

ECONOMICS – IMPACT STUDIES

Assessing the macroeconomic impact of the EIB Group

2022 update



European
Commission



European
Investment
Bank

The EIB bank

Assessing the macroeconomic impact of the EIB Group

2022 update



Assessing the macroeconomic impact of the EIB Group: 2022 update

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About the Economics Department

The mission of the EIB's Economics Department is to provide economic analyses and studies to support the Bank in its operations and in its positioning, strategy and policy. The Department, a team of 40 staff, is headed by Debora Revoltella, Director of Economics.

The Joint Research Centre (JRC) is the European Commission's science and knowledge service which employs scientists to carry out research in order to provide independent scientific advice and support to EU policy.

Disclaimer

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Notes on the 2022 update

The 2022 update amends the original RHOMOLO-EIB methodology note: The first version of the note was published in 2018.¹ It presented the methodology underpinning the RHOMOLO-EIB exercise. The present note is an update of this note. It preserves the previous version but updates the results, and discusses additional methodological aspects relevant for the exercise that emerged along the way. This builds on a continued collaboration between the JRC and the EIB in delving deeper into the data and intricacies of the model. It also better incorporates the role the EIB Group has as a financial intermediary and how it is reflected in the model.

The model results remain broadly in line with those found previously. Results for the EIB Group and the impact of the European Fund for Strategic Investments (EFSI) are published and updated regularly on the EIB website. The scope of the results remain in line with previous model uses, taking into account the portfolio composition in terms of instruments, areas of focus and geography. As the portfolio fluctuates, in order to make the results of the analysis presented here less dependent on specific events, a normalised dataset is used that reflects the typical composition of EIB Group-supported investments over the past five years, and the magnitude of the investment is fixed overall to €100 billion. This makes the analysis more robust and less dependent on specific annual effects, such as for example the substantial pandemic response in 2020.

Further methodological considerations have helped refine the interpretation of such results. The most significant change to this note is the inclusion of more in-depth methodological considerations. The main insights still hold and remain untouched. Additional considerations are added in the Annex that have a bearing on how the results can be interpreted and suggest future work for further refinement of the results.

More granular results are highly influenced by spillovers between regions and sectors. Taken as a whole, the results for the European Union internalise the various spillovers. Disaggregated results are substantially influenced by spillovers — positively or negatively — from investments outside the country and other sectors. The magnitude of such spillovers is assessed.

The selection of the baseline scenario affects the results. The current version of the RHOMOLO-EIB is calibrated for a steady-state baseline in 2013. This is a particular year amidst the lingering effects of the financial crisis. The sensitivity of the results to some changes in the economic situation, especially unemployment levels, are considered in more detail.

Macro-additionality is a critical assumption in the model. While discussed briefly in the main text, additional experience with the model and further testing show how critical the assumptions surrounding macro-additionality are for the model results.

With its 60-year history of investment in Europe the EIB Group-supported activities influence the baseline scenario. The baseline of the model already includes the EIB Group's activity during and predating the baseline year. This existence of the EIB Group as part of the baseline needs to be taken into account, possibly with a focus more towards the structural effects.

Changes in the text compared to the previous note are limited to the absolute necessary. They mainly reflect updates of the results in Section 4. The main methodological aspects added are introduced in the Annex with some references in the text.

¹ https://www.eib.org/attachments/efs/assessing_the_macro-economic_impact_of_the_eib_group_en.pdf

Executive summary

Key messages

- *The Economics Department of the EIB together with the Joint Research Centre of the European Commission carried out an extensive quantitative analysis to evaluate the macroeconomic impact of the investments supported by the EIB Group (EIB and EIF together) within the European Union.*
- *The framework, called RHOMOLO-EIB, capitalises on the well-established RHOMOLO model, initially developed by JRC to evaluate the performance of EU policies, and extends it to cover the business model of the EIB Group. It helps capture both the short- and long-term effects of EIB-supported investment projects, exploiting cross-sector synergies and geographical interlinkages.*
- *The results are in line with similar exercises and provide significant granularity in terms of sectoral and geographic impact.*
- *Following extensive sensitivity analysis, the results of RHOMOLO-EIB are found to be robust to reasonable variations in the working assumptions, input data and model specifications.*

Using a model to assess the macroeconomic impact of EIB Group-supported operations

Complementary to the bottom-up approach that mainly assesses the direct effects of EIB Group-supported operations, a macroeconomic modelling approach is pursued to better capture the indirect and induced effect of EIB Group-supported investments. For example: building a road will create direct employment during the construction phase, but by lowering transport costs the potential impact on the economy can be much greater by making the region more accessible, or by lowering costs for goods and services. Such a project would foster exports and imports with potentially diverging effects. These and many other interlinkages can be better taken into account in a large-scale macroeconomic model that explicitly looks at such relationships and takes such trade-offs into account.

Therefore, to estimate the overall impact of EIB Group-supported operations the EIB uses a computable general equilibrium model called RHOMOLO-EIB. It is based on the RHOMOLO model, developed and used by the European Commission's JRC for policy impact assessment, and provides sector-specific, region-specific and time-specific simulation results. The difference between RHOMOLO-EIB and RHOMOLO lies in certain specifications to the model and the use of the model to best reflect the EIB Group business model as a Bank, as opposed to a public-sector approach.

Any model has certain limitations, which need to be acknowledged and taken into account when interpreting the results. RHOMOLO-EIB is a computable general equilibrium model. Computable general equilibrium models do not provide unconditional forecasts, but rather give answers to what-if type questions. The RHOMOLO-EIB model builds on good practices grounded in economic theory and available data, and it is published in a transparent manner. Certain assumptions enter the modelling specifications. All require interpretation and extensive sensitivity analysis to verify the robustness of the results.

Results and sensitivity analysis

The scope of the modelling exercise encompasses an assessment of the EIB Group's activities each year and a special focus on the cumulative investments supported under EFSI. The results of the specific annual model runs for the EIB Group based on signatures in the previous year, and for EFSI as a cumulative portfolio of approved projects since inception, are published and updated each year on the EIB website and as part of regular reporting obligations such as the EFSI report to the European Parliament and the Council.²

As the portfolio shifts each year, and special effects, such as the impact of the pandemic on the EIB Group portfolio in 2020, may come into play, for the sensitivity analysis and methodological discussion a normalised file is used that spans five years of EIB Group investment and normalises the total shock to €100 billion. This can better reflect the breadth of the EIB portfolio and avoid particular biases that may distort the results. It also has the advantage of relying on more detailed historical accounts in tracking the EIB Group's investments in practice. Overall, using such a normalised portfolio is better suited for sensitivity analysis and methodological discussions.

Interpreting the model results must take into account what the model can and cannot do, and what the results reflect. Generally, the results reflect the relative increase in GDP and employment over a baseline scenario. When looking at the results broken down by geography, sector or effect additional insights emerge: in the longer term the structural effect, reflecting improvements in competitiveness and productivity, drive the results; regional impact is heterogeneous, not only due to local investment differences but also given the economic situation and links to other regions and the world. Overall the finding is that all territories benefit in the long term; cohesion regions benefit relatively more than better-off EU regions; and a significant share of the longer-term economic impact comes from spillovers from investment in other regions.

An extensive sensitivity protocol is applied to check the robustness of the findings in relation to the underlying model options and parameters used in the model. The results are robust to specific model and market assumptions. Importantly, the scope of the results is in line with broader policy discussions (such as on fiscal multipliers), comparable to similar exercises carried out in similar contexts.

Collaboration between the EIB and JRC will continue in the coming years, covering both the new EIB Group activities, updating the model baseline to more recent data, but also updating the existing results as more accurate information is received throughout the operations' lifetime.

Purpose and structure of the report

The purpose of this document is twofold. First, it highlights the main methodology used in the impact assessment exercise. Second, it describes the outcome of the exercise, together with the robustness analysis. We divide these tasks into five sections. Section 1 describes the rationale behind the exercise and the choice of the model. Section 2 describes the model together with the caveats. Section 3 describes the way in which the EIB uses this model. Section 4 discusses the results, and Section 5 lays out the approach and findings of the sensitivity analysis. The conclusions wrap up the findings and

² See EIB website: <https://www.eib.org/en/about/key-figures/eib-impacts/index.htm> or as part of the annual press conference: <https://www.eib.org/en/events/annual-press-conference-2021>. For EFSI see the 2020 report from the European Investment Bank to the European Parliament and the Council on 2020 EIB Group Financing and Investment Operations under EFSI: <https://www.eib.org/attachments/strategies/efsi-2020-report-ep-council-en.pdf>

benchmark the scope of the results. The Annex sets out the details of the model specifications and the sensitivity analysis, including additional in-depth methodological considerations.

1. BACKGROUND AND PURPOSE

As a public institution, the EIB Group³ looks at the economic impact of its activities. As a Bank, the EIB Group focuses on financial results such as lending commitments, signatures or disbursements in order to provide a sense of scope of its contributions to the economy. Going one step further, the EIB Group also assesses the results of its operations such as the physical outcomes and the employment created during construction and operation to provide a richer picture of what the EIB Group is achieving.⁴ In addition, the EIB carries out a thorough ex-ante economic and financial analysis of each project. Yet, to assess the macroeconomic impact — such as GDP and employment — of EIB Group-supported operations in Europe a broader macro-modelling approach can be useful.

EIB operations produce indirect effects in the economy, positive and negative, which deserve to be quantified and explored in more detail. EIB Group-supported operations cannot be viewed in isolation because they are likely to generate spillovers and externalities to other sectors or regions and possibly influence the entire structure of the economy. For example, when investing in a broadband network some direct observable activities would refer to the amount of workers' time, machinery and materials, not least the fibre optic cables. Workers lay the cables underground. The km of cabling can be observed, the workers' time can be measured. They possibly connect homes and businesses to enable faster communication services. This too can be observed directly. What cannot be easily measured is what it takes to produce the machines and materials needed, what the workers may be spending their income on, and even harder, how the new services may help create new industries or disrupt existing ones, how productivity may be increasing, fostering new kinds of work, etc. For the most part, those aspects are unobserved and it would be impossible or prohibitively expensive to measure them on a case-by-case basis. A similar line of argument applies to the measurement of inputs needed to finance these investments. Funding needs to have sources and it has to be properly accounted for. It can come from extra savings, it can come from abroad, but it can also derive from existing savings that may have been invested differently. To be able to consider the range of such aspects — the positive and the negative — and to form a more comprehensive view of the economic impact, typically a modelling approach is used.

Indirect and induced effects are not typically observable, but they can be assessed through modelling (see Figure 1). Many methods and approaches exist to assess the economic impact of operations. They range from microeconomic assessments of a single operation to large-scale macroeconomic models of entire portfolios. A standard microeconomic impact assessment is based on a rigorous analysis of a wide range of project-related data to firmly establish a counterfactual vis-à-vis an observed scenario. Macroeconomic modelling approaches impact from a different angle, focusing more on the wider context such as multiple forward and backward interlinkages, sectoral and territorial proximity and heterogeneous behaviour of economic agents. Such macroeconomic modelling is widely used in academia, economic analysis and policy evaluation. Central banks rely on them to forecast and assess policy changes, as does the IMF, the World Bank, the European Commission and economic forecasters.

³ By EIB Group we refer to both the European Investment Bank (EIB) and the European Investment Fund (EIF).

⁴ The exact figures and methodologies can be found in the EIB and EIF annual reports (Financial Report, Statistical Report, Activity Report) and results-related publications including the 'Annual Report on EIB operations inside the European Union' and 'The EIB outside the European Union' report.

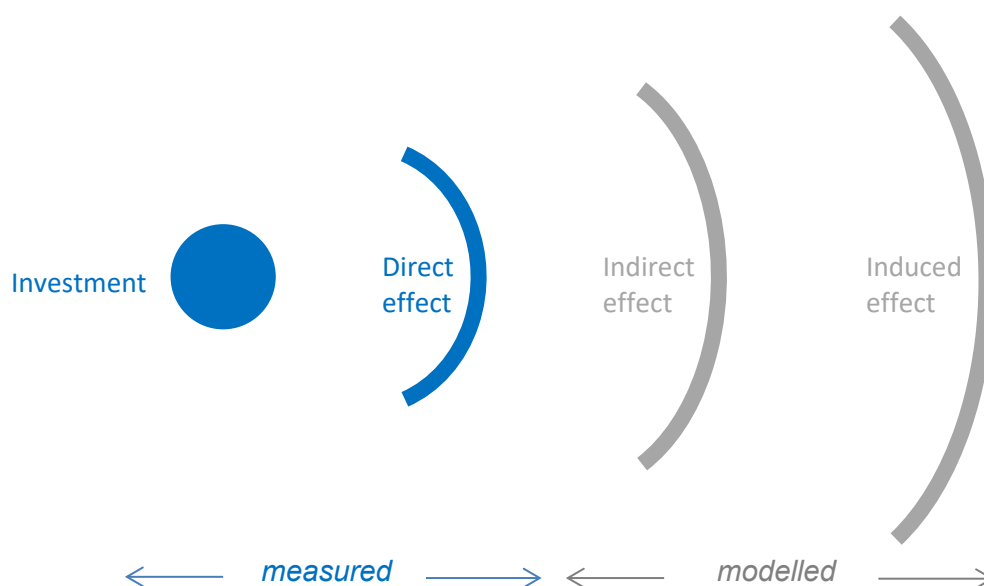


Figure 1: Why a macroeconomic impact assessment?

Many modelling approaches exist to assess macroeconomic impact. Econometric methods are usually applied for the ex-post evaluation of policies or programmes that have already been implemented. Computable general equilibrium models are the standard tool for conducting the ex-ante large-scale impact assessment of programmes or policies that do not yet exist, or are used to evaluate alternative versions of existing programmes, or to capture other ex-post aspects that are not easily measurable or easy to monitor. None of the existing modelling approaches is perfect and is able to capture all aspects of reality. Macroeconomic models should be seen rather as a stylised snapshot that captures important institutional characteristics of the economy being modelled. Limitation exists in the underlying economic theory — incorporating the institutional and structural details, economic mechanisms, data availability, and assumptions with regard to future economic development — and in the computing power required to perform complex simulations.

One approach to assess the macroeconomic impact of EIB Group activities is a spatial computable general equilibrium (CGE) model developed by the European Commission’s JRC. A range of complex applied models are already in use for various purposes. They are readily available and have already been scrutinised in a transparent and rigorous manner. Building one from scratch requires a vast amount of time and dedicated resources. Based on the most relevant features of the EIB Group’s macroeconomic assessment, the availability and reputation of the approach, the EIB selected the RHOMOLO model — a recursively dynamic spatial computable general equilibrium (SCGE) model — developed and currently used by the Joint Research Centre of the European Commission to assess a wide range of policy-funding instruments such as the Cohesion Policy and other funding programmes directly related to innovation support and infrastructure development across all European regions and sectors (see, for instance, Crucitti et al., 2022, and Christensen, 2018). It is a well-established model, thoroughly based on academic research, publicly scrutinised and discussed in technical publications and scientific forums (recent peer-reviewed scientific publications include Barbero et al., 2021, Di Pietro et al., 2021, and Lecca et al., 2020). The advantage of RHOMOLO has been identified in its ability to both simulate the effects of investment activities, but also — and this is what sets it apart from many other models — to model the structural effect of investments by taking into account the spatial

and sectoral interlinkages of a specific investment activity. For instance, the construction of a road in one region, which may draw on the local construction industry, employ labour and consequently spill over through the economy, may also have a broader implication for surrounding regions or regions farther away. The model also takes into account the structural effects of the road, such as changes in the region's competitiveness due to the reduction in transport costs between and within regions. This makes RHOMOLO particularly well suited for analysing policies related to human capital, R&D, innovation and transport infrastructure.

The model is used for assessing the macroeconomic impact of EIB Group-supported activities in general, and those of EFSI in particular. After conducting an initial test run on the assessment of the macroeconomic impact of the EIB during the capital increase in 2012, the EIB has worked closely with the European Commission's JRC in Seville to further develop the modelling approach in order to run the macroeconomic assessment. The goal of the impact assessment is to provide a coherent and comparable framework. Therefore, all simulations are carried out under the same model specification, called RHOMOLO-EIB. Hereinafter in this report we always refer to the RHOMOLO-EIB version, unless stated otherwise.

The purpose of this document is twofold. First, it highlights the main methodology used in the impact assessment exercise. Second, it describes the outcome of the exercise, together with the robustness analysis. For presentational transparency, we divide these tasks into four sections. Part 2 focuses on the model's main mechanisms and the characteristics of RHOMOLO. First, a brief overview is presented highlighting the complex structure of the model. Second, the main theoretical building blocks such as the labour and product market assumptions are explained together with the spatial and sectoral interlinkages embedded in the model. And lastly, some limitations and caveats are discussed. Part 3 discusses how the EIB uses the RHOMOLO-EIB model. This section describes the main channels of impact transmission and their relation to EIB Group-supported activities. Two channels are discussed: (i) the impact on demand supporting but also refinancing the investment activities in a region and sector; and (ii) the structural channels that result from such investments, such as cheaper transport from transport infrastructure, productivity gains from research and development, effects from non-transport infrastructure, productivity gains from better quality capital and labour inputs. Part 4 presents the results of the modelling exercise and discusses them in more detail and from various angles. Part 5 presents the sensitivity analysis conducted to verify the robustness of the modelling strategy, and it provides guidelines on how to interpret these results. The conclusion (Part 6) takes stock of the findings and contextualises the results. The Annex sets out in greater technical detail the sensitivity analysis together with the model options used and parametrisation employed.

2. THE RHOMOLO MODEL

2.1. Overview

RHOMOLO is a recursively dynamic spatial CGE model. It has been developed and maintained by the regional economic modelling team at the European Commission's Directorate-General Joint Research Centre (DG JRC) in cooperation with the Directorate-General for Regional and Urban Policy (DG REGIO). It is used for policy impact assessment and provides sector-, region- and time-specific simulations to support EU policy evaluation of investments and reforms across a wide array of policies (see, for instance, Di Comite et al., 2018).

RHOMOLO is rooted in the tradition of CGE models. The model relies on a microfounded neoclassical equilibrium framework where supply and demand are balanced through a system of relative prices and behavioural functions. Policy-driven scenario perturbations (technically referred to as "shocks") are introduced as deviations from a benchmark equilibrium state of the economy affecting the optimal supply and demand behaviours of all the agents in the economy. All equations are solved simultaneously, thus resulting in reallocation of goods and factors consistent with the new price system in a new counterfactual equilibrium. Policy appraisal is based on a comparison between the counterfactual and the benchmark equilibrium. RHOMOLO therefore provides an evaluation of the interaction effects between all agents through market transactions. Particular attention is devoted to the explicit modelling of spatial linkages, interactions and spillovers between regional economies. For this reason, models such as RHOMOLO are referred to as SCGE models.

A key feature of RHOMOLO is its high dimensionality to capture interlinkages between sectors and regions and to distinguish between the short and long-term effects of investments. RHOMOLO distinguishes between ten economic sectors and captures sectoral interlinkages such as forward and backward linkages in value chains. Furthermore, there are spatial interlinkages between every pair of European regions and with the rest of the world (RoW) such as trade flows, factor mobility, competition, borrowing and lending of investment capital. It exploits the advantages of a full asymmetric bilateral trade cost matrix for all EU regions to capture a rich set of spatial market interactions and regional features. The focus on regions and sectors allows the model to take into account territorial specificities and better reflect the spatial interlinkages of an often substantially heterogeneous level of development or sectoral composition within European countries. It also makes it possible to work at a geographical scale where macro impacts of individual investments are non-negligible.

The model is calibrated at the base year of 2013 on the basis of publicly available data sources, including Eurostat and AMECO databases, and an inter-regional trade flow matrix provided by PBL (Netherlands Environmental Assessment Agency).⁵

⁵ A description of the data used in RHOMOLOv3 is provided in Lecca et al. (2018) and the methodology used for the construction of interregional trade-linked supply and use tables can be found in Thissen et al. (2019).

2.2. Theoretical background

The model is based on established economic theory and modelling techniques. In this section, we highlight the main theoretical building blocks of RHOMOLO. A full description of the model with all the facets, formulas and interlinkages is beyond the current scope (see Box 1). Here the main elements are briefly presented.

Box 1: The RHOMOLO model — technical details, equations and reviews

The RHOMOLO model draws on a long tradition of CGE modelling. The model has gone through several modifications to fit policy advice purposes, and is firmly grounded in an academic review process.

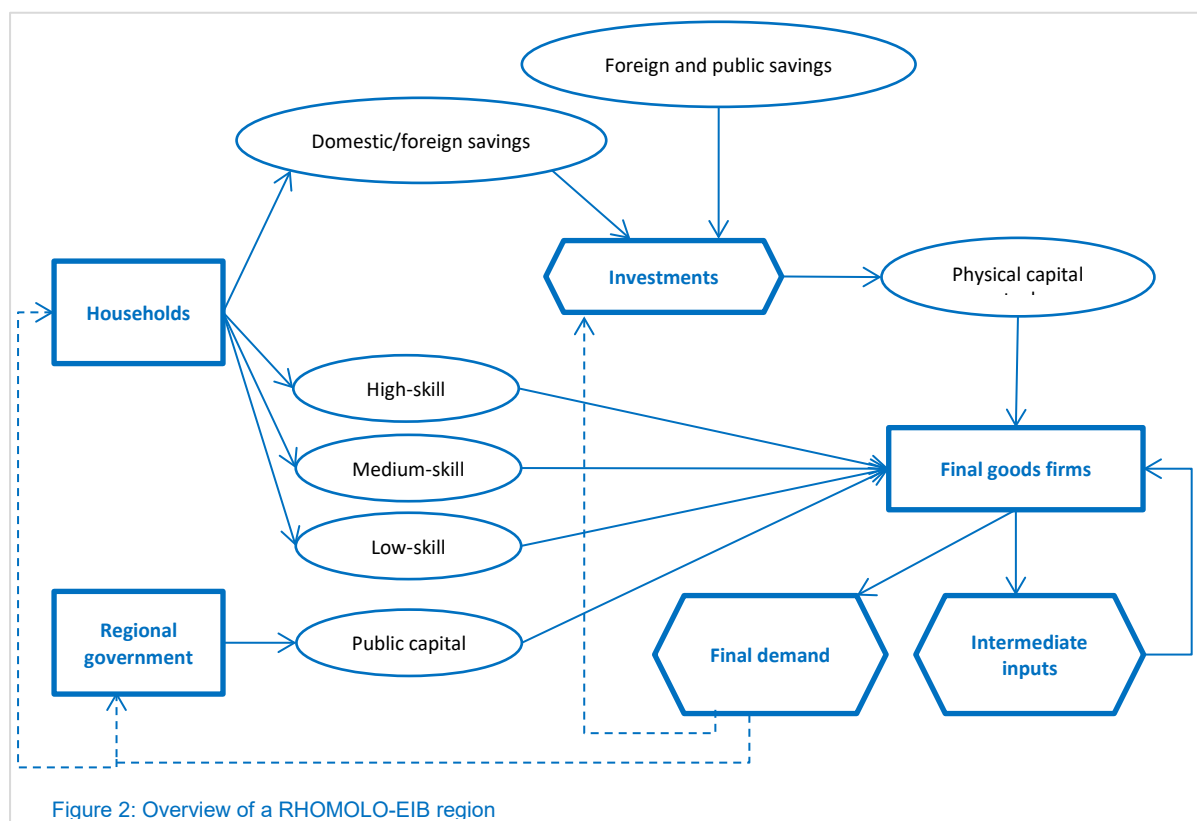
As a CGE model, it is based on a complex system of a large number of non-linear equations that are solved simultaneously. By its very nature the underlying model setup, with the equations and theoretical underpinnings, should be viewed as a whole.

RHOMOLO has made the underlying structure publically available for outside stakeholders and modellers. It has been extensively documented with *equation-by-equation* descriptions and technicalities (e.g. Mercenier et al., 2016). RHOMOLO-EIB is based on the most recent version of the model (version 3) which has been documented by Lecca et al. (2018). The application of RHOMOLO-EIB to EFSI is presented in Christensen et al. (2019).

Every model builds on simplifying assumptions, whether due to the theory it is based on, or the techniques, data and technologies available at the time. Given that it is virtually impossible to account for all aspects of reality, every model is a stylised snapshot, which represents the most important characteristics of reality. Some modelling techniques look puzzling to an untrained modeller. To ensure this is consistent with good practice, expert judgement of those familiar with such models is required. To this end, peer review and review board processes are important. The RHOMOLO model is used for analyses featured in peer-reviewed scientific articles published in high-quality international journals, and there is a Review Board of academics and practitioners in place to assess the model and provide recommendations to further improve it. The latest review was conducted in 2017 with the findings and recommendations published: Review of the RHOMOLO model (November 2017).⁶

All transactions in the economy are included in the model as results of agents optimising decision-making. Goods and services are consumed by households, government and firms, and are produced in markets. Spatial interactions between regions and sectors are captured through trade matrices of goods and services, capital mobility is represented through inter-regional investment flows, labour mobility through the option of inter- or intra-regional reallocation (see Figure 2 for a stylised overview of a RHOMOLO-EIB region).

⁶ available at https://ec.europa.eu/jrc/sites/jrcsh/files/review_of_the_rhomolo_model_final.pdf



Spatial dimensions are a key element of the RHOMOLO model vis-à-vis trade, labour and capital mobility (in terms of investment flows), and the location decisions of firms. Trade activities between regions depend to a great extent on transport costs, which are of iceberg type and imply that a given share of the goods ‘melts’ during shipping. Thus, transport infrastructure projects can reduce transport costs between and within regions, thereby increasing the competitiveness of regions.

Social accounting matrices (SAMs) represent the basic organisation of the main set of data feeding into RHOMOLO. A SAM is a matrix that reflects an account where each of the elements represents a flow of economic activities within the regional economy. This matrix displays economic relationships between all agents (households, firms, government and RoW) and represents a macroeconomic equilibrium where aggregate demand equals aggregate supply. The base year, and thus the assumed equilibrium period, is 2013. Figure 3 below shows a simplified version of a SAM.

	Commodities	Activities	Factors	Households	Government	Savings and investment	RoW	Total
Commodities		Intermediate demand		Consumption spending	Government spending	Investment demand	Intra- and extra-EU exports	Total use in purchasers' prices
Activities	Domestic supply							Activity income
Factors		Wages Employees' SSC Net Operating Surplus (-corp tax)						Total Factor income
Households			Wages Employees' SSC Net Operating Surplus (-corp tax)		Social transfers		Expenditure of tourists	Total Household income
Government	Taxes less subsidies on products	Net producer taxes Corp tax	Wages Employers' SSC Corporation tax Net producer taxes Taxes less subsidies on products	Employees' SCC Personal income tax			Net lending and borrowing	Government income
Savings and investment		Capital consumption		Household savings	Fiscal surplus	Net change in inventories	Capital transfers	Total savings
RoW	Intra- and extra-EU imports			Household expenditure abroad	Government transfers to abroad			Foreign exchange outflow
Trade and Transport Margins	Trade and Transport Margins							
Total	Total supply at purchasers' prices	Gross output	Factor expenditures	Total household spending	Government expenditures	Total investment spending	Foreign exchange inflow	

Figure 3: Social accounting matrix (Source: Potters et al., 2014)

2.3. Caveats and limitations

As with any model, RHOMOLO relies on a set of simplifying working assumptions that offer a stylised snapshot of economic activity. Such assumptions should be pointed out explicitly to make the interpretation of the results more meaningful.

- **Representation of the economy:** As is common in CGE models, representation of the economy in RHOMOLO relies on simplified assumptions regarding behaviour of economic agents (profit maximisation of producers, utility maximisation of consumers, institution structure), the economic environment such as competition on product markets, factor mobility, behaviour of the rest of the world, and price signals. However, RHOMOLO allows for considerable flexibility in model specification, making it possible to select different types of competition in commodity markets, factor mobility, wage setting and investment behaviour.
- **Equilibrium steady state:** Given RHOMOLO's general equilibrium model features, the model has been calibrated to replicate a benchmark year. In the RHOMOLO-EIB case, the model is calibrated to replicate the year 2013. It is further assumed that the model is in steady state in the benchmark year. This implies that in the long run and without structural shifts, variables will tend to converge to the assumed steady state in 2013 over the simulation horizon. This may be problematic in cases where, for example, the unemployment rate does not represent the 'natural level'. In general, it is difficult to justify that one specific year represents the 'equilibrium' of an entire set of economies such as the EU-28. The year 2013 has been chosen because it is the latest available for which a full dataset was available. It could be more advantageous to use a longer-term average, but given the scarcity of data at the sectoral-regional level and the economic situation in Europe it is not clear which year would be the most appropriate (see Annex 3 for more detailed discussion on the implications).

- **Dynamic scenario:** There is an inherent discrepancy between the static nature of the steady-state representation of the economy, and the dynamic nature of the economic consequences of investment shocks, common to CGE models. Any dynamic disturbance to the model would be evaluated through a prism of a baseline development scenario based on 2013 data and therefore does not assume any counterfactual changes in the evolution of baseline model figures. This makes it difficult, however, to assess the cyclicity of the results, simplifies the evaluation of the results, isolating the baseline situation from the complex interaction effects, thus avoiding the “black box” type of model responses, when it is difficult to attribute results to the concrete policy intervention. One can view the steady-state economy as a point in time, rather than a full economic path over time. One may try to superimpose the business cycle dynamics on the results; however, such an exercise would require additional working assumptions on the duration and the magnitude of the cycle, which we leave for further extensions of the model.
- **Non-intertemporal:** The high dimensionality of RHOMOLO enables sectoral and spatial relationships to be studied more coherently, but at the same time it requires greater computational power. The detailed regional and sectoral dimensions of RHOMOLO require hundreds of thousands of complex non-linear equations to be solved simultaneously. Therefore, in order to keep the model manageable from a computational point of view, the mechanisms of model dynamics are kept relatively simple without loss of generality. Agents are assumed to save a constant fraction of their income in each period and their decision-making is myopic with regard to the current and past states of the economy. The model is therefore solved recursively, computing year-by-year the equilibrium with agents modelled as making instantaneously optimising choices. Each period is linked to the others through the accumulation or depletion of stocks (such as capital). The need for intertemporal optimisation seems more relevant for policy shocks where agents with full foresight can adjust to shocks before they happen ("prior announcements of policy changes"), but would constrain the approach used in other respects due to computational limitations⁷.
- **Real economy:** The model has been developed in real terms, with barter trade of goods and services. All prices in CGE models are relative; consequently, there is no money and no financial frictions in the framework. Despite this, a special effort has been made to mimic the intermediary role of the EIB in the European economy (see Annex 3 for more details on interpreting the role of the EIB in the RHOMOLO setting).
- **Limited scope:** A number of variables have to be selected for reporting and analysis and in this case the choice fell on GDP and employment. Welfare aspects such as benefits to the environment or to the quality of life are harder to capture and are not part of the approach adopted here.

⁷ Intertemporal CGE models are solved simultaneously for all periods, as agents optimise intertemporally. Large complex intertemporal models are computationally expensive to solve unless decomposition algorithms that split the model into separately solved submodules are applied.

3. MODELLING EIB GROUP-SUPPORTED OPERATIONS IN RHOMOLO-EIB

Inputs into RHOMOLO need to closely reflect the way the EIB Group works. RHOMOLO was originally developed to assess the macroeconomic impact of EU structural funds. While both the European Commission and the EIB Group seek to achieve long-term economic impacts the approach differs to a certain extent. The use of grants and loans, in particular, makes a difference both in terms of financial flows (where the money comes from or how it is levied, direct taxes or household income or savings, and if and how this money is repaid) and the areas of engagement. These aspects are reflected in the use of the model rather than changing the model per se.

Projects implemented affect the EU economy via two main channels, an investment effect and a structural effect. The short-term investment effect reflects higher demand for goods and services as the investments take place in a region, especially during the implementation and construction phase when the financing reaches the real economy. The longer-term structural effect of the completed investments reflects the effect on the structure and competitiveness of the economy, such as a better transport network, which can provide cheaper imports and exports, or greater availability of research facilities, which can lead to productivity-enhancing technologies. Both the investment and the structural channel will be discussed in turn.

Box 2: How EIB operations affect the EU economy

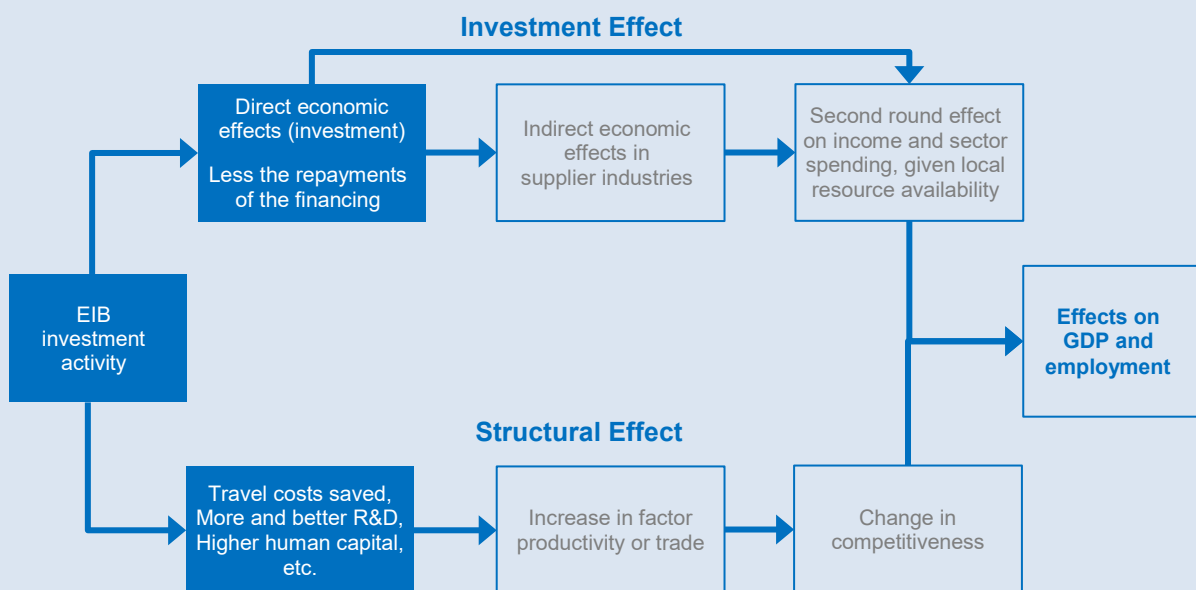


Figure 4: Impact channels in RHOMOLO-EIB

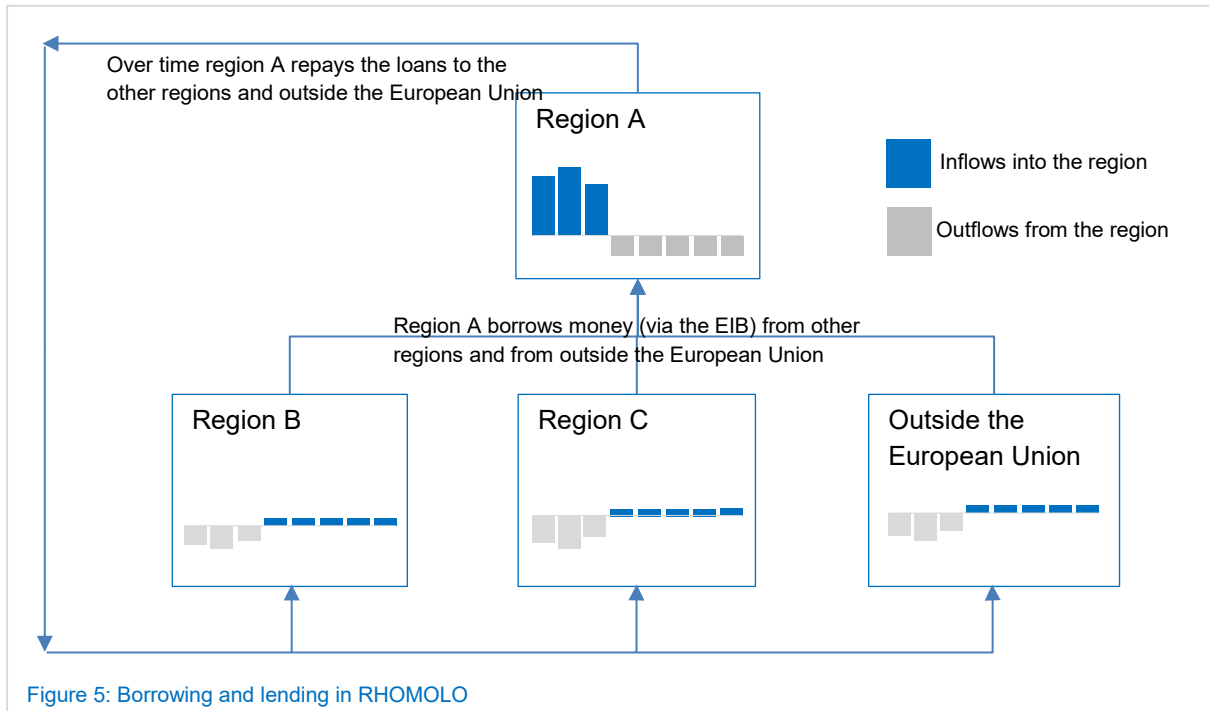
The investment effect is driven by the investments supported, but also by the financing needed for such operations. Investments reflect the EIB Group-supported operations in the European Union. This means the EIB Group channels its funding to a specific sector and region. This has a direct effect on the local economy through demand for fresh capital during project implementation or funds' disbursement. It increases investment in this area, which in turn has an effect on other sectors in the region, and also affects other regions, for example, through trade and factor mobility. Such investments need to be financed from

existing sources. Unlike structural funds that are based on taxation revenues, the EIB Group draws funds from the capital market. The EIB Group issues bonds on the market to finance its support for the operations. These operations are co-financed by private investors and/or public institutions, similarly drawing in funds. Funding can come from either the European Union or from abroad. As these are not grants but loans, funds need to be repaid over time. Initially, the financing impact on the recipient region is income-positive since a project region experiences a capital inflow, but the effect turns income-negative over time when the loan has to be repaid to its lenders. The reverse holds true for those regions providing the funding.

The long-term structural effect of a project can work through one of the five structural channels in RHOMOLO-EIB. In parallel to any impact of the investment financing and repayment, typically a structural effect on the model sets in once the investment is completed. This could be, for example, a road investment that, once completed, enables cheaper transport of goods between regions. RHOMOLO-EIB makes it possible to map EIB Group-supported operations going to five structural channels: Transport Infrastructure, Non-Transport Infrastructure, R&D, Human Capital, Industry and Services. All have a distinct effect on the local economy, for example through cheaper trade, new technology and production methods, improved labour productivity, more efficient public or private infrastructure, and enhanced capital quality.

3.1. Investment Effect

The investment effect consists of two components: capital deepening in a region, and the financing of such investments. The EIB Group, together with other co-financiers, supports private or public investors in financing a specific operation. This has an economic effect in the region where such investments take place. It deepens the capital base in the region over time and in specific sectors, which can then lead to a range of indirect effects. This is labelled the ‘capital deepening’ effect. Such investments need to be financed from somewhere in the economy or from abroad (an outflow of resources from the lending region) and paid back over time to those financing the project (an outflow of resources from the borrowing region, see Figure 5). This latter effect of borrowing and repayment is labelled the ‘financing effect’. Both are discussed in turn.



3.1.1. Capital deepening

During the implementation period, EIB Group-supported projects raise the capital stock in a specific sector and region. The EIB Group supports the financing of specific investment operations. This means raising the capital stock through higher local demand for investments in the specific region and sector where the operation takes place. It constitutes the immediate effect. This may then lead to an effect on the local labour market, such as higher salaries and thus incentives to join the local labour force, which spills over into other sectors — the indirect effect. Overall, the benefits for the project region depend on many factors such as the sectoral structure, the local labour market, and how many inputs come from the local market rather than from other regions, all of which are determined by the RHOMOLO-EIB structure.

Investments lead to higher output. The investment directly translates into an increase in aggregate demand and in the physical capital stock in a given sector. In turn a higher capital stock, together with possibly attracting more labour, increases output in future periods. The effect on growth can come from the direct effect of increased output in the sectors, but also from indirect effects on other sectors. As investments in one sector increase, this can affect supplier and client industries via the input-output linkages — within the constraints of available resources and effects on wages. In addition, with a change in production, trade and movement of production factors will be affected, which can further affect the growth pattern. The pattern and magnitude of the overall growth effect can vary but should lead to higher output in the regions invested in for some time due to an immediate increase in one of the production factors.

Capital depreciates over time. Just like general capital stock, once in place new investments also depreciate over time, which also holds true for EIB Group-supported projects. With such depreciation the magnitude of the overall capital deepening fades over time. The magnitude of the depreciation rate can have a significant effect on results because of the implied initial capital stock in the

counterfactual-baseline scenario (indirectly determining the relative amount of new capital associated with EIB Group-supported investments).

The employment effect can be ambiguous. RHOMOLO-EIB does take employment effects into account. Investments can affect employment directly and indirectly. The direct effect stems from the increased demand in order to implement the EIB Group-supported project. However, in the long run capital investment could crowd out, and under circumstances also crowd in, employment mostly depending on the sector where the investment takes place. Employment can rise compared to the base year level due to higher labour demand caused by an increase in private capital stock, labour productivity and total factor productivity (TFP), but could also be lower given its relative competitive position. In principle, the employment effect is a priori ambiguous at the regional level.

3.1.2. Financing

As the financial sector, and with it the EIB Group, is not reflected explicitly in the model, the effects are exogenously introduced as transfers in RHOMOLO. The EIB Group borrows funds on the capital markets to finance its lending activities. Together with other co-investors, EIB Group-supported investment operations are implemented. In effect, the EIB Group and its co-investors finance such investments with available funding from other sources in the economy. In the model these channels must be explicitly introduced as input data to reflect both the location and amount of such financing. Investment projects are financed by available income in the economy and abroad, income that also needs to be repaid over time by the borrowers to the lenders. While the investment project will have a direct effect on the capital stock in the borrowing region, the financing will also affect income in the lending regions, and, as the financing is paid back by the borrowing to the lending region, will affect both regions. Income in lending regions initially decreases to finance investments in other regions, and increases as repayments are made to the lending regions. Income in the borrowing regions is exogenously reduced over time as repayments are made to the lending regions (see Figure 5).

Lending draws on available income in the economy and from abroad. The source of such financing can be income within the European Union or income from abroad. The EIB Group obtains its resources by issuing bonds on European and international capital markets to fund its financing activities. Similarly, co-financing from other sources may come from domestic sources or from abroad. The share of financing from the European Union and from abroad is derived from internal EIB bond-holding data, and the balance of payments of the European Union and the rest of the world. The former approximates the share of EU external funds attracted to the project by the EIB Group in support of the operation, financed by bond issuances. To this end, the average share of EIB bonds held outside the European Union is relied on. The latter approximates the average foreign ownership of domestic EU assets as indicated by the financial account of the EU-wide balance of payments, published by Eurostat.

The source of financing matters for the overall impact. Financing from within the region implies that households residing in the region forgo current consumption to finance investments. Financing from within the European Union is assumed to be borrowed from household incomes across the Union. The effect can be a reallocation of income from lending regions to borrowing regions if more investment takes place in some regions than others in proportion to regional income. Financing from outside the European Union is assumed to be borrowed from household incomes in the rest of the world. In terms

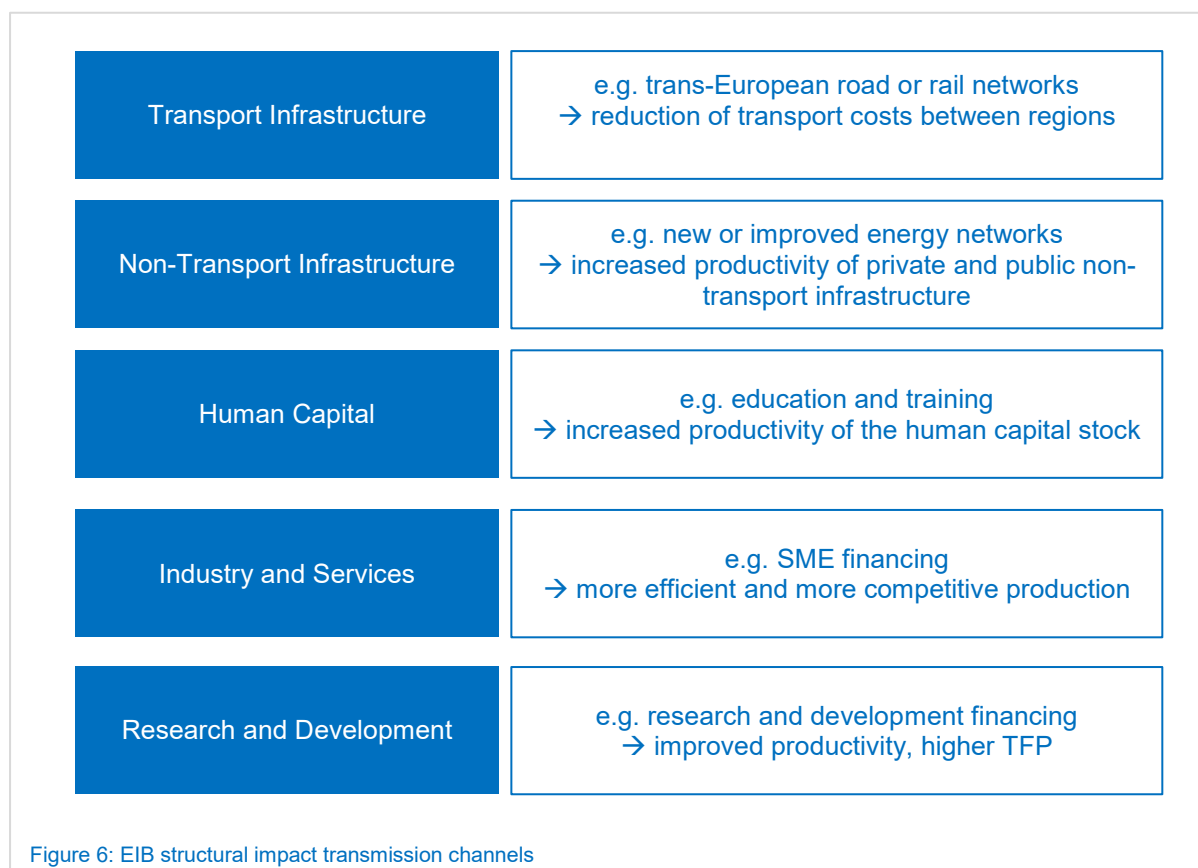
of the regional trade balance, external borrowing means importing resources, i.e. worsening of net exports. Hence, in the short run investments increase and net exports decrease. Over time capital accumulation improves competitiveness and net exports rise, enabling the region to pay back loans to external lenders. Effectively, imports, in the form of intermediate goods, are financed via increased exports of final goods by the region. Therefore, in terms of external borrowing, the additional physical capital stock accumulation — and with it the effect on the European economy in terms of GDP — is limited in the short run but potentially higher in the long run.

Over time, borrowed resources are paid back. With the implementation of the investment project, the borrowed financing is being repaid over time. The repayment period depends on the nature of the underlying investment and structure of the loan. Income is reduced in the borrowing region and transferred back to the lending regions or abroad according to where the money originated from.

3.2. Structural Effect

Once completed, operations can have a structural impact on the EU economy. In addition to the investment channel, EIB Group-supported operations contribute to a longer-term impact on the economy. Operations not only add capital, but, upon completion, are geared towards productive employment of this capital to foster a more efficient allocation of resources and more productive combination of inputs. For example, an inter-regional road not only has an investment effect while it is built, employing labour and capital in the process, but the true purpose is to enable better connectivity between regions.

RHOMOLO-EIB has five channels to translate such structural contributions into the model (Figure 6): (i) Transport Infrastructure, (ii) Non-Transport Infrastructure, (iii) Human Capital, (iv) Industry and Services, and (v) Research and Development.



3.2.1. Transport Infrastructure

Transport infrastructure projects aim to better connect people and markets across Europe and beyond. New transport routes are constructed (such as a new road, railway or port) and existing ones improved or expanded (for example, ports, motorway extension, rehabilitation, etc.). This reduces transport costs, facilitates trade and better connects the people of Europe.

Transport costs in RHOMOLO-EIB are applied to all shipments within a region, between regions and with the rest of the world. Transport costs in the model are of an iceberg type, which can be interpreted as if part of the goods shipped melts during the shipping, and is a standard modelling assumption in international trade to account for the fact that more expensive goods are normally associated with higher insurance and handling costs, besides often opting for faster but more expensive modes of transport.⁸ The "iceberg parameters" associated with each bilateral (i.e. region-pair) transport link in each sector and direction of shipment are estimated through TRANS-TOOLS, which is a European transport network model developed by JRC together with external scientific partners to estimate the time needed for a good to be shipped between any two points in Europe.⁹

Investments in transport infrastructure lead to a reduction in transportation costs. The associated reduction in bilateral transportation costs following an infrastructure investment is calculated in two steps. Step one imputes the spatial dimension of transport infrastructure expenditures by estimating how a region-specific investment in transport infrastructure translates into region-pair-specific

⁸ The transport cost variable is represented by $\tau_{r,r',j} > 1$, which is the quantity of sector j goods that needs to be sent from region r in order to have one unit arriving in region r' . It is assumed to be identical for a given good but specific to sectors and trading partners.

⁹ More information on TRANS-TOOLS can be found on <http://energy.jrc.ec.europa.eu/transtools>.

expenditures. The spatial dimension is crucial, as a transport infrastructure investment affects not only the region where the money is invested, but through trade linkages, also all the other regions. Step two transforms the bilateral measure of expenditures into changes in bilateral trade costs between regions, using a transportation cost elasticity measuring the effectiveness of transport infrastructure investments.¹⁰

Reduced transport costs will change the trading patterns and relative competitiveness of local industries. Lower transport costs make companies in the affected region more competitive by reducing both the costs of sourcing intermediate inputs and the costs of distributing goods to households and companies. This, in turn, enables them to charge a lower price and improve their competitiveness vis-à-vis companies in other regions, so expanding their output and employment. However, it is also important to note that the better the connection of a region with the rest of Europe, the greater the competition from other companies outside this region, which can reach domestic markets more cheaply. Therefore, together with exports, imports are also expected to soar and increase welfare, while inducing efficiency-enhancing sectoral reallocation of factors in the affected economies. The impact of better infrastructure is greater in regions with more potential for trade expansion, i.e. in regions that are already competitive and show a healthy export performance, but still lack transport links to reach new potential markets.

3.2.2. Non-Transport Infrastructure

Non-transport infrastructure projects aim to upgrade or expand existing infrastructure. Notably, this includes energy production, especially from renewable sources, improved energy efficiency, transmission networks, but also telecommunication infrastructure and broadband networks, water and wastewater infrastructure, etc.

The structural impact of non-transport infrastructure is introduced into RHOMOLO-EIB by adjusting the capital productivity parameters based on estimated elasticities from the literature. Two types of capital are distinguished: public, i.e. in the ownership of governments, and private, in the ownership of private economic agents. For public infrastructure investments we address the former, and for private non-transport infrastructure we target the latter, where the specific elasticities for capital productivity are in line with established parameters drawn from the respective literature.¹¹

Non-transport infrastructure offers another channel to mimic the impact of EIB Group-supported operations. It comprises a range of infrastructure investments, which are not directly related to transport, including energy, utilities and communication. It lowers the unit costs of production and makes a regional industry more competitive. The impact will be higher in regions where inputs from the affected sectors (such as energy, ICT, water) account for a larger share of total production costs in the economy, so it can be expected that manufacturing-oriented regions will benefit more than the others.

¹⁰ We use an elasticity of 0.0026. This elasticity of trade costs with respect to the infrastructure quality is retrieved from previous studies by the European Commission (Di Comite et al., 2018).

¹¹ Private investments increase capital productivity within the sector whereas public investments lead to higher public capital productivity that affects all sectors. For private investments, an elasticity of 0.1 is used in line with estimated output elasticities with respect to non-transport infrastructure investments in the literature (Calderón et al., 2015). For public investments, a lower elasticity of 0.05 is used.

3.2.3. Human Capital

EIB human capital projects aim at increasing the productivity of the human capital stock. These projects usually comprise the construction or improvement of education facilities such as schools and universities that will affect positively the quality and availability of teaching.

RHOMOLO-EIB models investments in human capital as an increase in the productivity of labour, differentiated by skill level.¹² Given that the EIB does not typically engage in ongoing education programmes, but rather improves the quality of existing education facilities, it focuses on the quality of the existing education cohorts without distorting labour market participation. This means people currently in education receive a higher quality of education. Contrary to some other modelling approaches, it does not necessarily assume more people are trained and temporarily withdrawn from the labour market in addition to the existing education cohort that later joins at a different skill level as the EIB Group typically supports the surrounding infrastructure, not the programmes or attendance itself.

Since investment in support of human capital increases labour productivity, the relative factor composition of the economy is affected, and so are the returns on investment. Overall, it is expected to make a region more competitive and its benefits are spread over the long run because investments and the capital stock also adapt after labour becomes more productive to reap the benefits of higher returns. The impact is higher in regions where education expenditure is relatively low and production is more labour-intensive.

3.2.4. Industry and Services

Investments in new capital formation are typically associated with the deployment of more modern and productive technologies. New investments expand the capital stock or replace old capital, which is composed of less productive vintages of capital, with more productive capital, the typical example being the purchase of new computers to replace old ones. This includes direct operations in various industries and especially loans to SMEs and mid-caps.

Investments are thus assumed to improve the efficiency of the capital stock by replacing old machines with more modern ones at a faster pace than they would do in the absence of the policy. This is introduced into RHOMOLO-EIB by increasing private capital productivity based on existing elasticities of technology embodied in capital formation. The magnitude of this productivity increase depends on the scale of new capital formation relative to the existing private capital stock in the base year. The technology efficiency effect is applied separately to different sectors to better represent the cross-sectoral heterogeneity of the EU economy and EIB Group-supported operations.¹³

As the productivity of capital increases, its relative input share in the production process increases, but production becomes more competitive and the sector expands, so that the impacts on labour demand are not determined a priori. However, if the output expansion is strong enough, the overall demand for labour can increase and attract more workers into the workplace. It should be pointed

¹² Human capital investment uses a Mincerian elasticity of 0.07 (De la Fuente and Ciccone, 2003; and Canton et al., 2018).

¹³ A rise in capital productivity is consistent with an assumption that new technology is embodied in installed capital (for example, see Sakellaris, 2004 and Boucekkine et al., 2011). Capital formation in industry and services increases capital productivity within the sector with an elasticity of 0.1 in line with estimated productivity effects of vintage capital in the literature (Sakellaris and Wilson (2004) and Licandro et al. (2005)).

out that this channel alters capital productivity and, in fact, it can materialise over time. Even though in the short run the effects may seem to weaken labour demand in certain sectors or regions, over the medium to long term the effects can cascade through the economy, stimulating the production of interlinked businesses.

3.2.5. Research and Development

R&D projects aim to boost the number of innovations through greater R&D production, and consequently to increase the productivity and competitiveness of companies, which are expected to benefit from better products or more efficient production processes. Projects that are assumed to achieve this objective include support for specific research programmes conducted by private corporates and public institutions.

In RHOMOLO-EIB, innovation is modelled as an increase in TFP, based on the relevant literature.¹⁴ The estimated elasticity that drives the increase in TFP depends on R&D intensity and R&D value added. Extending empirical firm-level observations to the regions at large, higher R&D intensity is associated with the higher elasticity of R&D spending to TFP increase. The intuition is that firms and regions that are already spending a lot on R&D before EIB support signal their pre-existing capacity to generate value from innovation activities.

Increases in TFP lower unit costs and make a company more competitive. This may attract more capital and labour, and expand trade and production capacity.

3.3. The use of EIB Group data

Sound modelling requires good data. To reflect EIB Group-supported activities in the macroeconomic model, detailed data on each operation are required. Each EIB Group-supported operation has a detailed set of data available on timing, implementation, location, sector, financing and objective. The data are broken down to the most granular available level that is relevant for the RHOMOLO-EIB model to most accurately reflect the investment activities in the real economy (see Figure 7).

¹⁴ The specific elasticity depends on the regional R&D intensity. The elasticity of R&D expenditure on TFP is based on Kancs and Siliverstovs (2016). The regional R&D elasticities are in the range of 0.008-0.152 with the mean value at 0.021. In the national account, R&D expenditure is treated as GFCF. To be consistent, R&D investments are modelled as a rise in private investments (“investment effect”) with the capital stock decaying over time, and a lasting rise in TFP (“structural effect”).

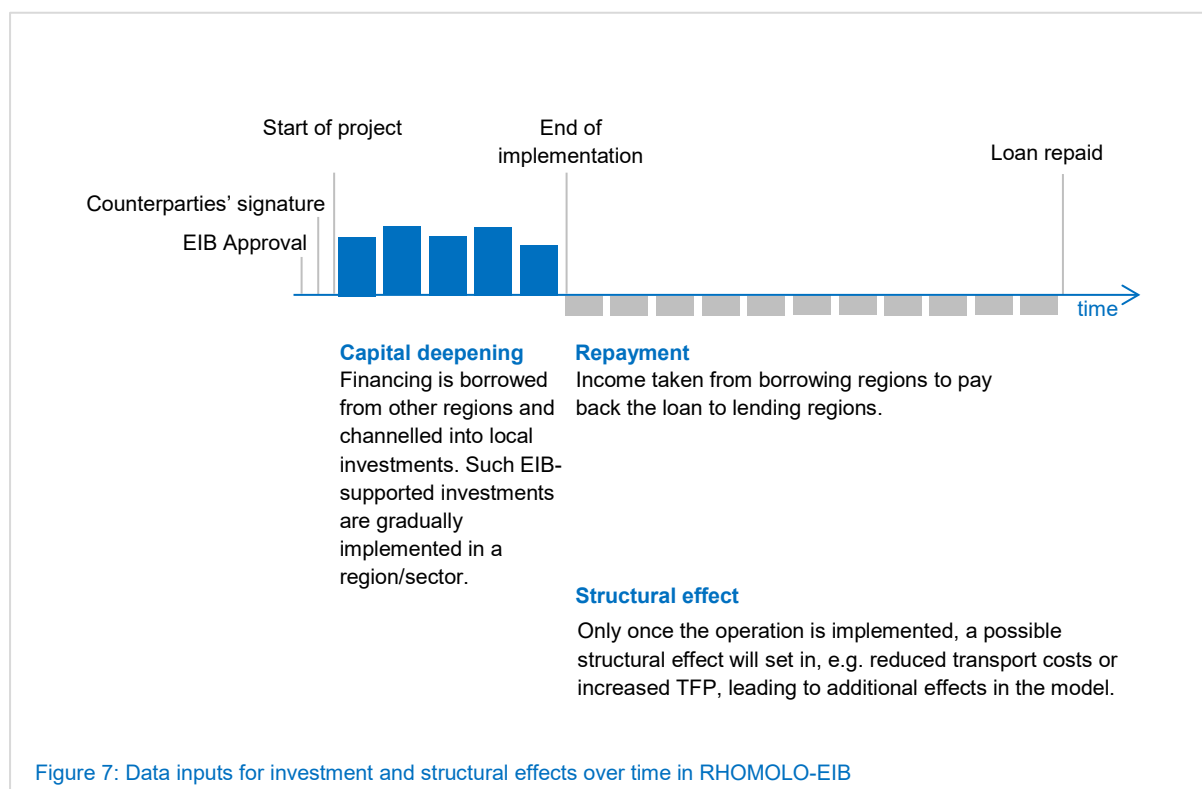


Figure 7: Data inputs for investment and structural effects over time in RHOMOLO-EIB

To model the investment effect, details of when and where the funds reach the real economy are required. These start and end dates of the actual investment activity are needed together with the investment volumes over time. Each operation needs to specify in which sector and in which location such investment activity takes place to reflect this in RHOMOLO-EIB (see Table 1). For the financing effect, available EIB Group data on the source of funding are collated and additional assumptions on the sources and distribution of borrowing are made to account for the funds borrowed by the investing regions (see Table 2). Such borrowing is taken from incomes in the respective regions, from other regions, or from abroad, and channelled into the borrowing region. The reverse is true for lending regions. As the repayment process sets in, income is taken from the borrowing regions and transferred back to income in the lending regions. Repayment speed and volumes over time follow the available EIB Group data or stylised depreciation processes in the economy. The settlement period is taken from the detailed repayment schedules, and is netted out over all the operations and regions in a given year.

Table 1: Input table for investments by RHOMOLO sector and region — separate table for each year

Regions	A	BDE	C	F	GHI	J	K	L	MN	OPQ	RSTU
AT11											
AT12											
AT13											
AT21											
AT22											
AT31											
AT32											
AT33											
...											

Table 2: Input table for financing sources from various regions — separate table for each year

Regions	RoW	EU_PRIVATE	EU_PR_SAV	EU_PR_CON	EU_PUBLIC
AT11					
AT12					
AT13					
AT21					
AT22					
AT31					
AT32					
...					

The structural effect relies on additional data points. Each EIB Group-supported operation needs to clearly contribute to set policy objectives, such as to improve European infrastructure, foster innovation, mitigate climate change, etc. These policy objectives in their most granular form can be mapped to the structural channels available in RHOMOLO-EIB to establish a clear link to the structural effects of the supported operation. For example, it is important to know if a project is supporting research and development in a specific sector or capital renewal. Together with the information on the timing, scope and location of the investments the model inputs can be described in necessary detail (see Table 3). Structural effects only take effect once the operation is completed — transport does not become cheaper until the bridge financed is actually completed.

Table 3: Input table for policy areas by region — separate table for each year

Regions	TRANS	INF-ENERGY	INF-ICT	INF-PUBLIC	HC	IND- (by 11 sectors)	RTD
AT11							
AT12							
AT13							
AT21							
AT22							
AT31							
AT32							
...							

Where data are not available ex-ante, proxies or estimates are used. At the time an operation is approved or signed, certain expectations are formed based on the nature and scope of the project and on when and what will be implemented and delivered. As actual (ex-post) data become available, the data will be successively updated to reflect the most recent and most accurate information. For example, for certain types of operations such as SME finance or equity funds it is difficult to gauge the sector or geographic distribution of the investments ex-ante. Assumptions based on previous experience and details provided from the intermediary are used to model such distribution ex-ante. As the data are collected during implementation, this data will be updated and used for the exercise.

4. RESULTS

The results are published and made available on a regular basis. The objective of the RHOMOLO-EIB exercise is to assess the expected macroeconomic impact of the EIB Group-supported investments in general, and EFSI-supported operations in particular. The results for EIB Group-supported investments are published annually on the EIB website and the results for EFSI are reflected also as part of the EFSI report to the European Parliament and the Council.¹⁵ For the discussion in this methodological note a normalised, representative portfolio is used to avoid any specific bias in interpreting the results and testing the sensitivity of the results.

The results reflect well the scope of the EIB Group's lending operations. In the following section the scope of the inputs is discussed with respect to how well it is able to capture the EIB Group's lending activities. Next the results for the standardised dataset are presented and discussed in some detail. Finally, a discussion takes place on what these results reflect and how to interpret them. Any such results should be read with the appropriate care in terms of what they mean, taking into account the specific model context that produces them.

4.1. Scope of the EIB Group-supported investment inputs

RHOMOLO-EIB can reflect many of the EIB activities, but not all. The EIB Group offers a range of products and activities. Not all can be covered in the model. The focus is on financially-supported operations. Advisory activities and the knowledge work of the EIB Group are not included. And of those financially-supported operations, given the EU focus of RHOMOLO, only operations within the European Union are considered.¹⁶ Non-EU investments fall outside the scope of this exercise and different modelling strategies are available.

The exercise considers the overall investment volumes supported by the EIB Group as an input. The reason behind this is twofold. First, the EIB aims to mobilise investment projects, which without the EIB's support would either not have materialised or, if they did, in a different form. Second, the projects are usually indivisible. It would be questionable to assess the impact of a fraction of a road, factory or power plant instead of the full project, for example. This has implications for reading the results as they should not automatically be attributed to the EIB financing alone, but the projects as a whole.

A specific set of input data is modelled. RHOMOLO-EIB allows for modelling at different stages of the operational cycle depending on the availability of data. When modelling EIB Group impact, different datasets can be used. For some programmes an ex-ante assessment is used, relying on approvals and on expected data collected during the due diligence process. Other exercises rely on signature data which come slightly later and possibly with more up-to-date information. Ex-post modelling has the most reliable information available as the projects have been implemented and actual costs, timing and direct results are available. However, the results come very much later in the process. If the EIB were to wait until the repayment of all the loans this would be many years after the start of the

¹⁵ See EIB website: <https://www.eib.org/en/about/key-figures/eib-impacts/index.htm> or as part of the annual press conference: <https://www.eib.org/en/events/annual-press-conference-2021>. For EFSI, see the 2020 report from the European Investment Bank to the European Parliament and the Council on 2020 EIB Group Financing and Investment Operations under EFSI: <https://www.eib.org/attachments/strategies/efsi-2020-report-ep-council-en.pdf>

¹⁶ Note that overseas territories are not included in the RHOMOLO model due to data availability issues.

projects. It is important to reiterate that the approval or signature date only determines the scope of activities, not the time of the actual investment. To determine when investments take place, the model considers the necessary project data (i.e. once approved the project starts building a bridge over the next five years; the shock to the model mimics this over that period, and the repayment according to the financing plan).

Inputs are considered in isolation. The RHOMOLO-EIB exercise considers a specific set of activities in a specified time interval. It is not concerned with the activities that came before or are coming after. It implicitly assumes the specific shock is a one-off set of activities that start at a certain point and cease any activities afterwards. This is best reflected in modelling a specific funding envelope that is made available, such as EFSI. It is slightly more complicated when considering the EIB Group's activities. The EIB Group supported operations in previous years, and will likely continue to support more activities after. This needs to be taken into account when interpreting the results (for a more in-depth discussion see Annex 3.4).

Inputs also consider sources of funding. To finance the EIB Group's activities, bonds are issued to borrow from the capital market, within the European Union and abroad. Co-financing for the operations supported follow similar financing from equity, or borrowing from inside the European Union or abroad. When using RHOMOLO-EIB, this financing forms an important input into the model based on best available data corresponding to the financing structure of the underlying operations and the issuance of bonds. This also implies certain assumptions on where these funds are sourced from and how this impacts the model results. (See also Annex 3.3 on macro-additionality for a more extensive discussion on this).

For this methodology note a standardised dataset is used. The results for EFSI and the EIB Group cover a specific scope of EIB activities. Activities vary by country or are specific to the mandate, like EFSI. To facilitate the interpretation of the results more generally a normalised shock file has been constructed. To avoid specific biases in a given year, for example, the specific portfolio composition in 2020 due to the COVID-19 pandemic, a more representative portfolio is considered based on EIB Group operations over the past five years. This reflects the evolving mandate of the EIB based on the most recent available data, and is more representative than 2020 alone. While maintaining the relative distribution, the overall input is normalised to €100 billion to give a more intuitive sense of scope as the investment supported also varies with the portfolio and non-linearities factored in, and the relevant implementation dates are proportionally aligned with a standardised starting date in 2020. The shock then reflects a representative portfolio of the EIB Group-supported investment.

4.2. Modelling results

The macroeconomic impact of the EIB Group in terms of jobs and GDP based on RHOMOLO-EIB is part of the EIB operational plan and its results are published in a transparent manner. The EIB has applied the RHOMOLO-EIB model since 2016. It has become part of the EIB operational plan and its legal reporting obligation to the European Parliament. The results are all published and updated annually on the EIB website, and as part of the EIB operational plan, as well as part of the reporting on EFSI such as the annual report to the European Parliament and the Council, and recently also as

part of the comprehensive report on the functioning of EFSI.¹⁷ For example, according to RHOMOLO-EIB, overall investment supported by the EIB Group within the EU-27 in 2020 amounting to some €240 billion will add 1.1% to GDP and 1 million jobs over the baseline after five years, by 2024. In the longer term, in 20 years, by 2039, as the investment effects fade out and the structural effects have taken hold, the supported investments are expected to still have increased the level of GDP by 0.8% and created 590 000 jobs. Similarly EFSI-supported operations approved between 2015 and end-2020 amounting to some €545 billion are expected to add 2.1 million jobs and will increase EU GDP by 2.4% by 2025 compared to the baseline scenario. By 2040, EFSI-supported operations will still have created 1.3 million jobs and will have increased EU GDP by 1.6%.

EIB Group-supported investments are expected to have a sizeable impact on Europe’s economy. In order to avoid the specific bias due to annual shocks, a normalised investment shock is used. The normalised investment shock is constructed as €100 billion of EIB Group-supported investments starting in 2020 and allocated across EU countries following the pattern of EIB Group-supported investments over the period 2015-2020. The results from RHOMOLO-EIB suggest that EIB Group-supported investments according to the normalised €100 billion investment data are expected by 2025 to increase EU GDP by around 0.6% over the baseline GDP and add 500 000 jobs. In the long term, i.e. in 20 years (by 2040), the same investments are expected to still add around 0.4% to GDP and some 280 000 jobs (see Figures 8 and 9).

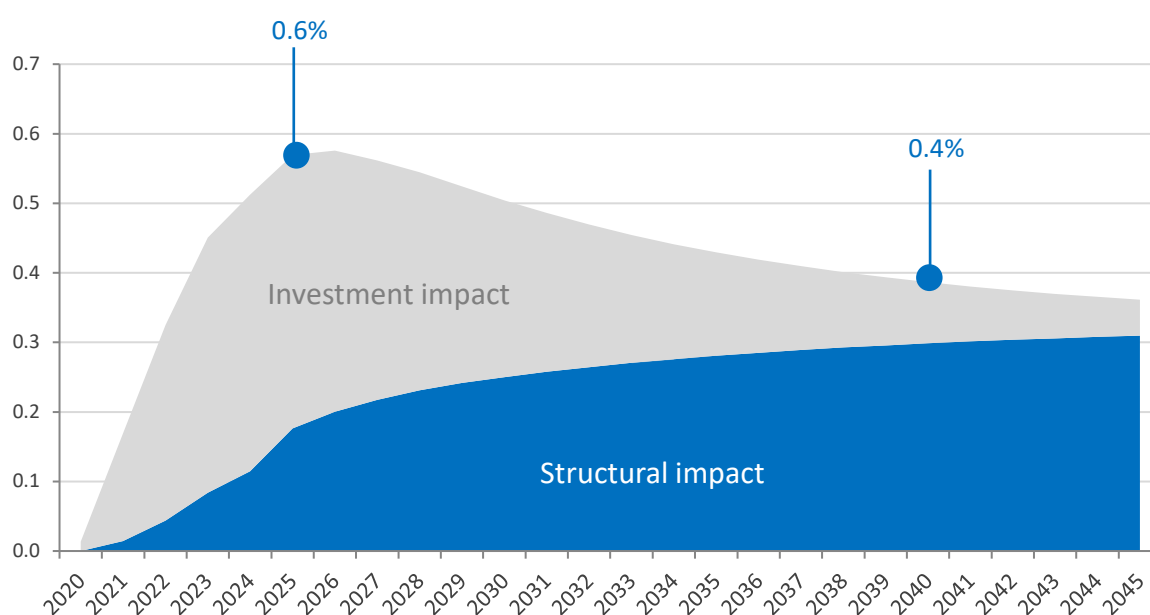


Figure 8: Expected GDP impact of EIB Group-supported operations (€100 billion normalised shock).

¹⁷ [Macroeconomic Impact of the European Fund for Strategic Investments: \(eib.org\)](https://www.eib.org/en/press/2021/06/macroeconomic-impact-of-the-european-fund-for-strategic-investments)

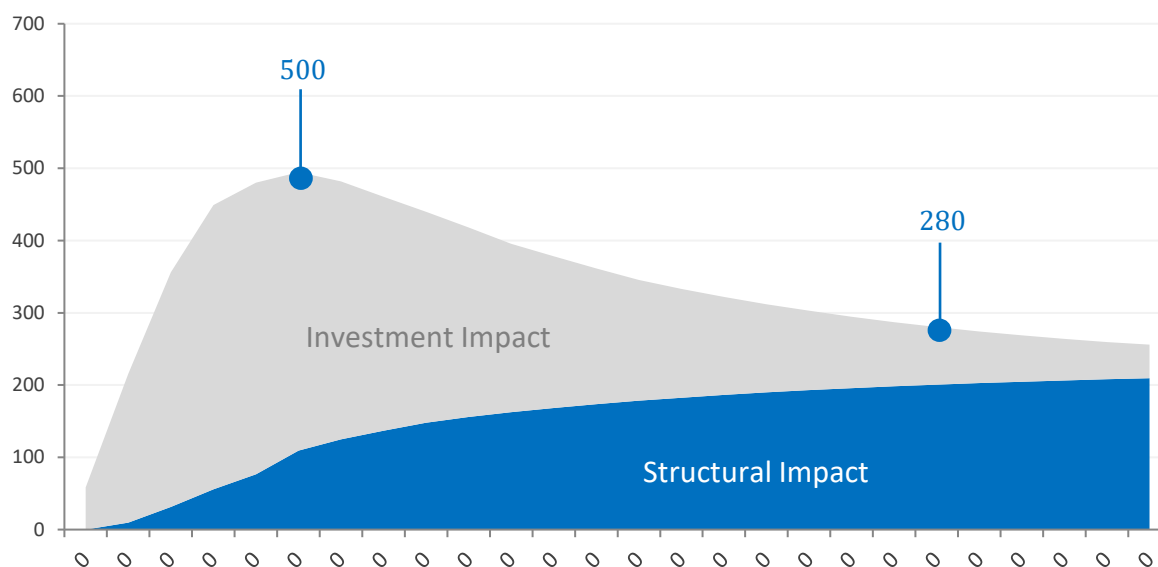


Figure 9: Expected jobs impact of EIB Group-supported operations (€100 billion normalised shock).

Short-term results are mainly driven by the investment effect. The investment effect sets in quickly, and fades out over time. This reflects the implementation of the investments, such as building a road, conducting research and development, improvements to public infrastructure, firm investments, etc. This has a direct effect on capital and labour usage in the production process. It has forward and backward linkages along the value chain, and has an indirect, second-round effect on income and sector spending, while taking into account local resource availability (for more information, see Box 2). The effect would be steeper where resources are relatively more abundant, and somewhat slower to pick up in regions where resources, especially labour, are scarcer. As investment activities reach completion, the overall effect will start to phase out. The new investment impetus will cease, the capital will depreciate over time, and loans will be repaid from borrowing regions to lending regions, which will also affect consumption spending. Overall, the investment effect phases out over time.

Longer-term effects are mainly driven by the structural effect. The structural effect is a key objective for the EIB as a long-term investor focusing on growth and competitiveness in the European Union. Investment activity, such as laying a broadband cable, will be reflected in the investment effect. The structural effect, i.e. providing faster and better access to information and communication services, is possibly more important as the investment may have a profound structural impact on the region: it may disrupt certain services and lead to new services being offered. Similarly, completing a transport link will allow for cheaper imports that may compete with the local economy, but also offer cheaper exports which make the regional economy more competitive. These longer-term, structural effects only set in once a project is finished (a road can only be used once completed). Therefore, it would be expected to set in with some lag compared to the investment effect, and grow over time as more and more investment projects come to a close. Furthermore, the structural effect is much more persistent. Enhanced production technologies, better private and public infrastructure and greater labour productivity are expected to have a lasting impact on the economy. The results show such effect growing over some time and persisting compared to the baseline.

4.3. Interpreting the results

Results should be interpreted with due care. The results do not represent growth rates, but changes in the level of economic activity and employment over the baseline. Jobs created ‘by’ 2025 is different to jobs created ‘in’ 2025. The model expects to see 500 000 more jobs in the EU economy *by* 2025, but only some 15 000 new jobs *in* 2025. Thus, in terms of annual contribution to GDP and employment the difference to the previous year would be the reference value.

Results consider a specific baseline. Results reflect the relative increase in GDP and employment over a baseline scenario. For modelling reasons, the baseline scenario considers a world in a steady state. This is based on 2013 available detailed data in the European Union. Work is ongoing to update the base year using more recent *data*. The model baseline could be made dynamic following a non-steady state time path, but this would require an amount of speculation as to how the economy will behave in the coming 30 years, when crises occur, etc. In most cases the differences in results would be modest using a dynamic baseline compared to a steady-state baseline. Specific occurrences like the COVID-19 pandemic are not predicted in the model, nor can the model easily mimic a recovery path which is still unclear if it rebounds quickly or has some more lasting effects. The results should be read in such a way that the stated effect on GDP and employment is always over the baseline, which assumes a counterfactual world without the specific EIB-supported investments, and also without the borrowing for such investments. The effect seen is ‘additional’ or ‘over’ such baseline.

Results reflect macro-additionality. Additionality is a critical aspect of EIB Group-supported operations. As a bank, the EIB engages in the market; as a public institution, the EIB should only engage in the market where a clear value added can be achieved. The macroeconomic assessment can only provide a partial answer to the question of additionality. The EIB Group will continue to critically assess additionality at a project-by-project level, i.e. would a specific project have happened or not, or would it have happened differently? The macroeconomic assessment looks at this from a different, complementary angle, where the EIB’s role is channelling financing into productive investments, thus providing macro-additionality. The results show an overall increase in investments in the EU economy, and in priority sectors in particular. To what extent this reflects macro-level additionality depends on the model inputs and parametrisation (a more in-depth discussion is provided in Annex 3.3).

To understand the results properly, they should be seen as standalone investment initiatives. The EIB as a long-term public institution has been investing for more than 60 years and will continue to do so in the future. However, the results considered in RHOMOLO-EIB concern a specific set of EIB Group operations carried out in a specified time period. The assessment of economic impacts does not consider EIB operations in the past or any potential future activities still not known. Hence, EIB Group-supported operations in the RHOMOLO-EIB context should be considered as a limited set of initiatives which runs over a given time interval and then stops. This rationale is implicitly assumed in the results, but does not change the scope of the results; however, it needs to be considered when interpreting the effects (a more detailed discussion is provided in Annex 3.4).

Results on a national and regional level are available, but require some extra interpretation. The results reflect an aggregate level, i.e. for the EU-27. Whilst RHOMOLO-EIB is able to provide results at a country level and even at a regional level, the results cannot easily be disaggregated. Due to a high level of spillovers from regions to other regions, and a degree of non-linearity of results (building two

roads is not double the effect of one, for example), country results cannot be compared to country investments. For example, a region could have no investments in its territory and still benefit from investments in neighbouring regions or from an overall increase in competitiveness. Or vice versa, building a key network link as part of a trans-European transport corridor in a region could mean significant investment activity in a specific region, yet the main benefits may not occur in this region but in the trading centres across Europe that this corridor now connects better. On average, results show that 35-40% of the effect is explained by spillovers when investment in one region also benefits other regions, reflecting the high degree of interlinkages in the European economy. Consequently, if results are read with due care and taking these interlinkages and spillovers into account, RHOMOLO-EIB is able to provide more granular results on a country and regional level. However, comparing the investment activities in a region or country with the disaggregated results for the same region or country would be potentially highly misleading. Also, from a policy perspective, taking into account the spillovers from investments provides a different sense of scope of the EIB Group's operations. Instead of a country-by-country approach, they convey the results and benefits from investments from a European perspective. If investments were considered by country, with disregard for the spillovers, or as a negative aspect, the pan-European benefits that spill over from investments in one region or a country to another — for example, building a road in Austria benefits neighbouring Italy and Germany or even regions farther away — would be overlooked. At an aggregate EU level much of these spillovers are internalised and better reflect the European nature of the portfolio and benefits to EU citizens (see Annex 3.1 for more detailed information on the spillover effects).

4.4. Taking a closer look at the results — by region and sector

Results vary across regions. Results can be looked at through different prisms. One key dimension would be to look behind the aggregate data, and consider the relative performance within the European Union — bearing the spillovers in mind. In absolute terms, the model outcomes suggest that the highest impacts in terms of value added and jobs created are achieved in the richest countries. But this may not be the most telling conclusion when looking at the underlying data. As illustrated by the baseline model data, well-off regions also have relatively higher capital intensity, and, in the EU context, they are also some of the largest in terms of population and value added, such as France or Germany. More telling would be to look at the relative increase in terms of percentage increase of GDP and percentage increase in employment. This better reflects the relative macroeconomic impact. The results show that all EU regions and countries benefit in terms of jobs and growth. Furthermore, those countries that were hit hardest by the financial crisis, and those that lag behind in terms of income, benefited relatively more than did the most well-off countries. Figures 10 and 11 plot respectively the percentage increase in GDP and employment in three different groups of countries: periphery countries (those countries that have been hit hardest by the lingering financial crisis of 2007-2008), cohesion countries (the countries that are in a catching-up process, but still fall somewhat short of EU average income), and other countries, those with higher GDP per capita levels (such as Germany, France, Sweden, Denmark, etc.).¹⁸

¹⁸ A country is defined as a cohesion country if it has access to the Cohesion Fund, except for Greece, Cyprus and Portugal. The Fund is aimed at countries whose gross national income (GNI) per inhabitant is less than 90% of the EU-27 average. Member States that can benefit from the Cohesion Fund are Bulgaria, Croatia, Cyprus, the Czech Republic, Estonia, Greece, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Slovenia. Periphery countries are EU Member States that were affected by the crisis comparably more than the other countries.

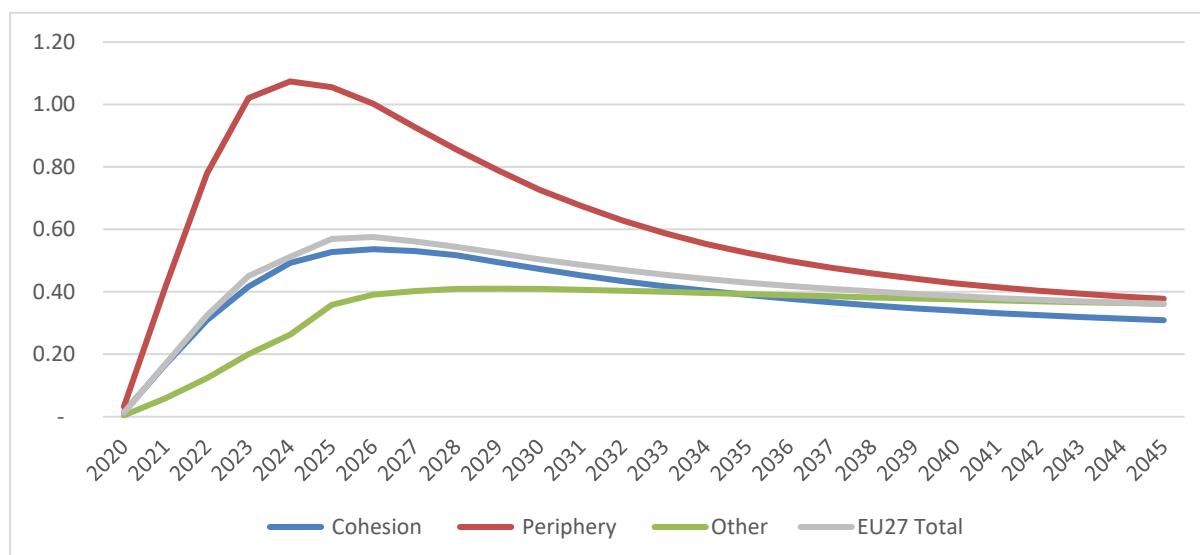


Figure 10 Expected GDP impact of EIB Group-supported investments (€100 billion normalised shock) by country groupings

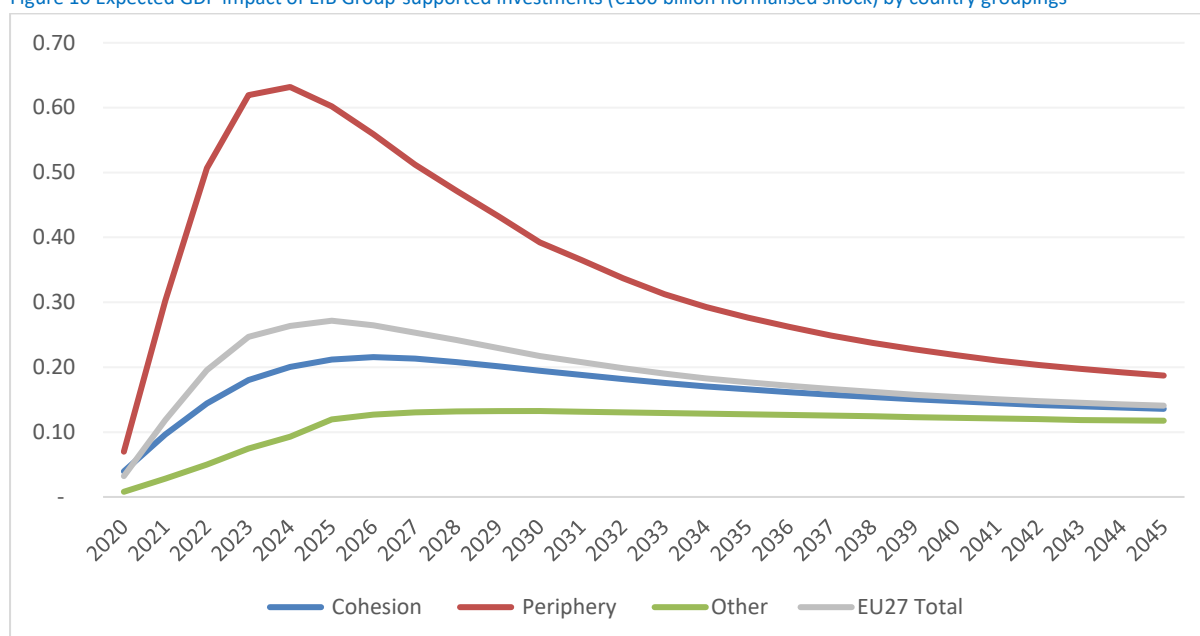


Figure 11: Expected employment impact of EIB Group-supported investments (€100 billion normalised shock) by country groupings

Cohesion and periphery countries benefit relatively more than other, better-off EU countries. The strongest effect can be seen in the periphery countries in terms of GDP and employment. This is unsurprising as these countries receive a substantial share of the EIB funds and in many of its regions unemployment was relatively high in 2013 and investment levels low. Supported investments will immediately turn into higher demand for workers, which will draw in workers and will be reflected in economic growth. Such crisis-hit regions and countries would therefore be expected to see a larger impact, as the results confirm. The structural effect only sets in over time, and compared to the investment effect it is more modest but also more persistent. It still contributes more in periphery countries than in other countries, also due to the difference in investment levels, but also again in relation to the existing infrastructure and productivity levels, and competitiveness in general. For

They include Cyprus, Greece, Ireland, Italy, Portugal and Spain. The group of “Other EU members” include the remaining nine EU Member States: Austria, Belgium, Denmark, Finland, France, Germany, Luxembourg, Netherlands and Sweden. The United Kingdom is not included.

other better-off countries the picture is different, as expected. The investment effects both on GDP and the employment rate are more delayed and more limited in size compared to the periphery countries since the economic situation is better, unemployment levels are lower and ex-ante investment levels typically higher. The effect is more modest and takes longer to pick up. On the other hand, the structural effects achieved are able to significantly contribute to the long-run economic growth of these countries. This reflects their economic environment, with a more richly endowed infrastructure, human capital and technology, and the fact that they are characterised by a high GDP and employment rate. Cohesion countries are between the two groups. They are not as hard hit by the crisis as the periphery countries, but the economic situation is also not as advanced and as favourable as in the better-off countries. The short-term effect is smaller than for the periphery. On the other hand, the long-term effect is extremely persistent and significant, meaning that even if the supported investment will have a limited investment effect on the local economy it will be able to enhance competitiveness in these regions to boost future economic growth.

Less developed and transition regions benefit relatively more. Looking at the regional level (NUTS2, at which regional policy is defined¹⁹) instead of countries, more details emerge. All 230 regions in the EU-27 show a positive long-term impact on income, but the magnitude of the effect differs (see Figure 12). The lowest still shows a positive long-run impact of 0.1% of GDP in well-off regions such as in Germany (Lüneburg, Schwaben), Luxembourg, or Finland (South Finland) and the highest are mostly in Spain, Greece and Bulgaria.

¹⁹ For regional policy at the EU level, regions are classified into 'more developed regions' (with GDP per capita over 90% of the EU-27 average), 'transition regions' (between 75% and 90%), and 'less developed regions' (less than 75%). <https://ec.europa.eu/eurostat/web/regions-and-cities/overview>. For the analysis here, less developed regions and transition regions are classified together as 'cohesion regions' in accordance with EIB policy. Corresponding to the timeframe considered, the analysis relies on the 2014-2020 classification.

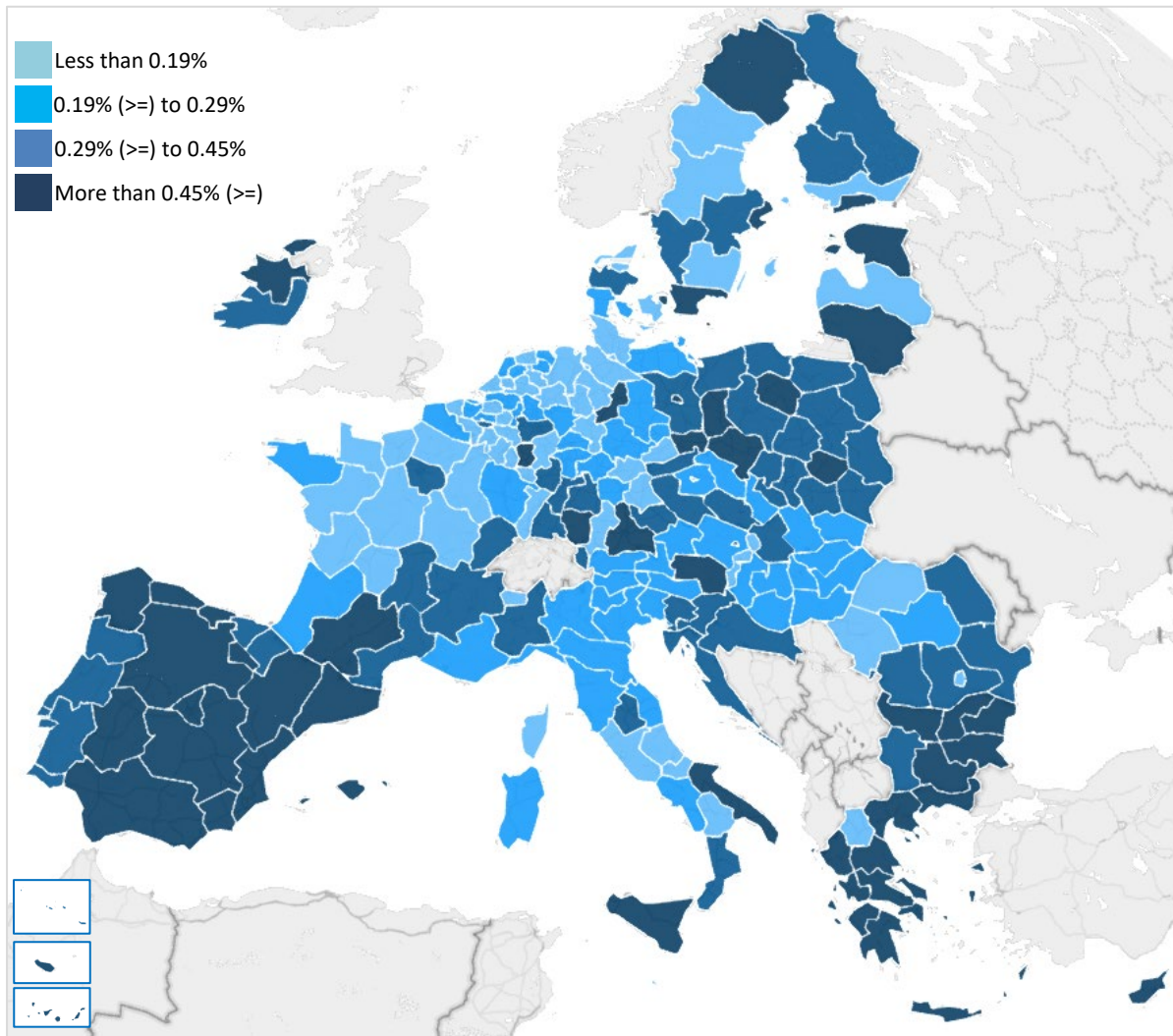


Figure 12: The impact on GDP of EIB Group-supported investments (€100 billion normalised shock) in the long run (2040), at NUTS 2 level, in quartiles % of GDP

Cohesion regions, encompassing both less developed and transition regions, benefit significantly more than more developed regions. The impact on GDP at its peak is almost twice as high, driven mainly by the investment effect. Over time the structural effects become more important and more dispersed. As regions are repaying the loans the GDP effects converge (Figure 13). The effect on employment follows a similar pattern to GDP but the long-term effect is still some 20% higher in cohesion regions than in better-off regions (Figure 14).

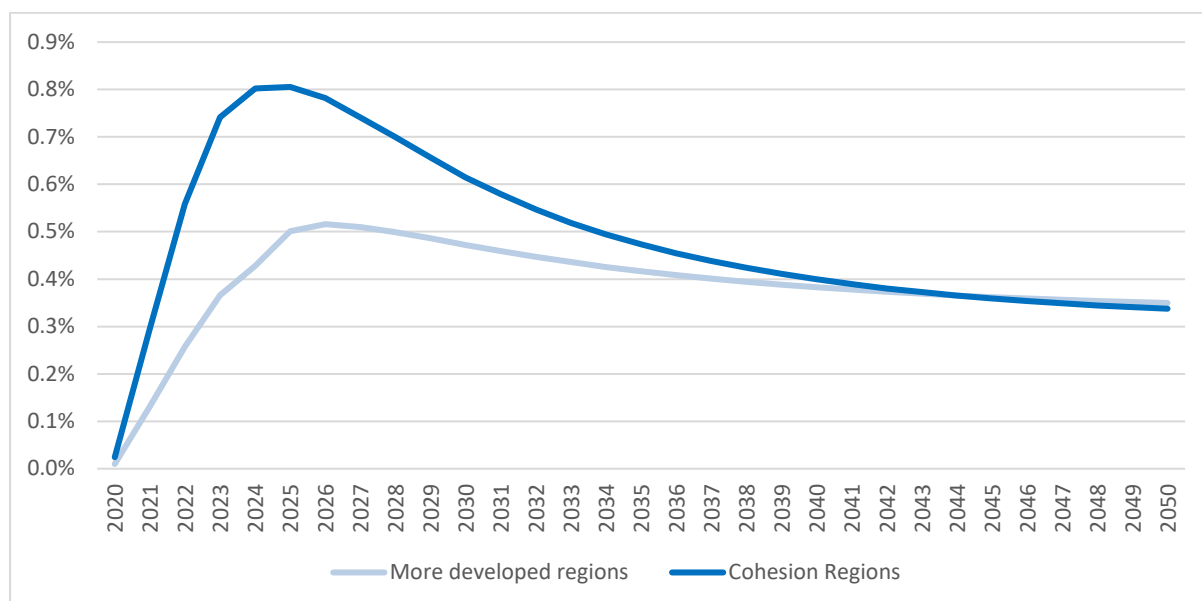


Figure 13: Impact of EIB Group-supported investments (€100 billion normalised shock) on GDP in NUTS 2 regions, cohesion/more developed regions, GDP %

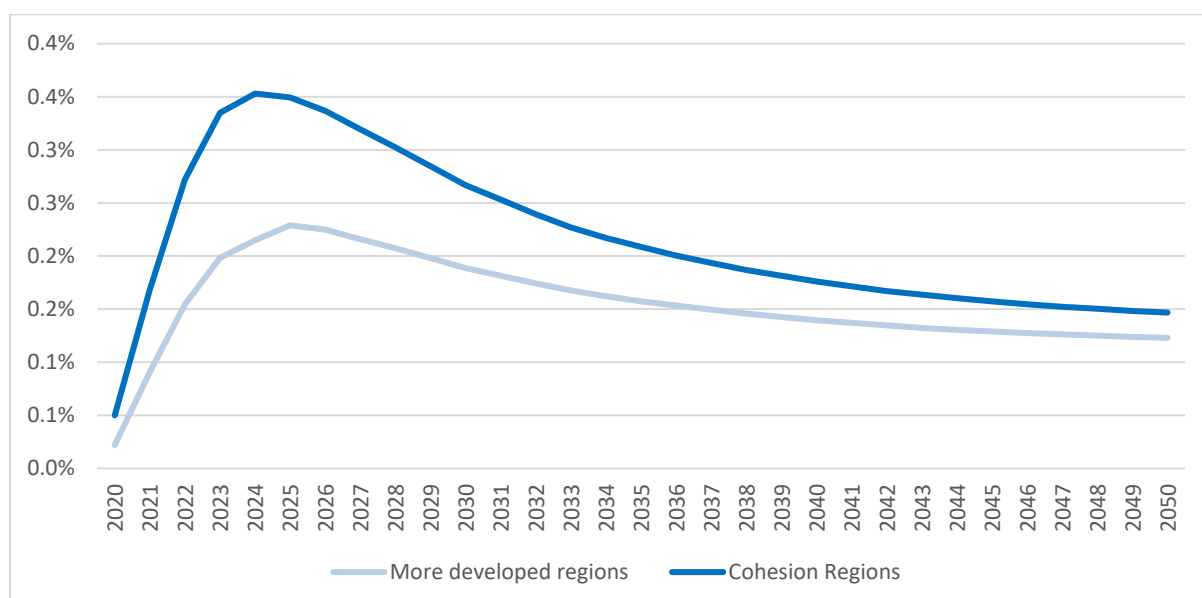


Figure 14: Impact of EIB Group-supported investments (€100 billion normalised shock) on employment in NUTS 2 regions, cohesion/more developed regions, jobs %

Similar to the country perspective, the results hinge both on the relative share of investment to cohesion regions, the economic situation in these regions, and the spillovers in the European Union. The scope of the investments in cohesion regions is somewhat higher than in better-off regions (1.2% of GDP versus 0.8% of GDP in better-off regions). This may explain part of the higher impact in the cohesion regions. More important, however, is the economic situation in the cohesion regions, and, especially in the longer term, the spillover effects. The economic situation matters significantly for the results especially the investment effect but also the long-term impact of the supported investment. The Greek region Kentriki Makedonia, for example, was facing a 30% unemployment rate in 2013 compared to, for example, only 2.5% unemployment in the German region of Lower Bavaria (Niederbayern). The capital stock was much lower compared to many better-off regions and the

investment levels in the 2013 baseline scenario were relatively low. Again, for example, in Kentriki Makedonia the investment rate in 2013 was 15% of regional GDP whereas in Lower Bavaria it was 23%. In addition, spillovers from other regions, especially neighbouring or close trading partners, contribute significantly to the long-term economic impact.

Manufacturing is a key driver of the results. Looking at a sectoral decomposition of the impact adds interesting insights into the results (see Figures 15 and 16). In the two initial periods, it is chiefly the construction sector driving the results, especially in terms of employment. This seems reasonable as many investments require some time to be built — a road, a manufacturing plant, a research facility, a windfarm, etc. — thus drawing in labour.

Over time, also as more and more construction is completed, the various sectors benefit. Here it is interesting to note that manufacturing is a key sector. Not because the size of investments is the highest, but mainly also because of spillovers via indirect and induced effects from other investments (in other words, an increase in the overall income level will be directly reflected in a higher demand for machinery). Hence, by 2025 the resources devoted to the manufacturing sector will have added 190 000 jobs and the GDP produced in this sector will be 0.2% higher than in the baseline model. Even once the short-term effects fade, the structural effects generated by the improvement in productivity will still support economic growth in the long run. This should be read in the context of the underlying steady state. It does not necessarily imply an expansion of the manufacturing sector if indeed this sector sees long-term decline, but rather over the baseline of 2013.

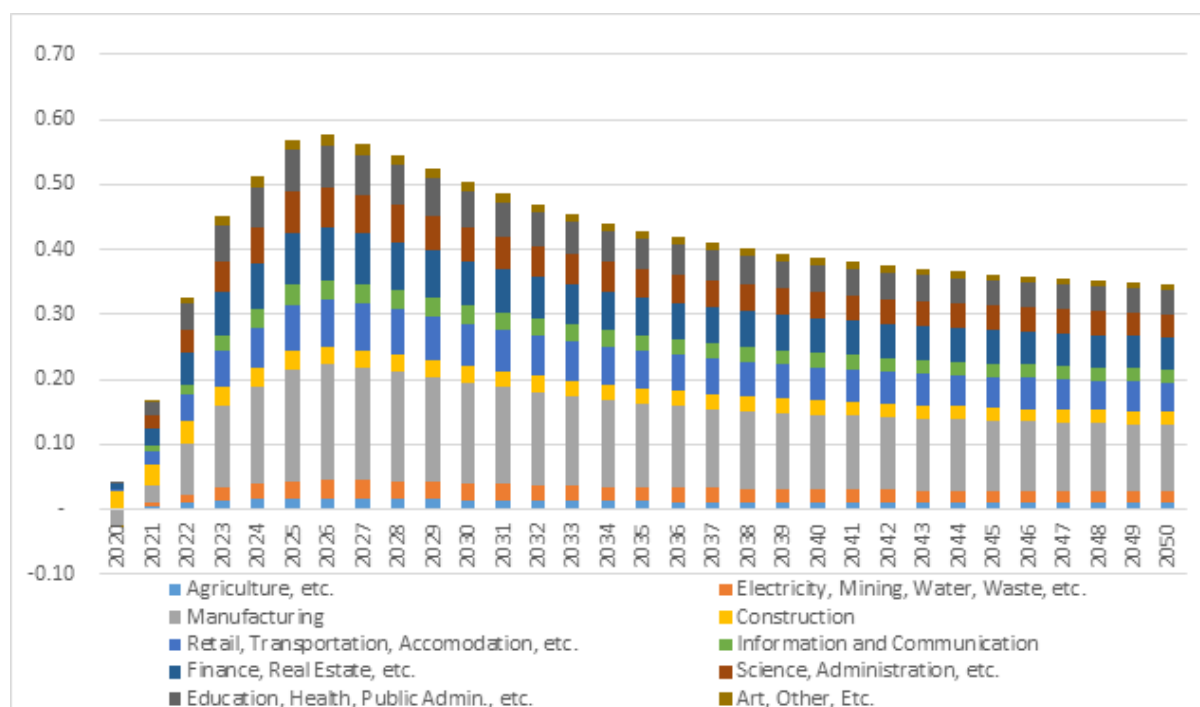


Figure 15: Expected GDP impact of normalised €100 billion input, by sector, in % of GDP

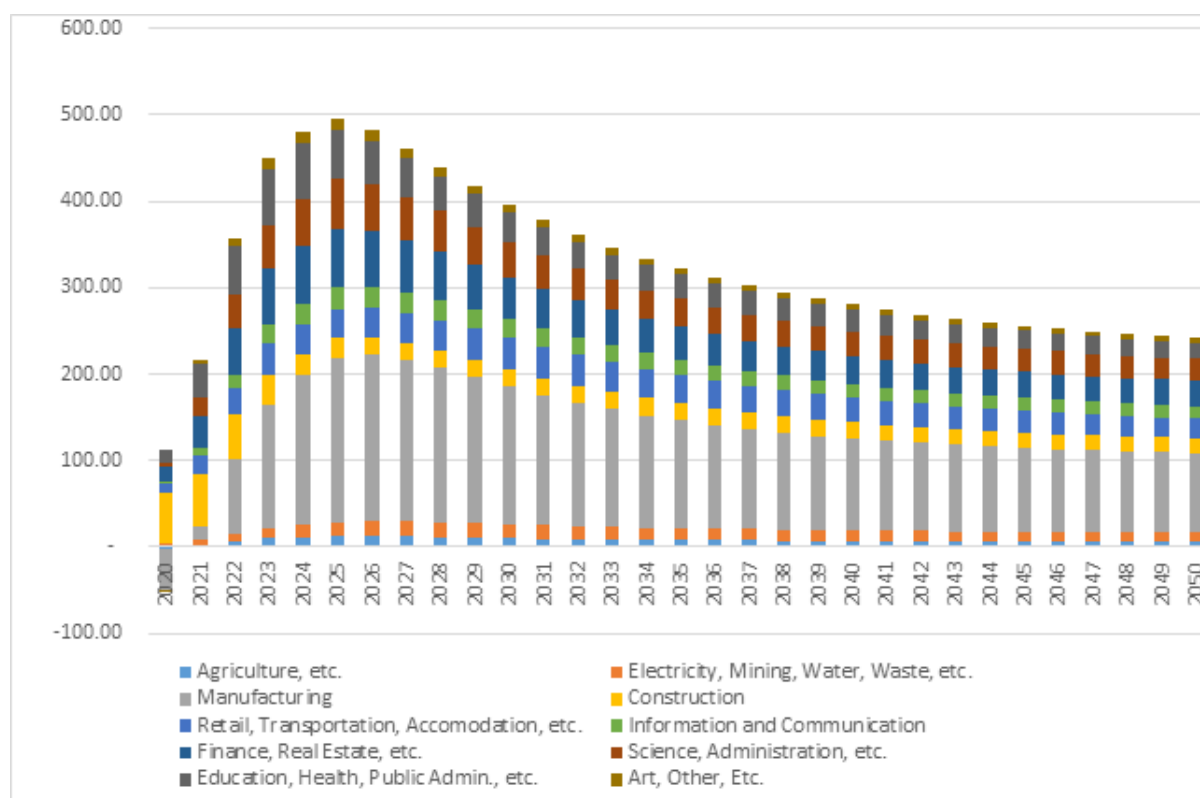


Figure 16: Expected employment impact of normalised €100 billion input, by sector, in thousands of jobs

Other sectors also see an increase, but to a lesser extent both in absolute and relative terms. Sectors vary in terms of export shares and in terms of the mix and sourcing of production inputs, and therefore benefit differently from improved competitiveness due to productivity gains and lower transportation costs. Overall, to reiterate the argument of the risks of disaggregation, it is important to underline that the relationship between the amounts of investment devoted to a specific sector and the role that sector plays in GDP and employment is complex and tractable only through multiple effects in the model. The RHOMOLO-EIB model also takes into account the spillovers generated by the European Union's intertwined economies so that the impact of the supported investments is not limited to the recipient sector or recipient region only.

5. SENSITIVITY ANALYSIS

The results are robust to reasonable variations in the working assumptions. To ensure the robustness of these results, an extensive sensitivity analysis has been conducted to look at different parametrisation and variation in the model specification to determine how sensitive the results are to the alternative specifications (in Annex 3, the sensitivity analysis is described in more detail). The sensitivity analysis is based on the technical report (Diukanova, 2018), which provides a detailed description of the technical details, algorithms and computer codes.

Results are only as good as the model setup. The RHOMOLO-EIB model contains a number of parameters which govern the institutional settings of the economy, the preferences and the behaviour of the economic agents, and market-specific rigidities. The values of these parameters are either estimated directly from the data or chosen in line with the existing literature. Moreover, the model can mimic various institutional and market structures, including wage dynamics, market imperfections and factor mobility. Even though the specific modelling options are chosen at a conservative level, they also potentially influence the model outcomes. Therefore, in addition to the results as discussed above, which are derived from the core specification of the RHOMOLO-EIB model, the results need to be complemented by a detailed and careful analysis of how sensitive the simulation results are to each of the parameters.

The sensitivity analysis covers two broad sets of tests. Firstly, the model contains a range of options to describe the underlying functioning of the economy. Their potential influence on the results is examined by comparing the most relevant combinations of modelling options. Secondly, the model uses a range of structural parameters, which interpret a given policy intervention as structural adjustment in the model, and parameters which describe agents' behaviour and market rigidities. Such parametrisation of the model needs to be assessed in terms of the sensitivity of the values employed and the effect of the interrelation of these values. To this end, the sensitivity of results to such parameters is assessed at the 10% interval boundaries.

Conservative modelling options are employed. The model setup serves to determine a range of discrete options on how the economy works, such as perfect or imperfect competition (including Cournot, Bertrand and monopolistic setups), some or no labour mobility between regions, perfect or imperfect capital mobility, autonomous or return-optimised investments, and Phillips-type wage curve or flexible wage labour market. These settings will have a significant impact on the results. The sensitivity analysis verifies the degree of deviation from the baseline of the results for each of the above-mentioned options. As the analysis confirms, the baseline RHOMOLO-EIB relies on the most conservative of each of these modelling options (perfect competition, perfect capital mobility, return-optimised investments), except for the labour market. Only in the labour market, based on a wage curve, the impact results are reported as being 'more generous' than using the alternative options based on a Phillips curve or flexible wages. A Phillips curve would imply that unemployment gradually returns to its previous level (at a presumed natural rate) whereas a wage curve would allow for more sustained employment of the previously unemployed. The rationale for choosing the wage curve over the alternatives is the notion of high unemployment during the model base year of 2013 in many regions. It seems reasonable to claim that the observed unemployment rates are well above the

natural rate of unemployment, which would also leave room for a more lasting employment effect than a Phillips curve or flexible wages options would be able to account for.

Parametrisation indicates robust margins: CGE models, and especially regional models like RHOMOLO-EIB where regional data are not always readily available, can be sensitive to changes in the values of some parameters. Identification of the sensitivity of model results to the values of such parameters is done through a series of simulations, in each of which the value of the key exogenous parameters (elasticity parameters that define behavioural preferences of economic agents and parameters that characterise dynamics and investment behaviour) was changed by +/- 10%, holding all other parameters and settings constant. Computer simulations revealed that the degree of sensitivity to changes in parameter values falls within a limited range. For GDP figures this range is bounded by 6% and converges to the baseline at the end of the model horizon, and for employment impact it is bounded by 7% maximal deviation from the baseline and with much slower convergence to the baseline over time (see Figures 17 and 18).

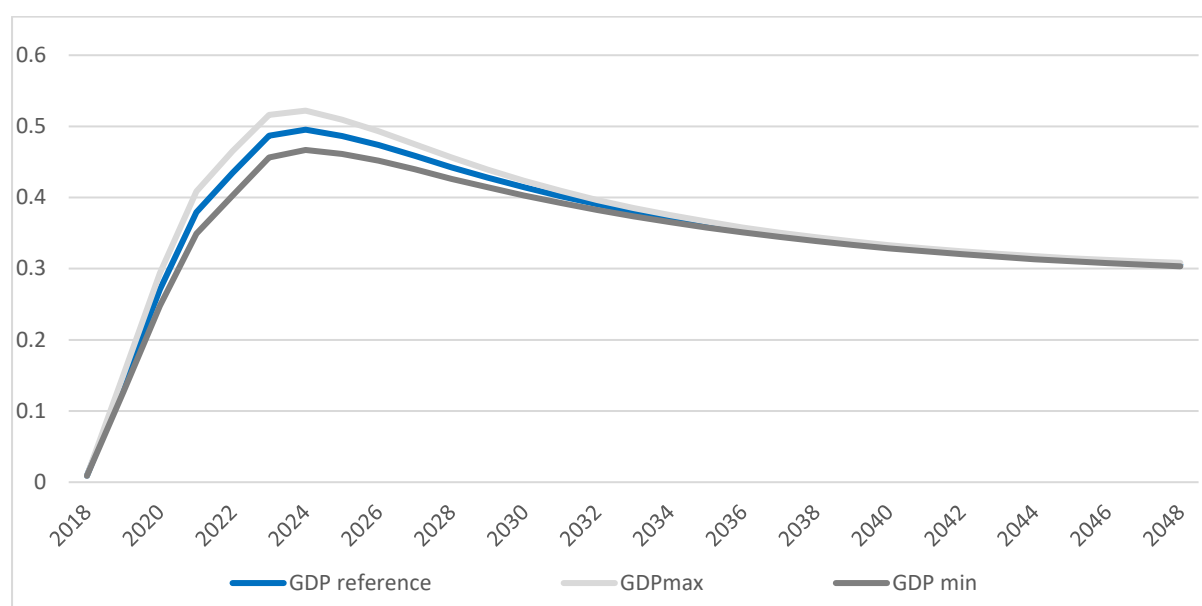


Figure 17: Maximum and minimum results for expected GDP impact (in % over baseline) from one-at-a-time variation of structural parameters

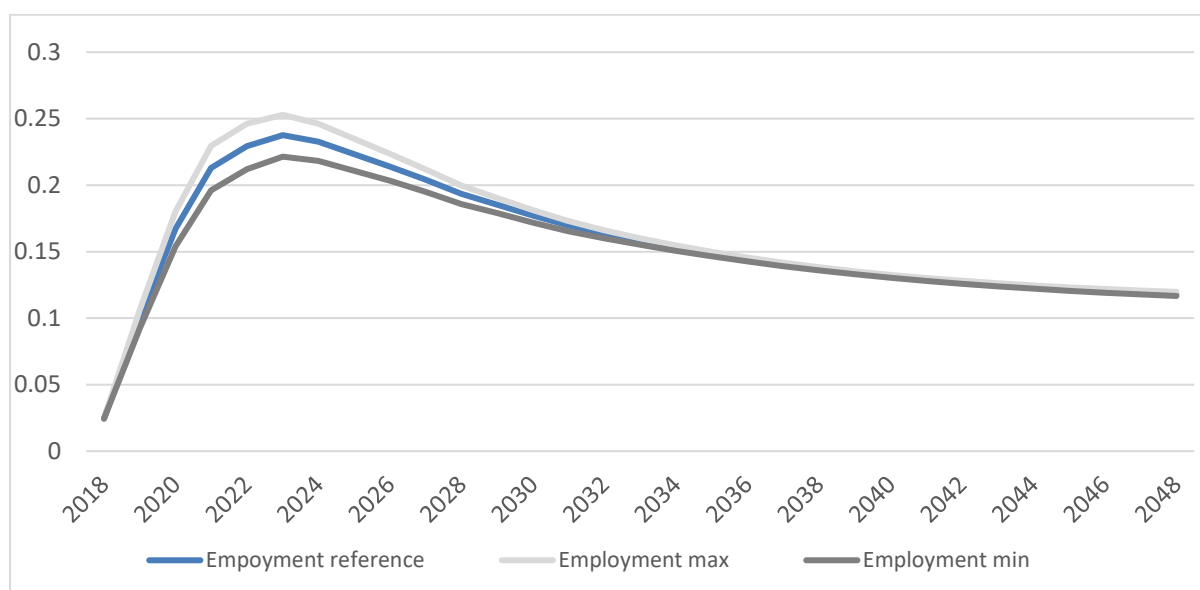


Figure 18: Maximum and minimum results for expected employment impact (in % over baseline) from one-at-a-time variation of structural parameters

To capture the possible co-effects between parameters, the multivariate sensitivity analysis then looks at the combined effect (see Annex for details). Given the large number of possible combinations of parameters, a clear protocol is followed to assess the sensitivity in a credible manner. The sensitivity analysis identified that the results are most sensitive to trade elasticity (often referred to as the Armington elasticity), substitution between aggregate labour and capital, the wage curve elasticity, the depreciation rate of capital and the firms' speed of investment adjustment. The multivariate analysis shows that the effects from combined 10% changes in the most crucial parameters and elasticities on GDP are bounded by 13% maximum deviations²⁰, steadily converging towards 6% at the end of the forecast horizon in 2048 (see Figure 19). On the other hand, the effects on employment are modestly more persistent, bounded by 25% maximum deviations and converging to around 15% with respect to the benchmark model in the long run (see Figure 20).

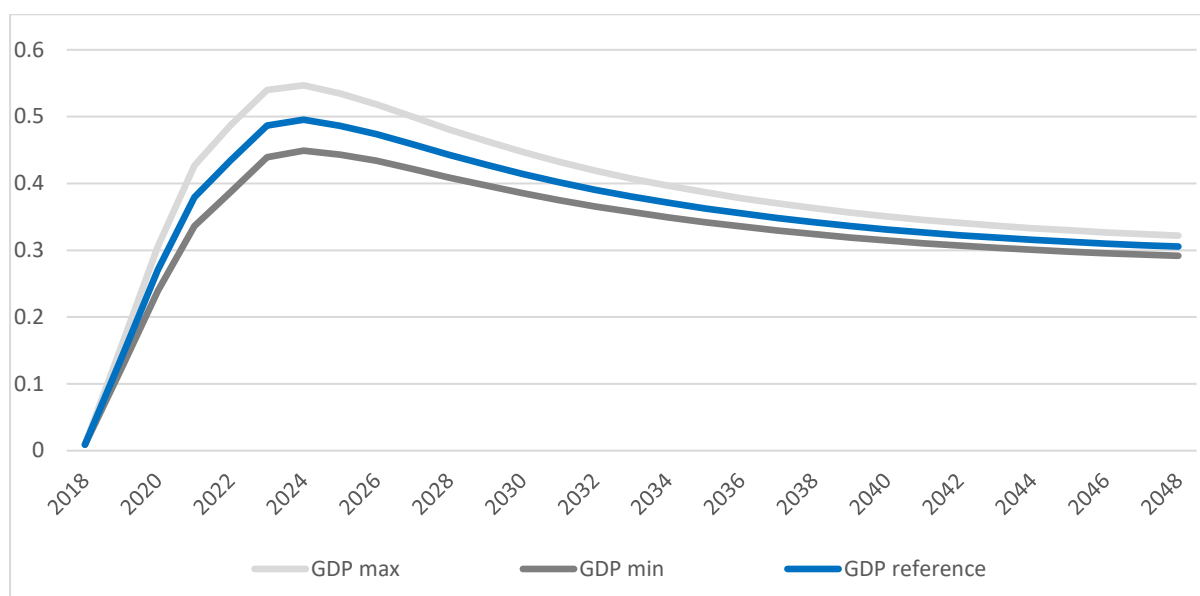


Figure 19: Maximum and minimum results for expected GDP impact (in % over baseline) from multivariate sensitivity analysis

²⁰ 20% maximum bound is observed only in 2019. The average effect is bounded by 10% deviations, as indicated in Table A3 in the Annex.

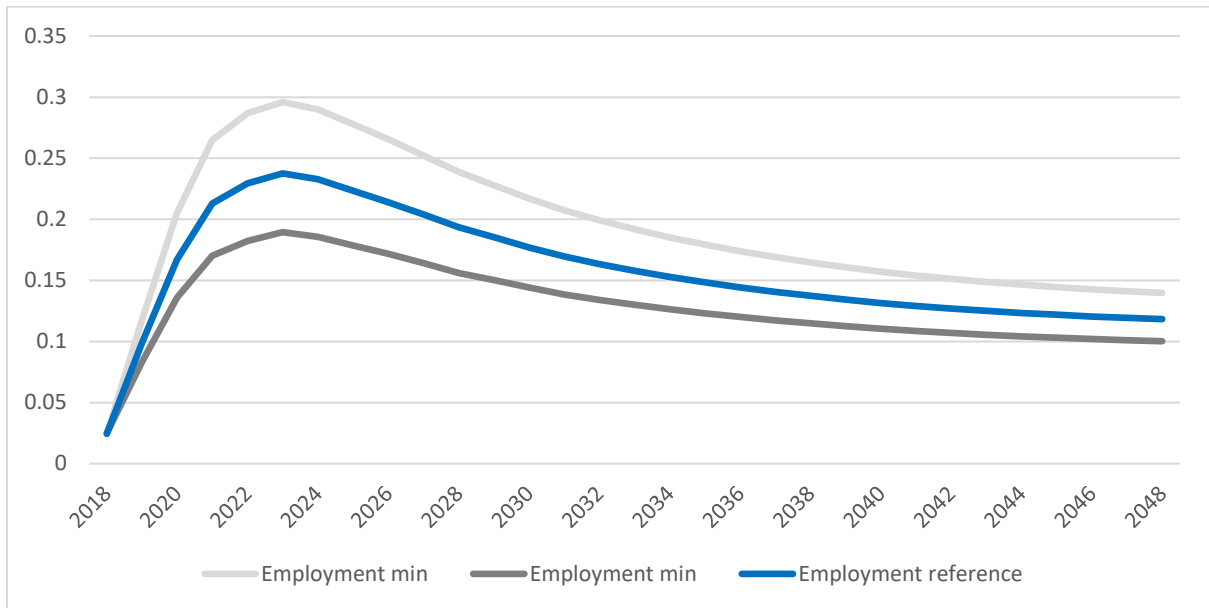


Figure 20: Maximum and minimum results for expected employment impact (in % over baseline) from multivariate sensitivity analysis

6. CONCLUSIONS

The RHOMOLO-EIB model is well suited to assess the macroeconomic impact of EIB Group activities.

The purpose of the approach was to look beyond the direct effects of EIB operations and assess the macroeconomic impact of the EIB Group's supported investments in the European Union. This complements the EIB's existing results focus that tracks the direct outputs and outcomes of its operations. Looking at the indirect and induced effects helps better understand the overall and lasting impact on the EU economy in terms of jobs and GDP of many types of policies. To achieve this, RHOMOLO was chosen as the most suitable instrument. It reflects a well-established approach, already used in the policy arena to assess the macroeconomic impact on growth and employment. It has been around for years, vetted and reviewed extensively in the relevant academic and policy forums, besides having been featured in a number of peer-reviewed scientific articles in international journals. It provides a credible and adaptable approach that serves to assess the macroeconomic impact of EIB Group-supported activities. In a fruitful collaboration between the European Commission's Joint Research Centre and the EIB's Economics Department, the model was adjusted to properly reflect the EIB Group business model as a bank employing financial instruments rather than grants.

The impact of EIB Group-supported activities is sizeable in terms of the Bank's contribution to both economic growth and employment in the European Union.

The results are demonstrated to be robust. The results of the normalised file provide a sense of scope of the results of a representative portfolio of EIB Group-supported operations. A typical €100 billion portfolio of EIB Group-supported investments would help to increase EU GDP by around 0.6% over the baseline GDP and add 500 000 jobs after five years. In the long term, i.e. in 20 years, the same investments are expected to still have added around 0.4% to GDP and some 280 000 jobs. All regions benefit, and cohesion regions benefit more. A sizeable part of the impact in the long run can be traced to pan-European spillovers across regions and value chains. The results of the specific EIB Group or mandate portfolio will vary with its composition. Actual results are published on the EIB website and in public reports such as the EIB Group Corporate Operational Plan or the EFSI report to the European Parliament and the Council.

The scope of the results is comparable to similar findings. The detailed results the model provides have enabled a granular analysis of EIB Group-supported activities in terms of geographic scope and sector impact. The scope of the results, however, is difficult to benchmark as this is one of the first efforts to assess such macroeconomic impact in this way. A number of comparisons are possible to gauge a sense of scope of the results. The simplest is to compare the results of different interventions. Other benchmarks can be considered to get a broader sense of the results, either in terms of other indicatives using RHOMOLO, other approaches looking at EIB activities or other public investment programmes that have undergone a similar assessment, to provide a sense of scope of the results from RHOMOLO-EIB.

Compared to common fiscal multipliers the scope of RHOMOLO-EIB results looks very reasonable.

The most common approach to gauging the effect of public intervention is to use a simple fiscal multiplier. This is subject to extensive and thorough research, and a common policy tool to provide also a sense of scope of what public interventions can achieve. For the EIB Group as a public institution that supports both public and private investments in the European Union and pursues a public mandate, fiscal multipliers seem a reasonable benchmark. Within the spectrum of fiscal multipliers

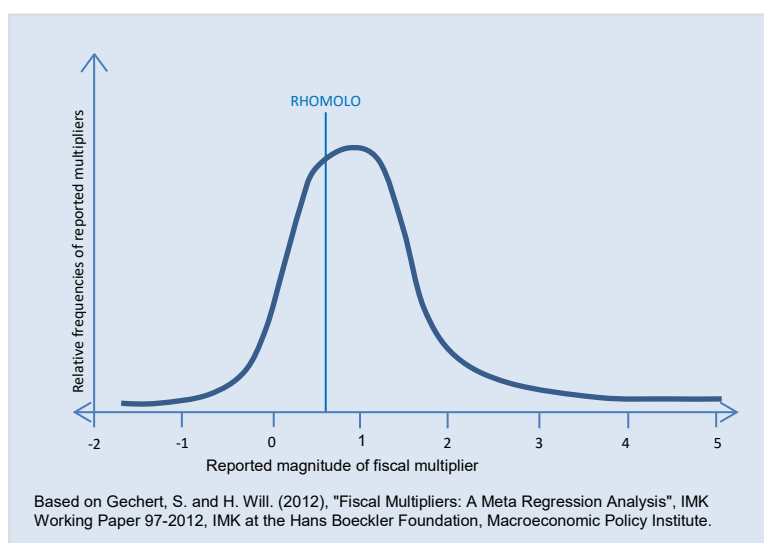
the RHOMOLO-EIB results compare well; if anything they are more on the conservative side. With a shock of €100 billion, this generates an increase in GDP at its peak of some €64 billion. This is in line with the role of the EIB Group and the conservative impact modelling approach. For a more detailed discussion on the comparison between the RHOMOLO-EIB results and fiscal multipliers please see Box 3 below.

Box 3: RHOMOLO-EIB results compared to fiscal multipliers

How reasonable are the RHOMOLO-EIB results?

A common way of analysing the average effect that public policy interventions have on the economy is by estimating fiscal multipliers, which indicate by how many euros GDP increases after a fiscal policy shock of one euro. Fiscal multipliers have been widely studied for a long time and have undergone thorough research and discussions among both academics and policymakers²¹. The EIB, as a public institution, supports investments, both public and private, not unlike a fiscal investment stimulus would. Given this, an effective approach to assess how reasonable the scope of the RHOMOLO-EIB results are is to compare the results to the existing empirical evidence on fiscal multipliers.

Estimations of fiscal multipliers often range from negative effects to large positive effects, and depend on a set of important specifications and modelling choices such as the definition of the spending product (or channel) and the prevailing economic situation. Most of the literature offers estimates



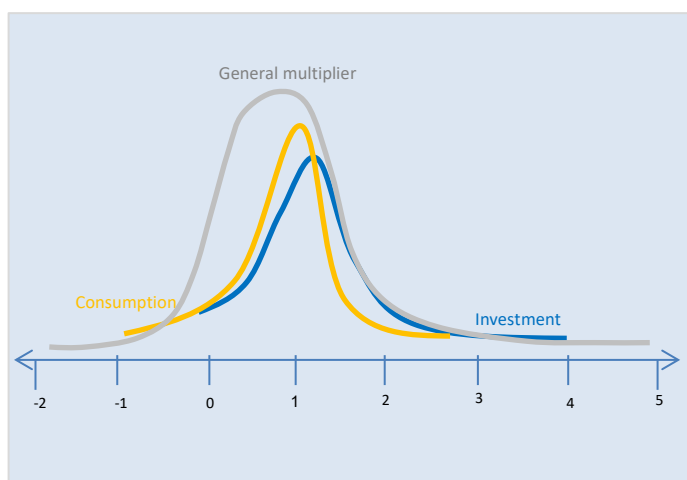
based on partial equilibrium methods (such as vector autoregressive models), although multipliers have been studied also within general equilibrium frameworks. No single agreed multiplier exists. Looking at meta-studies that comprise large parts of the multiplier literature empirically, multipliers mostly range between 0.5-1.3 (see Figure 1 which shows the multiplier and the frequency of estimated multipliers in the literature).

RHOMOLO-EIB has an EU-wide implied multiplier of 0.64. Such a comparison is valid, though with some caveats to be considered. Fiscal multipliers are often computed looking at the impact of an investment shock two years after the shock occurs. The EIB Group-supported investments reflect a protracted shock taking place over a number of years, and which generates structural effects that last even longer than that. To be on the cautious side, the implied multiplier of RHOMOLO-EIB is considered at the very peak of the impact it has. This suggests that the RHOMOLO-EIB results are within a very reasonable, slightly conservative range of what the multipliers of the economic literature typically suggest. The results are also robust to a variance of nuances as presented below.

²¹ See for example Warmedinger, Checherita-Westphal and De Cos (2015); Batini et al. (2014); Gechert (2015); Blanchard and Leigh (2013); Leeper, Traum and Walker (2017); Čapek and Crespo Cuaresma (2020), van der Wielen (2020).

Fiscal multipliers may vary with the economic situation: The empirical estimates depend on the data used in each case, and it seems that fiscal multipliers are sensitive to the economic situation, as they often vary over the business cycle. Typically, multipliers are larger in recessions where unemployment is higher and the economy is not functioning at full capacity than during expansionary phases. RHOMOLO-EIB exhibits similar sensitivity. Countries severely affected by the crisis in the base year of 2013 show a higher multiplier than countries that were better off. For example, Greece, a country that was severely hit by the crisis, exhibits a multiplier of 0.7. This is to be compared with a country like Austria which experienced a lower level of unemployment in the same year and also a lower multiplier of 0.4.

Fiscal multipliers may vary with the impact channel: The size of the fiscal multiplier depends on the type of intervention, such as tax reduction, consumption spending, etc. Typically, multipliers are



higher for investment spending, with infrastructure projects at the higher end of the spectrum. The EIB Group supports investments, with a sizeable infrastructure share, and one could therefore expect the multiplier to be higher than the general fiscal multiplier. However, the investments supported by the EIB Group to a large extent concern private sector investments and the analysis with RHOMOLO-EIB assumes a certain level of macro-additionality (depending on the extent to which EIB

Group-supported investments crowd out private investment activity elsewhere in the economy) and this would suggest a multiplier that remains at the lower part of the spectrum.

Overall, the results of the RHOMOLO-EIB model seem well within the reasonable scope of expected public impact and if anything, more on the conservative side. In addition, the model is also able to provide significant granularity by tracing the disaggregated linkages in the economy and provide a richer impact assessment.

The results also compare well with similar exercises. More specific benchmarks can also be considered, such as (i) results from other modelling exercises that cover the same programme, (ii) the same model applied to different programmes, or, less direct, (iii) other approaches applied to similar but different programmes.

- (i) With the initiation of EFSI, several stakeholders independently tried to assess the macroeconomic impact of EFSI-supported investments. The approaches differ, but may provide a sense of scope as they directly compare with the RHOMOLO-EIB exercise applied to the same programme. The European Commission used QUEST (the global macroeconomic model DG ECFIN uses for macroeconomic policy analysis and research) to estimate the impact of the €315 billion. They concluded it has the potential to add €330-410 billion to the

European Union's GDP in the first three years and add 1.3 million new jobs.²² Oxford Analytica, an economics consulting firm, concluded that the €315 billion of additional EFSI investment would result in a GDP increase of 1-1.8%.²³ The International Labour Organization (ILO), using its own Global Economic Linkages Model, expected up to 2.7 million jobs to be created.²⁴ These results are directly comparable with the results of the RHOMOLO model for EFSI. RHOMOLO-EIB results based on the initial EFSI investment target of €315 billion, achieved in mid-2019, estimate that by 2019 (as the European Commission and Oxford Analytica estimates compare) EFSI had increased EU GDP by 0.9% and added 1.1 million jobs compared to the baseline scenario. At its peak (to which the ILO could be compared) the Juncker Plan will have increased EU GDP by 1.8% and added 1.7 million jobs.²⁵ Similarly, RHOMOLO-EIB and other models, such as QUEST (Pfeiffer et al., 2021), have been used to assess the potential impact of the EU Recovery and Resilience Facility. Here results differ somewhat, highlighting the nature of the different assumptions made in forward-looking modelling and when defining the shocks, but remain qualitatively similar when accounting for these differences.²⁶

- (ii) RHOMOLO is a well-established model also used to assess policy and investment initiatives other than those of the EIB. The European Commission has used it to assess the macroeconomic impact of the Cohesion Policy in Europe. From 2007 until 2013, cohesion-related mobilised investments, including co-financing from the public and private sectors, amounted to some €477 billion. By 2016 these investments, under similar model settings, were expected to have created 2.4 million jobs. Regional GDP in cohesion countries is expected to have increased by 4.2% by 2023. While the nature of the intervention differs, the regional focus is more targeted, and different sectors are focused on, the scope of the results is not so different. More recent results on the Cohesion Policy can be found in Crucitti et al. (2022).
- (iii) Other large-scale public investment schemes can also be used for some proxy benchmarking. Again, different approaches and different types of interventions are also used beyond investment, covering some tax incentives and transfers, but it may still be reasonable to provide a sense of scope of the results. The American Recovery and Reinvestment Act (ARRA) was designed to make crucial public investments in order to save and create jobs, as well as to cushion the economic downturn in the wake of the global financial crisis. The American Congress approved the \$787 billion ARRA in February 2009. The Executive Office of the President, Council of Economic Advisers concluded that by 2012, ARRA was estimated to have created 6.8 million jobs. In this instance also, the RHOMOLO-EIB results seem well within the scope of other results.

Nonetheless, results should be read with care. While the model delivers very specific results in terms of the number of jobs and GDP over the baseline, the results provide more of a sense of scope of the impact than a concrete number. It should be recognised, that, as a model, it represents a simplified version of reality, and cannot anticipate all future events. As explained, RHOMOLO-EIB does not try to

²² European Commission (2014) [EU launches investment offensive to boost jobs and growth](#)

²³ Oxford Analytica (2016) ['Juncker Plan' could mean EU investment bulge](#)

²⁴ ILO (2015) [An employment-oriented investment strategy for Europe](#).

²⁵ See also European Commission press release IP/19/6119 from 22 October 2019: [Juncker Plan has made major impact on EU jobs and growth](#), and policy brief: Christensen et al. (2019).

²⁶ EIB Investment Report 2021/2022, https://www.eib.org/attachments/publications/economic_investment_report_2021_2022_en.pdf

forecast the future 30-50 years of economic development to create a dynamic baseline and therefore does not incorporate events such as the 2020 COVID-19 pandemic as it is unforeseen. In other contexts special considerations for COVID are possible and can be taken into account (see for example Conte et al., 2020, and Sakkas et al., 2021, for an assessment of the macroeconomic implications of COVID-19-related disruptions in the European Union using the RHOMOLO model). However, such events should be read with extra care in terms of how the model incorporates such shocks, taking into account its depth and future recovery paths for countries, etc. Also, RHOMOLO-EIB is one of many possible modelling approaches. Other models may deliver different results, depending on their database, structure and underlying assumptions. While we believe this to be a robust and credible model, further dialogue on the results will be pursued to discuss other findings, compare notes and discuss assumptions and parameters to ensure as much as possible the credibility of the results.

Further analysis will be conducted in the future. Many important lessons can be drawn from a series of modelling exercises, and especially also from a normalised portfolio exercise, and many interesting questions have emerged. In future runs of the model, additional aspects will be looked at and the data will be analysed and disaggregated further. This updated note reflects several such emerging lessons and insights in the Annex (Annex 3), discussing further findings from applying this model. They provide additional insights and surely in the continued application of this model and in collaboration between EIB and JRC additional aspects will emerge that will require updating in the future.

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TECHNICAL ANNEX

The Annex provides more technical details on (i) the model options, (ii) the sensitivity analysis, and (iii) more technical methodological considerations. Given the highly technical nature of this exercise, the main report examines only its main setup and results, with the details presented in this Annex.

A.1. Different modelling options

RHOMOLO allows for a set of modelling options, which are described below. The options in bold denote the choices made for RHOMOLO-EIB.

Competition: In RHOMOLO-EIB it is assumed that all firms in the economy operate in perfectly competitive sectors. All firms are price takers in their input markets, have constant returns to scale technologies and are constrained by marginal cost pricing. RHOMOLO allows firms in a subset of sectors to operate under imperfect competition. These firms face fixed costs, and hence, increasing returns to scale in production. To survive, firms in imperfect competitive markets have to charge positive mark-ups over marginal costs. These mark-ups are determined optimally conditionally on the competitive game, as well as the properties of the demand these firms face. RHOMOLO enables firms in the imperfectly competitive sectors to set prices according to Dixit-Stiglitz monopolistic competition, Cournot or Bertrand price behaviour, to generate a different mark-up of price over the marginal cost. **RHOMOLO-EIB operates under perfect competition assumption.**

Capital mobility: RHOMOLO allows for mobility of financial capital between regions. Under the assumption of capital mobility the allocation of investments between regions is driven by the differences between regional and EU average returns to capital. Assumptions concerning the allocation of investments between regions can be altered to prevent mobility of capital. When capital mobility is absent, region-specific investments are driven by the distance between the regional rate of return to capital and the corresponding regional replacement cost of capital. **RHOMOLO-EIB operates under perfect capital mobility**, in line with the cross-border nature of the EIB portfolio.

Private investment: The level of private capital in RHOMOLO is governed by an adjustment rule that determines the optimal path of private investment. According to this formulation, the investment capital ratio is a function of the rate of return to capital and the user cost of capital, allowing the capital stock to smoothly reach its desired level. It is possible to impose a balance-of-payments constraint to RHOMOLO under which EU savings match the EU investment level. **RHOMOLO-EIB operates under the assumption that investments follow the investment-return behaviour described above.**

Wage setting: RHOMOLO incorporates friction in the labour market. The model makes it possible to switch between a wage curve and a Phillips curve. The setting further permits the use of a dynamic or a static form of wage setting. Wage setting, under the assumption of a wage curve, implies a negative relationship between the wage rate and unemployment. A Phillips curve implies that in the absence of migration or an exogenous increase in the labour force, in the long run the employment and unemployment rates will return to their steady-state levels. The model can also be run assuming neoclassical perfect competition in the labour market. Assuming no changes in the labour force the supply of labour forms a vertical line in each period of the model. Therefore, the wage rate for each

type of skill can be determined endogenously. **RHOMOLO-EIB operates under the wage curve assumption.**

A.2. Multivariate sensitivity analysis with the RHOMOLO-EIB model

While CGE models are an established tool to analyse the aggregate welfare and distributional impacts of policies, with corresponding effects being transmitted through multiple markets, they are known to be susceptible to parameter uncertainty. In particular, uncertainty relates to structural parameters that characterise (a) behavioural preferences (elasticities of transformation/substitution), (b) technology (factor productivity parameters), (c) policy decisions (allocation of funding) and (d) dynamics and investment behaviour (for example, growth/interest/depreciation rates).

Since there is often no available data to run reliable econometric estimates at a micro level for all the sectors and regions involved in large-scale general equilibrium models, a common practice is to relate the values of parameters in question to other models or econometric studies. While borrowing parameters are a sensible starting point in any modelling exercise, the elasticities obtained in external studies are generally at higher levels of aggregation, different sectoral composition and may cover different time horizons, reducing their applicability to a given policy context. The econometric methods used to derive such values are often incompatible with the structure of nesting of model expenditure functions²⁷. For instance, the elasticities on lower nests of expenditure functions can depend on elasticities of higher nests, making their joint probability distribution ever harder to pin down. As a result, the covariation between parameters that are collected from different sources might not be well accounted for. Similarly, the temporal or spatial variability model is driven through a set of parameters, which need to be estimated externally. Such a problem is particularly severe for regional models because of the lack of large regional datasets (Partridge and Rickman, 1998).

Given that the values of elasticities have no impact on a base-year unperturbed situation in the economy, a common approach is to investigate the sensitivity of a CGE model output to a small subset of elasticities or parameters for one or several scenario shocks, assuming no changes in all the other inputs (Saltelli, Annoni and D’Hombres, 2010; Hermeling and Menzel, 2008; Hertel et al., 2007; Webster et al., 2008).

In the case of RHOMOLO-EIB, it is the EIB Group’s normalised investment shock in question that builds a reference scenario. We then investigate the responsiveness of RHOMOLO-EIB to the different combinations of structural parameters that characterise behavioural preferences, dynamics and investment behaviour, thus performing the multivariate sensitivity analysis (MSA). Such selection of parameters is of particular importance in the context of the EIB investments in accordance with a number of corresponding policy objectives.

Because CGE frameworks are resource-intensive (in terms of time and CPU, see for instance Arndt (1996)), the sensitivity analysis resorts to a deterministic approach that does not require prior knowledge of the probability density functions of specific parameters. This is the only feasible option

²⁷ On each level of nesting of expenditure functions (for instance, CES, Cobb-Douglas, Leontief, CET, etc.) the elasticities of substitution/transformation characterise the behavioural choices of economic agents regarding consumption and/or supply.

considering RHOMOLO-EIB's dimensionality (Lecca et al., 2018)²⁸. Resorting to the deterministic approach, we established two levels for each parameter (baseline value, +/-10%).

Even in this case, to investigate how the interactions between elasticities and parameters (that characterise dynamics and investment behaviour) impact model results, we would need to run RHOMOLO 4 096 times (two to the power of 12). Clearly, this number of computations is unmanageable with models of the dimension of RHOMOLO-EIB simulated over a 36-year horizon. Therefore, to bypass the dimensionality curve we implement the MSA exercise in two steps.

In the **first step**, we run RHOMOLO-EIB varying one parameter per model run. We vary each of the 12 structural parameters two times (avoiding repetition of the baseline values) while keeping the values of the rest of the elasticities fixed at their baseline values. That requires 25 model runs (eight runs varying values of elasticities, four runs varying the values of parameters that characterise dynamics and investment behaviour, and one run for a baseline combination of all structural parameters). This step enables us to identify the set of the most influential parameters.

In the **second step**, we consider all possible two-element combinations of the values of five parameters, determined as the most important, running the RHOMOLO-EIB 31 times (two to the power of five minus one, to exclude the baseline combination). The results of the MSA with RHOMOLO-EIB enable us to rank the combinations of parameters that characterise dynamics and investment behaviour according to their impact on model results.

Below we describe the details behind the MSA exercise. The description of elasticities used in RHOMOLO-EIB is provided in Table A1.

Table A1. Selection of elasticities for multivariate sensitivity analysis

	Notation	Baseline value
Substitution between different household consumption goods	S_CH	1.2
Substitution between different public goods	S_CG	0.3
Substitution between primary factors and intermediate inputs	S_ZS	0.2
Substitution between intermediate goods	S_XS	0.25
Substitution between aggregate labour and capital	S_QS	1.1
Substitution between different labour skill groups	S_LS	2
Substitution between goods from different regions	S_A	4
Wage curve elasticity	WgeCurv	0.1

The selection of specific parameters that characterise dynamics and investment behaviour applied in the model is depicted in Table A2.

Table A2. Selection of parameters characterising dynamics and investment behaviour for multivariate sensitivity analysis

	Notation	Baseline value
Speed of investment adjustment	phi_inv	1.5
Depreciation rate of private capital	DepRK	0.15
Depreciation rate of public capital	DepGK	0.05

To proceed with analysis of the results obtained on the first step of MSA we had to select among a dozen importance measures and sensitivity indices (Hamby, 1995, Pannell, D.J., 1997). Given that

²⁸ Although there may be many other sources of uncertainty (the choice of nesting structure, temporal and spatial variability, etc.) they are outside the focus of this study, simply because it is impossible to estimate all parameters of complex models and the number of obtained model solutions may be beyond computable reach.

different indices may attribute distinct influence rankings to the same input parameters, the Hoffman and Gardner sensitivity index (Hoffman and Gardner, 1983) that calculates the difference in model output varying the input parameter from its minimum value to its maximum value was found to be the simplest and the most reliable sensitivity measure (Hamby, 1994, 1995).

For the thorough analysis we combined the Hoffman and Gardner sensitivity indices with the standard elasticity indices (Pannell, 1997), and computed coefficients of variation. For the current exercise we limited our analysis to the projections of accumulated GDP changes relative to the baseline values, calculated over the model horizon. The results are presented in Table A3:

Table A3. Influence ranking of elasticity parameters for the different combinations of scenario shocks

	Hoffman and Gardner Sensitivity Index	Standard Elasticity Index	Coefficient of Variation
DepRK	2946.8164	0.0102	1.6447
S_QS	1393.0828	0.0048	1.6437
S_A	1377.5804	0.0105	1.6436
DepGK	328.6113	0.0011	1.6434
S_CH	64.1159	0.0002	1.6434
S_ZS	33.6220	0.0001	1.6434
S_XS	8.0793	0.0001	1.6434
S_LS	3.5213	0.0000	1.6434
S_CG	0.8672	0.0000	1.6434
WgeCurv	-2266.9463	-0.0078	1.6437
phi_inv	-2541.9549	-0.0088	1.6462

As shown in Table A3 the highest importance ranking can be attributed to the speed of investment adjustment, phi_inv, depreciation rate of private capital, DepRK, wage curve elasticity, WgeCurv, substitution between aggregate labour and capital, S_QS, and substitution between goods from different regions, S_A.

Considering that structural parameters might have a strong impact on some policy indicators and a weak impact on others, we measure model responses with two macroeconomic indicators: real GDP and employment, all reported at regional, national and EU level. The most important elasticities and parameters are then used as an input for the multivariate analysis in the second step.

The MSA considers the time frame of 2020-2055. The GDP results are presented in Table A4 whilst the employment figures are depicted in Table A5.

Table A4. Multivariate sensitivity analysis of GDP results (average effects)

The most influential structural parameters					Deviations from the baseline projections, %
S_A	S_QS	WgeCurv	phi_inv	DepRK	Average 2020-2055
+10%	+10%	-10%	-10%	+10%	0.3948
+10%	-10%	-10%	-10%	+10%	0.3850
-10%	+10%	-10%	-10%	+10%	0.3844
+10%	+10%	+10%	-10%	+10%	0.3784

+10%	+10%	-10%	+10%	+10%	0.3761
-10%	-10%	-10%	-10%	+10%	0.3743
+10%	+10%	-10%	-10%	-10%	0.3699
-10%	+10%	+10%	-10%	+10%	0.3690
+10%	-10%	+10%	-10%	+10%	0.3673
+10%	-10%	-10%	+10%	+10%	0.3658
-10%	+10%	-10%	+10%	+10%	0.3655
+10%	-10%	-10%	-10%	-10%	0.3629
-10%	+10%	-10%	-10%	-10%	0.3608
+10%	+10%	+10%	+10%	+10%	0.3600
-10%	-10%	+10%	-10%	+10%	0.3577
+10%	+10%	+10%	-10%	-10%	0.3551
-10%	-10%	-10%	+10%	+10%	0.3550
+10%	+10%	-10%	+10%	-10%	0.3549
-10%	-10%	-10%	-10%	-10%	0.3535
-10%	+10%	+10%	+10%	+10%	0.3505
+10%	-10%	+10%	+10%	+10%	0.3486
+10%	-10%	-10%	+10%	-10%	0.3470
+10%	-10%	+10%	-10%	-10%	0.3469
-10%	+10%	+10%	-10%	-10%	0.3469
-10%	+10%	-10%	+10%	-10%	0.3455
+10%	+10%	+10%	+10%	-10%	0.3403
-10%	-10%	+10%	+10%	+10%	0.3389
-10%	-10%	+10%	-10%	-10%	0.3385
-10%	-10%	-10%	+10%	-10%	0.3374
-10%	+10%	+10%	+10%	-10%	0.3318
+10%	-10%	+10%	+10%	-10%	0.3312
-10%	-10%	+10%	+10%	-10%	0.3226

Notes: Table presents average percentage deviations from the baseline GDP results for 2013-2048 time frames. The description and calibration values for structural parameters are presented in Tables A1 and A2.

Ranking the results by their impact, from Table A4 we observe that the highest value of EU GDP is achieved when the elasticity of substitution between aggregate labour and capital (S_{QS}), elasticity of substitution between goods from different regions (S_A) and the depreciation rate of private capital ($DepRK$) are at their high level, while the speed of investment adjustment (ϕ_{inv}) and the wage curve elasticity ($WgeCurv$) are at their low levels, respectively. Symmetrically, the lowest value of the EU GDP is achieved at the low levels of S_{QS} , S_A and $DepRK$, and at the high levels of ϕ_{inv} and $WgeCurv$. Indeed, higher substitution between labour and capital gives producers additional flexibility of adjustment to the external shocks, such as labour- or capital-biased technical efficiency. Since the elasticity of substitution between goods from different regions determines the flexibility of substituting the goods when their prices change, higher S_A enables a region to easily replace a more expensive product with a cheaper one, and the opposite also holds true. The wage curve elasticity determines the flexibility of unemployment to wage changes. Therefore, lower $WgeCurv$ results in higher GDP and employment. Given that steady-state capital stock in the model is a function of steady-

state investments and the assumed depreciation rate of capital, the higher DepRK results in a lower calibrated steady-state capital stock and it increases the responsiveness of a model to EIB-supported investments, and vice versa. In turn, the speed of investment adjustment governs the responsiveness of investments to changes in the ratio between the rental price of capital and the user cost of capital. The EIB-supported investments enter the model through a reduction in the risk premium, which lowers the user cost of capital. Hence, lower phi_inv produces a higher decline in risk premium, rising GDP and employment, and the opposite also holds.

Broadly, the highest GDP growth along the model horizon is achieved at high DepRK, low phi_inv and WgeCurv. Inversely, the lowest GDP growth is attained at the low values of DepRK and high phi_inv and WgeCurv. The rest of the combinations produce mixed results without a definite pattern.

Table A5. Multivariate sensitivity analysis of employment results (average effects)

The most influential structural parameters					Deviations from the baseline projections, %
S_A	S_QS	WgeCurv	phi_inv	DepRK	Average 2020-2055
+10%	-10%	-10%	-10%	+10%	0.1910
+10%	+10%	-10%	-10%	+10%	0.1798
-10%	-10%	-10%	-10%	+10%	0.1794
+10%	-10%	-10%	-10%	-10%	0.1783
+10%	-10%	-10%	+10%	+10%	0.1780
-10%	+10%	-10%	-10%	+10%	0.1684
+10%	+10%	-10%	+10%	+10%	0.1684
-10%	-10%	-10%	-10%	-10%	0.1678
+10%	-10%	+10%	-10%	+10%	0.1673
+10%	+10%	-10%	-10%	-10%	0.1672
+10%	-10%	-10%	+10%	-10%	0.1671
-10%	-10%	-10%	+10%	+10%	0.1669
+10%	+10%	-10%	+10%	-10%	0.1575
-10%	+10%	-10%	+10%	+10%	0.1574
-10%	-10%	+10%	-10%	+10%	0.1573
+10%	+10%	+10%	-10%	+10%	0.1572
-10%	-10%	-10%	+10%	-10%	0.1570
-10%	+10%	-10%	-10%	-10%	0.1569
+10%	-10%	+10%	-10%	-10%	0.1565
+10%	-10%	+10%	+10%	+10%	0.1555
-10%	+10%	-10%	+10%	-10%	0.1475
-10%	-10%	+10%	-10%	-10%	0.1474
-10%	+10%	+10%	-10%	+10%	0.1474
+10%	+10%	+10%	+10%	+10%	0.1469
+10%	+10%	+10%	-10%	-10%	0.1464
+10%	-10%	+10%	+10%	-10%	0.1462
-10%	-10%	+10%	+10%	+10%	0.1459
+10%	+10%	+10%	+10%	-10%	0.1376
-10%	+10%	+10%	-10%	-10%	0.1375

-10%	-10%	+10%	+10%	-10%	0.1374
-10%	+10%	+10%	+10%	+10%	0.1374
-10%	+10%	+10%	+10%	-10%	0.1289

Notes: Table presents average percentage deviations from the baseline employment results for 2013-2048 time frames. The description and calibration values for structural parameters are presented in Tables A1 and A2.

Ranking the results in Table A5, we observe that the largest growth in employment is achieved at the high values of S_A and DepRK, and low WgeCurv, phi_inv and S_QS. Inversely, the low values of S_A and DepRK and high values of WgeCurv, phi_inv and S_QS ensure the lowest employment. Generally, the highest positive effects on employment along the model horizon are achieved at low WgeCurv. Inversely, the lowest negative effects are attained at the high values of WgeCurv.

A.3. Additional methodological considerations.

To interpret the results appropriately several aspects warrant a more detailed discussion. The results of the RHOMOLO-EIB stem from a complex model that is highly interlinked, is based on particular assumptions, and, as it does not explicitly model the financial sector, rests on specific assumptions of how the EIB Group would be reflected in using the model. While the results are robust, grounded in reasonable assumptions, some of the interpretation of the results benefits from a more detailed account of the intricacies of the model. Four aspects stand out:

- 1) **The magnitude of spillovers:** Given the high degree of interlinkages in the economy, any geographic or sectoral breakdown will be highly influenced not only by local/specific investments but also by spillovers from other regions and sectors. Having some understanding of the scope of these spillovers may help explain some of the results better and also serve to caution a linear interpretation of level of activity and local effects.
- 2) **Sensitivity to the economic situation:** The results are affected by the specific economic situation in the baseline data. The current version of RHOMOLO-EIB is calibrated for a steady-state baseline in 2013. This is a particular year amidst the lingering effects of the financial crisis of 2007-2008. The sensitivity of the results to changes in the economic environment, especially in unemployment levels, is considered in more detail.
- 3) **Macro-additionality and the role of the EIB:** A critical assumption in any macro model is the interpretation of the macro-additionality of the modelled activity. This is different to microeconomic additionality which asks to what extent the EIB support has made a difference to the operation. Macroeconomic additionality asks to what extent the investment activities are crowding out other investments somewhere else in the economy (that is, channelling savings away from other productive investments). RHOMOLO-EIB does not provide a model-inherent answer to this, but this enters through assumptions both in the model setup (most importantly in terms of the closure condition of the model) as well as through the assumptions in the input data. Clarifying this in more detail allows for a better understanding of what drives the results and the rationale behind the chosen setup.
- 4) **EIB as part of the baseline:** The EIB has existed for over 60 years. It was present also in the model baseline in 2013. This also means that the baseline already reflects the economic activities of the EIB at the time. Were the EIB to cease to exist in the baseline year, the model

would see a fall in GDP and employment and it would entail a reversal of the macro-additionality assumptions. To correctly interpret the results both in the sense of macro-additionality and the possible reading of the results it is important to take this baseline effect into account.

All four aspects are important for a deeper understanding of the results of RHOMOLO-EIB. We feel the assumptions made in the current setup are sound and reasonably conservative and this discussion should therefore not be read as challenging the validity of the current model use. Instead, it aims to present the assumptions behind the model in a transparent manner and hopefully add some perspective in reading the results.

A.3.1. The magnitude of spillovers

The European economy is complex and interdependent. It has vastly complex interrelations of sectors and regions reflecting extensive value chains, division of labour, intra-European and international trade links. This is reflected in RHOMOLO-EIB with its 28 European countries (EU-27 and the UK), 267 regions, ten sectors and links to RoW. Taken together (all trade links and forward and backward linkages), they result in over a million equations. Any local effect, be it in a specific region and/or sector, will have a significant effect in other regions, positive or possibly negative. Therefore, when considering any investment activity and in order to get a sense of the true impact of the EIB-supported operations, these spillover effects are important to take into account.

Economic interlinkages make disaggregating results complicated. Effects on GDP and jobs in a specific region (for example, Midi-Pyrénées) cannot solely be traced to investments made in that region. Instead, a sizeable part of the effect stems from spillovers (spill-ins) from investments in other regions (both in France and Spain but also other European regions), and likewise a large proportion of the effects from investments in the region spills out to other regions (spill-outs), which makes them non-visible in the local results. Any country-specific or disaggregation of the overall European Union-wide results should therefore be read with due caution, keeping in mind these interlinkages among countries and how they affect the final results. It would be wrong to compare the amount of investments with the local or sectoral results. Spillovers can be sizeable, vary significantly, and would overlay any direct link from input to results.

Spillovers between regions are significant. To provide some sense of how much such spillovers account for, the model is run 27 times, each time assuming no investments were made in a particular country. By excluding investments and any financing contribution of a single country, the effects of EIB operations supported in the other 26 countries are considered to show the impact of spillover effects. Any effect in the specific country with no direct investments supported would stem from spill-ins from investment supported elsewhere. In the long run, the unweighted results show that roughly 35-40% of the local effects are accounted for by spillovers from other regions (see Figures A1 and A2). In the short run, the results are much lower as it takes time for the effects to propagate through the economy. It should also be noted that the average is unweighted. Alternatively, in aggregate, a weighted average by GDP could be considered which would still result in around 28-34% spillover in the long run.

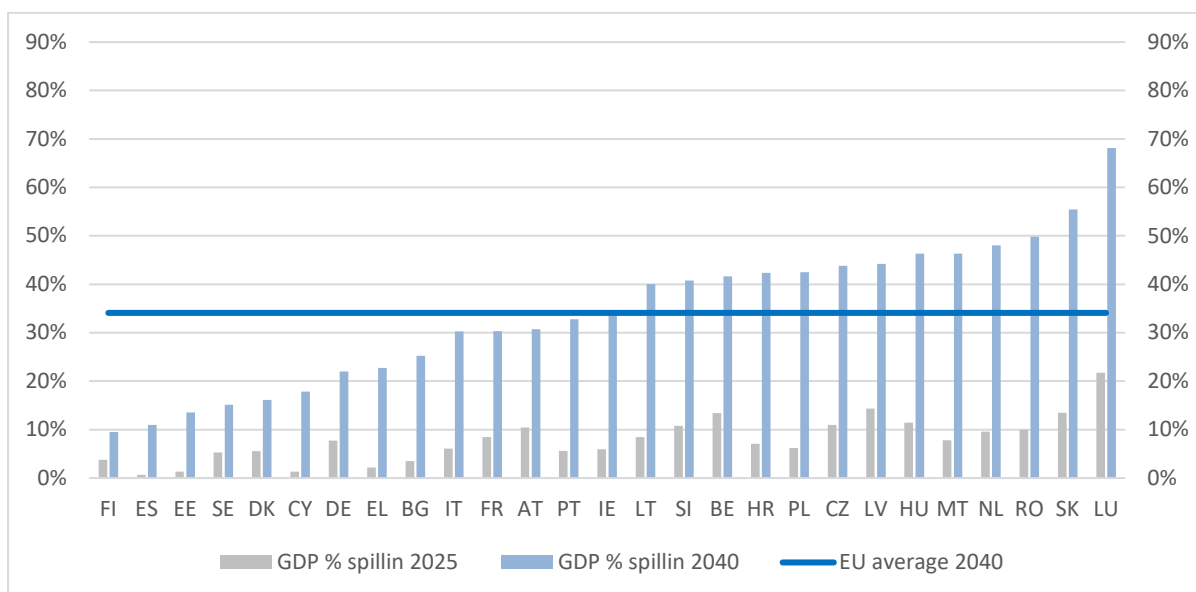


Figure A1: The share of cross-country GDP impact in total impact per country and year.

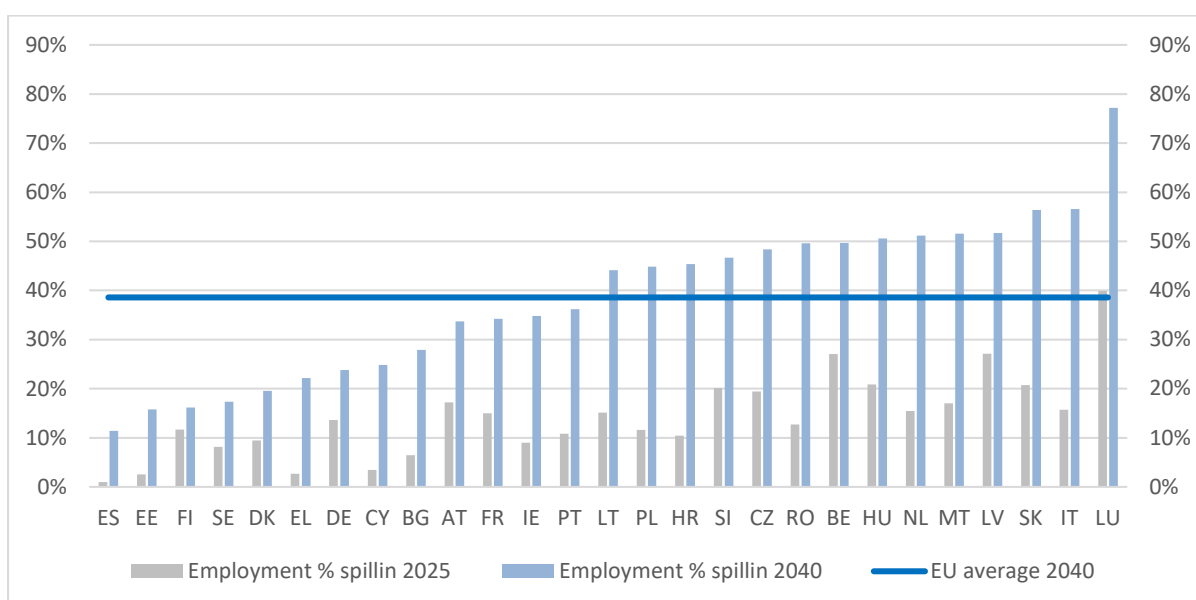


Figure A2: The share of cross-country employment impact in total impact per country and year.

Heterogeneous effect among countries. Spillovers vary with time, by country and by sector depending on the interlinkages of the economy, the size and diversity of the internal economy, etc. The effect also depends on the magnitude of the investment activities and is dependent on the relative input sizes of the economies. If for example the EIB Group were to support very little investment in a particular country and much in neighbouring and trade-related ones, the spill-in would be relatively large compared to the domestic effect, and vice versa. But equally, even if all investment were proportional, it would depend on the internal structure of the economy considered. Smaller economies that are more specialised and dependent on surrounding countries and with a less diversified economy will experience larger spillover effects. This is in comparison to larger economies that are less specialised and more diversified within their own country, making them less exposed to spillover effects.

Spillover effects vary with time. The initial spillovers are relatively small, or may even be negative in the initial periods, and may be more significant in the longer term as interlinkages can play out fully, and structural effects set in that often have stronger spillover effects such as knowledge creation, trans-European infrastructure, etc. Another aspect to consider are the negative spillover effects during the first years of the investment implementation. As operations are launched they require large amounts of both capital and labour which subsequently causes the initial spillover effects to be negative.

A.3.2. Sensitivity to the baseline

The baseline may drive the scope of the results. RHOMOLO-EIB builds on a steady state in 2013, the latest year of full available datasets necessary for a complete and functioning model. But 2013 may be a very particular baseline year for Europe, as it reflects a year when the second dip of the lingering financial crisis hit. This may in turn mean the model is based and calibrated for a baseline that may have a biased effect on the results. For example, the 28% unemployment rate in Andalusia, Spain does not represent a normal baseline year. Such a peculiar situation has a large effect on the results but it is however unlikely to persist in the future and the same may hold for other variables such as sectoral composition that would not see gradual structural change, etc. Investigating how the baseline may affect the results could shed additional light on how the results should be interpreted.

Altering the baseline is challenging. It should be noted that changing baseline data is different to performing a sensitivity analysis. A sensitivity analysis checks for the robustness of the assumed parameters in the model, but does not typically question the actual data used in the baseline. Altering baseline values is more challenging. Trying to guess the future 30-50 years of economic development to create a dynamic baseline is just as problematic as settling for a specific baseline year in a steady state. To confront the peculiarity of the chosen baseline year, an alternative would be to superimpose assumptions that do not form part of the baseline data, i.e. force some variables to take a specific value. This may for example include assumptions of current employment being in a steady state and/or constraining growth by demographic dynamics (for example, 1% growth in labour force a year). But any such assumptions would also affect the interpretation of the actual data used, and just as the baseline would have particular issues in the economic rationale, and the incongruity with existing baseline data (such as sectoral composition, etc.), either approach has its advantages but also its drawbacks. To look at alternative baseline scenarios a limited number of variables can be tested for without upsetting and overriding the actual data consistency embedded (for instance, unemployment may be sectoral, different levels of investments have an effect on the calibrated capital stock, etc.).

Some variables can be artificially altered to shed light on how they affect results. In particular, unemployment seems an exceptional value in the baseline year given the economic situation in Europe in 2013. To test this in RHOMOLO-EIB the initial situation is adjusted considering four alternative scenarios: (i) unemployment is updated to the 2019 unemployment data. The data shows that the labour market pre-pandemic had recovered significantly compared to the baseline scenario; (ii) the revised unemployment data for the baseline year is employed. RHOMOLO-EIB is based on the available unemployment data at the time. This data gets revised periodically and unemployment has been revised upwards since the baseline was created; (iii) to avoid using a particular base year an

average unemployment rate over the cycle is used, relying on the unemployment average over the period 2000-2020. This varies significantly in different countries, with average unemployment higher in some countries where the unemployment is low in the baseline case, and lower in others where unemployment is high in the baseline case; (iv) a further scenario is added that reflects an artificial 5% unemployment rate in all regions, irrespective of their baseline. Note that while unemployment is updated, this does not imply a recalibration of sectors or an adjustment in other regional data employed.

The impact is significantly affected by changes in the baseline employment. Changing the unemployment levels in the model baseline can have significant effects on the impact on GDP, and especially on jobs created (see Figures A3 and A4). Overall, the impact on GDP is lesser than the effect on jobs, which seems reasonable in terms of the nature of the change in unemployed labour. The effect moves in the same direction, but the magnitude is different. Changing the unemployment levels to reflect the most recent data in 2019 which reflect considerably lower unemployment in many regions (at the EU level from 8.3% in the RHOMOLO-EIB baseline to 6.5% when relying on 2019 data) also sees a considerably lower impact on jobs (some 100 000 fewer jobs at its peak). More pronounced still is the difference when comparing the RHOMOLO-EIB baseline to an artificial 5% unemployment rate across all regions. This would almost halve the jobs impact given tighter labour markets making it more difficult to draw in additional labour. Conversely, using the revised data for unemployment for the base year in 2013, which is considerably higher than the baseline used (8.3% in the baseline compared to 11% in the revised data), would also mean a higher employment impact (by some 100 000 jobs).

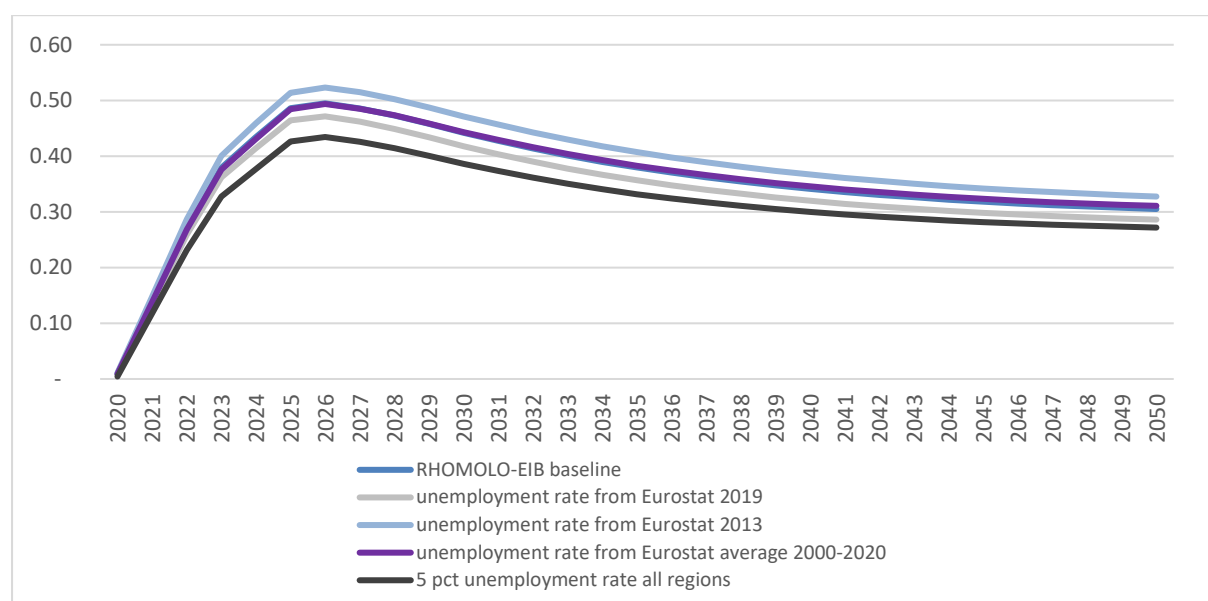


Figure A3: GDP impact, normalised portfolio, with different labour market scenarios.

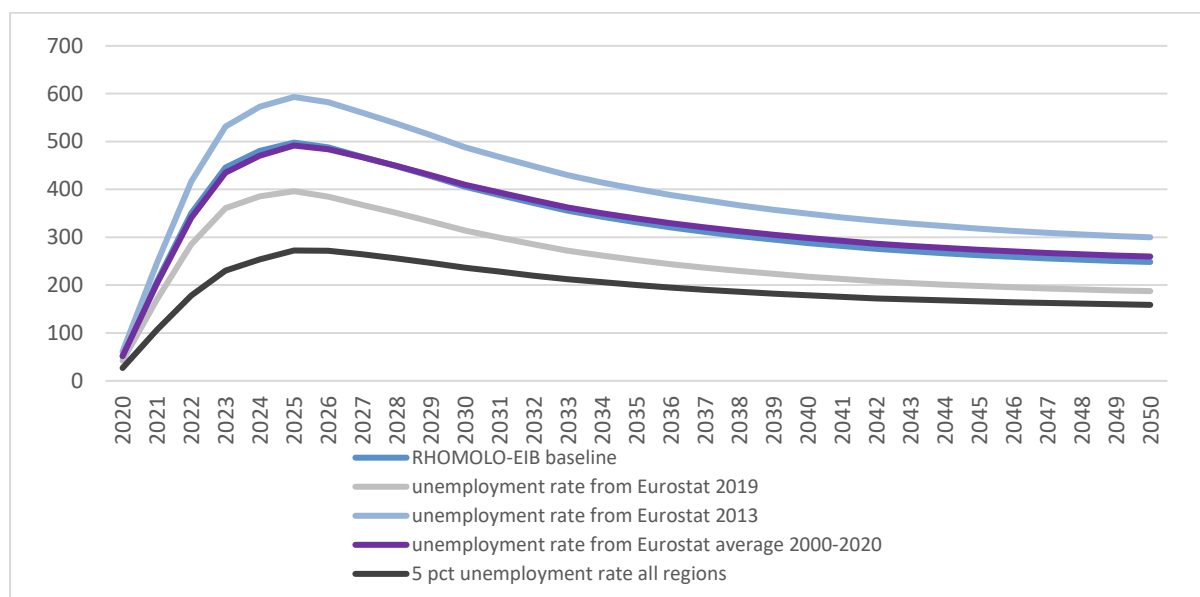


Figure A4: Employment impact, normalised portfolio, with different labour market scenarios.

Relying on actual data seems prudent, but the possible impact should be kept in mind. The specifications of the baseline year are an important factor affecting the results. In the RHOMOLO-EIB setting it is deemed prudent to not alter the baseline year data but instead to rely on actual data available. This ensures consistency of the data, and often avoids trying to guess a highly uncertain long-term future (Will the economy look differently? Will there be cycles? Does it make sense to assume natural rate of unemployment? What will the shape of the recovery from the global pandemic be? And many more). Instead, it would seem more appropriate to rely on actual data while clearly acknowledging the possible shifts in the baseline, and taking this into account in the actual results. For example, looking at the results of programmes like EFSI spans several years. Some would see an improved labour market to the RHOMOLO-EIB baseline, but some a worse scenario, with many unknowns, like the developments following the global pandemic. Constructing artificial alternative scenarios seems more biased as it lacks consistency of data and it does not reflect the actual setting. To some extent, altering basic data unbalances the model and entails further adjustment moving the model farther and farther away from the empirically observed towards a stylised economy of the modeller. Over the long run, the economic situation is likely to change and the baseline may diverge further which makes an update of the baseline year necessary, if possible. This on the other hand would make comparability of the results more difficult.

A.3.3. Macro-additionality and the role of the EIB

Additionality is a fundamental principle of EIB activities. The EIB Group as a public institution aims to deliver public benefit. To achieve this, it focuses on addressing market failures and facilitating investments that, without its support would not have happened or not to the extent or in the same timeframe. This is at the core of its project-by-project additionality assessment. A macroeconomic assessment goes one step further. Instead of looking at whether a particular project would have happened in a different way, it needs to consider if other projects elsewhere in the economy would be affected by the EIB Group financing. To some extent, the macro-additionality assumption reflects the important role and functioning of the EIB Group in the economy.

Macro-additionality is complementary to project additionality. The EIB as a public financial institution aims to complement, not replace or distort the market. From a macroeconomic perspective, project additionality indicates whether a project might have been financed in a different way, but the macroeconomic effect ultimately hinges on where this financing is coming from and whether the project is simultaneously crowding out any other productive projects elsewhere in the economy. Project additionality does not imply macro-additionality, nor does macro-additionality automatically imply project additionality. A project may have no project additionality, i.e. financing a project the market simply deemed inefficient, not due to market failures, but as such (like digging a hole for no reasons other than to employ labour). However, this project might still be macro-additional if indeed it does not crowd out any other projects the market would have financed otherwise. Alternatively, a project might have project additionality, but no macro-additionality. For example, helping to implement a project that the market normally would not have financed but that still offers significant public value would demonstrate project additionality. This type of project may still lack macro-additionality if indeed it crowds out investments to the same extent elsewhere in the economy by diverting available resources away. In this sense, macro-additionality is complementary to project additionality looking at it from a different angle.

By supporting specific projects, other investments elsewhere in the economy might be crowded out.

Any EIB-supported investment activity will require funding. This funding needs to come from somewhere. The EIB as an issuer of bonds attracts savings. Co-financiers also attract savings from issuing bonds, borrowing from the market (via financial institutions) or investing their own funds which technically also represent savings. The question macro-additionality poses is where in the economy do these funds come from? Two extreme alternatives exist. One approach assumes some fixed pool of savings to draw on. Every euro borrowed is a euro saved that was destined for some investment elsewhere in the economy. In effect, each and every euro invested crowds out investment elsewhere in the economy. The other extreme is that every euro invested constitutes additional investments that will not crowd out any other investment but, like the original investment via the multiplier, will create sufficient economic output and with this savings to justify the investment. In the former sense there is no macro-additionality, in the latter, full macro-additionality. In the former case the EIB Group would be a mere disturbance reallocating savings inefficiently in the economy, which would result in a negative macroeconomic effect. Effectively, such a setup does not allow for macro-additionality or a role for the EIB Group other than a harmful distortion. The other extreme of full macro-additionality would allow for public intervention to remedy market failures, but it would require a rationale as to what extent such macro-additionality prevails and provide a rationale for the extent of the macro-additionality. The assumptions of macro-additionality are critical since they determine the potential scope of the macroeconomic impact of EIB-supported activities. The extent to which this affects the results depends both on (a) the model setup, especially the closure condition; and (b) the data input assumption, i.e. where the financing is taken from.

- (a) **The model setup can predetermine the scope of macro-additionality.** Embedded in each model setup are assumptions about causality. A critical component that determines the overall causal direction is the closure condition (see Box 4). Different closure conditions are chosen for different model purposes. How the model is set up can already determine the possible scope of macro-additionality. For example by keeping a total amount of savings fixed, indirectly by assuming full employment, the model may be able to discuss compositional

effects by rearranging investments in an economy. However, this implies an assumption of zero macro-additionality since all investments fully crowd out investments elsewhere in the economy. To allow for a public institution to contribute with at least some macro-additionality, such setup seems inappropriate and also questionable from an economic perspective. Closure conditions of investments where indeed a supported public investment may come in additionally to what the market would be doing elsewhere, i.e. adding to total output and with this also total savings, seems more appropriate to at least allow for the possibility of public intervention. This does not yet automatically imply full macro-additionality. This still depends on where the money is taken from. The RHOMOLO-EIB model is set up in such a way that EIB Group-supported investments can technically add to the stock of investments in an economy and still not fully crowd out investments elsewhere. However it does not assume full macro-additionality either. How much the EIB investments can add depends on where the model draws the money from in the economy.

Box 4: Model Closure Conditions

In technical terms an economic model requires a closure condition that, depending on which one is chosen, can strongly influence the scope of the results. Any model has a certain number of exogenous factors (given data, assumptions, etc. that are entered into the model) and endogenous variables (those aspects to be determined by the model itself when solved). Mathematically this requires a squared system with an equal number of endogenous variables and equations to specify the model. Which variable is considered exogenous and which endogenous is important. In the simplest terms (following Amartya Sen's 1963 fundamental paper²⁹) the main issue can be shown in a simple set of equations:

- (1) $Y=I+C$
- (2) $Y=f(K,N)$
- (3) $w=MPN=dY/dN$ with $Y=f(K,N)$, $Y'>0$, $Y''<0$
- (4) $r=MPK=dY/dK$
- (5) $I=sY$

This simple model would be underspecified. It has eight variables: w,r,N,K,Y,s,I,C , but only five equations to determine them (P as numeraire ($P=1$) dropped and $wN+rK=Y$ is redundant as already specified under income identity). It is common to assume a given stock of capital K in the short run/period and, for simplicity's sake, take the savings rate as exogenously determined. This adds two more equations:

- (6) $K=\underline{K}$
- (7) $s=\underline{s}$

This still leaves one equation (or exogenously determined variable) missing to fully determine equilibrium. This is where the closure condition enters. Whichever equation is added, this will significantly influence or determine the causal structure of the model.

²⁹ A.K. Sen (1963): NEO-CLASSICAL AND NEO-KEYNESIAN THEORIES OF DISTRIBUTION. In The Economic Record, vol. 39, issue 85, pp. 53-64. <https://doi.org/10.1111/j.1475-4932.1963.tb01459.x>

Tradition	Value theory (New Classical, Arrow-Debreu)	Wage setting (New Keynesian)	Expectations-based investment (post-Keynesian) "savings-investment identity"	Interest rate setting (Jorgenson, Fischer)
Closure condition	$N=N$ sometimes as shortcut: $sY=S$ (but lacks economic rationale, determined by $s=s$ and $N=N$ thus sY as fixed)	$w=w$	$I=I$	$r=r$
Intuition	Assumes full employment (implied instant price movements or policies that lead to full employment). Full employment to determine output, and savings, through price mechanism match investments. Endogenous investment equal to savings in full production.	Assumes exogenous wage-setting process or wage rigidity to a certain extent. Given capital, the wage rate will determine the demand for labour in production until $MPL=w$. Output is determined, with it savings, and investments are induced by implied price mechanism to equate $I=sY$.	Level of investment determined by mostly forward-looking expectation and policy action (not merely induced). Given the level of investment via the savings rate (multiplier), output is determined and, with a given capital stock, the level of employment.	With a given capital stock and a given return on capital the level of employment can be determined so that $MPK=r$ (as a function of N). This determines output, savings and investments as induced (assumes price mechanism). [alternatively $I=f(r)$, if both, over-specified]
Use	Used to look at theory of value, stability, uniqueness and compositional effect only. No effects on GDP and employment except negative (through distortions of optimum).	This allows for involuntary unemployment as not all labour willing to work at a certain wage will be employed.	Leaves employment endogenous and determines level of GDP and employment. No inherent crowding out.	This is particularly useful for institutions affecting interest rates but also those operating on the capital market and possibly having some effect on interest rates.

The choice of closure condition will specify the model to such an extent that it may also determine what it can reasonably be used for. For example, fixing full factor employment will make it possible to study compositional effects but not really to determine growth and jobs, both are quasi-fixed by assumption of zero macro-additionality.

This is a very simple model. CGE models are vastly more complex adding other closure aspects and interlinkages that may affect the results: trade (current account closure), transfers (government closure), unemployment, etc. But the principle remains: closure conditions matter for the possible scope of the results.

- (b) If the model setup allows for macro-additionality, the scope is determined also by the assumptions embedded in the input data.** Given the model does not exclude additionality by assuming full crowding out through a restrictive closure condition, nor does it lock in full additionality of investments, none of the extreme alternatives are adopted. Instead the RHOMOLO-EIB model should be placed somewhere in between the two alternatives. As a public institution, the EIB Group should complement the market, not distort it and the model

should therefore allow for macro-additionality in the setup. However, it does not mean that everything the EIB Group does is additional, there might still be some crowding out of other investments happening. The question then becomes, by how much does the EIB support crowd out other investments and by how much does EIB support expand the investment base? The intuition is built on the notion that investments can potentially crowd out other investment activities in two ways: either through increasing financing costs, or by increasing production costs. The former works via financial markets outside of a non-financial model. By issuing bonds, the EIB would attract savings that otherwise would not be available in the existing savings pool and thus, with a given demand for investments and a shortfall in financing, would raise the costs of borrowing which in turn would make some investments unattainable. This per se does not need to be to the exact extent as full crowding out, in other words it does not have to imply zero macro-additionality. This would only be the case if a pool of savings for whichever reason is assumed fixed, or if an institution finances projects that the market would finance anyhow, i.e. replacing all other projects. This is, on the other hand, something that the additionality assessment at project level should limit. Instead, the elasticity of the investment demand function would determine the extent of the forgone investment projects at higher financing costs. The second channel would entail binding existing means of production. The intuition is that by supporting new investment projects, sources of production are bound up. For example in the construction industry, capital and labour that are not scaled up to the same extent would increase the prices of production, and in turn make some other investments non-viable since factors of production are either no longer available or have become too expensive. This does not need to be one-to-one in magnitude but depends on the respective elasticities of the investment function. This may also vary with the prevailing economic context. In situations of full or close to full factor employment when there is no slack capital or labour available, such crowding out may be higher than in times when sufficient resources are more easily drawn in. Similar consideration needs to be made with respect to the additionality or crowding out from funds borrowed from abroad, and the possible repercussions that may have.

In the absence of specific data, RHOMOLO-EIB relies on reasonable macro-additionality assumptions. The setup of RHOMOLO-EIB employs a closure condition that allows for macro-additionality by addressing investments indirectly through the risk premium. This best reflects the investment supporting role of the EIB Group in the market, but it does not per se imply full macro-additionality. Lowering the risk premium in the investment function in a specific sector or region would increase investment in that sector or region, but would not necessarily imply higher investment in other sectors or regions allowing for crowding out. Many factors enter to determine this but the main components are on the financing side (see Section 3.2 for an explanation) and the propagations throughout the model. Firstly, on the financing side it matters where the sources of financing come from. Part of the financing for investment comes from borrowing from abroad, some comes from existing domestic savings, and some from new domestic savings through forgone consumption. Given that international transfers such as factor payments, interest payments and institutional transfers and the exchange rates in the model are assumed constant implies that any additional inflow of funding from abroad is financed through an increase in the trade deficit, in other words a reduction in net exports. This decline in net exports would be the result of higher domestic prices and a worsening of competitiveness relative to RoW. The scope of financing from abroad is based on EIB Group bond

issuance data and the EU capital accounts, which indicates that the share of financing from abroad amounts to around 1/3. Part of the financing comes from existing domestic (EU) savings and some from domestic (EU) forgone consumption. In the absence of better evidence it is assumed to reflect the same share as the given baseline savings rate entering the RHOMOLO-EIB model, corresponding to 1/4. Only part of the financing therefore is coming from existing savings. Secondly, crowding out works through price effects in the RHOMOLO-EIB model. Through the EIB Group-supported investments domestic resources are employed that may crowd out other investment projects by increasing project costs that may outweigh enhanced returns. It also worsens the competitiveness of domestic input factors relative to imports which could lead to substitution of the income. The overall quantification of macro-additionality is difficult to assess as it varies with the economic situation, the relevant sectors and the overlapping primary and secondary effects. But essentially the RHOMOLO-EIB model neither assumes full macro-additionality nor assumes it away, but it is partly determined by the input assumptions of financing sources and partly through endogenous crowding out, which in turn varies over the economic cycle.

A.3.4. EIB Group as part of the baseline

The EIB Group is present in the baseline data. The EIB can look back at over 60 years of existence. It was already a major financial institution supporting investment across Europe at the time of the baseline in 2013. The EIB Group-supported activities will show up in the investment activities in the European Union in the baseline both as investments implemented and taking effect several years before as well as new investments starting implementation that year, just as borrowing will show up in the capital accounts, and it will affect the level of GDP and employment of the steady-state baseline assumed.

This does not need to impair the results, but will affect the interpretation of the results. Basing the model on a steady-state baseline implicitly assumes either that the EIB did not exist at all and instead the market was supporting the required investments, or that the EIB Group maintains its current activities, with ever new investments of the same size to maintain the current investment levels. In the latter case, any activities replacing previous investment activities would merely help maintain the current output, compensating for the potential deterioration in the baseline that would occur if the EIB Group were to cease its investments after the baseline. To showcase what this implies, a hypothetical scenario is constructed in which the EIB would always have existed and continued the same level of activities each year before the base year, but also continue to exist thereafter (see Figure A5). The structural effect would continue to grow continuously (slightly non-linear) as the structural effect on productivity, transport, etc. is sustained (the dark and light blue area in Figure A5). On top of the structural effect, an almost constant investment effect in which each new vintage of investments would replace the decrease of the investment effect in previous years would also set in (the dark and light grey areas in Figure A5).

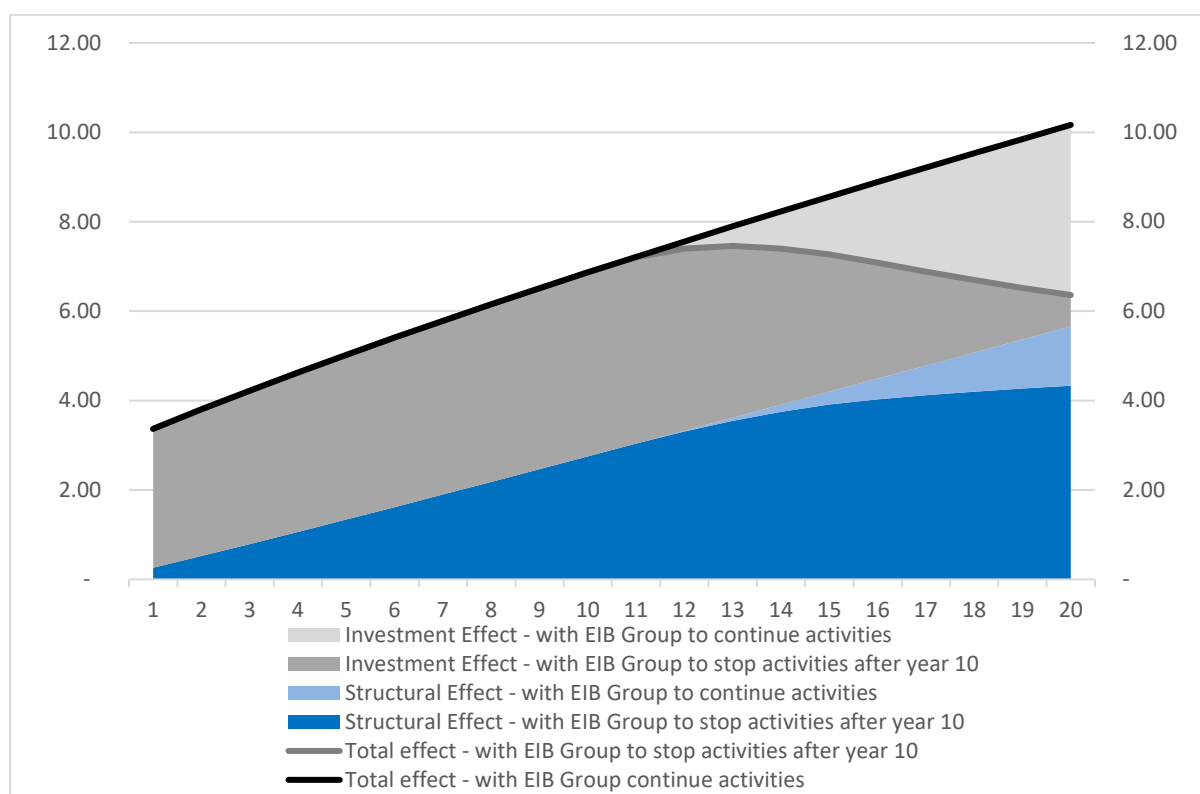


Figure A5: GDP impact with and without EIB Group’s continued investment support before and after the baseline year. In GDP %.

Were the EIB Group to suddenly stop its investment support and not be replaced by other initiatives, the structural effect would start to decrease over time as the previously supported investments reach the end of implementation and no structural effect is generated. The investment effect would start to decrease immediately as it no longer compensates for the decrease in the investment effect in previous years. In effect the baseline would not be stable, but would deteriorate (Figure A6). The missing investment effect would suggest a rapid deterioration of the baseline (green line in Figure A6). The structural effect has a similar trajectory, but with a certain latency, as some projects that started before the EIB Group stops supporting new investments would still reach completion. This latent structural effect in the initial years may still compensate for the fallout from the deteriorating investment effect but eventually cease so that the overall effect would see a falling baseline (see blue line in Figure A6).

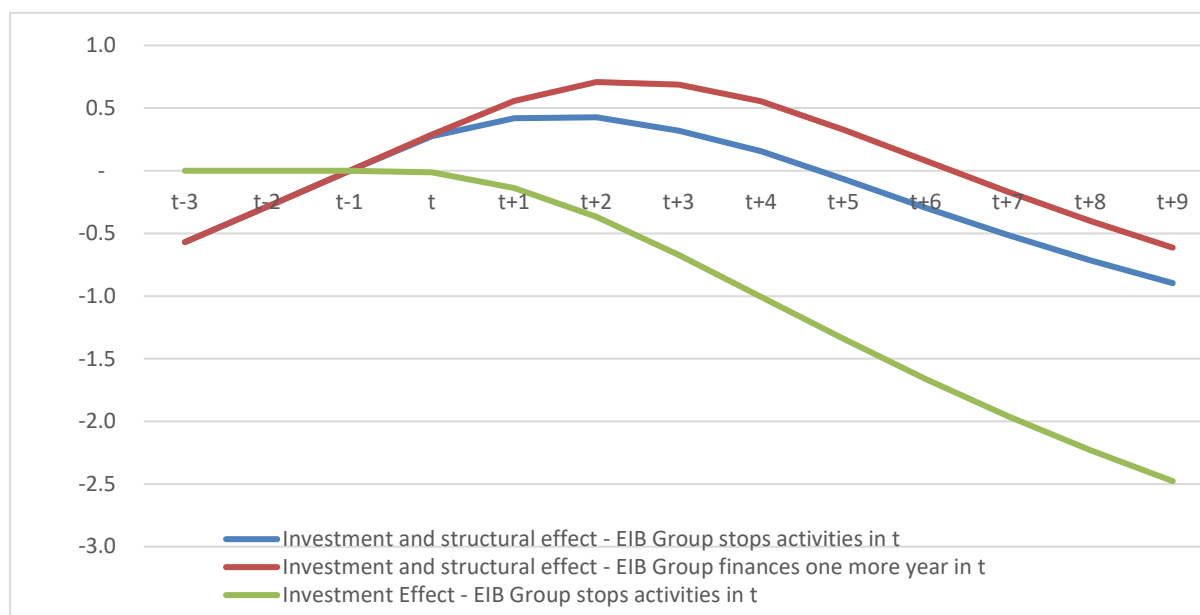


Figure A6: The effect on the baseline with stop in EIB Group activity and with one additional period.

The EIB Group impact should be read as over a stylised baseline. The RHOMOLO-EIB model assumes a steady baseline. If instead the baseline were variable, for example in the sense that the EIB Group would stop supporting investment, then the effect should be understood as the effect over such a variable baseline. For example, in the case above if the EIB Group were to stop supporting investments in year t the baseline would at first still bulge as long as the lingering structural effect compensates for the rapidly deteriorating investment effect, but then would also decrease. An additional year of investment supported would simply be above such a dynamic baseline. This has two implications for the interpretation of the results. For one, any effect should be considered over a steady baseline that represents a simplifying assumption to better read the results. While the impact may be somewhat nonlinear with the magnitude of fluctuations in the underlying baseline, in normal times where these fluctuations are not excessive it should still provide a reasonably solid sense of scope. The reading still holds true: the impact reflects the effect of a particular funding envelope (such as a certain year or programme). The second, more importantly here, is that the focus of the EIB Group-supported investment over the longer-term perspective as a lasting institution is on the structural contribution it makes to growth and jobs. Much of the investment effect would compensate for the deterioration in the effect from previous investment vintages.

The baseline effect has implications for interpreting macro-additionality. Macro-additionality considers how much the EIB Group investments would be in addition to existing investment activities and how much would potentially be crowded out. As the EIB Group is part of the baseline, to a large extent the EIB Group is replacing the own investment effect it has generated in previous years. This does not constitute a jump in investments in the order of the newly supported investment activities, but, if the portfolio were stable, would mean sustaining the level of investment in the economy. This puts considerably less burden on the assumptions underpinning macro-additionality as even in a scenario of fixed absolute amounts of savings the effect would still be the same overall, only to be interpreted as replacing previous investments that required public support with new ones, equally deserving of public support, as established in the project-by-project assessment.

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Assessing the macroeconomic impact of the EIB Group

2022 update



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