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The impact of the recovery fund on EU regions: a spatial general equilibrium analysis

Javier Barbero^{a,b} , Andrea Conte^a , Francesca Crucitti^a ,
Nicholas-Joseph Lazarou^a , Stylianos Sakkas^a  and Simone Salotti^a 

ABSTRACT

We use a spatial general equilibrium model to assess the macroeconomic and distributional impact of the European Commission's Recovery and Resilience Facility (RRF). We employ two alternative regional distributions of investments: one based on the regional share of population only, and the other based on Cohesion Policy criteria. Our results suggest that the disbursement of RRF grants would lead to an increase in the European Union's gross domestic product (GDP) of approximately 0.85% in 2026, corresponding to a present value GDP multiplier of 1.22. The latter rises to 3.25 in the long run. Under the population criterion, GDP impacts are higher relative to the Cohesion criterion, at the detriment of territorial cohesion.

KEYWORDS

recovery fund; general equilibrium; regional growth; regional disparities

JEL C68, E27, R13

HISTORY Received 11 January 2022; in revised form 4 September 2022

1. INTRODUCTION

The Covid-19 pandemic caused an unprecedented health and economic crisis worldwide. The pandemic hit all countries almost simultaneously and had heterogeneous national and regional impacts due to different containment measures and policy reactions (Sakkas et al., 2021). In response to the crisis, the European Commission launched the Recovery Plan for Europe, now referred to as NextGenerationEU (NGEU). The package covers a wide range of policy interventions and reforms.

Academic research on the potential impact of the Recovery and Resilience Facility (RRF), which constitutes the bulk of NGEU, is presently scant. Building on existing literature on the impact of public investments and rescue packages,¹ a few RRF studies concentrate on EU-level results (Bankowski et al., 2021; Pfeiffer et al., 2021; Picek, 2020), while others focus on specific countries (e.g., Malliaropulos et al., 2021). In contrast with the above studies, our analysis contributes to the discussion about the macroeconomic impact of the RRF by evaluating the different measures of the policy at the regional level (NUTS-2). To the best of our

knowledge, this is the first study to attempt this kind of evaluation.


In doing so, we employ a recursively dynamic spatial general equilibrium model calibrated with data for 230 EU NUTS-2 regions plus those of the UK and the rest of the world as a residual exogenous entity.² The data are organized in a set of fully interlinked social accounting matrices. The model features a regional dimension in which spatial interactions and spillovers between regions are captured through bilateral trade flows and capital mobility (see Appendix B in the supplemental data online). Hence, our modelling set-up is particularly suited to account for the spillover effects across regions both internationally and within each country.

The use of a spatial general equilibrium model as opposed to a one-country (region) model is particularly relevant when assessing the effects of big-scale policies and reforms such as those of the RRF. On the one hand, the RRF territorial allocation might not be homogeneous within countries since the criteria for the implementation fall under the autonomous responsibility of central governments. On the other, even with a homogeneous distribution, regions within the same country

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differ with respect to their economic fundamentals such as, for example, capital intensity (private or public), capital-to-labour ratio, skills and education level of the workforce, unemployment rates, and trade openness. Thus, a spatial general equilibrium model is well suited to capture the effects of RRF taking into account both the regional heterogeneity of the distribution of funds and the economic fundamentals of each region.

The existing evidence of the potential impact at the EU level of the full RRF lacks the level of detail which would be needed for a thorough analysis of the country-specific recovery and resilience plans (RRPs). Bankowski et al. (2021) use a dynamic general equilibrium model to examine the effects on the Euro Area and selected EU countries with simplistic assumptions on the use of the funds.³ In particular, the authors analyse three scenarios in which the funds are used alternatively as public investment, public current expenditure or to repay existing debt.

Pfeiffer et al. (2021) provide a stylized quantitative assessment of NGEU investment for the EU and its member states taking into account spillover effects across member states based on the assumption that all the funds will be channelled in the economy through public investments. Picek (2020) employs a static multiregional input–output model to study the effects of NGEU that also allows for spillover effects, but the adopted framework only allows all funds to be modelled as generic demand shocks.

The territorial granularity of this study allows us to comment on the issues of economic convergence and growth. Indeed, social and territorial cohesion is one of the six pillars of the RRF and the distribution of funds across member states followed a cohesion-type approach (European Commission, 2020). However, in contrast to Cohesion Policy, there is no ex-ante NUTS-2 regional allocation in the funds and the governance is more centralized at the national level than under the shared management of the Cohesion Policy funds.⁴ Moreover, RRFs have a strong reform component with a focus on maximizing national economic recovery and growth. Nonetheless, the nature of the reforms listed in the RRFs often implies an impact on territorial cohesion.

Given the regional character of the model, we assess the macroeconomic impact of the RRFs with two alternative distributions based on two different regionalization criteria through which the funds will reach the regions of each country. Our analysis reveals that the disbursement of RRF grants over the 2021–26 period would lead to an increase in EU gross domestic product (GDP) of approximately 0.85% in 2026, corresponding to a present-value GDP multiplier of 1.22. The inclusion of RRF loans increases the impact to 1.36% in 2026. The effects of the RRF are persistent in the long run: 20 years after the end of the funding period, GDP is 0.19% higher compared with the no policy scenario when considering only the RRF grants (and 0.25% higher when loans are included). The long-run mean GDP multipliers across EU NUTS-2 regions are 3.25 under the grants scenario and 3.17 under the grants and loans scenario.

We find that the planned investments contained in the national RRFs may have the capacity to improve GDP per capita convergence. This is particularly true if funds are distributed according to the second regionalization criterion. The model's results are robust to a set of alternative assumptions such as changes in the output elasticity of public capital, interest and unemployment rates, and potential implementation delays.

2. A LOOK AT THE RRF DATA

NGEU is the EU recovery package agreed by the European Council on 21 July 2020 to support the economy recovery severely hit by the Covid-19 crisis. Its largest component is the RRF, which provides grants of more than €300 billion and loans of up to €360 billion. In order to use this funding instrument, EU member states started submitting their national plans in the second quarter of 2021 with information on the planned reforms and public investment projects to be implemented until 2026.⁵

Despite the existence of templates and common principles guiding the creation of the RRFs, it is not straightforward to compare the various national plans since their structure varies substantially from plan to plan. Moreover, it is hard to define non-overlapping spending categories as a particular investment could support more than one of the purposes defined by Article 3 of the RRF Regulation (European Union, 2021).

In terms of aggregate figures, the situation emerging from the existing RRFs as of the second quarter of 2022 is that presented in Table 1 (we also used the data released by Bruegel, 2021, in order to compile the dataset). The Netherlands has yet to submit its RRF, and the rest of the EU-27 have requested a total of €337.5 billion in grants and €166.0 in loans. Only seven countries have requested loans, but any country can request them until the end of August 2023, so this situation may change in future. Apart from that, the numbers in Table 1 are the result of negotiations between the EU and its member states, based on several criteria for the distribution of the funds across member states.

As for the non-repayable RRF financial support (grants), the maximum financial contribution per member state was calculated using three indicators: population, the inverse of GDP per capita and the unemployment rate (mimicking what is done at the regional level for the Cohesion Policy's European Regional Development Fund – ERDF).

We identify seven areas of intervention using text analysis and keeping as a reference the macro-areas targeted by Cohesion Policy, which is a comparable EU investment policy in terms of overall magnitude (although it targets reducing regional disparities and it concentrates on specific areas of the EU, differently from the RRF). Also, this particular classification of the RRF measures is made in order to associate specific modelling shocks to each area, as explained in the following sections. The areas are the following: (1) urban development (including measures related to housing policy, local public transport

Table 1. Requested grants (and loans) according to the country-specific recovery and resilience plans (RRPs) (€ billions).

Country	Grants (loans)	Country	Grants (loans)	Country	Grants (loans)	Country	Grants (loans)
Austria	4.5	Estonia	1.0	Italy	68.9 (122.6)	Portugal	13.9 (2.7)
Belgium	5.9	Finland	2.1	Latvia	1.8	Romania	14.3 (15.0)
Bulgaria	6.6	France	40.9	Lithuania	2.2	Slovakia	6.6
Croatia	6.4	Germany	27.9	Luxembourg	0.1	Slovenia	1.8 (0.7)
Cyprus	1.0 (0.2)	Greece	17.8 (12.7)	Malta	0.3	Spain	69.5
Czechia	7.1	Hungary	7.2	Netherlands	n.a.	Sweden	3.3
Denmark	1.6	Ireland	0.9	Poland	23.9 (12.1)	Total	337.5 (166.0)

Source: National RRP and Bruegel (2021).

and biodiversity) and social policy; (2) public infrastructure (including water and waste management, and climate disaster resilience), public administration reforms (including digitalization and justice reforms), and health measures; (3) transport infrastructures; (4) support to enterprises; (5) research and innovation; (6) labour market training and reforms; and (7) labour market inclusion.

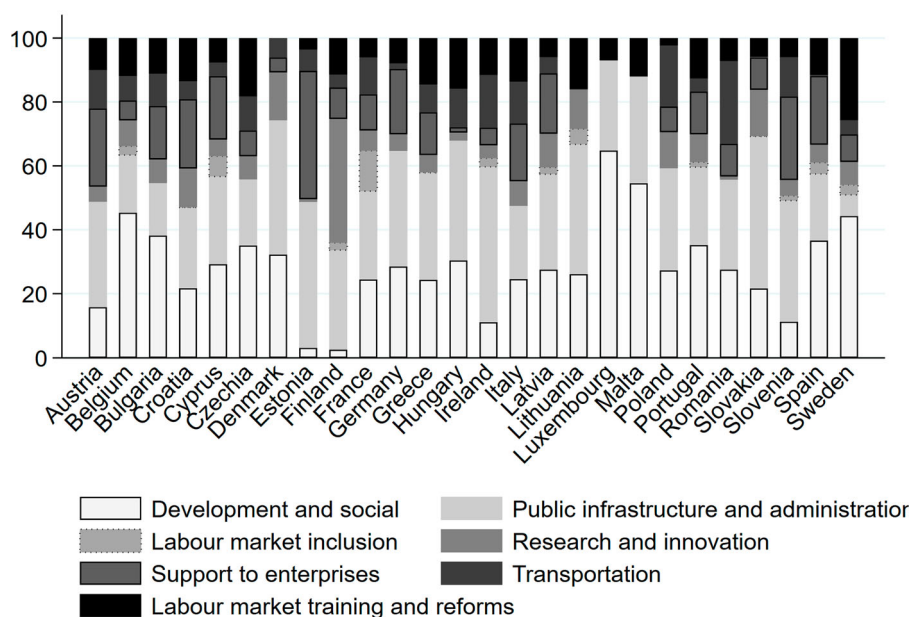
At the EU level, the bulk of the funds are targeting urban development and social policy (31%), public infrastructure and public administration reforms (27%), and support to enterprises (17%). Labour market training and reforms then constitute 10% of the RRF, and the remaining areas (transportation, research and innovation, and labour market inclusion) account each for between 4% and 6%. Obviously, these numbers mask a significant country heterogeneity (Figure 1).

In terms of timing, the money is supposed to be spent over a period of six years starting from 2021, and only a few national RRP contain an actual time profile with the expected amount to be spent in each year. In terms of territorial distribution, at the moment it is not clear how this money will be actually distributed within each

country since the RRP do not contain enough information at this stage. This issue is obviously more relevant for those EU member states with a higher number of regions.

Current regional disparities in the EU (Monfort, 2020) call for an assessment of the territorial consequences of different funding choices also in the context of the RRF. Given the regional dimension of the model and uncertainty over the actual distribution of the funds over time, we offer two potential alternative distributions of RRF funds based on two different regionalization criteria. The first option is a regional distribution of funds made according to the regional share of population.⁶ Figure 2 shows the regional distribution of the RRF investments when distributed within each country proportionally to regional population (we label this criterion 'Population'). Each region in the EU is expected to receive investments amounting to between 0.02% and 2.96% of their annual GDP on average every year over the 2021–26 period.

We also investigate the potential consequences of an alternative distribution that mimics (within each country and using regional indicators) that used to distribute the

**Figure 1.** Composition of the recovery and resilience plans (RRPs) by area of intervention.

Source: RRP, Bruegel (2021), and authors' own computations.

RRF funds across member states. According to this alternative criterion ('Cohesion'), the share of funds assigned to region r within each country is calculated as follows:

$$\alpha_r = \frac{\frac{GDP_{average}^{PC}}{GDP_r^{PC}} \cdot \frac{pop_r}{pop_{EU}} \cdot \frac{U_r}{U_{EU}}}{\sum_{i=1}^R \frac{GDP_{average}^{PC}}{GDP_i^{PC}} \cdot \frac{pop_i}{pop_{EU}} \cdot \frac{U_i}{U_{EU}}},$$

where GDP_r^{PC} is the GDP per capita in region r in 2019; pop_r is population in 2019; and U_r is the average unemployment rate over the period 2015–19. Similarly, $GDP_{average}^{PC}$ is the average GDP per capita in the EU in 2019; pop_{EU} is EU population in 2019; and U_{EU} is the EU average unemployment rate over the period 2015–19.

The methodology uses the following capping rules to avoid excessive concentration of funds in some regions, which are the same ones used in the distribution of funds among the EU member states:

- $1.5 \geq \frac{GDP_{average}^{PC}}{GDP_r^{PC}}$
- $1.5 \geq \frac{U_r}{U_{EU}}$
- $0.75 \geq \frac{U_r}{U_{EU}}$ if $GDP_r^{PC} \geq GDP_{average}^{PC}$.

The result of the Cohesion scenario is displayed in Figure 3. There are substantial differences from the regional distribution shown in Figure 2. First, the range of the values of the funds relative to GDP is narrower when population is used as the sole criterion to regionalize the national funds (the maximum increases from 2.96% to

5.05% when adopting a cohesion regionalization). Moreover, more regions receive funds that are $> 1.50\%$ of their yearly GDP on average, with particularly significant differences in the bigger EU countries.

This means that the populous and less developed regions of the EU would receive a higher share of RRF funds should those same funds be distributed according to principles favouring convergence and cohesion within each country.

3. THE SPATIAL GENERAL EQUILIBRIUM MODEL

The model used is based on an amended version of the spatial computable general equilibrium model by Lecca et al. (2018). The model is calibrated with data on 230 European plus 37 NUTS-2 regions of the UK, disaggregating all economies into 10 NACE Rev. 2 sectors (see Appendix A for the detailed model description and Appendix B online for its calibration, both in the supplemental data online). It involves three types of economic agents: households, firms and the government.

Each regional economy can be considered as a small open economy where the interest rate is fixed to 2.29%, which is the 10-year average risk-free interest rate registered in EU between 2011 and 2020. In the robustness section of the paper we experiment by replacing the interest rate with a lower bound value of 0.29%, which is the 2020 average, and an upper bound value of 4%. In each region/sector, a representative firm produces a single variety, which is considered an imperfect substitute for the variety produced in other regions. Regional goods are produced by combining the value added (labour and capital)

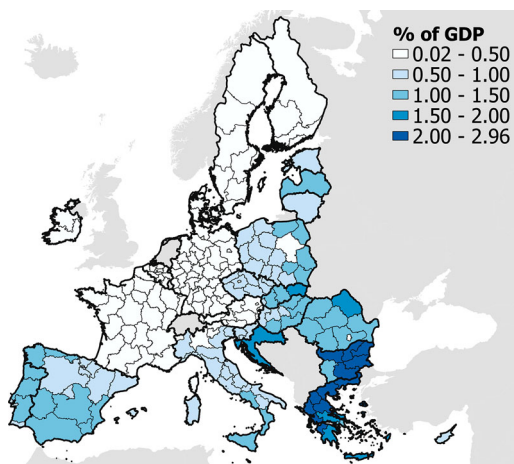


Figure 2. Regional distribution of Recovery and Resilience Facility (RRF) funds proportional to population, average % over yearly gross domestic product (GDP) over the period 2021–26.

Source: National recovery and resilience plans (RRPs), Bruegel (2021) and authors' own assumptions. EuroGeographics for the administrative boundaries.

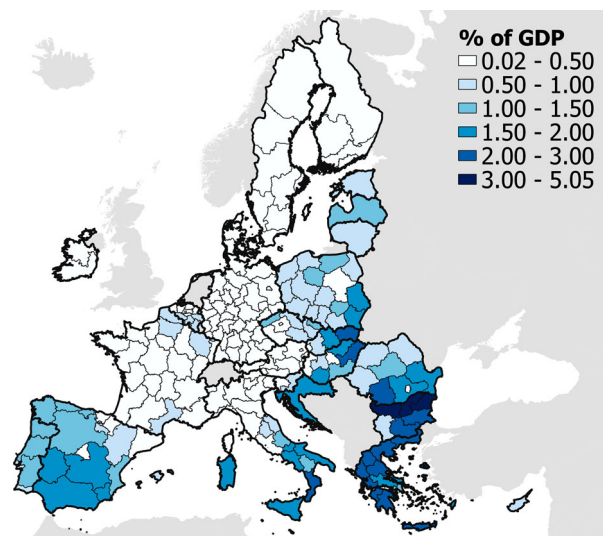


Figure 3. Regional distribution of Recovery and Resilience Facility (RRF) funds according to the RRF country-level ('cohesion') criterion, average % over yearly gross domestic product (GDP) over the period 2021–26.

Source: National recovery and resilience plans (RRPs), Bruegel (2021) and authors' own assumptions. EuroGeographics for the administrative boundaries.

with domestic and imported intermediates. Final goods are consumed by households, governments and investors (in the form of capital goods), while firms consume intermediate inputs. The model incorporates imperfect competition in the labour market. This is modelled by means of a wage curve that fixes non-market clearing wages depending on the level of unemployment:

Costly trade exists among regions. Traded goods are differentiated by origin in the fashion of Armington (1969) and by sector. Consumers and firms in a region choose to consume bundles of goods indexed by sector-origin with a constant elasticity of substitution and pay a constant mark-up over the marginal cost, and a transport cost which is modelled as an iceberg cost (e.g., Krugman, 1991). Hence, each region imports from all other regions a share of their production of a given good, for consumption and investment purposes.

Finally the government collects taxes to finance a stream of public expenditures (current expenditures, public investment and transfers). Given the nature of our analysis, the regional budgets are not constrained to be balanced, so that the regions of the model are able to run either deficits or surpluses. However, at the EU level, and over the whole simulation period, the amount of resources spent in relationship to policy investments financed with grants are to be repaid with an equal amount of lump-sum transfers from the households plus interest.

The model is solved in a recursively dynamic manner, where a sequence of static equilibria is linked to each other through the law of motion of state variables (private capital). This implies that agents are not forward-looking and their decisions are solely based on current and past information.

4. ANALYSIS STRATEGY

In our simulations we assume that the economy starts from its initial steady-state equilibrium in which fiscal policy variables are set at their baseline year values and then study the implications of the various RRF policies over time which effectively shock the initial equilibrium.

4.1. Modelling the RRFs measures

This section illustrates how we translated the RRFs' planned investments into model variables, essentially assigning a proper transmission channel to each individual expenditure detailed in the plans. As described previously, we identified seven areas of intervention to group the single measures, and we exploit this information in order to devise specific shocks capable of reproducing in modelling terms the actual economic mechanisms supposed to be triggered by the measures themselves.

Thus, and in contrast with other studies that modelled the RRF impacts as a single uniform shock such as public investment, or public current expenditure (Bankowski et al., 2021; Pfeiffer et al., 2021), we assume a mix of policy shocks reflecting the nature of the planned interventions. This means that in our analysis there are several behavioural mechanisms through which the seven areas of

intervention of the RRF introduced above (Figure 1) affect the economy.

Following Pfeiffer et al. (2021), we assume that the repayment of grants starts at the end of the period of implementation of the RRF (in 2027), and goes on until the end of the simulation period (2046) following a linear schedule using the calibrated interest rate (to account for the debt-financing of the RRF done at the EU level). It is further assumed that all the EU regions contribute to the EU budget according to their GDP shares via lump-sum taxation. On the other hand, the loan repayments are made by the countries asking for the loans themselves. The repayment starts at the end of the implementation period and is financed via reductions in government current expenditure, with a compounding interest rate of 2.29% to pay over the remaining debt stock in each period.

For the detailed explanations of the calibration of the shocks and the economic mechanisms triggered by each of the shocks listed in Table 2, see Appendix C in the supplemental data online.

5. RESULTS

In this section we first present the aggregate EU and country-level results of the analysis, and then the regional ones. We concentrate most of the analysis on scenarios in which the policy is deployed with grants only and over the 2021–26 period, assuming two alternative regionalization criteria, as well as two alternative output elasticities of public capital (high and low). Finally, Appendix D in the supplemental data online shows the consequences of including loans into the simulations.

5.1. EU- and country-level results

We first show how the main macroeconomic variables of the model behave at the EU level and how our results compare with the existing aggregate evidence on the RRF impact. All results are presented as per cent deviations from their initial steady state values unless stated otherwise. Figure 4 presents the evolution of key macroeconomic variables over the implementation period of the RRFs (2021–26) and for the following 20 years using the population criterion for regionalization.

According to our simulations, EU GDP can be expected to be 0.85% above its baseline value in 2026 that is, at the end of the implementation period of the RRF, implying a present value GDP multiplier of 1.22. While the policy shocks end in 2026, the impact on the EU economy is long lasting due to the supply side effects of the shocks as well as the residual effects of the demand-side ones.

Thus, the disbursement of RRF grants has both short- and long-run effects on the EU economy. The initial demand stimulus causes short-run increases in investments, real wages, prices, consumption and employment. Economies become less competitive due to the inflationary pressures observed and exports decline. After the end of the implementation period and as investments in infrastructure materialize, output expands further. Levels of

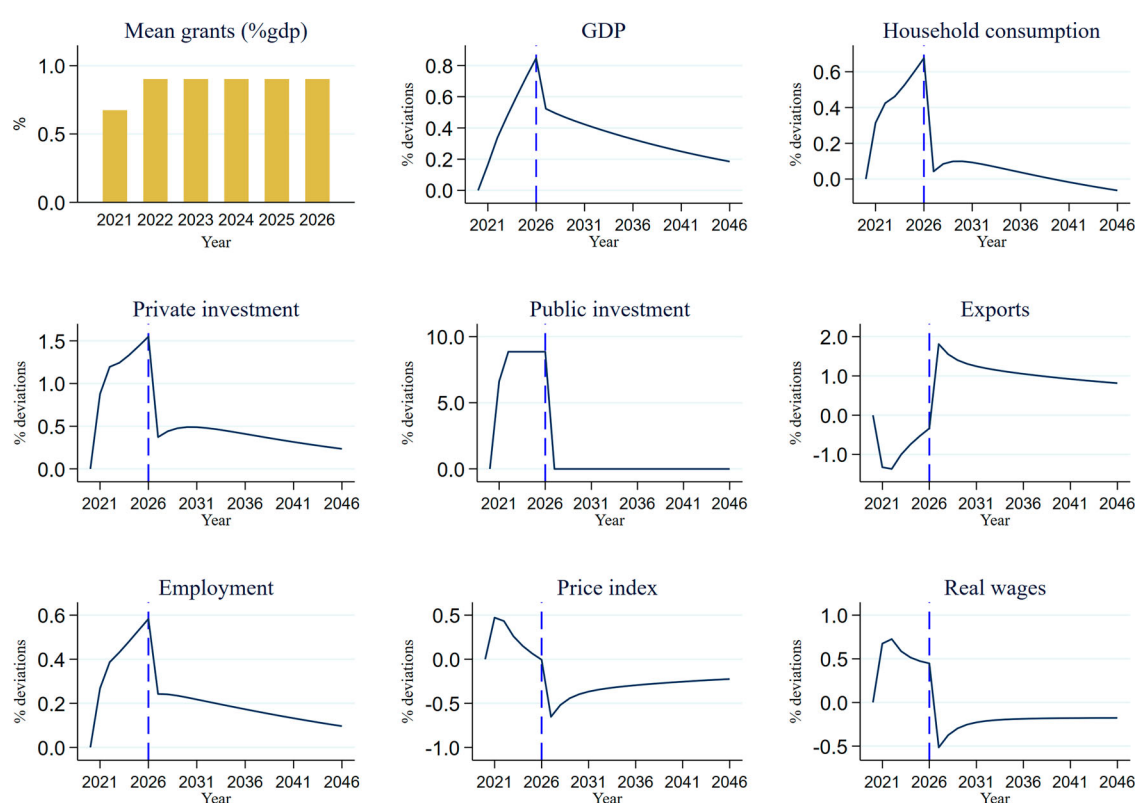
Table 2. Description of the Recovery and Resilience Facility (RRF) shocks.

Type of shock	Areas of intervention	Demand-side effects	Supply-side effects
Public current expenditure	1	Increase in government consumption	
Public investment	2	Increase in public investment	Temporary increase in public capital stock
Transport investment	3	Increase in government consumption	Decrease in transportation costs
Risk premium	4	Reduction in the risk premium stimulating private investments	Temporary increase in private capital stock
Research and development (R&D)	5	Reduction in the risk premium stimulating private investments	Temporary increase in private capital stock; increase in total factor productivity
Labour productivity	6	Increase in government consumption	Increase in labour productivity
Labour supply	7	Increase in government consumption	Increase in labour supply

capital adjust, so do employment, factor returns, and ultimately prices and economies regain competitiveness in exports. Upward changes in household incomes caused by increases in the real wage gradually decline because of adjustments in long-run factor returns. In addition, the depreciation of public and private capital in the long run and the repayment of the grants by member states after the end of the implementation period of the RRF,

which in our scenarios occurs through lump-sum taxation, further reduces the growth in household incomes.

Table 3 presents the mean present-value GDP cumulative multipliers (i.e., the euro return on GDP following €1 of investment) at the end of the implementation period of the RRF (2026), and five, 10 and 20 years later.⁷ In the benchmark case of a high output elasticity of public capital, €1 of RRF grants returns €1.22 at the end of the

**Figure 4.** Evolution over time of key macroeconomic variables at the European Union level: % deviations from baseline.

Note: Grants are disbursed to member states between 2021 and 2026. The dashed line represents the end of the implementation period.

Source: Authors' own simulations.

Table 3. Mean present-value of European Union (EU) gross domestic product (GDP) multipliers.

Output elasticity of public capital	Regionalization criterion	2026	2031	2036	2046
0.1	Population	1.22	2.03	2.60	3.25
	Cohesion	1.10	1.86	2.38	2.99
0.05	Population	1.08	1.70	2.10	2.53
	Cohesion	0.97	1.54	1.91	2.30

Source: Authors' own simulations.

implementation period, increasing every year to reach €3.25 twenty years later under the population criterion. The findings are similar for the regionalization under the cohesion criterion, although this alternative regional allocation leads to slightly lower returns to the RRF investments.

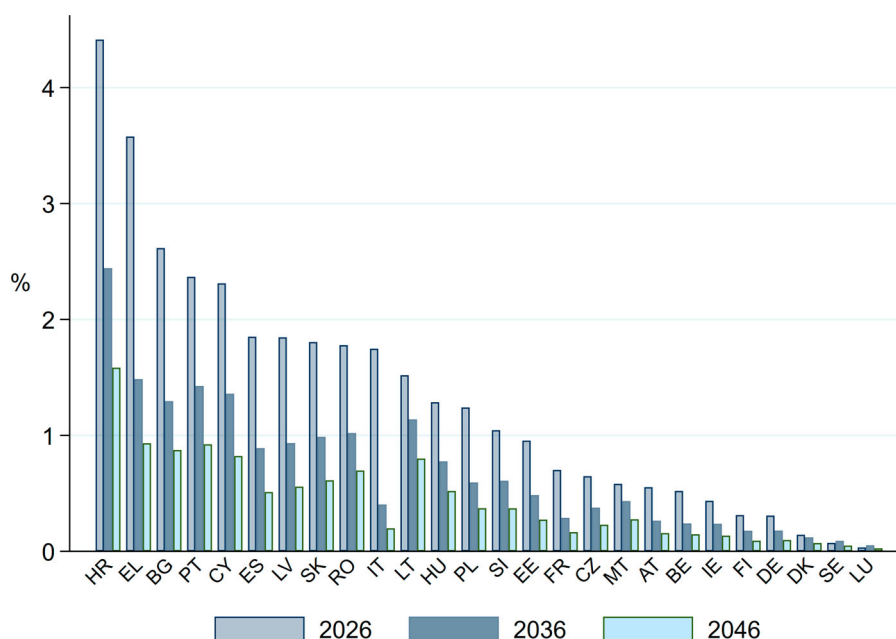
Our results are in line with those of Pfeiffer et al. (2021) who report present value multipliers of around 1.5 in 2025, 2.5 in 2031, 3.2 in 2037 and 3.8 in 2045, assuming a higher elasticity of output of public capital value of 0.12 and a lower interest of 1.5%, as well as including loans. Under the low elasticity scenario using a value of 0.05, they report multipliers for the case of grants and loans standing at 1 in 2025, 1.3 in 2031, 1.7 in 2037 and 2 in 2045.

Figure 5 depicts the GDP level at the end of the implementation period of the RRF, and 10 and 20 years after, as per cent deviations from the baseline GDP using the population criterion for regionalization. The results indicate that Croatia, Greece, Bulgaria, Portugal and Cyprus exhibit the highest deviations from the baseline GDP. The effect is persistent across time with some variation arising as Lithuania, Slovakia and Romania have relatively high GDP impact 10 and 20 years after the end of the programme, comparable with those of Greece, Portugal, Spain and Cyprus.

The persistence of the GDP impact depends on the amount of money received under the RRF versus the amount to be repaid as a financial contribution after the end of the implementation period, which is correlated with a member state's GDP. As a consequence Italy's deviation from its baseline GDP tends to be high only in the short run before the repayment of grants commences. After year 6, the impact drops as Italy's contribution to the RRF repayment approaches the EU mean contribution, with an RRF investments to grant repayment ratio of 1.37 compared with 1.26. Other member states to the left of Italy exhibit higher RRF-to-grant repayment ratios and therefore have persistently higher GDP impacts across time. This is true for Lithuania, Hungary, Poland and Slovenia which, on average and together with the others to the left of Italy, exhibit a mean RRF-to-grant repayment ratio of 2.39.

5.2. Regional results

The model's regional results enable the analysis of the distributional aspects related to the RRF. Figure 6 shows the distribution of the GDP impact in 2026 and 2036 across EU regions in which the RRF is implemented. The regional results are presented for the two regionalization criteria and the two alternative values of the output

**Figure 5.** Gross domestic product (GDP) impact by grants-recipient member states: % deviations from baseline.

Source: Authors' own simulations.

elasticity of public capital. At the end of the implementation period in 2026, the cohesion criterion generates a thicker right tail of the distribution of GDP compared with the population criterion. Altering the value of the output elasticity of public capital, a homogeneous parameter across regions, does not change the skewness, or the kurtosis. The implications are that under the cohesion criterion, incidences of higher GDP impacts are more frequent and the interquartile range values are wider. The same is true 10 years after the end of the implementation period.

Table 4 presents the within-country percentage changes in GDP per capita in the last year of the implementation period, 2026, relative to the baseline, evaluated at the 25th, median, 75th and 90th percentiles. The positive differences in incomes are generated by the RRF investments, and there are differences depending on the assumed regionalization criterion. The latter appears to be the main source of variation in our results and affects the distribution of GDP changes and multipliers. The cohesion criterion leads to a more even distribution in per capita incomes compared with the population criterion: lower per capita incomes tend to increase more compared with the population criterion. There are, however, notable exceptions as in Austria, Hungary, Portugal and Romania the 90th percentile accrues more income in 2026 compared with the 25th percentile. While the cohesion criterion leads to a more equitable distribution of funding across regions, this seems to generate lower aggregate regional growth. Indeed, the

corresponding multipliers under the cohesion criterion are lower than those of the population criterion, as the returns to investment are lower in those regions. Thus, our analysis indicates a common pattern in the policy domain, namely the existence of a potential (regional) growth-equity trade-off. Essentially, our results suggest that a larger reduction in regional disparities can be achieved at the expense of lower overall growth.

Table 5 and Figure 7 report the baseline and minimum observed values of the coefficient of variation and inter-percentile ratios for the two regionalization criteria during the simulation period. The smaller the coefficient of variation, the more uniform is the distribution of GDP per capita.⁸ The smaller the inter-percentile ratio, the smaller the differences between the rich and the poor regions of the EU, in this case. Our results point to a decrease in regional disparities resulting from the RRF compared with the baseline, as the standard deviation of income per capita relative to the mean reduces across time, more so under the cohesion criterion than the population criterion. The per capita GDP gap between rich and poor EU regions decreases by at least 1% and the effect is more prominent under the cohesion criterion.

While there appear to be small changes in measures of dispersion at the aggregate EU level, within country changes in dispersion are more prominent. Table 6 shows the percentage changes in the equivalent measures by country, where there appear to be reductions in disparities across all member states, particularly in Spain, Slovenia, Slovakia and Hungary. The reduction is larger under

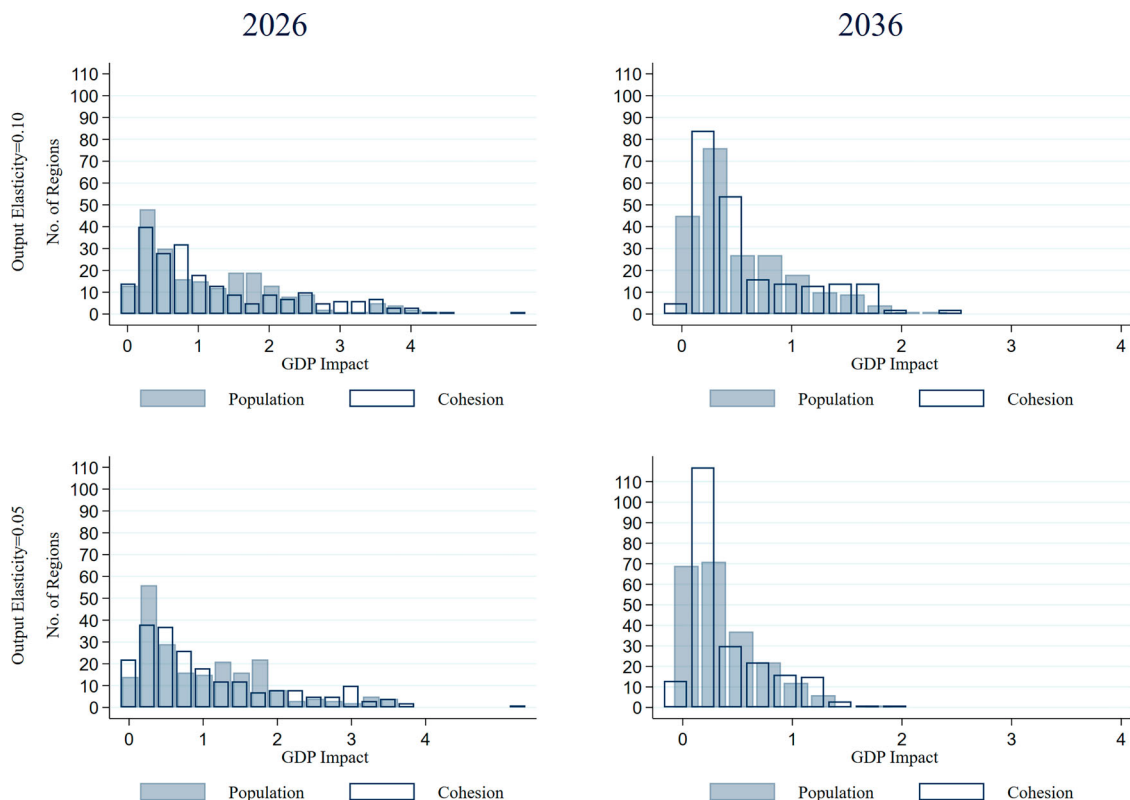


Figure 6. Distribution of the regional gross domestic product (GDP) impact, 2026 and 2036.

Source: Authors' own simulations.

Table 4. Per cent changes of percentile values of gross domestic product (GDP) per capita by country, 2026.

RRP recipient	Population criterion				Cohesion criterion			
	Δt 25th	Δt 50th	Δt 75th	Δt 90th	Δt 25th	Δt 50th	Δt 75th	Δt 90th
AT	0.3	0.5	0.4	1.7	0.4	0.4	0.3	2.0
BE	0.3	0.3	0.8	1.1	0.6	0.2	0.5	0.7
BG	2.2	2.2	2.4	3.2	2.6	2.1	3.0	2.4
CY	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
CZ	0.6	0.6	0.6	1.1	0.6	0.7	0.5	0.5
DE	0.2	0.4	0.3	0.4	0.2	0.5	0.1	0.3
DK	0.1	0.2	0.2	0.1	0.2	0.2	0.2	0.1
EE	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.9
EL	3.3	3.3	3.6	3.4	3.4	3.4	3.7	3.5
ES	1.7	1.6	1.7	1.9	2.3	2.0	1.8	1.0
FI	0.2	0.6	0.2	0.3	0.2	0.6	0.2	0.2
FR	0.5	0.6	0.6	1.1	0.6	0.7	0.5	0.8
HR	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
HU	1.0	1.1	1.1	2.2	1.3	1.1	0.7	1.6
IE	0.3	0.4	0.5	0.5	0.6	0.5	0.4	0.4
IT	1.1	2.1	1.2	2.1	2.0	1.3	1.3	1.4
LT	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
LU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LV	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
MT	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
PL	1.1	1.1	1.2	1.2	1.3	0.9	1.0	1.2
PT	2.0	2.1	2.5	2.9	1.7	2.3	2.3	2.7
RO	1.4	1.6	1.6	3.1	1.9	1.4	1.7	2.3
SE	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0
SI	1.0	1.0	1.1	1.1	1.2	1.0	0.9	0.9
SK	1.3	1.3	1.7	2.1	1.7	1.2	0.9	0.8
Mean	1.2	1.2	1.3	1.6	1.3	1.2	1.2	1.3

Note: CY, EE, HR, LT, LU, LV are single-region countries. RRP, recovery and resilience plan.

Source: Authors' own simulations.

the cohesion criterion for regionalization as less developed regions within countries receive more funding compared with the population criterion. On the other hand, a distribution of funds proportional to population would favour more the normally richer capital city regions, leading to more persistent disparities over time (as suggested by the little change in measures of dispersion in the left panel of Table 6).

Table 5. Measures of statistical dispersion.

Regionalization criteria		Baseline	Minimum
Coefficient of variation	Population	0.540	0.535
	Cohesion	0.540	0.534
80th/20th percentile	Population	2.776	2.775
	Cohesion	2.776	2.772
90th/10th percentile	Population	4.754	4.706
	Cohesion	4.754	4.702

Source: Authors' own simulations.

Finally, we investigate what drives the regional GDP impact of the policy apart from the allocation of funds and the distribution of the expenditures across the various shocks. Table 7 reports the correlations between the

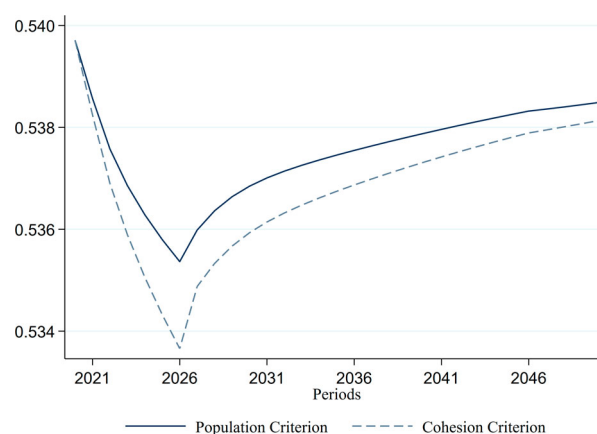
**Figure 7.** Coefficient of variation by regionalization criteria. Source: Authors' own simulations.

Table 6. Per cent changes in measures of statistical dispersion relative to baseline, by country.

RRP recipient	Population criterion			Cohesion criterion		
	$\Delta CV\%$	$\Delta 80\%–20\%$	$\Delta 90\%–10\%$	$\Delta CV\%$	$\Delta 80\%–20\%$	$\Delta 90\%–10\%$
AT	–0.12	–0.29	–0.12	–0.36	–0.52	–0.18
BE	–0.05	–0.01	–0.06	–0.29	–0.37	–0.45
BG	–1.02	–0.30	–1.05	–2.33	–0.17	–2.91
CY	–	–	–	–	–	–
CZ	–0.12	0.00	–0.11	–0.64	–0.03	–0.62
DE	–0.11	–0.13	–0.08	–0.44	–0.35	–0.22
DK	–0.07	–0.01	–0.03	–0.19	–0.05	–0.10
EE	–	–	–	–	–	–
EL	–0.60	–0.59	–0.66	–0.88	–0.62	–0.68
ES	–0.98	–0.35	–0.70	–3.36	–1.55	–1.97
FI	–0.02	–0.03	–0.02	–0.13	–0.09	–0.10
FR	–0.21	–0.01	–0.05	–0.47	–0.28	–0.13
HR	–	–	–	–	–	–
HU	–0.21	–0.35	–0.23	–1.06	–0.99	–1.36
IE	–0.17	–0.10	–0.10	–0.68	–0.39	–0.39
IT	–0.05	–0.06	–0.08	–0.72	–0.47	–1.02
LT	–	–	–	–	–	–
LU	–	–	–	–	–	–
LV	–	–	–	–	–	–
MT	–	–	–	–	–	–
PL	–0.33	–0.24	–0.37	–0.90	–0.41	–1.03
PT	–0.59	0.00	–0.38	–1.25	0.00	–0.84
RO	–0.54	–0.19	–0.49	–0.94	–0.99	–0.18
SE	–0.08	–0.02	–0.04	–0.15	–0.04	–0.07
SI	–0.56	–0.17	–0.17	–1.76	–0.54	–0.54
SK	–0.72	–1.01	–1.01	–1.47	–2.30	–2.30
Mean	–0.34	–0.20	–0.30	–0.95	–0.53	–0.79

Note: CY, EE, HR, LT, LU, LV and MT are single-region countries. RRP, recovery and resilience plan.

Source: Authors' own simulations.

cumulative GDP impact across time, on the one hand, and the initial levels of public and private capital, unemployment and two measures of intensity of global value chain participation, on the other. There is a negative relationship between the stock of capital and the GDP impact that appears to be stable and significant, implying that the provision of funds to regions with higher initial levels of capital, public or private, lead to a lower GDP impact, and vice versa. This finding is consistent with Ramey (2020) who mentions that the initial level of public capital matters, and if it is below the socially optimal level, it is inversely proportional to the long run multipliers. The GDP impact from RRF-related reforms appears to be higher in regions with higher initial levels of unemployment, with a slightly stronger relationship for those containing a higher proportion of medium-skilled unemployed. Regions with a higher embodiment of their exported goods and services in other regions' production processes (forward linkages) are characterized by a higher GDP impact. Conversely, a region's amount of domestic sectoral trade or imports of intermediates (backward linkages) does not seem to

correlate with the level of investment return. The lack of any significant correlation suggests that in the more integrated importing regions the RRF investments do not necessarily generate higher returns.

An additional set of simulations carried out in order to identify interregional spillovers confirms that the GDP impact of the policy is positively associated with trade openness (measured by the ratio of imports over production). By shocking individually each region receiving RRF funding, we are able to calculate the difference between the EU-wide returns from that individual shock and the region-specific returns (expressed in terms of multipliers). The difference between the two represents the spillover generated by the RRF investments in that region, here expressed as a percentage over the EU-wide returns.⁹ By 2036, the interregional spillovers generated by the RRF investments can be significant, and close to 30% in some cases. The data for Figure 8 suggest that the higher the amount a region imports with respect to its production, the higher the generated spillovers, driven by the increased import demand for intermediates within the EU (there is a

Table 7. Correlation of gross domestic product (GDP) impact and initial levels of unemployment, capital and global value chains participation.

	GDP cumulative impact (%)			
	2026	2031	2036	2046
<i>Unemployment (%)</i>				
Low skill	0.11	0.19**	0.19**	0.21**
Medium skill	0.20**	0.30**	0.29**	0.31**
High skill	0.17**	0.25**	0.25**	0.27**
<i>Public capital (%)</i>				
GDP)	-0.22**	-0.24**	-0.24**	-0.21**
<i>Private capital (%)</i>				
GDP)	-0.14**	-0.25**	-0.24**	-0.21**
Forward linkages	0.39**	0.48**	0.49**	0.49**
Backward linkages	0.00	-0.01	0.00	-0.01

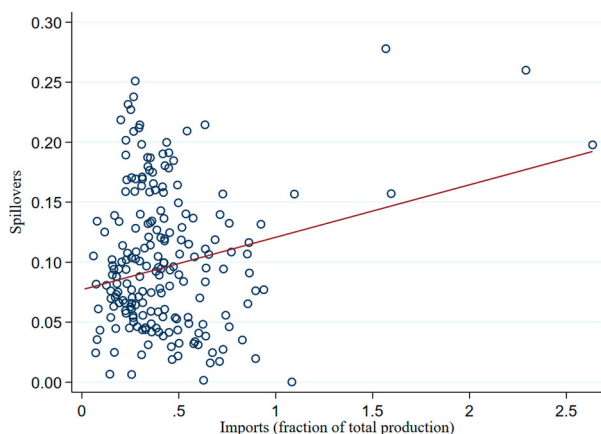
Note: **Significance at 5%. Forward (backward) linkages are defined as the sum of the row (column) elements of the Leontief inverse of the model's interregional input-output matrix and they measure the amount of intermediates a particular region supplies to (receives from) the world. For more information, see Johnson and Noguera (2012).

Source: Authors' own simulations.

positive relationship between the spillovers and imports/production).

6. ROBUSTNESS CHECKS AND SENSITIVITY

We checked the robustness of our results against a series of alternative specifications and scenario hypotheses. First, we report in Appendix D in the supplemental data online additional results obtained by simulating, besides the grants of the benchmark scenario, the loans requested by seven EU countries as of the second quarter of 2022. Appendix D also reports the results of alternative simulations in which the RRF investments are deployed over a longer time period in order to check whether this would affect the overall impact of the policy.

**Figure 8.** Regions' spillovers by 2036 and trade openness (imports over production).

Source: Authors' own simulations.

We now present additional results obtained with alternative calibrations of the model. First, we replace the interest rate used in the simulations illustrated so far with 0.2%, which is the risk-free interest rate registered in EU in 2020, and with 4% which is an upper bound to reflect monetary policy in a state of high inflation. These changes are homogeneous across regions and countries. In both cases, we replace the base year unemployment rates, these being 10-year averages in the simulations illustrated above, with the 2020 rates. The change in the calibrated unemployment rates maintains a certain heterogeneity, both across regions and across labour types (and it produces more significant deviations from the benchmark results). In most cases, the unemployment rate registered in 2020 is lower than the unemployment rate used in the baseline simulations, and this is especially true for low skilled labour. In fact, during the Covid crisis, though the observed GDP loss was large, the employment loss was mostly contained by the policy response.

Finally we remove the assumption that the policy structural effects are characterized by a decay rate. Shocks affecting transport infrastructure, total factor and labour productivity, and labour supply have a decay rate of the form $(1 + 0.05)^{-t}$, implying that 20 years after the start of the policy approximately 37% of the total structural impact of the shock still affects the economy. By removing this assumption, we imply a new (and higher) steady state of the model at the end of the simulation period.

The behaviour of the main macroeconomic aggregates at the EU level is not substantially different from the one reported for the benchmark simulations.¹⁰ As shown in the upper panel of Table 8, a lower interest and unemployment rate leads to slightly higher multipliers across time compared with the benchmark results (Table 3). The contrary is observed in a regime of high interest rates (middle panel of Table 8) and this is attributed to the discount factor, which is lower or higher, respectively, according to the interest rate.

Lastly the removal of decay rates leads to the highest return of the policy investments (bottom panel of Table 8). The 20-year multiplier for the case of the population criterion coupled with a high output elasticity of public capital is €0.47 above the benchmark of €3.25. This occurs due to the lack of any shock depreciation across time and preventing regional economies to return to the original steady state.

7. CONCLUSIONS

We quantify the EU, national and regional impacts of the investments planned in the EU national RRFs using a recursively dynamic spatial general equilibrium model calibrated to all the EU NUTS-2 regions in which regional interactions and spillovers occur through bilateral trade and capital mobility. Our analysis suggests that the EU GDP would be between 0.85% and 1.36% higher in 2026 thanks to the RRF, depending on whether or not loans are included in the analysis. The long run mean GDP multipliers across EU NUTS-2 regions are 3.25

Table 8. Mean present-value gross domestic product (GDP) multipliers across European Union regions, grants, robustness checks.

Output elasticity of public capital	Regionalization criterion	2026	2031	2036	2046
<i>2020 interest and unemployment rates</i>					
0.1	Population	1.20	2.08	2.74	3.62
	Cohesion	1.08	1.89	2.50	3.32
0.05	Population	1.07	1.73	2.19	2.77
	Cohesion	0.96	1.56	1.99	2.51
<i>4% interest rate and 2020 unemployment rates</i>					
0.1	Population	1.15	1.86	2.31	2.78
	Cohesion	1.03	1.69	2.11	2.54
0.05	Population	1.02	1.55	1.86	2.16
	Cohesion	0.91	1.39	1.68	1.95
<i>No decay rates for the structural effects and 2020 unemployment rates</i>					
0.1	Population	1.32	2.20	2.85	3.72
	Cohesion	1.17	1.98	2.58	3.37
0.05	Population	1.18	1.88	2.37	3.03
	Cohesion	1.04	1.67	2.12	2.71

Source: Authors' own simulations.

for grants and 3.17 when including loans, in line with the little existing evidence on the potential effects of the RRF. The results are robust to alternative specifications and assumptions, including different output elasticities of public capital, regional distribution of funds, and alternative interest and unemployment rates. As for the latter, the insights stemming from the analysis obtained with the average EU interest rate of the last 10 years are robust to simulations in which the interest rate is either decreased or increased, with the latter hypothesis becoming increasingly more realistic given the recent developments related to rising inflation and interest rates.

Our results highlight the potentially crucial role of specific regional distributions of the RRF funds in terms of impact on GDP and on regional disparities. In particular, a regionalization criterion favouring catching up of the less developed regions would have the capacity to reduce regional disparities, but at the expense of slightly lower aggregate GDP impact across the EU. A convergence-neutral distribution of funds, proportional to population, would yield higher returns on investment but at the cost of smaller improvements in terms of regional disparities reduction.

These results are relevant for the ongoing debate on the potential complementarities between the RRF and Cohesion Policy. One of the pillars of the former is supporting economic, social and territorial cohesion, but most RRFs do not appear to have this as a significant objective, focusing rather on the green and digital transitions. Synergies between the two policies may emerge given some common themes and the fact that the implementation of the RRF could take advantage of the well-established structures and procedures of Cohesion Policy.

However, the common themes may also lead to conflicts in terms of which funds would be deployed to

achieve the same objective, with the Cohesion Policy funds risking to be put aside in favour of the RRF ones. The latter come with a lower administrative burden and a higher priority, as recovery is currently the primary concern in the EU. In this respect, the delays observed in the launch and implementation of the 2021–27 Cohesion Policy programmes seem to suggest that the RRF investments are already acting as a (partial) substitute for many EU regions. This is related to the issue of absorptive capacity, as it is unclear whether the EU territories will be able to put to use all the resources at their disposal via RRF and Cohesion Policy. This could constitute the focus of a more specific analysis on the complementarities between the two policies. Finally, the interactions between the RRF and Cohesion Policy are relevant for the future of the EU regional disparities, since the RRF effects on the latter would depend on the territorial distribution of its funds, as highlighted by our analysis.

Future research would also need to address inevitable updates of the data underlying the analysis, as new RRF-related requests are submitted by the member states and approved by the European Commission (for instance on loans), and as new data on the actual deployment of the funds become available.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors. The views expressed in this paper are purely those of the authors and may not in any circumstances be regarded as stating an official position of the European Commission.

NOTES

1. Previous studies that have attempted to quantify the impact of similar post-recession rescue packages and fiscal stimuli include Leeper et al. (2010), Drautzburg and Uhlig (2015) and Ramey (2020).
2. Since the RRF only takes place in the EU, the UK and the rest of the world are not shocked in the simulations that follow, but they participate in trade with the EU regions (see also Figures 2 and 3).
3. The paper was published in January, before the EU countries had the time to submit their plans.
4. The macroeconomic impact of Cohesion Policy has been assessed using both econometric methods and modelling frameworks. The existing econometric estimations are mainly based on cross-country or cross-region growth regressions augmented with Cohesion Policy variables. This strand of the literature is inconclusive regarding the impact of Cohesion Policy on growth (for instance, see the surveys by Berkowitz & Pieńkowski, 2016; and Mohl, 2011). Some contributions conclude to a positive and significant impact (e.g., Dall'erba, 2005), sometimes conditioned by other factors such as openness to trade, the quality of institutions or the regions' absorption capacity (Becker et al., 2013; Rodríguez-Pose & Garcilazo, 2015). Others point to no significant or even negative impact (Breidenbach et al., 2016). Alternative econometric methods such as regression discontinuity analysis led to evidence pointing to a significant positive impact of Cohesion Policy, albeit sometime modest (Pellegrini et al., 2013). Model simulations have also been used to analyse the impact of Cohesion Policy. There is little evidence at the regional level (one exception being Crucitti et al., 2022), as mostly national-level models have been used such as HERMIN (Bradley & Untiedt, 2009), GIMF (Allard et al., 2008) or QUEST (Monfort et al., 2017). The evidence in these cases points towards significant macroeconomic effects of the policy in both the short and long terms.
5. At the time of writing this paper (second quarter of 2022), 26 countries have submitted their RRFs.
6. In fact, some countries have decided to indicate criteria governing the territorial distribution of the funds. For instance, the Italian government has decided to earmark at least 40% of the funds which can be allocated territorially to its Southern regions (LEGGE 29 luglio 2021, n. 108, art. 2.6 bis), while the Spanish criteria are established via a consultative process across different government levels (Real Decreto-ley 36/2020; <https://planderecuperacion.gob.es/ejecucion/criterios-distribucion-fondos-ccaa>). As a result, the data on these distribution criteria are not homogenous over the whole EU, making it difficult to incorporate in the present analysis.
7. Present value multipliers at time t after the policy change are given by:

$$m_t^{GDP} = \frac{\sum_{i=0}^T (\Pi_{i=0}^t (r_{t+i})^{-1}) \Delta GDP_{t+i}}{\sum_{i=0}^T (\Pi_{i=0}^t (r_{t+i})^{-1}) \Delta \Phi_{t+i}},$$

where r_{t+i} is the model's interest rate used to discount the multiplier; and $\Delta \Phi_{t+i}$ and ΔGDP_{t+i} are the changes in the policy variables of interest and the associated change in output, respectively.

8. The coefficient of variation is calculated by dividing the standard deviation of the GDP per capita distribution by its mean. The interpercentile ratio is the GDP per capita of a high percentile divided by a low percentile. We present the 80th/20th and the 90th/10th ratios.
9. Defined as:

$$Spillover_r = 1 - \frac{Multiplier_r}{EU-wide Multiplier_r}.$$

10. Detailed results not reported for the sake of brevity, but are available from the authors upon request.

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REFERENCES

- Allard, C., Choueiri, N., Schadler, S. M., & Van Elkan, R. (2008). Macroeconomic effects of EU transfers in new member states. *IMF Working Papers*, WP/08/223. <https://doi.org/10.5089/9781451870817.001>
- Armington, P. S. (1969). A theory of demand for products distinguished by place of production. *Staff Papers – International Monetary Fund*, 16(1), 159–178. <https://doi.org/10.2307/3866403>
- Bankowski, K., Ferdinandusse, M., Hauptmeier, S., Jacquinot, P., & Valenta, V. (2021, January). *The macroeconomic impact of the NextGenerationEU instrument on the euro area* (Occasional Paper Series No. 255). European Central Bank (ECB). <https://doi.org/10.2139/ssrn.3797126>
- Becker, S. O., Egger, P. H., & von Ehrlich, M. (2013). Absorptive capacity and the growth and investment effects of regional transfers: A regression discontinuity design with heterogeneous treatment effects. *American Economic Journal: Economic Policy*, 5(4), 29–77. <https://doi.org/10.1257/pol.5.4.29>
- Berkowitz, P., & Pieńkowski, J. (2016). Econometric assessments of Cohesion Policy growth effects: How to make them more relevant for policymakers. In J. Bachtler, P. Berkowitz, S. Hardy & T. Muravska (Eds.), *EU Cohesion Policy: Reassessing performance and direction. Regions and cities* (pp. 55–68). Routledge.
- Bradley, J., & Untiedt, G. (2009). *Analysis of EU Cohesion Policy 2000–2006 using the CSHM: Aggregate impacts and inter-country comparisons* (Report to the European Commission (DG REGIO)).
- Breidenbach, P., Mitze, T., & Schmidt, C. (2016). *EU Structural Funds and regional income convergence – A sobering experience* (CEPR Discussion Papers No. 11210).

- Bruegel. (2021). *European Union countries' recovery and resilience plans*. Bruegel. Version 1.0. <https://www.bruegel.org/publications/datasets/european-union-countries-recovery-and-resilience-plans/>
- Crucitti, F., Lazarou, N., Monfort, P., & Salotti, S. (2022). *The RHOMOLO impact assessment of the 2014–2020 Cohesion Policy in the EU regions* (JRC Working Papers on Territorial Modelling and Analysis No. 01/2022). European Commission, Seville, JRC128208.
- Dall'erba, S. (2005). Distribution of regional income and regional funds in Europe 1989–1999: An exploratory spatial data analysis. *The Annals of Regional Science*, 39(1), 121–148. <https://doi.org/10.1007/s00168-004-0199-4>
- Drautzburg, T., & Uhlig, H. (2015). Fiscal stimulus and distortionary taxation. *Review of Economic Dynamics*, 18(4), 894–920. <https://doi.org/10.1016/j.red.2015.09.003>
- European Commission. (2020). *Annexes to the Proposal for a Regulation of the European Parliament and of the Council establishing a Recovery and Resilience Facility*. COM(2020) 408 final.
- European Union. (2021). *Regulation (EU) 2021/241 of the European Parliament and of the Council of 12 February 2021 establishing the Recovery and Resilience Facility*. L 57/17.
- Johnson, R. C., & Noguera, G. (2012). Accounting for intermediates: Production sharing and trade in value added. *Journal of International Economics*, 86(2), 224–236. <https://doi.org/10.1016/j.jinteco.2011.10.003>
- Krugman, P. (1991). Increasing returns and economic geography. *Journal of Political Economy*, 99(3), 483–499. <https://doi.org/10.1086/261763>
- Lecca, P., Barbero, J., Christensen, M. A., Conte, A., Di Comite, F., Diaz-Lanchas, J., Diukanova, O., Mandras, G., Persyn, D., & Sakkas, S. (2018). *RHOMOLO V3: A spatial modelling framework* (JRC Technical Reports JRC111861. EUR 29229 EN). Publications Office of the European Union. <https://doi.org/10.2760/671622>
- Leeper, E. M., Walker, T. B., & Yang, S. C. S. (2010). Government investment and fiscal stimulus. *Journal of Monetary Economics*, 57(8), 1000–1012. <https://doi.org/10.1016/j.jmoneco.2010.09.002>
- Malliaropoulos, D., Papageorgiou, D., Vasardani, M., & Vourvachaki, E. (2021). The impact of the recovery and resilience facility on the Greek economy. *Bank of Greece Economic Bulletin*, 53, 9–28. <https://doi.org/10.52903/econbull20215301>
- Mohl, P. (2011). Econometric evaluation of EU Cohesion Policy: A survey. In *Empirical evidence on the macroeconomic effects of EU Cohesion Policy*. Springer Gabler. https://doi.org/10.1007/978-3-658-13852-3_2
- Monfort, P. (2020). *Convergence of EU regions redux. Recent trends in regional disparities* (DG REGIO Working Papers No. 02/2020). <https://doi.org/10.2776/27556>
- Monfort, P., Piculescu, V., Rillaers, A., Strzyczynski, K., & Varga, J. (2017). *The impact of cohesion and rural development policies 2007–2013: Model simulations with QUEST III* (Directorate-General for Regional Policy WP 05/2017). <https://doi.org/10.2776/521934>
- Pellegrini, G., Terribile, F., Tarola, O., Muccigrosso, T., & Busillo, F. (2013). Measuring the effects of European regional policy on economic growth: A regression discontinuity approach. *Papers in Regional Science*, 92(1), 217–233. <https://doi.org/10.1111/j.1435-5957.2012.00459.x>
- Pfeiffer, P., Varga, J., & in 't Veld, J. (2021, July). *Quantifying spillovers of NextGenerationEU investment* (European Economy Discussion Papers No. 144). <https://doi.org/10.2765/80561>
- Picek, O. (2020). Spillover effects from next generation EU. *Intereconomics*, 55(5), 325–331. <https://doi.org/10.1007/s10272-020-0923-z>
- Ramey, V. A. (2020). *The macroeconomic consequences of infrastructure investment* (No. w27625). National Bureau of Economic Research (NBER). <https://doi.org/10.7208/chicago/9780226800615-007>
- Rodríguez-Pose, A., & Garcilazo, E. (2015). Quality of government and the returns of investment: Examining the impact of cohesion expenditure in European regions. *Regional Studies*, 49(8), 1274–1290. <https://doi.org/10.1080/00343404.2015.1007933>
- Sakkas, S., Crucitti, F., Conte, A., & Salotti, S. (2021). *The 2020 territorial impact of Covid-19 in the EU: A RHOMOLO update* (Territorial Development Insights Series, JRC125536). European Commission.