive and detailed coverage of the macroeconomic impact of the investments supported by EIB financing. The Thematic Evaluation report focused strictly on investments supported by EIB *cohesion* financing and assessed whether these investments serve their purpose of benefiting cohesion regions. This paper, by contrast, has a wider purpose. The key question it seeks to answer is what impact *total* EIB financing has on EU regions and, more specifically, how this impact contributes to the reduction of regional disparities between cohesion and non-cohesion regions.<sup>4</sup>

**The model constructs two scenarios — one with and one without EIB intervention — and compares their outcomes.** Conventional evaluation methodologies adopt an ex post perspective, assessing in hindsight the effectiveness and efficiency of the EIB operations and the achievements of the EIB-supported projects. An ex post approach would measure the impact of the EIB intervention by considering the available data on the outcomes already occurred. Various statistical or econometric techniques could then be used to quantify the extent to which the effects are attributable to the EIB intervention. This paper, by contrast, takes an ex ante perspective. It takes the data on the EIB inputs — the volume of investments supported by EIB financing — and simulates two scenarios. The first one — called the baseline scenario — models the likely evolution of the economy without the EIB-supported investment. The second — referred to as the policy scenario — represents the evolution of the economy with the EIB-supported investment introduced. Considering that the two otherwise identical scenarios differ only in terms of the EIB intervention, the differentials between them illustrate the impact of the EIB-supported investment.

**Figure 1 – Logic of the macroeconomic modelling**



<sup>4</sup> From a methodological perspective, this study also differs from the evaluation of EIB cohesion financing. The approach adopted in the former was to assess the impact of EIB financing in cohesion regions only with respect to the baseline of no EIB financing anywhere, then to assess the impact of EIB financing in non-cohesion regions only with respect to the baseline of no EIB financing anywhere. The present paper compares the impact of EIB financing in all regions of the European Union to the baseline of no EIB financing anywhere. While the baseline is the same in both cases, the policy scenarios logically differ and so do the results.

**The simulation in the present paper relies on macroeconomic modelling using the European Economic Modelling System (EU-EMS), the Dynamic Spatial General Equilibrium Model for EU Regions and Sectors developed by the PBL Netherlands Environmental Assessment Agency.** Like any spatial general equilibrium model — for example RHOMOLO (see below) — this model takes into account all the interactions between economic agents, namely sector and region linkages. It considers the macroeconomic effects of the investments supported by EIB financing at different spatial disaggregation levels — EU-28, Member States or EU regions. The present study focuses on the regional level, enabling a distinction to be made between cohesion and non-cohesion regions.

**The definition of cohesion regions is based on GDP per capita and therefore the effects of the EIB-supported investments on the GDP of the EU regions is of central importance.** Nevertheless, the study considers the wider economic impact of the investments supported by EIB financing. The modelling takes into account the impact on employment, total factor productivity and aggregate investment. Furthermore, the paper accounts for the spillover effects between regions through trade and capital linkages embedded in the model.

**The study examines 271 EU NUTS 2 regions, of which 136 are considered cohesion regions and 135 non-cohesion regions.**<sup>5</sup> The investments considered in the study include all investments supported by EIB financing in the period 2007-2018. The scope of EIB financing under consideration covers operations which have at least one contract signed between 1 January 2007 and 31 December 2018. The effects of the investments supported by EIB financing are simulated over five-year periods for 2010-2050. The corresponding sections and appendices of the paper provide further details regarding the characteristics of the data used and the modelling strategy and assumptions.

The study dataset represents a total volume of EIB financing of €658 billion and a total volume of investment of around €2 342 billion. This dataset comprises, in turn, two datasets: one for EIB financing in cohesion regions and one for EIB financing in non-cohesion regions. The dataset for EIB cohesion financing has a total volume of EIB financing of €224 billion and a total volume of investment of €1 001 billion. The dataset for EIB non-cohesion financing has a total volume of EIB financing of €434 billion and a total volume of investment of €1 341 billion.

**The macroeconomic effects of EIB financing have been explored in the past.** For instance, the EIB, in collaboration with the European Commission's Joint Research Centre (JRC), assessed the macroeconomic impact of EIB and European Fund for Strategic Investments (EFSI) operations.<sup>6</sup> The present paper adopts a comparable modelling strategy, but has a different scope by focusing on the impact of the investments supported by EIB financing at the regional level. Furthermore, this paper distinguishes between cohesion and non-cohesion regions. Finally, the paper adopts a longer-term perspective, considering the impact of EIB-supported investments over several periods up to 2050.

**As mentioned before, the modelling takes into account the inter-regional linkages.** This feature is significant, because it serves to gauge both the direct and the indirect effects of EIB-supported investments. The direct effects refer to the impact of the investments within the region where they are made. The indirect effects, in the context of this study, refer to the impact of the investments in other regions. The indirect effects typically arise through trade or financial exchanges. Projects situated in cohesion regions may require purchasing inputs from non-cohesion regions and vice versa, so the overall positive effect on investment and GDP might theoretically end up being higher for non-cohesion regions than for cohesion regions. The modelling performed in this study serves to capture both the direct and the indirect effects and incorporate them into the results. This paper accounts for both the direct and the indirect effects and provides an answer to the question of whether EIB financing actually helps cohesion regions to catch up with the rest of the European Union.

**The scope of the study is restricted to EIB financing and does not include the activities of the European Investment Fund (EIF).** Thus, the results presented in the paper underestimate the overall macroeconomic impact of the EIB Group. Furthermore, the scope of the EIB activities considered in the study is restricted to the financing of projects. It does not include advisory services, knowledge transfer or technical assistance, all of which are important EIB inputs for the European economy.

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5 The United Kingdom is included in the study as in 2007-2018, the period of the investments supported by the EIB, the country was an EU Member State.

6 "Assessing the macroeconomic impact of the EIB Group," July 2018, see [here](#).

**Although the modelling methodology and the data used are sufficiently reliable, each result should be viewed as an order of magnitude rather than a precise figure.** Compiling a useable dataset from the raw data of EIB operations and contracts required making assumptions on the distribution between cohesion and non-cohesion financing, the treatment of grant funding and the use of some indicators as proxies of the variables necessary for the modelling. Thus, even though the results do not have any known bias, like any model-based simulation results they may indicate a certain degree of deviation from the realised macroeconomic outcomes.

The rest of the paper is organised as follows:

- The second section describes in detail the EU-EMS, customised for the specific needs of the present modelling, the assumptions underpinning the exercise and the limitations of the tool.
- The third section presents and analyses the results of the impact of investments supported by EIB financing at the regional level.
- The fourth and final section summarises the findings of the modelling exercise.



## 2. MODEL – PRESENTATION OF THE EU-EMS

### Summary

The European Economic Modelling System (EU-EMS) is a spatial computable general equilibrium (SCGE) modelling system built by the PBL Netherlands Environmental Assessment Agency, a Dutch public research institute. It covers 62 countries — including 28 EU Member States — and the rest of the world region. The model includes the 271 NUTS 2 regions of the EU-28 considered in the study. It also covers 60 NACE Rev. 2 sectors.

For this study, the EU-EMS was tailored to fit the characteristics of the investment support provided by the EIB. The baseline scenario starts from 2015 (base year) and simulates the evolution of the economy without EIB financing until 2050 in five-year steps. In the policy scenario, investments supported by EIB financing are added into the economy, which is otherwise identical to the baseline scenario. The difference between the two scenarios in terms of evolution of macroeconomic aggregates (GDP, employment, investment, etc.) provides a measure of the impact of the investments supported by EIB financing.

In the short run, the EIB intervention has an investment (or demand) effect. In the medium to long run, the implementation of the supported project also has a structural effect. This structural effect has two components: an increase in the capital stock and an increase in the productivity of firms located in the region when investment is channelled to the specific NACE Rev. 2 sectors.

As with any applied general equilibrium model, the EU-EMS is built on specific theory- and/or data-driven assumptions and therefore has a number of well-known limitations and caveats. For example, one conceptual limitation is the fact that it does not take into account market imperfections.

### 2.1 Overview of the EU-EMS

**The European Economic Modelling System (EU-EMS) is a spatial computable general equilibrium (SCGE) modelling system.** It was built by the PBL Netherlands Environmental Assessment Agency as part of the Horizon 2020 MONROE project.<sup>7</sup>

**From a theoretical standpoint, the core SCGE model combines the notion of the Walrasian Arrow-Debreu general equilibrium framework with the Heckscher-Ohlin trade and Krugman-Fujita-Venables monopolistic regional competition models.** It relies on the notion of the representative agent, representing the typical (average) behaviour of households or firms in a region/sector. By assumption, the behaviour of each firm (household) is driven by profit (utility) maximisation or, which numerically is the same, by cost minimisation. Firms produce goods and services which are consumed by households, governments and other firms and traded in the (perfectly or imperfectly competitive) markets. The model represents a real economy, thus market clearing is ensured by relative prices. Starting from this core, the EU-EMS has a flexible modular structure which can be adapted to specific policy questions. For instance, the EU-EMS allows for modelling of (dis)economies of scale, external economies of spatial clusters of activity, continuous substitution between capital, labour, energy and material inputs in the case of firms, and between different consumption goods in the case of households. Moreover, the monopolistic competition of the Dixit-Stiglitz type allows for heterogeneous products implying variety, and therefore enables the cross-hauling of close substitutes of products between regions.

The EU-EMS can be further customised across the following dimensions:

- Geographical dimension (groups of countries, country, NUTS 1, NUTS 2 regions)
- Sectoral aggregation (up to 60 sectors)
- The form of sectoral production functions: Leontief, Cobb-Douglas, Constant Elasticity of Substitution (CES) for Capital-Labour (KL), CES for Capital-Labour-Energy-Materials (KLEM)
- The type of recursive dynamics (like in the Monash or Mirage models)

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<sup>7</sup> For more information, please see [here](#).

- The type of labour market closure (model includes the representation of three education levels)
- Exogenous or endogenous technological change and total factor productivity growth
- The type of market structure at the sectoral level: perfect competition or monopolistic competition

### *Spatial dimension*

**The model covers 62 countries specifically and one rest of the world region representing countries not explicitly included in the model. The model further disaggregates between 271 NUTS 2 regions selected from the 28 EU countries using a database for 2013.** All the regions in the EU-28 are linked by trade of goods and services (subject to trade and transport costs), knowledge spillovers, capital (investment) and labour movement (migration) flows between them, with the largest non-EU countries and with the rest of the world.<sup>8</sup> The model includes new economic geography (NEG) features such as monopolistic competition, increasing returns to scale and regional net migration.

### *Sector dimension*

**The model covers 60 economic sectors according to the NACE Rev. 2 classification.**<sup>9</sup> Regions differ by the type of production sectors that dominate overall production activities in the region. Some specialise in traditional sectors like agriculture, whereas others specialise in modern sectors such as finance and industry. The level and relative importance of agglomeration effects differ among these sectors. Traditional sectors do not experience any agglomeration effects whereas modern sectors do. This allows some sectors to grow faster in regions where these sectors or their suppliers are large and therefore experience agglomeration effects.

### *Parameter calibration*

**In order to calibrate the linkages between regions and sectors, the EU-EMS relies on the Multi-Regional Input-Output (MRIO) database.** This database uses a combination of national, European and international data sources and represents a detailed regional level (NUTS 2 for EU-28 plus 34 non-EU countries) MRIO table for the world.<sup>10</sup> The main datasets used for the construction of this MRIO include the OECD database, BACI trade data, Eurostat regional statistics, national supply and use tables and DG MOVE's detailed regional level transport database ETIS-Plus.<sup>11</sup> The latter dataset helps to estimate inter-regional trade flows at the level of NUTS 2 regions that are currently not available from official statistical sources.<sup>12</sup>

The elasticities of substitution and other behavioural parameters used in the EU-EMS are based on recent econometric studies.<sup>13</sup> The impact of variation in the values of different behavioural and technological parameters of the model on the EU-EMS simulation results is analysed as part of the sensitivity analysis in Annex 4 – Sensitivity analysis.

## **2.2 Modelling the impact of investments supported by EIB financing**

**The modelling features of the EU-EMS were customised in order to adapt it to the specific features of the investment support provided by the EIB.** For the assessment of the impacts of the investments supported by EIB financing in various regions of the EU-28, the modelling uses the SCGE model specification of the EU-EMS and customises its regional and sectoral dimensionality. Thus, the current study aggregates the economic sectors to the one-digit NACE Rev. 2 classification used by the

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8 See [here](#).

9 See [here](#).

10 See [here](#).

11 See [here](#).

12 See [here](#).

13 Koesler, S. and Schymura, M., "Substitution Elasticities in a CES Production Framework – An Empirical Analysis on the Basis of Non-Linear Least Squares Estimations"; Ciccone, A. and Peri, G., "Long-run substitutability between more and less educated workers: evidence from US States, 1950-1990"; Hertel et al., "GTAP model description, Chapter 14: Behavioral Parameters."

EIB to record its investment activity. 271 NUTS 2 regions of the EU-28 are included in the model alongside the largest non-EU countries and the rest of the world region.

**The EU-EMS model was also adapted to the focus of the present study — the impact of investments co-financed by a public bank.** The main particularity of the EIB intervention as compared to discretionary fiscal policies or grant funding is the reliance on financial instruments (loans, equity or guarantees). Thus, one of the key components of the EIB intervention modelling is that EIB financing needs to be repaid by the beneficiaries. Another important difference with implications for the modelling is the EIB's need to rely on capital markets to be able to lend in turn (while governments, apart from borrowing on capital markets, can also rely on taxation and seigniorage).<sup>14</sup> This sub-section describes in detail the modelling of the EIB intervention and of its effects.

**The baseline scenario starts from 2015 (base year) and simulates the evolution of the economy until 2050 in five-year periods.** The model follows a steady-state growth path consistent with the latest EU official statistical forecasts such as the EU Ageing Report.

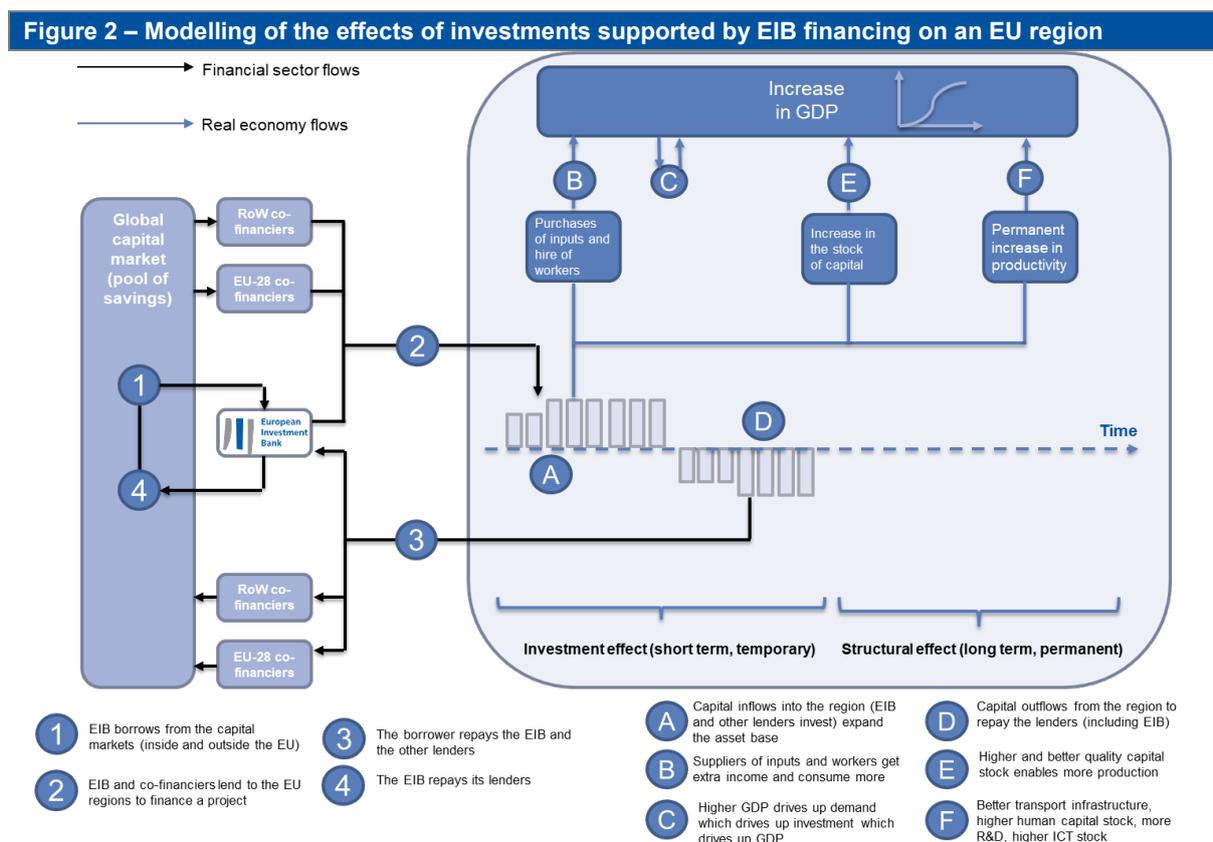
**In the baseline scenario, for each region the EU-EMS models a pool of total savings which consists partly of domestic savings coming from the same EU region and partly of savings coming from other EU regions and from the rest of the world.** This pool of savings is further redistributed by the model's investment agent between regions and sectors in the form of investments according to a certain investment rule that distributes the savings between regions/countries and sectors according to their expected profitability. The investment rule of the investment agent is based on the maximisation of its Cobb-Douglas unity production function. The shares of the demand function of the investment agent are calibrated to the fixed capital formation column of the final demand in the use table. An important modelling feature of the EU-EMS is the optimality of the distribution of savings across sectors and regions. This implies that any deviation from the investment rule and an alternative distribution of investments is likely to be distortionary and suboptimal.

**In the policy scenario, in order to finance projects in the EU regions, the EIB has to borrow on the capital markets.** It borrows inside and outside the EU-28. Thus, the model postulates that a share of the EIB resources comes from the EU-28 and the rest comes from borrowing outside the European Union. To determine the share of the EIB's foreign borrowing, the study relied on the information available in the EIB financial reports for 2007-2018. The EIB is never the sole financier, its share of financing being, in principle, limited to 50% of the total project investment cost. The co-financiers also draw resources from the global capital markets, outside and inside the European Union. The study used the balance of payments data from Eurostat for different EU regions in order to estimate the relative shares of foreign and EU borrowing. The share of the EU financing of a project also integrates the domestic sources of financing for the region under consideration.

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14 When the EIB intervenes under specific mandates like the External Lending Mandate or the European Fund for Strategic Investments, it can rely on the EU guarantee. This study does not explicitly include this feature in the modelling. However, the introduction of the EU guarantee would not fundamentally alter the results of the analysis.

Figure 2 illustrates the sources and the effects of EIB-backed investments on an EU region:



Source: PBL-IG/EV

**In the short run, the EIB intervention has an investment (or demand) effect.** A first direct effect involves an inflow of funds into the region/sector where the supported project is located/belongs, disbursed by the EIB and other co-financiers over a given number of years (A). The EIB funds — and those of the co-financiers external to the region — increase the financing capacity of the region, which serves to finance the implementation of the supported project. An indirect effect is the increase in purchases of inputs — inside and outside the region and in various sectors — and, potentially, the hire of supplementary labour (C: accelerator effect — an increase in investment translates into an increase in output). The resulting extra income leads to an increased demand for goods and services and potentially therefore to a new round of investment (D: multiplier effect — the income increase feeds new investment). Overall, this combination of direct and indirect effects translates into an increase in aggregate investment in the short run. This oscillation between the accelerator and the multiplier effect gradually diminishes with time. Furthermore, after some time the loans have to be repaid. This involves a period of capital outflow from the region to other EU regions and the rest of the world (B) and a resulting contraction of funds available to finance projects in the region. This, in turn, translates into the reduction of aggregate investment in this region. Meanwhile, for the lending regions the repayment translates into an inflow of funds, which can serve to finance investments. The short-term effects of investments supported by EIB financing are similar across sectors within the supported region.

**In the study dataset, the investments supported by EIB financing are disbursed over 2015-2035 with the main bulk of disbursement taking place in 2015-2025.** Thus, the investment (demand) effect is likely to play out in full over this period, increasing the demand and therefore the GDP of the EU regions. In subsequent periods, the repayment of the borrowing takes place, subtracting from the GDP of the recipient regions and adding to the GDP of the donor regions (and the rest).

**In the long run, the implementation of the supported project also has a structural (or productivity) effect.** It reflects the effect on the structure and competitiveness of the economy, such as a better transport network, which can lead to lower-cost imports and exports, or greater availability of research facilities, generating productivity-enhancing technologies.

**The structural effect has two components. The first component is the increase in capital stock in the region, which enables greater production (E).**<sup>15</sup> This feature is relevant for all economic sectors where EIB-backed investments are made.

**The second component of the structural effect is the increased productivity of sectors in the region where the EIB-supported investments are channelled (F).** The productivity of the economic sectors is influenced positively in the long run by investments in human capital stock, R&D stock, transport infrastructure stock and ICT stock (see the empirical studies reviewed in Annex 5 – Literature review of the meta-regression studies). The magnitude of the positive impact depends on the level of these various types of stocks in the region and its sectors, as well as on the elasticities of total factor productivity with respect to changes in these stocks. These elasticities are taken from the recent meta-regression studies that are described in the dedicated section of this report. The model assumes therefore that investments in four specific sectors generate the increase in productivity of all local firms. These sectors are: “Transportation and Storage,” “Information and Communication,” “Professional, Scientific and Technical Activities” and “Education.” To assess the long-term structural impact of the investments supported by EIB financing in these sectors, the study extends the total factor productivity module of the EU-EMS to include the impacts of R&D, human capital, transport infrastructure and ICT investments on productivity. The quantification of this module is based on a number of recent meta-regression studies described in Annex 5 – Literature review of the meta-regression studies. The advantage of using the results of meta-regression studies instead of using the results of a particular individual econometric estimation is to have a more reliable and robust estimate of the impacts of investments on productivity as well as of the possible spread of the effects that could be used for sensitivity analysis.

**In order to be able to use the estimates of the average elasticities of productivity with respect to R&D stock, human capital, transport infrastructure stock and ICT stock, these stocks are estimated at the regional NUTS 2 level for the EU-28.** In the case of R&D capital, human capital and ICT capital, the study used the EU KLEMS Growth and Productivity Accounts 2017 release. The EU KLEMS database provides the estimates of these stocks for various EU countries at the national level and differentiated by economic sector. The study disaggregates EU KLEMS data, Eurostat regional accounts and population data as well as regional structural business statistics. For the EU countries that are not present in the EU KLEMS database, the study constructed the stocks using proportions between the stocks and output/value added from EU KLEMS for comparable countries. For transport infrastructure stocks, the study relied on the OECD database of transport infrastructure investments at the national level and constructed the stocks of transport infrastructure using the perpetual inventory method. The national transport infrastructure stocks are disaggregated to the regional level using regional data on transport activity from Eurostat. The more transport activity the region has, the higher its share of national transport infrastructure stock.

### **2.3 Limitations of the modelling approach**

**As with any applied general equilibrium model, the EU-EMS has a number of well-known limitations and caveats.** This section describes these caveats in detail.

**The representative-agent assumption simplifies the representation of real behaviours in the model by aggregating regional households within a particular population group and regional firms within a particular economic sector into one aggregate agent.** Computable general equilibrium (CGE) models also assume that the agents in the economy have perfect information and behave rationally, which is not always the case in reality. The choices of households and firms are guided by utility maximisation and profit maximisation objectives, which simplifies to a large extent actual agents’ behaviour.

**Most of the parameters of CGE models such as the EU-EMS are calibrated on data for one year and hence do not have statistical significance and are not fully representative for longer periods.** The use of calibrated parameters in CGE models has been criticised in the literature. Unfortunately, the limited availability of detailed statistical data (especially at the regional-sectoral level) and the current

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<sup>15</sup> Nevertheless, this positive impact on GDP from the build-up of new capital stock is temporary as the new capital gradually depreciates in the longer run.

econometric estimation techniques for endogenous systems of non-linear equations do not allow all of the parameters of the EU-EMS to be estimated simultaneously. In order to remedy this caveat in our study, we use a sensitivity analysis with respect to the main parameters of the model.

**The EU-EMS is a highly detailed and extremely large global modelling system that cannot be implemented as a fully dynamic CGE model due to current software and hardware limitations.**

The EU-EMS uses recursive dynamics, which means that the model is solved separately in each time period and the time periods are linked with savings being distributed as investments into various sectors and regions of the model. In contrast, fully dynamic models include an inter-temporal optimisation behaviour component for households and firms with respect to savings and investments and assume forward-looking expectations. These models usually have limited sectoral scope and are implemented for a single country.

**The model represents a real economy driven by relative prices.** The present state-of-the-art SCGE new economic geography models applied have no role for money and therefore stay close to the Arrow-Debreu neoclassical framework. In the EU-EMS, return to capital stock that is owned by households is determined endogenously in the model. All prices in the model are relative prices and are calculated in terms of the numeraire. A GDP deflator is used as the numeraire in the EU-EMS. The model considers savings and investments, but does not take a banking system or financial assets into account. There is no representation of the financial sector as such in the model, which means that there is no financial multiplier, no inflation and results are expressed in real values.

**Assumption of perfect information and perfect financial markets.** The EU-EMS model is a standard SCGE model that relies on the assumption of perfect information and perfect financial markets. As a result, the model assumes that the distribution of savings across projects worldwide is optimal: the market allocates funding to the projects that generate the highest return and any deviation from this distribution of savings across projects is suboptimal. The financing of new projects implies that some projects that would have been financed in the baseline scenario do not find financing and are no longer implemented. These foregone opportunities represent a cost of distortion vis-à-vis the baseline. To the extent that the EIB borrows resources from the rest of the world, it is the rest of the world that misses out on these opportunities.<sup>16</sup>

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16 This study relies on the EIB financial reports for 2007-2018 to determine the share of the EIB's borrowing outside the European Union, which is between 33% and 56% depending on the year.

### 3. RESULTS – MACROECONOMIC EFFECTS OF EIB FINANCING FOR THE EU REGIONS

#### Summary

The purpose of this sub-section is to explore the impact of investments supported by EIB financing across EU regions, primarily on GDP and employment, but also on aggregate investment and productivity. The EU regions differ in terms of GDP and GDP per capita, levels of capital per capita, international trade specialisation, sector structure of the economies, and other economic characteristics, all of which play a role. Thus, the impact is understandably not uniform.

Investments supported by EIB financing benefit all EU regions which, by 2020-2025 (when the highest impact occurs) gain, on average, 0.8% in comparison to their GDP in the baseline scenario. The surge in GDP is driven by the increase in aggregate investment in the short run and by productivity gains in the medium to long run. Nevertheless, there is a lot of heterogeneity in impact across regions. At the peak (by 2020-2025), the impact ranges from near zero for some regions to strongly positive for others (up to 7.2%). The positive impact on employment, by contrast, is somewhat more limited, albeit still sizeable.

Cohesion regions gain, on average, more with respect to the baseline scenario than non-cohesion regions in every period. Furthermore, the cohesion regions which experience the highest increase in GDP gain more than the non-cohesion regions with the highest impact.

Almost all EU regions experience an increase in total factor productivity with respect to the baseline, with cohesion regions once again seeing their total factor productivity increase more with respect to the baseline than non-cohesion regions.

#### 3.1 Effects on GDP

**The investments supported by EIB financing have a positive and sizeable impact for the vast majority of the EU regions throughout 2015-2050. By 2020-2025, EIB-backed investments add, on average across regions, 0.8% compared to GDP in the baseline scenario. This positive effect persists up to 2050. There is a lot of heterogeneity across regions. The impact on the GDP of various regions ranges from -0.9% to 7.2% with respect to the baseline.**

The following table summarises the results of the analysis for the 271 EU regions:

Table 1 – Impact on GDP across regions of investments supported by EIB financing									
		2010-2015	2015-2020	2020-2025	2025-2030	2030-2035	2035-2040	2040-2045	2045-2050
Number of regions	with a positive impact on GDP	142	266	270	269	268	265	259	247
	with a negative impact on GDP	129	5	1	2	3	6	12	24
Average impact on GDP with respect to the baseline across regions (in %)		+0.0%	+0.4%	+0.8%	+0.7%	+0.5%	+0.5%	+0.4%	+0.4%
Range	Highest value	+0.6%	+4.1%	+7.2%	+7.0%	+6.0%	+5.7%	+5.5%	+5.4%
	Lowest value	-0.9%	-0.5%	-0.1%	-0.2%	-0.1%	-0.2%	-0.2%	-0.2%

Source: PBL-IG/EV

\* The simulation includes the United Kingdom as an EU member.

Except in the first period (2010-2015), the vast majority of the EU regions benefit from EIB financing and the investments it supports. The average impact is highest in 2020-2025 when EIB-backed investments add 0.8% to the GDP of the EU regions compared to the baseline scenario.

In the first period, the impact on GDP with respect to the baseline is close to zero. In the following periods, from 2015 to 2050, investments supported by EIB financing lead to increases in productivity in all sectors and an overall increase in GDP across regions. As the productivity gains (with respect to the baseline) gradually kick in, they boost GDP beyond the baseline levels. The positive impact on GDP with respect to the baseline persists even in the longer run, albeit getting somewhat smaller. Nevertheless, even by 2045-2050, the GDP of EU regions is, on average, still 0.4% higher compared to the baseline scenario.

**There is a lot of heterogeneity in impact across regions. Thus, by 2020-2025, the impact ranges from near zero (-0.1%) to strongly positive (up to 7.2%).** One explanatory factor is the volume of investments received, which varies across regions. The correlation between the total amount of investment received (adjusted by GDP of the region) and the size of the impact is understandably very strong (close to 0.9 in the peak years, then gradually descending to 0.8). Out of the top ten regions with the largest impact on GDP in 2025-2030, seven are also the top ten recipients of investments supported by EIB financing (adjusted by GDP of the region).

Even though almost all the EU regions benefit largely from the EIB-supported investments, for (very) few regions at some point in time GDP might be slightly lower than it would have been in the baseline scenario. The order of magnitude is generally minimal, for instance by 2020-2025 the GDP is only 0.1% lower with respect to the baseline scenario in one region. The main underlying reason for the negative results is the model's assumption that the EIB borrows from a fixed pool of savings. Under the baseline, all the savings would have financed investment projects somewhere. Thus, when the EIB and its co-financiers borrow from this pool of savings to finance projects, there is an opportunity cost of some projects not being financed elsewhere. In this context, even though all of the regions benefit from the EIB-supported investments, for some of them the loss in terms of foregone opportunities (unrealised projects) might slightly exceed the gain from the EIB-supported investments. However, those regions are very few in number and the loss generally does not exceed 0.2% of their GDP in the baseline scenario (except in the first period where it reaches 0.9% for one region).

**Cohesion regions gain, on average, more with respect to the baseline scenario than non-cohesion regions in every period. Furthermore, the cohesion regions which experience the highest increase in GDP gain more than the non-cohesion regions with the highest impact.**

The following table shows the difference between the two categories:

<b>Table 2 – Impact on GDP across regions of investments supported by EIB financing — cohesion and non-cohesion regions</b>									
		<b>2010-2015</b>	<b>2015-2020</b>	<b>2020-2025</b>	<b>2025-2030</b>	<b>2030-2035</b>	<b>2035-2040</b>	<b>2040-2045</b>	<b>2045-2050</b>
Number of <b>cohesion</b> regions	with a positive impact on GDP with respect to the baseline scenario	64	135	135	134	133	132	130	126
	with a negative impact on GDP with respect to the baseline scenario	72	1	1	2	3	4	6	10
Average impact on GDP with respect to the baseline across regions (in %)		-0.1%	+0.6%	+1.2%	+1.1%	+0.9%	+0.8%	+0.8%	+0.8%
Range	Highest value	+0.6%	+4.1%	+7.2%	+7.0%	+6.0%	+5.7%	+5.5%	+5.4%
	Lowest value	-0.9%	-0.5%	-0.1%	-0.2%	-0.1%	-0.2%	-0.2%	-0.2%
<hr/>									
Number of <b>non-cohesion</b> regions	with a positive impact on GDP with respect to the baseline scenario	78	131	135	135	135	133	129	121
	with a negative impact on GDP with respect to the baseline scenario	57	4	0	0	0	2	6	14
Average impact on GDP with respect to the baseline across regions (in %)		+0.0%	+0.3%	+0.6%	+0.5%	+0.4%	+0.3%	+0.3%	+0.3%
Range	Highest value	+0.2%	+2.0%	+3.1%	+3.0%	+2.7%	+2.5%	+2.4%	+2.4%
	Lowest value	-0.9%	-0.5%	+0.2%	+0.1%	+0.0%	-0.0%	-0.1%	-0.1%

Source: PBL-IG/EV

\* The simulation includes the United Kingdom as an EU member.

The impact on GDP for both categories of regions follows the same curve as the EU regions at large: a very slight decrease with respect to the baseline scenario followed by an increase and the peak around 2020-2025, then a gradually lower impact with respect to the baseline scenario until 2050. Except in the first period, almost all cohesion and non-cohesion regions see their GDP increase with respect to the baseline scenario. In the first period, the results in terms of impact on GDP are more contrasting, but the order of magnitude of a decrease is limited for most of the regions. The difference between cohesion and non-cohesion regions is in the magnitude of the impact. Thus, by 2020-2025, the EIB-backed investments add, on average, 1.2% to the GDP of cohesion regions compared to the baseline scenario. For non-cohesion regions, on average by 2020-2025, the EIB-backed investments increase the GDP by 0.6% with respect to the baseline scenario.

### Box 1 – Opportunity cost of Brexit — how do UK regions fare with EIB investment support?

In 2007-2018, the period covered by this study, the United Kingdom was part of the European Union and benefited from investments supported by EIB financing. Thus, even though the United Kingdom has ceased to be a member, the effects of the EIB-backed investments will affect the economies of the UK regions in the coming decades. This provides a legitimate reason for including the United Kingdom within the scope of the study and assessing the impact of the investments supported by EIB financing on the UK regions.

The United Kingdom has 37 regions covered by this study, of which 13 are cohesion regions and 24 are non-cohesion regions. How do the EIB-backed investments perform in these regions?

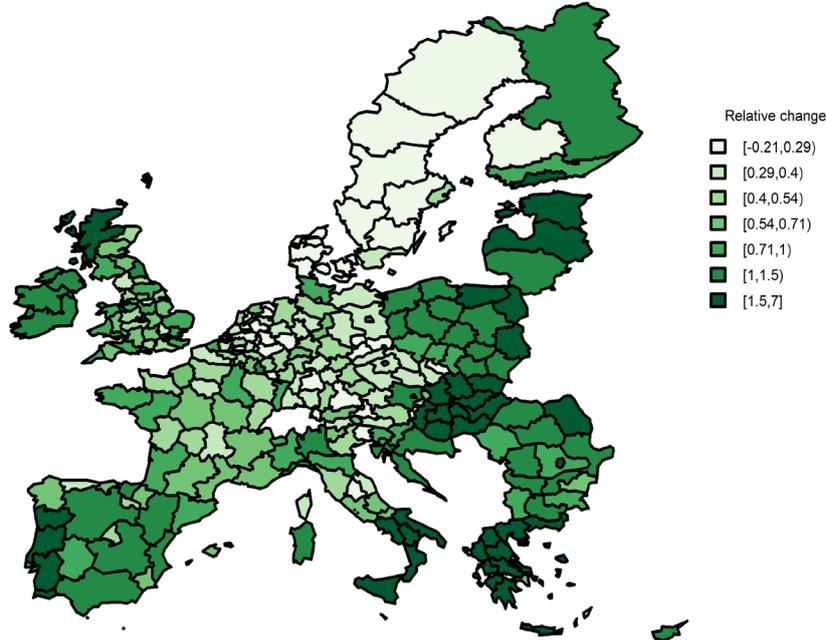
The results of the modelling show that the impact of the EIB-backed investments on the average GDP of the UK regions is substantial, albeit slightly lower than on the average GDP of the EU-28 regions: the GDP is 0.8% higher than in the baseline scenario by 2020-2025.

Furthermore, the impact of the EIB-backed investments in the UK *non*-cohesion regions is always higher than across the EU-28 non-cohesion regions. By contrast, UK cohesion regions tend to benefit slightly less, on average, than the average for the EU cohesion regions. Nonetheless, some of the UK cohesion regions clearly outperform the EU-28 average. In particular, the (cohesion) region “Highlands and Islands” in northern Scotland has its GDP increased by 2.5% with respect to the baseline scenario by 2020-2025 and by 1.8% with respect to the baseline scenario by 2025-2030, well over the EU-28 average for cohesion regions. For many of the UK regions — cohesion and non-cohesion — the EIB did make a difference.

**The EU regions with the lowest level of GDP per capita gain the most, while the richest regions gain the least. As cohesion regions exhibit a higher gain from the investments supported by EIB financing than non-cohesion regions, the EIB does indeed contribute to the reduction of disparities in terms of GDP between cohesion regions and the rest of the European Union.**

The following map illustrates the impact of EIB-backed investments on GDP across EU regions:

**Figure 3 – Impact of investments supported by EIB financing on GDP across the EU regions by 2025-2030 (% change with respect to the baseline scenario)**



Source: PBL-EIB.

\* The simulation includes the United Kingdom as an EU member.

\*\* The effects are shown only for the EU regions.

How to read this graph: by 2025-2030, the GDP in Sicily is between 1.5% and 7.0% higher than it would be without the investments supported by EIB financing.

The two EU regions experiencing a fall in GDP with respect to the baseline scenario — the two French regions of Martinique and Reunion — are actually not shown on the map. Thus, all the regions shown add at least a few decimals to their average GDP by 2025-2030. Regions in Hungary, Greece, southern Italy, northern Scotland, Portugal, eastern Poland, Estonia, Latvia and eastern Romania gain the most from the investments supported by EIB financing by 2025-2030.<sup>17</sup> Regions in Denmark, Sweden, the Netherlands and several regions in Germany and Austria gain the least. The major explanatory factor is the lower level of capital per capita in the regions that gain the most and, conversely, a relatively higher one in the regions that gain relatively less. Regions with lower income grow more as they grow from a lower base.

**Alongside this general explanation, what matters for the magnitude of the gain is the sectors in which the EIB-backed investments are made.** For instance, one of the reasons why Hungarian regions gain so much is that investments in Hungary are largely allocated to economic sectors (such as education) which — by design of the transmission channel — increase the total factor productivity.

#### **Box 2 – Reduction in disparities between cohesion regions and the rest of the European Union: relative and absolute**

In the longer run — by 2045-2050 — the total aggregate gain in euro with respect to the baseline scenario for cohesion regions becomes higher than for non-cohesion regions, thereby reducing the disparities between the two categories of regions even in absolute terms. This last result is all the more remarkable given that the share of EIB financing going to cohesion regions represents only 34.0% of total EIB financing and the volume of investment supported by EIB financing in cohesion regions is only 42.7% of the total volume of investment supported by EIB financing across the European Union.<sup>18</sup> Thus, in the long run, the EIB significantly contributes to the reduction of disparities in terms of GDP between the cohesion regions and the rest of the European Union even in absolute terms.

In the short and medium term, the impact of investments supported by EIB financing for cohesion regions (+1.2% with respect to the baseline by 2020-2025 on average across regions) is higher than for non-cohesion regions (+0.6% by the same period), thereby contributing to the reduction of disparities between cohesion and non-cohesion regions in relative terms. However, up to 2045, the total aggregate gain in euro for non-cohesion regions exceeds the total aggregate gain for cohesion regions. The result is trivial. By 2010-2015, the aggregate baseline GDP of all 136 cohesion regions represents only 27.7% of the total EU GDP against 72.3% for the 135 non-cohesion regions. Thus, even a much more modest positive impact for non-cohesion regions translates into a higher gain in absolute value.

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17 In 2045-2050, the same regions gain the most, with the exception of Latvia and Estonia and the addition of regions in central Poland.

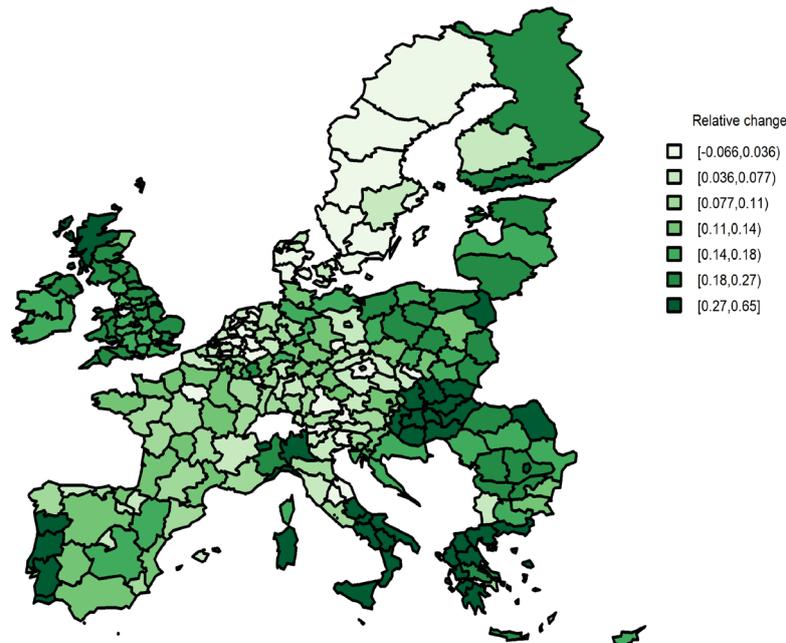
18 In this report, a region is classified in the “cohesion regions” category if it was a cohesion region under at least one of the two multiannual financial frameworks. For regions which were cohesion regions under one multiannual financial framework only, the analysis takes into account only investments supported by EIB financing in the corresponding period. Then, the share of EIB financing going to cohesion regions represents 36.2% of the total, while the volume of investment supported by EIB financing in cohesion regions is 45.4% of the total volume of investment supported by EIB financing across the European Union, still well below the corresponding shares dedicated to the non-cohesion regions.

### 3.2 Effects on employment

The impact on employment is positive in almost all the EU regions, albeit somewhat less pronounced than the impact on GDP. The regions that experience the largest increase in employment with respect to the baseline scenario add up to 0.7% to the number of persons employed by 2025-2030.

The following figure shows the impact of EIB-backed investments on employment:

**Figure 4 – Impact of investments supported by EIB financing on employment across the EU regions by 2025-2030 (% change with respect to the baseline scenario)**



Source: PBL-EIB.

\* The simulation includes the United Kingdom as an EU member.

\*\* The effects are shown only for the EU regions.

How to read this graph: by 2025-2030, the number of persons employed in Sicily is between 0.27% and 0.65% higher than it would be without the investments supported by EIB financing.

**The results in terms of employment are in line with the effects on GDP.** By 2025-2030, the impact is clearly positive in EU regions in Hungary, Greece, southern Italy, northern Scotland, Portugal and several regions in other areas. For a few other regions, the impact on employment is close to zero. Investments lead to an increase in the use of the labour input in the initial periods (to implement the project and as a response to a demand shock in the economy). However, in later periods the substitution of capital to labour leads to a lower use of the labour input in production. As a result of these two diverging channels of adjustment, the overall effect on employment is somewhat more modest in the long run.

### 3.3 Effects on productivity

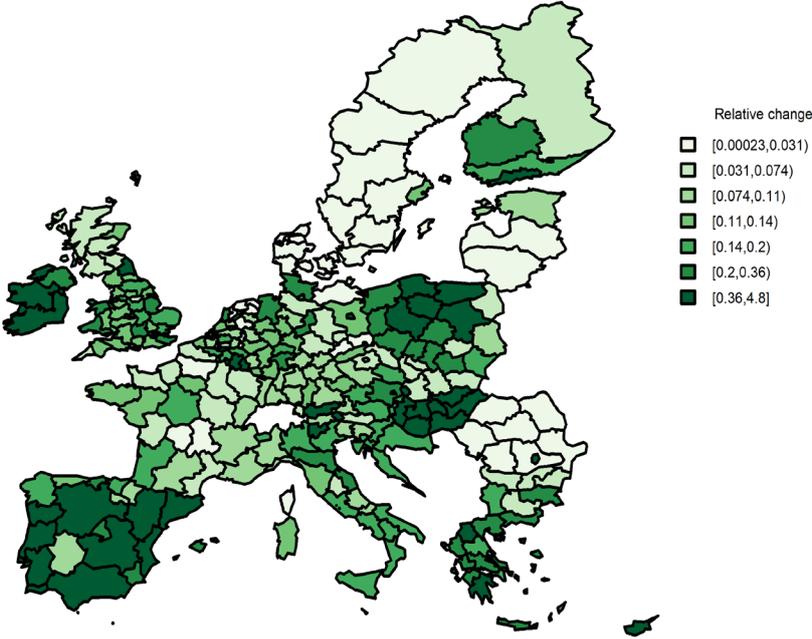
**Almost all EU regions experience an increase in total factor productivity with respect to the baseline scenario.** For instance, by 2025-2030 only two regions see their level of productivity fall slightly with respect to the baseline scenario. For the remaining 269 EU regions, productivity increases more or less substantially. For 79 regions out of 271, the productivity gain exceeds 1%, and for 29 regions the increase is more than 2% with respect to the baseline. For the top ten regions, the gain exceeds 3.8% with respect to the baseline scenario.<sup>19</sup>

<sup>19</sup> The increase in total factor productivity indicates how much higher the level of productivity in the policy scenario is by a given period as compared to the baseline scenario.

**Cohesion regions gain considerably more in terms of productivity than non-cohesion regions.** Out of the top 20 regions with the highest productivity increase by 2025-2030 and by 2045-2050, 19 are cohesion regions.<sup>20</sup> For cohesion regions, the average increase in productivity is +1.4% with respect to the baseline. For non-cohesion regions, productivity increases, on average, by +0.6% with respect to the baseline. This result holds in subsequent periods. Thus, by 2045-2050, productivity increases on average by +1.0% for cohesion regions and by +0.3% for non-cohesion regions with respect to the baseline. This outcome is explained by the fact that cohesion regions have a lower level of capital per capita and therefore increase more from a lower base.

The following figure illustrates the impact of investments supported by EIB financing on total factor productivity in the EU regions by 2025-2030:

**Figure 5 – Impact of investments supported by EIB financing on total factor productivity across the EU regions by 2025-2030 (% change with respect to the total factor productivity level in the baseline scenario)**



Source: PBL-EIB.  
 \* The simulation includes the United Kingdom as an EU member.  
 \*\* The effects are shown only for the EU regions.  
 How to read this graph: by 2025-2030, the total factor productivity in Sicily is between 0.14% and up to 0.2% higher than it would be without the investments supported by EIB financing.

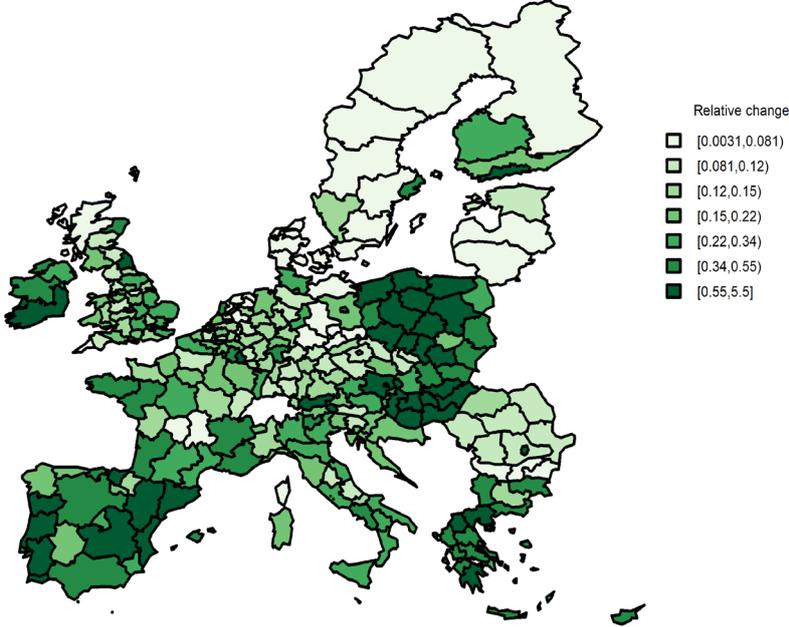
Hungarian, Greek, Irish and, to a lesser extent, Polish regions see their productivity increase the most with respect to the baseline. However, apart from the regions at the periphery of the European Union, some regions in the industrial heart of the Union show major productivity gains with respect to the baseline: regions in Germany, the United Kingdom, Luxembourg, Austria and northern Italy. Spanish and Portuguese regions — cohesion and non-cohesion — also see their productivity rise significantly compared to the baseline scenario.

**Productivity is a major driver of the increase in GDP for 31 out of 271 regions by 2025-2030, most of them (23) non-cohesion.** This is also the case for 161 out of 271 regions by 2045-2050, with non-cohesion regions also dominating (102). The most plausible explanation is that non-cohesion regions tend to specialise in high value added, upmarket segments of the economy, which allows them to reap benefits from investments in R&D and ICT stock to a greater extent than cohesion regions.

20 The only non-cohesion region in the top 20 in both periods is the Finnish region Helsinki-Uusimaa.

The following figure illustrates the impact of investments supported by EIB financing on total factor productivity in the EU regions by 2045-2050:

**Figure 6 – Impact of investments supported by EIB financing on total factor productivity across the EU regions by 2045-2050 (% change in the total factor productivity level with respect to the baseline scenario)**



Source: PBL-EIB.

\* The simulation includes the United Kingdom as an EU member.

\*\* The effects are shown only for the EU regions.

How to read this graph: by 2045-2050, the total factor productivity in Sicily is between 0.22% and up to 0.34% higher than it would be without the investments supported by EIB financing.

By 2045-2050, the picture remains similar to the period 2025-2030 considered above. Polish, Spanish, Hungarian, Greek, Irish and, to a lesser extent, Italian regions gain the most with respect to the baseline. Several regions in the United Kingdom, France, Austria and Luxembourg see their productivity increase substantially in comparison to the baseline.

## 4. CONCLUSIONS

**The results of the modelling show that the EIB successfully serves its dual purpose of fostering the economic development of the European Union and supporting convergence between the poorer EU regions and the rest of the European Union.** This finding is particularly important in view of the overall trend of increasing economic divergence across EU regions.

**In terms of the economic development objective, investments supported by EIB financing have a substantial impact on the GDP of the EU regions. On average across EU regions, by 2020-2025 (when the highest impact occurs), they induce a 0.8% increase in GDP with respect to the baseline scenario.** The effects on employment in the European Union are also non-negligible, adding up to 0.7% to the number of persons employed for some EU regions.

**In terms of the objective of supporting convergence, cohesion regions gain, on average, more with respect to the baseline scenario than non-cohesion regions in every period.** Furthermore, the cohesion regions which experience the highest increase in GDP gain more than the non-cohesion regions with the highest impact. At the peak of the impact, the investments supported by EIB financing add up to 7.2% to GDP with respect to the baseline scenario for some cohesion regions, and up to 3.1% for some non-cohesion regions. Similarly, cohesion regions gain much more in terms of productivity than non-cohesion regions.

**These results are robust to changes in some of the parameters of the model (Armington trade elasticity and the elasticity of substitution between capital and labour).** The change in these parameters does not significantly alter the results. Thus, the results are not highly sensitive to the specific value of a given parameter.



## ANNEX 1 – REFERENCES

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## ANNEX 2 – DATA

This annex describes the dataset built for the modelling exercise and the data preparation strategy adopted to build a relevant dataset from the raw data of the EIB internal corporate database.

The input unit used, which typically covers many operations, is the volume of investment supported by EIB financing flowing in a given EU region and a given sector in a given year (for example, volume of investment occurring in Tuscany in the transportation and storage sector in 2008). The volume of investment is the sum of project investment costs for the projects supported by the EIB operations belonging to the same year/region/sector combination.

### Dataset of the EIB-supported investments

**The study dataset was built from two distinct components.** The first component includes the investments supported by EIB financing in cohesion regions. The second component includes the investments supported by EIB financing in non-cohesion regions. The present study relies on the joint dataset which includes both components. Since the construction of each component followed the same process, the explanation below applies to both datasets. The joint dataset — including cohesion and non-cohesion EIB financing — was made by simply merging the two datasets.

**In order to model the effects of EIB financing, the study prepared a dataset of the EIB investments in the EU-28 in the period 2007-2018 (herein referred to as the “study dataset”).** The study dataset was built using the data extracted from the EIB internal corporate database. The present section describes the rationale and characteristics of the study dataset, while the next section details the approach and the assumptions underpinning the constitution of the study dataset from the raw data.

The study dataset was constructed in two steps.

#### *First step: dataset of individual operations*

The first step is the constitution of the dataset of the individual operations relevant for the present study. It comprises all EIB operations for which at least one contract was signed between 1 January 2007 and 31 December 2018. Each row in the dataset refers to a specific individual operation as shown in the table below:

Table 3 – Investments supported by EIB financing: individual operations							
Operation ID	Region ID	Signature year	Economic sector ID	EIB contract amount	Project investment cost	Duration of the project (years)	Duration of repayment (years)
x1	reg1	y1	A	€	€	#	#
x2	reg1	y1	A	€	€	#	#
x3	reg1	y1	C	€	€	#	#
x4	reg2	y2	A	€	€	#	#

Source: PBL-IG/EV

Alongside the operation ID, the dataset indicates the region — based on the NUTS 2 classification of EU-28 regional entities — where the underlying investment would be made based on the location of the project promoter.

The dataset also specifies the signature year, which is the year when the first underlying contract for the operation was signed. The starting year of the investment flow is subsequently taken as the year of signature of the contract between the project promoter and the EIB.

The dataset references the economic sector ID — based on the NACE Rev. 2 classification — specifying the sector to which the project financed by the operation would belong. It also indicates the EIB contract amount: the EIB financial contribution for all contracts signed under the operation in question.

The dataset also indicates the project investment cost associated with the project supported by the EIB through the financing operation. The project investment cost combines the EIB contribution and the contribution by co-financiers. It represents all capital expenditure associated with the implementation of the investment project. The project investment cost is the key input variable used in the modelling to assess the effects of the investments supported by EIB financing. There are three reasons for using the project investment cost rather than the EIB financial contribution only. First, it avoids the complex issue of the share of impact to attribute to EIB financing as such. Second, it takes into account the potential leverage effect of the EIB's involvement on other investors, in particular private investors. Third, the question of interest is not the impact of the EIB financing per se, but the impact of projects co-financed by the EIB on the economy (for example, the impact of a bridge built, not of a share of this bridge that the EIB helped finance). Furthermore, the use of the project investment cost as the input variable is a common feature of similar modelling exercises (RHOMOLO).

The model input also needed the duration of the investment flow in order to see over how many years the project investment cost would be distributed. The duration of the project was used as a proxy for the duration of the investment flow: if the project lasted for six years, it was assumed that the underlying investment was made in six equal instalments over the corresponding period.<sup>21</sup>

In order to model the outflow of funds corresponding to the repayment, the dataset of individual operations also specified the duration of the repayment period. By assumption, the repayment started upon completion of the project and represented an outflow of funds distributed over the number of repayment years. For instance, if the duration of the repayment specified in the database indicated ten years, it was assumed that the repayment would occur on a yearly basis in ten equal instalments.

*Second step: dataset of year/region/sector combinations*

The input unit used for the modelling of the EIB investment support and its effects is the volume of investment supported by the EIB occurring in a given EU-28 region in a given year and in a given sector. Thus, the second step of the study dataset constitution involved grouping together the individual operations belonging to the same signature year, economic sector and NUTS 2 region.

For instance, the operations x1 and x2 from **Table 3** having the same region, sector and first contract signature year would be combined into one number (in bold in the table). More specifically, the project investment costs of the two operations would be added and the duration of the underlying projects would be averaged, as would the duration of repayments.

The following table shows the resulting study dataset:

Table 4 – Investments supported by EIB financing: year/region/sector units						
Region ID	Signature year	Economic sector ID	EIB contract amount	Project investment cost	Average duration of projects (years)	Average duration of repayments (years)
<b>reg1</b>	<b>y1</b>	<b>A</b>	€	€	#	#
reg1	y1	B	€	€	#	#
reg1	y1	C	€	€	#	#
reg1	y2	A	€	€	#	#

Source: PBL-IG/EV

As mentioned before, the procedure described was used to build a dataset for EIB financing in cohesion regions and a dataset for EIB financing in non-cohesion regions. Both datasets were used in the macroeconomic modelling for the evaluation of EIB cohesion financing. The joint dataset used in the present study — and covering all EIB financing in all EU regions, cohesion and non-cohesion — was made by simply merging the two datasets.

21 The following section explains the treatment of equity and guarantees.

**The study dataset represents a total volume of EIB financing of €657.9 billion and a total volume of investment of around €2 342.2 billion.** This dataset is composed of two datasets: one for EIB cohesion financing and one for EIB non-cohesion financing. The dataset for EIB cohesion financing includes 19 993 region/sector/year combinations for a total volume of EIB financing of around €223.8 billion and a total volume of investment estimated at around €1 001 billion. The dataset for EIB non-cohesion financing includes 37 196 region/sector/year combinations for a total volume of EIB financing of around €434.1 billion and a total volume of investment estimated at around €1 341.1 billion.

## Data preparation strategy

This section explains the composition of the portfolio of relevant EIB operations and the choice of variables used in the dataset.

### Composition of the portfolio of EIB operations

The dataset for the modelling is based on the information available in the EIB internal corporate database. This section describes the main assumptions related to the composition of the portfolio.

#### *Volume signed as a proxy of volume allocated*

With the exception of multi-beneficiary intermediated loans (MBILs), the available information did not contain the data for actual allocations under the different contracts. Thus, for the operations involving MBILs, the data on actual allocations was used. For other operations, the amount signed was used as a proxy for the amount allocated. While the magnitude of the discrepancy between the two cannot be assessed, it is likely to be fairly limited and does not affect the results of the modelling.

#### *The specific case of multi-beneficiary intermediated loans*

**For multi-beneficiary intermediated loans (MBILs), the data of actual disbursements was used instead of the data on amounts signed.** For MBILs, the data on contracts available in the internal corporate database provides only the aggregate sector indication — sector Z “Global loans, loans for SMEs, loans for SMEs and mid-caps, loans for mid-caps.” In other words, the data are available only at the level of the financial intermediary through which the loans are channelled to the final beneficiaries (small and medium-sized enterprises and mid-caps). However, the data on allocations were retrieved from another internal corporate source. These data provided the figures of actual allocations for each of the final beneficiaries. It was thereby possible to break down the aggregate contract amount for the intermediated loan into a multitude of underlying contracts with final beneficiaries. The merit of this is twofold:

- First, instead of the compounded sector Z, the information is obtained on the sectors to which each of the final beneficiaries belong.
- Second, the information on actual allocations is more precise than the information on signatures.

In practical terms, the dataset based on the data extracted from the internal corporate database (aggregate MBIL amount with sector Z) was merged with the data provided from another internal source (individual loan amounts) as follows: each line of the MBIL aggregate amount marked with sector Z was deleted and replaced with the list of corresponding underlying contracts with final beneficiaries. The operation ID was used to control for the appropriate replacement.

#### *Removal of cancelled operations*

Some operations signed after 2007 were cancelled after signature. The data preparation involved systematically removing these operations from the dataset.

### *Removal of non-EU operations*

The focus of the present study is exclusively on EIB financing in the European Union. However, some operations in the internal corporate database marked with a cohesion eligibility code are situated in non-EU countries. Those operations were not included in the dataset.<sup>22</sup>

## **Definition of variables**

### *Project investment cost issue: missing data and definition of the variable*

**The project investment cost variable was used as a measure of the total investment for an individual project.**

The first issue related to the project investment cost was that the figures in the internal corporate database were available at the operation level, but not at contract level. The solution applied was to replicate the distribution of the operation level at the contract level.

The second issue related to the use of the project investment cost variable is the value of the land incorporated in it. The raw data of the project investment cost includes an item which is not strictly investment in the economic meaning of the term, namely the purchase of land. Unfortunately, there is no way of automatically adjusting the variable so as to eliminate the purchase of land. The importance of this item in the overall project investment is, nevertheless, quite limited and would not significantly affect the results of the analysis.

### *Average duration of financing and average duration of repayment*

For each of the contracts, the study computed two additional variables.

**The average duration of the project was used as a proxy for the period of disbursement of funds and the inflow of funds into the relevant region. The average duration of repayment was used as a proxy for the period of repayment of funds and the corresponding outflow of funds from the region.** For both disbursement and repayment periods, the corresponding sums were distributed equally over the years. In other words, if the funds are disbursed over five years, the assumption is that an equal amount is provided each year (the total amount is divided by five). The same principle applies to repayment.

### *Treatment of equity and quasi-equity operations*

**The study estimated the project investment cost for each of the contracts involving equity or quasi-equity, just as for the loan financing operations.** Although the project investment cost is an imperfect measure of the total volume of investment involved, it was deemed less controversial than the estimation of the multiplier. Equity and quasi-equity operations represent a marginal proportion of EIB financing in cohesion regions and a limited proportion of EIB financing overall. Thus, the use of an alternative method would be unlikely to alter the results of the analysis.

Regarding the timeline of disbursement and repayment for these types of operations, the following assumptions were made:

- The inflow of funds into the region occurs in its entirety in one year, the year of signature.
- The outflow of funds from the region occurs in its entirety in one year, the twelfth year after the signature year (the approximate duration identified after consultation with the EIB services).

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<sup>22</sup> The removal of cancellations and operations outside the European Union accounts for the difference between the €262 billion signed amount labelled as cohesion and the €224 billion of EIB cohesion financing mentioned in this report.

### *Treatment of guarantee operations*

**Guarantee operations are treated in the same way as loans as regards the estimation of the project investment cost and the disbursement/repayment of funds.** What makes guarantee operations different is that they are modelled like a “loan with a zero EIB contribution,” meaning that the entire project investment cost is borne by investors other than the EIB. The disbursement/repayment of funds is estimated in the same way as for loans.

### *Treatment of bullet contracts*

**Regarding the repayment of bullet contracts, the modelling considered that the bullet option is systematically exercised.** This means that for a fixed period of time only interest is paid and the capital is repaid at the end of the period.

### *Treatment of grant funding*

**Grant financing is approximated by loan financing.** Unlike loans, grants do not have to be repaid by the recipient. Nevertheless, the resources for grant funding still involve a corresponding volume of taxes (more or less distortionary). The data constraints precluded modelling the grant financing explicitly. Thus, the dataset uses loan financing as a proxy for grant financing across regions. The distributional implications of this choice are unclear: cohesion regions concentrate most of the grant funding, but bear a tax burden that is higher or lower in proportion to their GDP. While the overall magnitude of the results is unlikely to change significantly, in qualitative terms the main conclusions would be somewhat reinforced: cohesion regions are likely to benefit slightly more and non-cohesion regions slightly less than what is presented in the study.



## ANNEX 3 – THEORETICAL STRUCTURE OF THE EU-EMS

### Household preferences and government

Key economic “agents” in the model are households, firms and government; key production factors are different types of labour and capital. Household and government demand for goods and services is represented by the linear expenditure system (LES) that is derived as a solution to the Stone-Geary utility maximisation problem:

$$U_r = \prod_i (C_{ri} - \mu_{ri})^{\gamma_{ri}} \quad (0)$$

The resulting demand system where  $I_r$  denotes households' disposable income and  $P_{ri}$  are consumer prices of goods and services that include taxes, subsidies, transport and trade margins can be written as follows:

$$C_{ri} = \mu_{ri} + \gamma_{ri} \cdot \frac{1}{P_{ri}} \cdot \left( I_r - \sum_j \mu_{rj} \cdot P_{rj} \right) \quad (0)$$

According to (2), households consume a certain minimum level of each good and service where this level reflects the necessity (or price elasticity) of the good or service. Necessities such as food have low price elasticity and hence a higher minimum level of consumption. The disposable income of households consists of wages, return to capital, social transfers from the government minus income taxes and household savings.

The government collects taxes on production, consumption and income. The tax revenue is used to pay social transfers and purchase goods and services for public consumption. Government savings can either be endogenous or exogenous in the model depending on the type of simulation and the type of chosen macroeconomic closure.

For the purpose of simulations in the study we updated the parameters of the linear expenditure system according to an implicit, directly additive demand system (AIDADS) as income per capita develops over time.

### Firm production

Domestic production  $X_{ri}^D$  is derived from a nested constant elasticity of substitution (CES) production technology of KLEM type, where K is the capital, L is the labour, E is the energy and M is the materials. The figure below presents the nests in the KLEM production function used in the model, with services used according to the fixed Leontief input coefficients in the production process. In order to capture detailed energy-specific impacts of the InnoEnergy KIC, the energy sector in the model differentiates between electricity and other types of energy with some substitution possibilities between them. In order to capture detailed skill-specific impacts from the European Institute of Innovation and Technology investment in the area of education, the labour force in the model is differentiated according to their education level (high-skill, medium-skill and low-skill) in accordance with the International Labour Organization classification.

Domestic production is generated according to a nested production CES function that is described by the following set of composite CES functions that follow the production structure from the top to the bottom nest,

$$X_{ri}^D = \left[ (a_{ri} \cdot M_{ri})^{\rho_{M,KLE}} + ((1-a_{ri}) \cdot KLE_{ri})^{\rho_{M,KLE}} \right]^{1/\rho_{M,KLE}} \quad (0)$$

$$KLE_{ri} = \left[ (b_{ri} \cdot E_{ri})^{\rho_{E,KL}} + ((1-b_{ri}) \cdot KL_{ri})^{\rho_{E,KL}} \right]^{1/\rho_{E,KL}} \quad (0)$$

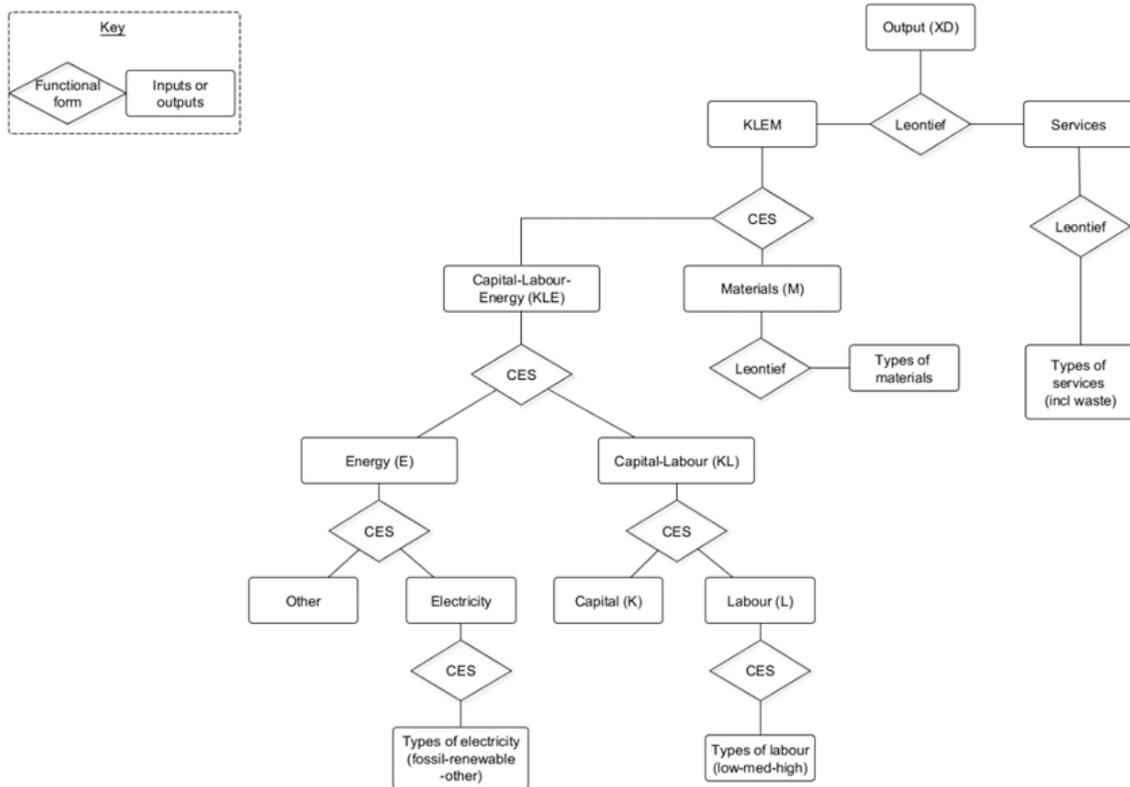
$$KL_{ri} = \left[ (c_{ri} \cdot K_{ri})^{\rho_{K,L}} + ((1-c_{ri}) \cdot L_{ri})^{\rho_{K,L}} \right]^{1/\rho_{K,L}} \quad (0)$$

$$E_{ri} = \left[ (d_{ri} \cdot E_{ri}^{NELEC})^{\rho_E} + ((1-d_{ri}) \cdot E_{ri}^{ELEC})^{\rho_E} \right]^{1/\rho_E} \quad (0)$$

$$L_{ri} = \left[ \sum_e (f_{rie} L_{rie}^{ED})^{\rho_L} \right]^{1/\rho_L} \quad (0)$$

where  $a_{ri}$ ,  $b_{ri}$ ,  $c_{ri}$ ,  $d_{ri}$  and  $f_{rie}$  are the share parameters of the corresponding production function nests and  $\rho_{M,KLE}$ ,  $\rho_{E,KL}$ ,  $\rho_{K,L}$ ,  $\rho_E$  and  $\rho_L$  represent the substitution possibilities on each of the production function nests. The inputs into production are denoted as  $M_{ri}$  input of materials,  $KLE_{ri}$  composite capital-labour-energy nest,  $E_{ri}$  energy inputs,  $KL_{ri}$  composite capital-labour nest,  $K_{ri}$  capital input,  $L_{ri}$  labour input,  $E_{ri}^{NELEC}$  input of non-electric energy,  $E_{ri}^{ELEC}$  input of electric energy and  $L_{rie}^{ED}$  inputs of labour by the level of education  $e$ .

**Figure 7 – Structure of KLEM production functions in the model**



Source: PBL

### International and inter-regional trade

The total sales  $X_{ri}$  of tradable goods and services  $i$  in region  $r$  in the model is an Armington CES composite between domestic output  $X_{ri}^D$  and imports  $X_{ri}^M$  such that

$$X_{ri} = \left[ (\alpha_{ri}^D \cdot X_{ri}^D)^{\rho_i} + (\alpha_{ri}^M \cdot X_{ri}^M)^{\rho_i} \right]^{1/\rho_i} \quad (0)$$

where  $\alpha_{ri}^D$  and  $\alpha_{ri}^M$  are calibrated share parameters of the CES function and  $\rho_i = \frac{\sigma_i - 1}{\sigma_i}$  with  $\sigma_i$  being the Armington elasticity of substitution between domestic and imported tradable goods and services. The elasticity of substitution varies between different types of goods and services and is sourced from empirical estimates. The composite non-tradable is equal to the domestically produced product.

Imported goods can be sourced from all regions and countries represented in the model and the composite imported goods and services are modelled by a CES composite that uses a higher Armington elasticity of substitution as compared to the upper Armington nest. We assume as in the GTAP model that the elasticity of substitution between the same type of goods and services coming from different countries is twice as large as the elasticity of substitution between domestic and aggregate imported goods and services. The aggregate imported good is computed according to the following CES aggregation function

$$X_{ri}^M = \left[ \sum_s (\alpha_{sri}^T X_{sri}^T)^{\rho_i^T} \right]^{1/\rho_i^T} \quad (0)$$

where  $\alpha_{sri}^T$  is the calibrated share coefficient of the CES production function,  $X_{sri}^T$  is the flow of trade in commodity  $i$  from country  $s$  to country  $r$ . Parameter  $\rho_i^T = \frac{\sigma_i^T - 1}{\sigma_i^T}$  with  $\sigma_i^T$  is the elasticity of substitution between commodities produced in different countries.

### Market equilibrium

The market equilibrium in each regional economy is achieved by the equalisation of both monetary values and quantities of supply and demand. The resulting equilibrium prices represent a solution to the system of non-linear equations that include both intermediate and final demand equations as well as equilibrium constraints that determine household and government incomes, savings and investments as well as the trade balance. The EU-EMS represents a closed economic system, meaning that nothing appears from nowhere or disappears into nowhere. This feature of a CGE model constitutes the core of the Walrasian equilibrium and ensures that even if one excludes any single equation of the model it will still hold. Computationally, the Walras law ensures that in a closed economic system, if  $n-1$  markets are in equilibrium, the last  $n^{\text{th}}$  market will also be in equilibrium (Debreu 1959).

In the EU-EMS, a general equilibrium is described by a set of commodity and factor prices, total outputs, final demand of households and government, investments, savings and net transfers from abroad such that (1) markets for goods and services clear, (2) total investments are equal to total savings, (3) total household consumption is equal to their disposable income minus savings, (4) total government consumption is equal to its net tax revenues minus transfers to households minus savings, (5) total revenue of each economic sector is equal to its total production costs, and (6) the difference between imports and exports is equal to net transfers from abroad.

### Dynamics

The EU-EMS is a dynamic model allowing for the analysis of each period of the simulation time horizon. For the purpose of the present study, this horizon is set at 2050 but it can be extended to longer time periods depending on a particular policy question. For each year of the time horizon, the EU-EMS computes a wide set of various economic, social and environmental indicators. Time periods in the EU-EMS are linked by savings and investments. By the end of each time period, households, firms and government save a certain amount of money. This money flows to a virtual "investment bank," distributing it as investments between the production sectors of the various regions. The allocation decisions of the "investment bank" depend on the relative sector's financial profitability.

The capital stock evolves according to the dynamic capital accumulation rule presented in equation (10), where the capital stock in period t is equal to the capital stock in period t-1 minus the depreciation plus any new investments in the capital stock:

$$K_{tri} = K_{t-1ri}(1 - \delta_i) + I_{tri}. \quad (0)$$

At the end of each time period, there is a pool of savings  $S_r$  available for investments in additional capital stock of the sectors. This pool of savings comes from households, firms and foreign investors. The sector investments  $I_{tri}$  are derived as a share of the total savings in the economy according to discrete choice decisions:

$$I_{tri} = \frac{ST_{t-1r} B_{ri} K_{t-1ri} e^{\vartheta WKR_{t-1ri}}}{\sum_j B_{rj} K_{t-1rj} e^{\vartheta WKR_{t-1rj}}}. \quad (0)$$

with

$$WKR_{t-1ri} = \frac{r_{t-1ri}}{PI_{t-1r}} \cdot (g_r + \delta_{ri}). \quad (0)$$

where  $WKR_{t-1ri}$  denotes the capital remuneration rate,  $g_r$  the steady-state growth rate,  $B_{ri}$  the calibrated gravity attraction parameter and  $\vartheta$  the speed of investment adjustments.

The economic growth rate in the EU-EMS depends positively on investments in R&D and education. By investing in R&D and education, the region is able to catch up faster with the technologically more advanced regions and better adopt already developed technologies. Moreover, every region in the European Union also benefits from knowledge and human capital investments in all other regions.

**Table 5 – Countries represented in the EU-EMS model**

AUS	Australia	ARG	Argentina
AUT	Austria	BGR	Bulgaria
BEL	Belgium	BRA	Brazil
CAN	Canada	BRN	Brunei Darussalam
CHL	Chile	CHN	China
CZE	Czech Republic	CHN.DOM	China – Domestic sales only
DNK	Denmark	CHN.PRO	China – Processing
EST	Estonia	CHN.NPR	China – Non-processing goods exporters
FIN	Finland	COL	Colombia
FRA	France	CRI	Costa Rica
DEU	Germany	CYP	Cyprus
GRC	Greece	HKG	Hong Kong SAR
HUN	Hungary	HRV	Croatia
ISL	Iceland	IDN	Indonesia
IRL	Ireland	IND	India
ISR	Israel	KHM	Cambodia
ITA	Italy	LTU	Lithuania
JPN	Japan	LVA	Latvia
KOR	South Korea	MLT	Malta
LUX	Luxembourg	MYS	Malaysia

MEX	Mexico	PHL	Philippines
MEX.GMF	Mexico – Global manufacturing	ROU	Romania
MEX.NGM	Mexico – Non-global manufacturing	RUS	Russian Federation
NLD	Netherlands	SAU	Saudi Arabia
NZL	New Zealand	SGP	Singapore
NOR	Norway	THA	Thailand
POL	Poland	TUN	Tunisia
PRT	Portugal	TWN	Chinese Taipei
SVK	Slovak Republic	VNM	Vietnam
SVN	Slovenia	ZAF	South Africa
ESP	Spain	row	rest of the world
SWE	Sweden		
CHE	Switzerland		
TUR	Turkey		
GBR	United Kingdom		
USA	United States		

Source: PBL

The following table recaps the modelling of short-term and long-term effects of investments supported by EIB financing depending on the sector:

Table 6 – Short-term demand and long-term effects of investments across sectors		
Groups of economic sectors	Short-term effects during implementation phase	Long-term structural effects upon finalisation of the investment project
SECTOR A: AGRICULTURE, FORESTRY AND FISHING SECTOR B: MINING AND QUARRYING SECTION C: MANUFACTURING	Increase in demand for investment goods during the implementation phase of the project	Increase in the capital stock of the corresponding economic sectors leading to an increase in production capacity
SECTOR D: ELECTRICITY, GAS, STEAM AND AIR CONDITIONING SUPPLY SECTOR E: WATER SUPPLY; SEWERAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES	Increase in demand for investment goods during the implementation phase of the project	Increase in the capital stock of the corresponding economic sectors leading to an increase in production capacity
SECTOR F: CONSTRUCTION	Increase in demand for investment goods during the implementation phase of the project	Increase in the capital stock of the corresponding economic sectors leading to an increase in production capacity
SECTOR H: TRANSPORTATION AND STORAGE	Increase in demand for investment goods during the implementation phase of the project	Increase in the capital stock of the corresponding economic sectors leading to an increase in production capacity  Improved productivity of firms in the region
SECTOR J: INFORMATION AND COMMUNICATION	Increase in demand for investment goods during the implementation phase of the project	Increase in the capital stock of the corresponding economic sectors leading to an increase in production capacity  Improved productivity of firms in the region

SECTOR K: FINANCIAL AND INSURANCE ACTIVITIES SECTOR L: REAL ESTATE ACTIVITIES SECTOR R: ARTS, ENTERTAINMENT AND RECREATION SECTOR S: OTHER SERVICE ACTIVITIES	Increase in demand for investment goods during the implementation phase of the project	Increase in the capital stock of the corresponding economic sectors leading to an increase in production capacity
SECTOR M: PROFESSIONAL, SCIENTIFIC AND TECHNICAL ACTIVITIES	Increase in demand for investment goods during the implementation phase of the project	Increase in the capital stock of the corresponding economic sectors leading to an increase in production capacity  Improved productivity of firms in the region
SECTOR P: EDUCATION	Increase in demand for investment goods during the implementation phase of the project	Increase in the capital stock of the corresponding economic sectors leading to an increase in production capacity  Improved productivity of firms in the region
SECTOR N: ADMINISTRATIVE AND SUPPORT SERVICE ACTIVITIES SECTOR O: PUBLIC ADMINISTRATION AND DEFENCE; COMPULSORY SOCIAL SECURITY SECTOR Q: HUMAN HEALTH AND SOCIAL WORK ACTIVITIES	Increase in demand for investment goods during the implementation phase of the project	Increase in the capital stock of the corresponding economic sectors leading to an increase in production capacity
SECTOR Z: GLOBAL LOANS, LOANS FOR SMEs, LOANS FOR SMEs AND MID-CAPS, LOANS FOR MID-CAPS	Increase in demand for investment goods during the implementation phase of the project	Increase in the capital stock of the corresponding economic sectors leading to an increase in production capacity

Source: PBL

## ANNEX 4 – SENSITIVITY ANALYSIS

The study also tested the extent to which the results presented in section 3 were conditioned by the value of different parameters used. The sensitivity check of the two major parameters — Armington elasticity indicating the substitutability of domestic and foreign goods and the elasticity of substitution between capital and labour — indicated that the results obtained in section 3 are not driven by the specific parameter values of the model and are robust to a range of reasonable alternative specifications.

### Testing for a different Armington elasticity for international and inter-regional trade

**The value of Armington elasticity for international and inter-regional trade represents how easily substitutable goods and services from one region are with the same type of goods and services from other regions of Europe.** The value of this elasticity is quite important for the level of inter-regional spillover effects via competition between firms at different locations. For example, if the elasticity is zero and it is not possible to substitute goods and services from one region with goods and services from another, an increase in productivity in the region will not improve its competitive position and will not lead to a shift in trade flows towards locations with enhanced productivity. Doubling the value of Armington elasticity should result in greater potential for improvement in the competitive position of regions with enhanced productivity and hence more positive GDP effects for them. The robustness check was made at an aggregate EU level. According to the sensitivity analysis, if European goods become more easily substitutable with rest of the world goods, Europe's GDP indeed increases further — as expected — considering that its productivity has increased. However, this gain is very limited. **Thus, the results of the model are robust to changes in this parameter.**

### Testing for a different value of the elasticity of substitution between capital and labour

**The elasticity of substitution between capital and labour represents how easy it is to substitute labour for capital in the production process.** If there is a high level of elasticity, an increase in the capital stock of the regional economic sectors may lead to less use of labour and hence less employment, which may have a negative impact on the GDP level of a country or region. Regions with higher EIB-supported investments are also those with a higher increase in capital stock; consequently, if the capital-labour substitution elasticity increases, this might result in some negative impacts on the use of labour and possibly also on GDP. The robustness check was made once again at an aggregate EU level. **The results remain almost unchanged with the elasticity of substitution between capital and labour increased.**



## ANNEX 5 – LITERATURE REVIEW OF THE META-REGRESSION STUDIES

This annex presents a brief description of the meta-regression studies used for modelling the long-term impacts of EIB-supported investments on productivity. The article of Ugur et al. (2016) in *Research Policy* investigates the impacts of R&D investments on firm/sector productivity using 1 253 estimates from 65 primary studies from the 1970s onwards. The estimated intercept of the meta-regression is 0.07, which means that the average elasticity of productivity with respect to R&D stock and the reported spread between the estimates are between 0.066 and 0.115.

The study of Benos and Zotou (2014) in *World Development* investigates the effects of education on economic growth. They apply a meta-regression analysis to 57 studies and correct for publication bias. The estimated intercept of the meta-regression is equal to 1.565 with the spread used for the sensitivity analysis between 1.592 and 1.648. The intercept represents an average elasticity of productivity with respect to human capital measured as the share of highly educated people in the labour force.

The article of Holmgren and Merkel (2017) in *Research in Transportation Economics* investigates the impacts of infrastructure investments on economic growth using 776 estimates from the literature. The estimated effect varies between -0.06 and 0.52 with the intercept of the meta-regression being 0.0013. This represents the elasticity of productivity with respect to the stock of infrastructure (mostly transport infrastructure).

The study of Stanley, Doucouliagos and Steel (2018) in *Journal of Economic Surveys* looks at the impacts of ICT on economic growth. They apply a meta-regression analysis to 446 estimates drawn from 59 econometric studies. In their meta-regression analysis they take into account econometric misspecification bias and publication selection bias. The intercept of the meta-regression is estimated to be 0.054 and represents the elasticity of productivity with respect to ICT stock. The spread between the estimates used for the sensitivity analysis is between 0.054 and 0.128.



## About the Evaluation Division

The Evaluation Division conducts independent evaluations of the European Investment Bank Group's activities. It assesses the relevance and performance of these activities in relationship to their objectives and evolving operating environment. It also helps the EIB Group to draw lessons on how to continuously improve its work, thereby contributing to a culture of learning and evidence-based decision-making.

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**OPERATIONS EVALUATION**

Evaluation of EIB  
Cohesion financing (2007 to 2018)  
**Macroeconomic impact of EIB  
financing on the EU-28 regions**

October 2020



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