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The impact of innovation policy on the regional economies of Europe

Pablo Casas[a], Tryfonas Christou[a], Abián García-Rodríguez[a], Nicholas Joseph Lazarou[a], Patrizio Lecca[b,c], Philippe Monfort[d] and Simone Salotti[a]

[a]European Commission, Joint Research Centre Seville, Calle Inca Garcilaso 3, 41092 Sevilla, Spain, pablo.casas-aljama@ec.europa.eu; tryfonas.christou@ec.europa.eu; abian.garcia-rodriguez@ec.europa.eu; nicholas.lazarou@ec.europa.eu; simone.salotti@ec.europa.eu
[b]ICADE School of Economics and Business Administration, Universidad Pontificia Comillas, Calle de Alberto Aguilera 23, Centro, 28015 Madrid, Spain, plecca@icade.comillas.edu
[c]Institute for Research in Technology, Universidad Pontificia Comillas, Calle del Rey Francisco 4, 28008 Madrid, Spain, plecca@icade.comillas.edu
[d]European Commission, DG REGIO, Cours Saint Michel 23, 1040 Etterbeek, Belgium, philippe.monfort@ec.europa.eu

We evaluate the economic impact of the Horizon 2020 innovation policy using a spatial dynamic general equilibrium model incorporating R&D-based semi-endogenous growth and calibrated for 235 NUTS2 regions of the European Union. The results suggest that the policy can have a positive impact on GDP and job creation, with considerable regional heterogeneity. The GDP gains are expected to be significant in the long run, due to the positive productivity effects of innovation policy funding. Our model provides insights into policy spillovers through production factor dynamics, trade linkages and innovation diffusion, and constitutes an example of how to assess the impact of innovation policy beyond individual projects and towards mission-oriented monitoring.

Keywords: computable general equilibrium modelling, regional economics, semi-endogenous R&D growth, entrepreneurial state, mission-driven policies, European innovation policy

JEL Classifications: C68, O38, O47, R11

Introduction

Mazzucato (2011, 2013) makes a compelling case for a proactive role for the state in promoting, managing and harnessing the directionality of innovation policy. In addition to a historical examination of the relationship between government intervention and economic growth, she presents a series of case studies in which governments have been the leading actors in achieving innovative breakthroughs that have enabled firms and economies to grow. According to the evidence presented, public intervention is necessary because the state is the principal actor willing to fund basic research, which is the most uncertain phase of research (see Angori et al., 2024). The private sector is too risk-averse for this and tends to engage in applied research, which guarantees more immediate returns (Castelnovo and Florio, 2020). Mazzucato (2011, 2015) uses the term "entrepreneurial state" to identify this proactive role of governments in innovation policy, where the state is seen as the creator of the knowledge economy.[1]

These reflections in the literature and the concept of the entrepreneurial state are in line with the evolution of actual innovation policies in recent decades. Their focus has shifted from addressing market failures to strengthening national innovation networks and now to tackling societal problems. [These three phases are well described by Schot and Steinmueller (2016).] In the European Union (EU), this shift in paradigm has been reflected in the evolution of the Horizon programmes. The forthcoming Horizon Europe programme explicitly uses the concept of missions to address the existing societal challenges,[2] which was already at the core of the previous Horizon 2020 (H2020) programme.[3]

Societal challenges are complex and cannot be solved by a single country, nor by a single region alone, and are best addressed at the supranational level. This is particularly

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true on the European continent, where the EU already relies on a multilevel governance system (Mazzucato, 2018). However, innovation policies, whether implemented through missions or not, must take into account the existing regional diversity and heterogeneity in terms of talent and expertise (McCann and Ortega-Argilés, 2013). Regional economies play a crucial role in the context of innovation ecosystems and innovation policy (Calignano, 2022, De Noni and Belussi, 2021; Gebhardt, 2012), and it is worth analysing the impact of European innovation policy on EU regions.[4]

While innovation policies such as H2020 aim to foster economic growth and address societal challenges, the effectiveness of such policies is likely to vary significantly across regions due to differences in the local context. Key determinants of the R&D production function, such as the existing stock of knowledge and the availability of skilled labour, show marked interregional disparities across the EU. Regions are likely to respond differently to such a policy depending on the presence or absence of robust R&D ecosystems and a high concentration of skilled labour.

This heterogeneity in regional responses raises important questions about the wider impact of H2020 on economic cohesion and regional disparities. While the policy aims to stimulate innovation-driven growth, its impact on interregional disparities remains unclear and warrants detailed investigation. Understanding these dynamics is particularly relevant for policymakers seeking to design inclusive innovation strategies that maximise positive spillovers and minimise unintended disparities. Against this background, in this study we use a spatial dynamic general equilibrium model to analyse the impact of H2020 funding across all NUT2 regions in the EU, explicitly accounting for interregional differences in initial conditions and R&D capacities.

The model incorporates R&D-driven endogenous growth and interregional technological spillovers, in the manner of a modified discrete-time R&D model originally developed by Jones (1995, 2005).[5] Our results suggest a significant positive long-term impact of the European innovation policy, with considerable geographical heterogeneity, in line with existing evidence (Bednář and Hálásková, 2018; Blažek and Kadlec, 2019). Furthermore, our model-based analysis suggests that government R&D policies take time to become fully operational and effective, especially if they are financed by corresponding distortionary taxes. In the short term, not all regions benefit from the disbursement of H2020 funds. Regions that receive smaller amounts of funding but contribute significantly to the EU budget may experience short-term negative effects. We also find that regions with a high initial endowment of resources or capabilities and a high degree of openness can mitigate these short-term effects and further enhance the positive long-term effects through positive R&D and trade-related regional spillovers (consistent with the findings of, among others, Audretsch and Feldman, 2004). Our work also highlights the need for impact assessment studies to identify causal effects beyond the perspective of individual projects.[6] Provided the modelling strategy is sound, we can then assess whether the policies designed are likely to achieve the quantitative objectives set out in the missions (where these are explicit), as well as the broader societal challenges to which the missions themselves are intended to contribute.

This paper is structured as follows. The next section reviews the literature on the entrepreneurial state and European innovation policy, with a focus on the H2020 data used as an input for the modelling analysis. This is followed by a presentation of the most relevant features of the model for analysing the impact of innovation policy and an outline of the simulation strategy. The macroeconomic impacts of H2020 in the EU regions are then reported and the determinants of these impacts are examined. The paper then examines the robustness and sensitivity of the results to key model parameters. Finally, the conclusion summarises the findings. Further details on the model and its calibration are provided in a Supplementary Appendix.

The entrepreneurial state and the European innovation policy

The EU's H2020 research and innovation programme was launched in 2013 for the 2014–2020 programming period (Regulation 1291/2013). With a budget of almost €74 billion, it represents a significant amount of investment in research and innovation, confirming it as one of the largest global funds for science and innovation and the largest fund under a single political authority (Mazzucato, 2018). H2020 was designed to drive economic growth and create jobs, with a focus on scientific excellence, and to address societal challenges related to health, demographic change and well-being; food security and sustainable agriculture; secure, clean and efficient energy; smart, green and integrated transport; climate action and the environment; inclusive, innovative and reflective societies; and security (Mazzucato et al., 2015).

H2020 provided funding through competitive calls for proposals and was open to researchers, businesses and innovators across the EU and beyond. It encouraged collaboration between universities, research centres, industry and other innovation actors. However, the design of the policy lacked concrete measures to monitor the achievement of these challenges, and it did not establish missions to facilitate their realisation. In fact, the only monitoring system attached to the policy is related to evaluation at the level of individual projects, thus lacking the systemic view that would be key to ensuring the guiding role of the above-mentioned entrepreneurial state (in this case, more than one state, the EU). The programme has attracted the attention of academics and researchers who have studied aspects such as its impact on innovation (Veugelers et al., 2015) and on firm growth (Mulier and Samarin, 2021), the creation of collaborative networks (Kosztyán et al., 2024), the policy's focus on GDP growth (Pollex and Lenschow, 2018) and what motivates institutions to participate in the programme itself (Enger, 2018).

A detailed presentation of the H2020 data is beyond the scope of this paper. Suffice it to say that the total amount of funding examined here is almost €56 billion, spent between 2014 and 2021. This is less than the total budget of the policy, as the analysis focuses on funding targeted at the regions of the 27 EU member states. Figure 1 shows the distribution of average annual H2020 funding over the period 2014–2021 across the EU regions, expressed as a percentage of 2017 GDP. Darker areas on the map represent regions receiving higher levels of funding, while lighter shades correspond to regions receiving progressively lower amounts. A visual inspection of the map shows that these funds are mostly concentrated in Central Europe, and in the most developed regions within the EU member states, including capital city regions (such as Paris and Dublin), with amounts exceeding 0.045% of GDP on average in each of the 8 years in which the policy has been implemented. The Eastern European regions stand out for the relatively low amounts of H2020 funding invested in them, with some exceptions in the capital city regions such as RO32 (București-Ilfov) in Romania, which received a total of just over €200 million, PL91 (Warszawski Stołeczny) in Poland, with almost €400 million, and EL30 (Attiki) in Greece, which received more than €1 billion.

The regional distribution of funds presented here is interesting in1–24 itself and should be kept in mind when reading the results of the modelling analysis presented in the remainder of this document. It is clear that the economic impact in a region will be correlated with the amount of money spent there, although interregional spillovers and indirect/induced effects of the shocks require the use of a general equilibrium framework to better understand the impact of the policy.

The model and the simulation strategy

A spatial model of semi-endogenous growth

Brief description

The model developed for and used in this paper is an extended variant of the RHOMOLO model (Barbero et al., 2022), calibrated with data for the year 2017 (García-Rodríguez et al., 2025). Unlike previous versions, this model integrates R&D-driven endogenous growth and interregional technological spillovers, using a modified discrete-time R&D model originally developed by Romer (1990) and extended by Jones (1995, 2005). This approach is aligned with the work of Butler and Pakko (1998), Diao et al. (1999) and the European Commission's dynamic stochastic general equilibrium model called QUEST (Pfeiffer et al., 2024).

The model consists of 235 NUTS2 regions of the EU and an aggregated region representing the rest of the world, which is modelled as an exogenous external aggregate. Each regional economy is composed of 10 sectors in which firms operate under monopolistic competition.[7] Firms produce a single variety that is an imperfect substitute for the variety produced elsewhere. Regional goods and services are produced by combining value added with domestic and imported intermediate inputs. These in turn are purchased by households, governments and investors in the form of final goods, and by firms themselves in the form of intermediate inputs.[8]

Profitability in the region drives investment by firms. We model investment using a partial adjustment model where profit opportunities exist when the desired level of capital is greater than the actual capital stock (Hall and Jorgenson, 1967; Jorgenson, 1963). This reflects a sluggish adjustment of capital due to existing adjustment costs, with firms gradually moving towards their optimal, frictionless level of capital stock in each period. Finally, government expenditure is divided into current expenditure on goods and services, capital expenditure and net transfers to households. Current expenditure has only a demand-side effect, while capital expenditure represents realised investment infrastructure that increases the public capital stock and thus has a supply-side effect, although this is partly mitigated by the congestion effects mentioned earlier. Revenues are raised through labour and capital taxes on household income and indirect taxes on the production of goods and services.[9]

The model incorporates interregional trade, labour market imperfections and technological spillovers, making it particularly well suited to assessing the spatial and dynamic effects of innovation policies. The R&D sector is modelled explicitly, allowing for the generation of new knowledge through the use of skilled labour, and allowing for diminishing returns to scale in R&D activities at the regional level. The model also captures regional heterogeneity in production structure, public investment and trade openness. The Supplementary Appendix provides a full mathematical description of the model.

Production of new capital varieties

In order to develop and produce new varieties of capital, firms must engage in R&D activities that result in a new design or blueprint. Firms in the R&D sector produce designs using only skilled labour (in the regional market), in line with the existing evidence on the employment effects of R&D activities (Aldieri et al., 2021). Moreover, R&D firms are symmetric and share the same production technology:

$$\Delta H_r = -\delta^H H + \upsilon Z_r^{\xi} H_r^{\phi} J_r^{\gamma}, \tag{1}$$

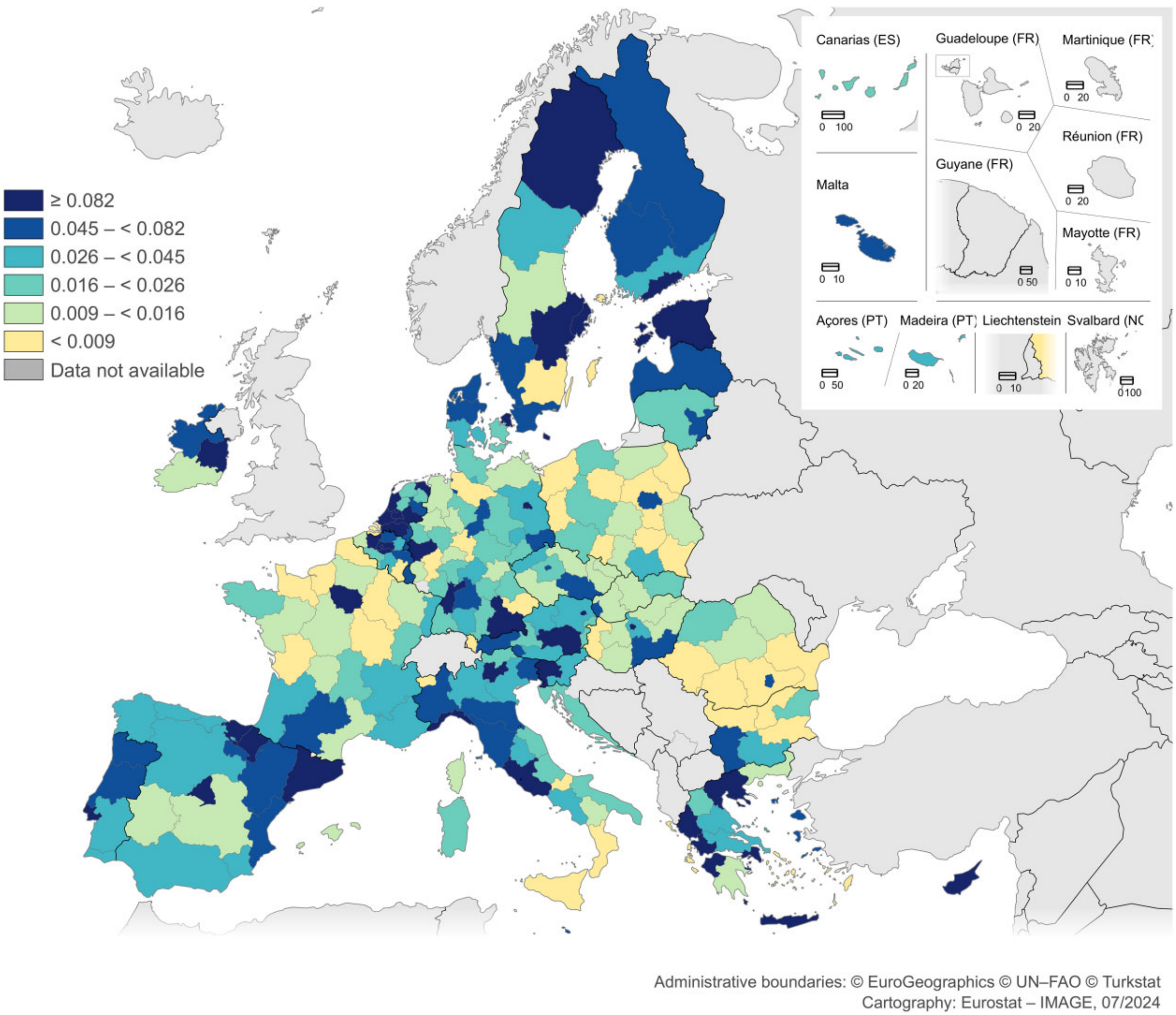

Figure 1. Territorial distribution of the H2020 funds in the EU regions (per cent of 2017 GDP, yearly average over the 2014–2021 period). *Source*: European Commission's DG RTD (H2020 funds) and García Rodríguez et al. (2025) (GDP). Data are categorised into six different classes, with each class representing a sextile of the data distribution.

where ΔH_r is the generation of new designs or blueprints, ν is the efficiency of R&D, H_r is the stock of R&D accumulated in each region that depreciates at the rate δ^H, Z_r captures the R&D regional spillovers and J_r is the input of skilled labour used to produce new ideas. This technology exhibits decreasing returns to scale in the input of individual firms, as γ is typically less than 1; γ measures the elasticity of R&D production to the number of researchers. However, once the new design is created, it will generate increased productivity via the accumulation of past knowledge stocks H_r and interregional spillovers Z_r according to the values of the elasticities ϕ and ζ, respectively. The parameter ϕ measures the elasticity of the common stock of knowledge to the production of new designs, while ζ measures the spillovers originating from the rest of the EU regions. In particular, the exponent ϕ determines the degree of diffusion of technological innovation, which implies that the rate of innovation decreases with the level of knowledge if $\phi < 0$ or increases with the level of knowledge if $\phi > 0$. In the case of fully endogenous growth, $\phi = 1$.

The technological R&D spillover Z_r is modelled following Coe and Helpman (1995), where the interregional R&D spillovers are transmitted via the import-weighted pool of technological knowledge of the rest of the EU, according to the following specification[10]:

$$Z_{r'} = \rho_{r'} \left[\sum_r H_r V_{r,r'} \right], \tag{2}$$

where $V_{r,r'}$ is the share of goods of region r imported from region r'. Essentially, the stock of common knowledge produced in each region spills over to regions r', according to the share of goods imported from region r' weighted by the parameter $\rho_{r'}$, which reflects the ability of regions to capture R&D developed elsewhere. Thus, regions that are able to stimulate their own domestic R&D or R&D policies targeted at specific regions can become an important growth factor for other regions.

Final output production and accumulated knowledge

The level of accumulated knowledge, $H_{r,i}$, enters the production function for final output as a form of capital-augmenting technological change[11]:

$$Y_{r,i} = \left(KG_r^d\right)^{\psi}\left[\zeta_{r,i}^K\left(H_{r,i}K_{r,i}\right)^{\frac{\sigma-1}{\sigma}} + \zeta_{r,i}^L L_{r,i}^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}, \quad (3)$$

where KG_r^d is the effective public capital entering the production function as an unpaid factor of production (Baxter and King, 1993; Glomm and Ravikumar, 1997), implying that all firms in all sectors enjoy the same level of free public capital. KG_r^d is obtained as an income-congested full stock of public capital accumulated through public investment in infrastructure. The congestion effects arise from the different degrees of non-rivalry and non-excludability associated with public goods (see Bergstrom and Goodman, 1973; Stiglitz and Rosengard, 2015). The model is then characterised by decreasing marginal congestion (see Edwards, 1990; Fisher and Turnovsky, 1998). The parameter ψ is the elasticity of value added to public capital. Substitution between the two types of primary factors is determined by the elasticity of substitution σ and the share parameters $\zeta_{r,i}^K$ and $\zeta_{r,i}^L$, for private capital $K_{r,i}$ and labour $L_{r,i}$, respectively.

Equation (3) defines the constant elasticity of substitution combination between the capital-augmenting technology and labour to obtain value added. In a top nest, value added is combined with intermediate inputs to produce total output (see the Supplementary Appendix). The model distinguishes between three different categories of workers according to their level of education (low, medium and high). There is no mobility of workers between education levels and regions, but the model allows for sectoral labour mobility within each region. For workers in each educational category, we allow for involuntary unemployment and the wage–setting relationship is represented by a wage curve (Blanchflower and Oswald, 1995), according to which lower levels of unemployment increase workers' bargaining power and hence real wages.

The simulation strategy

Based on the official impact assessment carried out by the European Commission (2024), which uses historical H2020 administrative data (source: Common Research Data Warehouse, CORDA), it is assumed that 40% of the H2020 funding (allocated to public bodies) is allocated to basic research and 60% to applied research.

The model considers three main channels: (1) increased public investment, (2) increased private investment and (3) subsidies to R&D employees. The funding of basic research is simulated through an increase in public investment, which leads to a temporary increase in the public capital stock of the regions (which depreciates at a rate of 5% per year). Due to the role of public capital in the production function, in addition to the demand-side effect of increased (public) investment, this increases the productivity of firms (see Equation (3) and Equation (A.14) in Supplementary Appendix A). It is assumed that the applied research funds are directed to private firms and either reduce the cost of capital, leading to an increase in private investment, or subsidise R&D workers J_r. The corresponding increase in private investment leads to a temporary increase in the private capital stock (which depreciates at an annual rate of 15%), while the subsidies reduce the cost of labour for R&D activities, thus stimulating R&D, which in turn has a positive effect on the productivity of capital, as shown in Equation (3). While additional shocks can be introduced into the model, we believe that these three broad categories provide a reasonable approximation of the effects of the policy, given the available information on specific interventions.

Finally, the policy is assumed to be financed by distortionary labour taxes (see also Pfeiffer et al., 2024). To mimic the financing of the EU budget, regional contributions are proportional to the GDP weight of each region in the EU GDP. A region does not necessarily have to finance the policy with a contribution equal to the amount of H2020 earmarked for the region itself, but instead the contribution depends on the share of EU GDP generated in the region. The choice of financing method, based on shifts in income tax rates, aims to assess whether negative supply-side effects of distortionary taxes can be partially offset by public policies to support R&D. The effects of tax-financed budget-neutral fiscal expansion are often uncertain, and the economic literature has repeatedly questioned the non-Keynesian effects of fiscal policy, even in the long run (see Briotti, 2005). In the next section, we show that even with distortionary taxes, the long-run impact is positive in all regions, although the short-run impact is negative in the majority of regions (see the "The macroeconomic impact of H2020" section).

It is important to note that this analysis focuses on the economic impact of H2020 by comparing the results to a baseline scenario with no policy, excluding any other external shocks. This allows us to assess the direct contribution of the R&D policy in isolation, without the interference of unrelated economic disturbances.[12] In addition, we assume that the disbursement of funds over the horizon reflects actual policy spending patterns and is not the result of a welfare-maximising optimisation process.

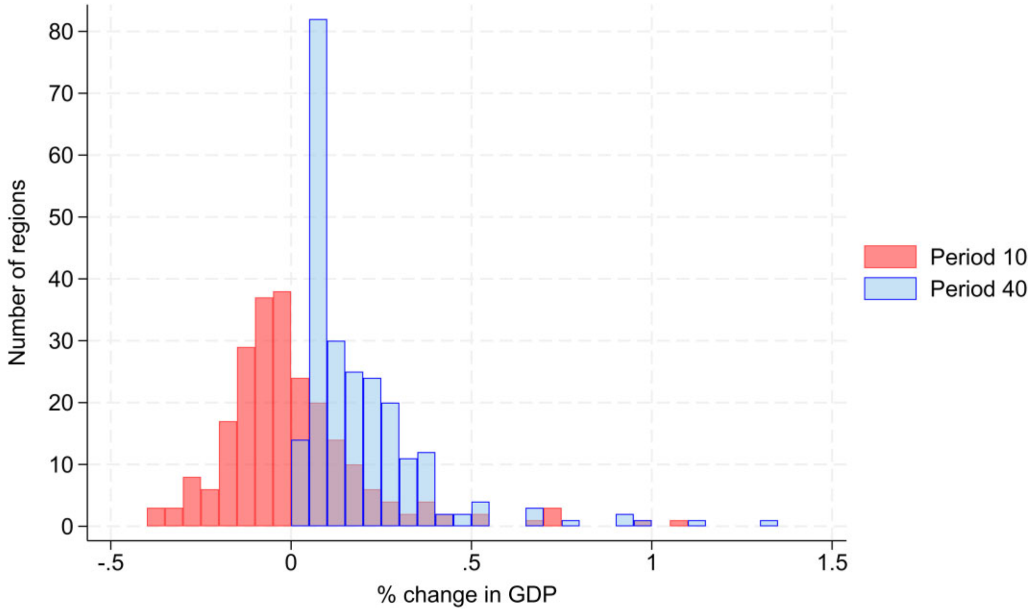

Figure 2. Regional distribution of GDP impact.
Source: Authors' calculations.
Note: Per cent changes from steady-state GDP.

In addition, we emphasise that the disbursement of H2020 funds followed region-specific timetables, reflecting differences in regional participation and absorptive capacity. While the model does not endogenously simulate early or late technology adoption, regional differences in initial R&D stock and funding allocation indirectly capture these dynamics. Regions with higher initial R&D capacity and earlier access to funds show stronger short-term responses, consistent with the benefits of early adoption.

The scenario analysed in this study is based on the actual disbursement of H2020 funds, ensuring that the analysis reflects the actual policy implementation rather than an idealised or planned scenario. While this approach takes into account adjustments in the allocation of funds during the implementation of the programme, it does not explicitly model the impact of broader exogenous shocks, such as macroeconomic crises or emergencies, on policy outcomes.

The macroeconomic impact of H2020

This section details the results of the policy analysis, focusing first on the general equilibrium effects on GDP and economic welfare and analysing the resulting relationships and movements between the model variables after the shock. We then examine how regional initial conditions affect the impact of the policy by running a series of regressions on simulated data (see the "The importance of the initial conditions" section). As the effects of R&D policies take time to fully materialise, the results are analysed over two periods: period 10, which is 2 years after the end of the implementation of the H2020 policy and is therefore considered to be the short term, and a long term period, which is assumed to be period 40.

Macroeconomic effects on GDP

Figure 2 illustrates the regional distribution of GDP deviations from baseline (expressed as percentage changes) in both period 10 and period 40. In period 10, most regions experience negative changes in GDP, suggesting that financing the policy through a distortionary income tax has negative effects in the short to medium term. By period 40, however, all regions are expected to experience a positive impact of the policy.

The changes in regional GDP in period 10 are negligible, with an average of about −0.004% and a standard deviation of 0.20. A positive impact on GDP is observed in 94 regions, while the rest experience a negative impact. In this period, the regions with a positive impact are those that received large amounts of net funding. Conversely, in period 40, the distribution is skewed to the right and the average change in GDP is around +0.2% with a standard deviation close to 0.18. All regions report positive GDP effects, including some that receive a relatively small amount of H2020 funding. The short-term effects of R&D are weak and cannot compensate for the corresponding increase in income tax, particularly in regions that contribute more than they receive from the budget. This is the case for some regions in Germany, France and Italy. In the long run, the variability of GDP changes between regions decreases, suggesting that even regions receiving less funding can realise benefits comparable to those of the main beneficiary regions. This long-term impact is driven by the legacy effects of the accumulation of private and public capital stocks, on the one hand, and the structural change effects of the accumulation of the R&D, which exerts downward pressure on prices, thereby improving competitiveness and therefore stimulating further economic activity, on the other.

Effects on economic welfare

Moving beyond the analysis of the policy impact in two specific periods, we now assess its effects on consumer welfare over the entire simulation horizon. We calculate money-metric welfare as the change in per capita consumption when comparing the policy scenario with the no-policy scenario, measured using the counterfactual prices (Paasche index) as shown in Equation (4) below:

$$\Omega_r = \sum_t^T \frac{1}{(1+d)^t} [P_t^c(\grave{C}_r - \overleftarrow{C}_r)]. \quad (4)$$

This is a compensating variation (CV) measure, where $\grave{C}_r$ is the per capita consumption in period t as a result of the implementation of the H2020 shock, $C^{\leftarrow}{}_r$ is the baseline per capita consumption and P_t^c is the consumer price index (CPI) in period t. (The discount rate d is set to 2%.)[13] In the case of a positive economic shock, such as the European innovation policy, which exerts downward pressure on prices, the CV measures the maximum amount a consumer is willing to pay for the economic change. Recall that the financing method involves a shift in the tax burden on labour, which has a direct impact on wages.[14] Therefore, in the short term, more open regions may experience a loss of competitiveness. This welfare measure is a direct result of the model, where each regional government spends the funds it receives exogenously, without any welfare-maximising objectives.[15]

Figure 3 shows the results of the monetary welfare calculations. We find that the change in welfare over the 40-year period is not positive in all regions. Several regions, particularly in France and Central Europe, show negative effects. However, the average change in consumer welfare per capita calculated across the regions is positive and around €69, while the median is negative and equal to −€106. The highest change in consumer welfare is observed in the Helsinki–Uusimaa region and amounts to around €3601. On the other hand, the lowest change in consumer welfare is observed in the region of Podlaskie and amounts to −€2316. Overall, the map suggests that Eastern and Central European regions do not experience welfare improvements, while Northern European regions such as Sweden, Finland, Ireland, the Netherlands and Belgium, as well as Italy and Greece, experience positive welfare effects. The maps also show a high degree of regional heterogeneity, even within the same country.

There are at least two notable aspects of our modelling that are directly reflected in the results so far. First, in an imperfectly competitive labour market, tax shifting will lead to higher nominal wages, while workers will try to demand higher real wages to restore pre-tax levels. However, these demands will be dampened by the size of the unemployment rate. In these circumstances, the fiscal stimulus is expected to have a negative impact, as tax shifting is likely to be accompanied by negative supply-side effects, operating through higher income tax rates on wages, which in turn generate negative competitiveness effects. This is in line with the standard literature on the negative balanced budget multiplier (Knoester and Van Der Windt, 1987). However, our modelling predicts that this is only the case in the short run and that these effects are typically smaller than in the standard literature on the balanced budget multiplier. Second, the period-to-period accumulation of R&D stocks generates structural change effects that, despite the temporary nature of the policy, may have long-lasting effects beyond the implementation period. In other words, unlike conventional studies of balanced budget multipliers, our model assumes that taxes finance expenditures that directly improve supply-side productivity, such as R&D investment. These expenditures contribute to long-term productivity growth, thereby mitigating the negative supply-side effects typically associated with distortionary taxes.

Comovements with R&D stock

To better understand the distinction between short-run and long-run effects, we examine the relationships and possible comovements between selected variables. Figure 4 shows the relationship between the changes in the stock of R&D (horizontal axis) and the changes in GDP (left panel) and household consumption (right panel) over periods 10 and 40. The model operates in annual time steps, with each period corresponding to 1 year. Period 10 represents the short-term effects of the policy 2 years after the end of its implementation, while period 40 represents the long-term effects 40 years after the start of the policy. These time periods were chosen to capture both the immediate responses to the policy and its lasting legacy effects.

We observe that the correlation between the changes in the stock of R&D and GDP and/or household consumption strengthens as we move from the short run to the long run. This suggests that the effect of R&D on the other economic variables takes time to fully manifest itself and that its benefits are more geographically dispersed and persistent only in the long run.

Estimates of the impact of public R&D investment on economic growth vary widely, particularly in econometric studies based on production functions. However, case studies of specific government-funded projects, such as those

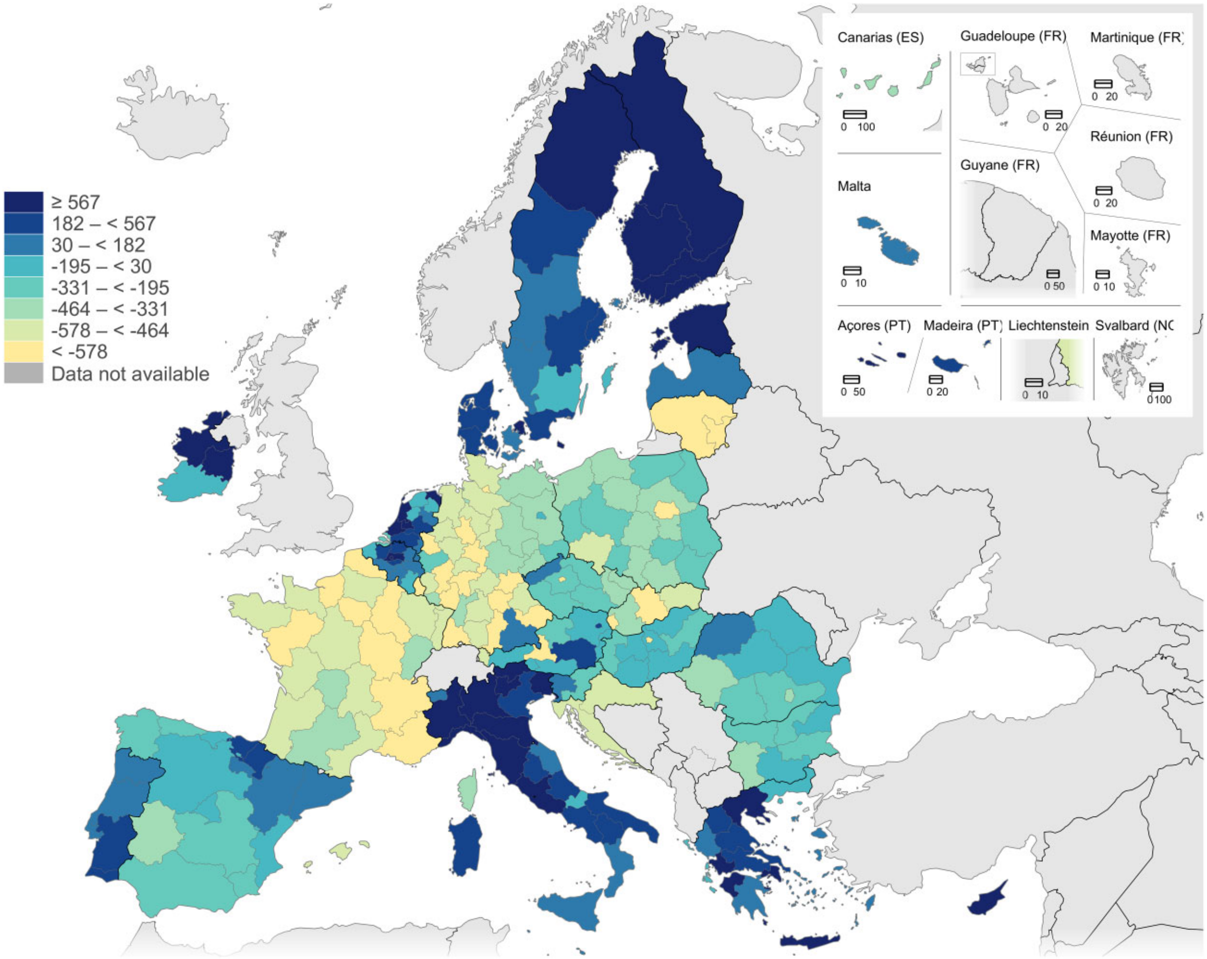

Figure 3. Territorial distribution of the long-run welfare impact of H2020 funds financed with distortionary taxation (euro per capita).
Source: Authors' calculations.
Note: Data are categorised into eight different classes, with each class representing a quantile of the data distribution.

discussed by Mazzucato (2013), show substantial economic benefits to the wider economy. While government spending on R&D undoubtedly promotes long-term growth, in the short term, increased government spending financed through income taxes can crowd out private investment in physical capital, thereby affecting economic dynamics.

The left-hand panel of Figure 5 shows the relationships between the changes in the stock of R&D and those in the stock of private capital for the two periods considered. We observe that, in the short run, changes in the stock of physical capital are negative in some regions and the correlation between the stock of R&D and physical capital is weak. This suggests that there may be crowding-out effects on physical capital in the short run for at least two reasons. First, as mentioned earlier, public interventions have to be financed internally through taxes, which have negative supply-side effects. Second, the increased stock of R&D raises the productivity of private factors. The changes in the stock of physical capital are positive in the long run for all regions and the correlation with private physical capital is strong.

The increased stock of R&D enhances competitiveness and stimulates exports of goods and services by reducing domestic prices. The right-hand panel of Figure 5 shows the relationship between the stock of R&D and the CPI for both the short and the long term. In the short run, prices are likely to fall in only a few regions and the correlation between the stock of R&D and prices is weak. However, as the stock of R&D accumulates over time, the effects on prices of improved factor productivity will become more pronounced and exert downward pressure. As a result, the CPI falls in all regions and the negative relationship between the stock of R&D and the CPI becomes stronger.

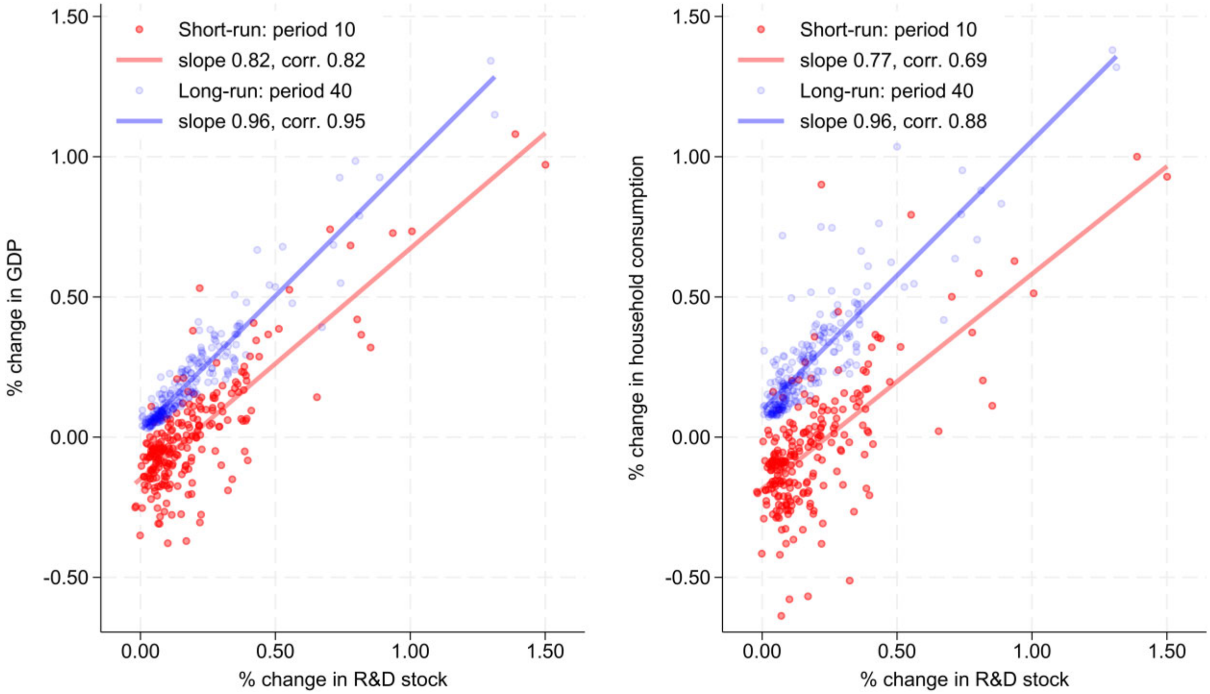

Figure 4. Comovement of the stock of R&D with GDP and household consumption.
Source: Authors' calculations.
Note: All correlations (corr.) are significant at the 1% level.

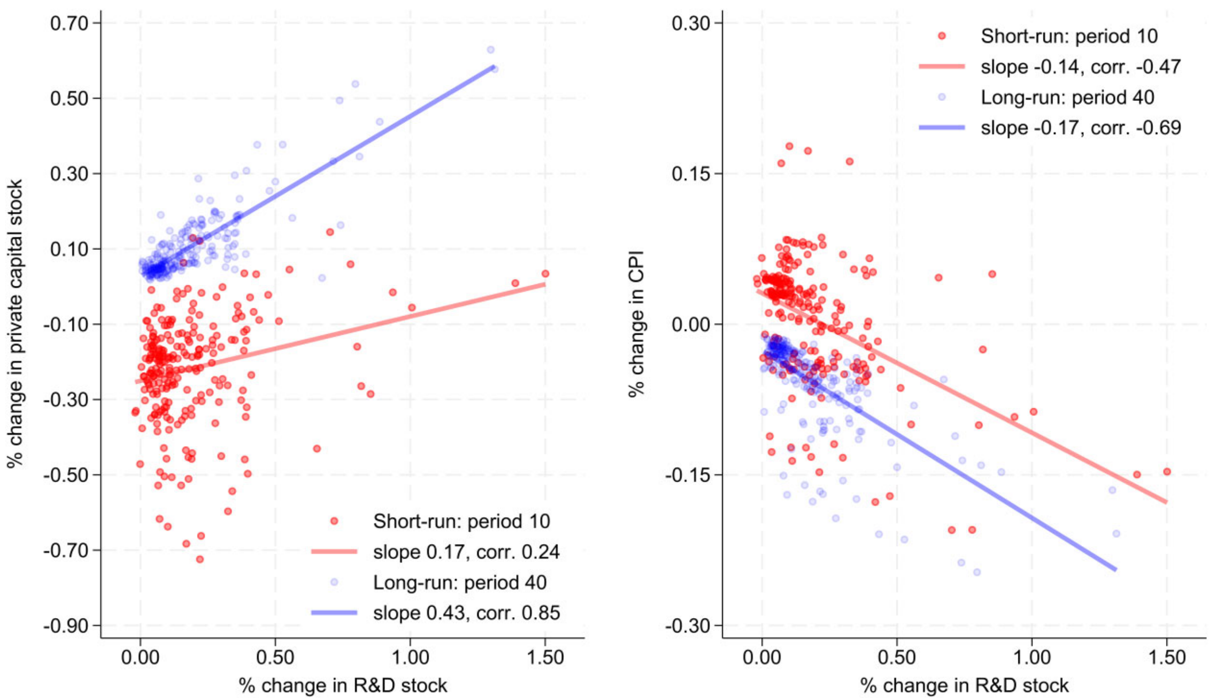

Figure 5. Comovement of the stock of R&D with private capital and CPI.
Source: Authors' calculations.
Note: All correlations (corr.) are significant at the 1% level.

Prices of goods and services are influenced not only by the stock of R&D but also by the accumulation of private physical capital, which exerts further downward pressure on prices. As shown in the left-hand panel of Figure 6, increases in the private capital stock lead to falling prices, and this relationship strengthens in the long run as regional economies transition. However, this effect is less pronounced for the public capital stock, as shown in the right-hand panel of Figure 6. The relationship is weak in the short run and absent in the long run. This result is due to the nature and role of public investment in the model. The exogenous nature of public investment means that once the shock ends, public investment returns to its initial value and the stock of public capital begins to decline according to the depreciation rate. In addition, the accumulation of the public capital stock is subject to congestion effects that moderate its impact on prices, especially in the short run.

The importance of the initial conditions

The determinants of the impact on regional GDP

The assumptions underlying the simulation strategy and the size and territorial distribution of the shock are key factors influencing the results of the policy. In this section, however, we examine the extent to which the pre-shock state of the economies can influence the magnitude and sign of the final results. To do this, we perform a regression analysis at the regional level of the simulated changes in GDP in periods 10 and 40 on a set of explanatory variables representing the state of the economy in the pre-shock equilibrium and reflected in the calibrated share parameters of the model (see Table A1 in the Supplementary Appendix). We consider the initial values of the capital share of total income, a measure of backward/input–output (IO) linkages, regional openness and the initial level of the unemployment rate to be appropriate and relevant variables representing the initial conditions of a region.

The share of capital in total income captures the initial economic structure and productivity differences across regions. According to the literature (Tamura et al., 2019), it is reasonable to expect that capital-intensive economies should be strongly affected by R&D-promoting policies (due to the role of intangible capital), so we expect a positive sign on the coefficient, implying that more capital-intensive regions experience a larger increase in GDP as a result of the policy shock. We also use measures of regional trade openness, given the evidence on its role in R&D-induced growth (see Zachariadis, 2004), generally expressed as exports plus imports divided by 2 times GDP ($\frac{EXP+IMP}{2GDP}$).[16] We distinguish between openness towards regions receiving large amounts of H2020 funding and openness towards regions that are highly R&D intensive. In both cases, we consider regional trading partners that are above the median level of H2020 funding or above the median level of R&D intensity, respectively. The backward linkages are derived from the Leontief inverse matrix (Miller and Blair, 2009) of the calibrated trade matrix in the model and are useful for assessing the importance of domestic intersectoral spillovers and understanding the extent to which the increased demand for goods and services generated by H2020 translates into increased output effects (multiplier effects). Strong IO linkages allow regions to capitalise on the increased demand for goods and services, thereby amplifying the output effects of innovation policies (see, for example, Lecca et al., 2023).

Additionally, we consider the initial calibrated unemployment rates as a measure of unutilised (or excess) capacity in the region (in line with the findings of the empirical literature on public investment multipliers in periods of high and low unemployment—see, among others, Petrović et al., 2021). This is particularly important given the bargaining process built into the model. Higher unemployment could indeed affect real wages, prices of goods and services, and thus incomes.

Finally, we include among the explanatory variables the Regional Innovation Index (RII), which captures the overall innovation performance of a region as measured by the Regional Innovation Scoreboard (Hollanders and Es-Sadki, 2017). The inclusion of this variable is based on the extensive evidence that regional innovation capacity plays a crucial role in determining the outcomes of R&D and innovation policies (see, for example, Crescenzi and Rodríguez-Pose, 2011). Innovation performance is related to both competitiveness (Hollanders and Es-Sadki, 2017; Olariaga-Santa-Cruz et al., 2024) and quality of government (Asheim et al., 2011; Rodríguez-Pose and Di Cataldo, 2015), which led us to include only RII among these three variables in order to have the closest link to the policy under analysis and to ensure easily interpretable results.

As the shock is not symmetric across regions, we also include the shock itself as one of the explanatory variables. This is measured as the ratio of H2020 funding to the initial level of regional GDP levels. We run separate regressions for two simulated periods, $T = 10$ and $T = 40$, to assess the short-run and long-run effects, respectively. These are cross-sectional ordinary least squares (OLS) regressions and the results are presented in Table 1. The first two columns show the regression results for simulated data at period $T = 10$, while columns three and four show the results for period $T = 40$.

In the first column, the only independent variable is the implemented shock, whose coefficient is positive and statistically significant, as expected. The exogenous H2020 shock explains more than 50% of the variability of GDP changes from the initial steady state. However, the importance of the shock diminishes as we move from the short

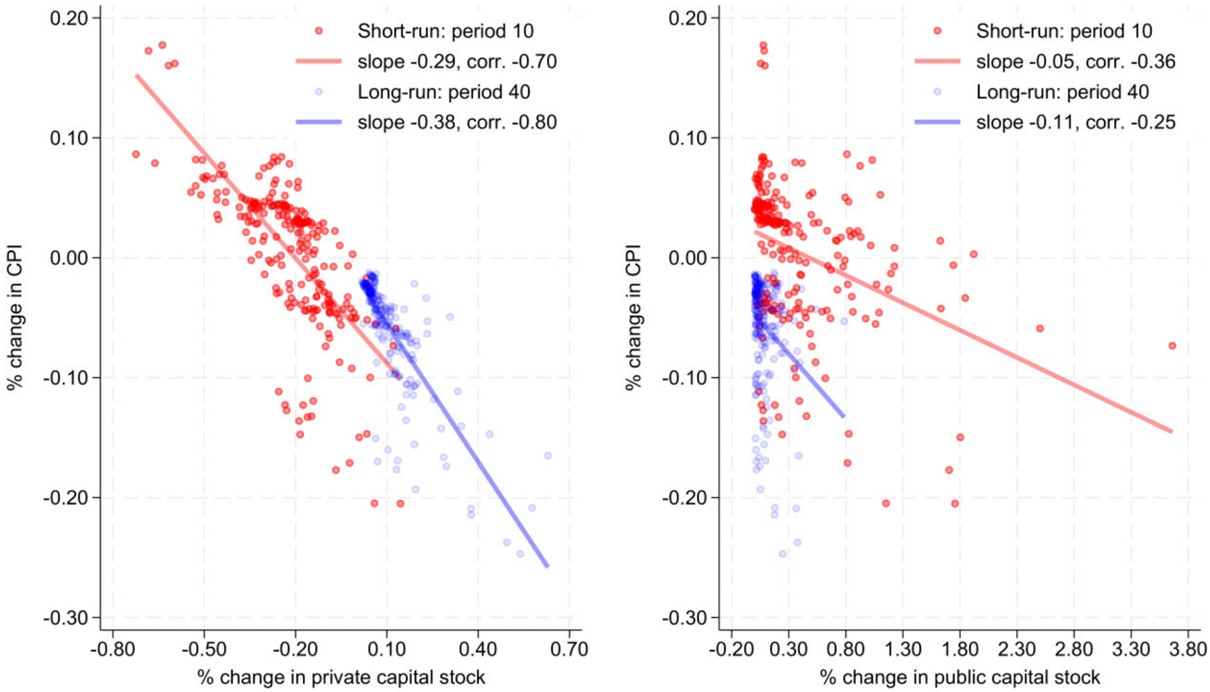

Figure 6. Comovement of the CPI with private and public capital.
Source: Authors' calculations.
Note: All correlations (corr.) are significant at the 1% level.

run to the long run. In fact, in the third column, we find that the size of the coefficient is smaller and the R^2 is reduced to around 30%. Intuitively, this is not a surprising result given that the shock is temporary and ends after eight periods. However, it can still partially explain the variability of regional GDP changes in period 40. This essentially means that the shock has been effective in creating a sufficiently large accumulated stock of R&D that is able to generate long-lasting effects on economic growth.

In the second column, we also include key calibrated shares as explanatory variables. As expected, the capital share has a positive sign and the coefficient is larger in the long run. This pattern is also observed for the other explanatory variables, with the exception of open R&D, unemployment and the RII. Specifically, open R&D becomes statistically insignificant in the long run, unemployment has a negative sign in the short run that becomes positive in the long run and the RII has a negative sign that becomes significant in the long run. Overall, initial conditions have a greater impact in the long run than in the short run. In the short run, the calibrated shares contribute only an additional 10% to the explanation of the variability of regional GDP changes, whereas in the long run their additional contribution is around 30%.

Specifically, the measure of openness is significant in both variants in the short run, while in the long run it is only significant for regions that are open to trading partners receiving substantial H2020 funding. Regions receiving larger amounts of funding will increase their capital stock to meet the additional demand. This also implies that recipient regions should import from other regions in order to maintain a high level of production, thus generating positive spillovers.

The sign of the IO linkages is positive and significant in the long run (period 40). This suggests that regions with stronger backward linkages are able to benefit from the increased demand generated by the policy. The initial level of the unemployment rate is negative in the short run but positive in the long run. Intuitively, one would expect the unemployment rate to have a positive sign because a larger pool of workers puts less upward pressure on wages, and encourages firms to hire more. This is observed in the long run. In the short run, however, GDP falls in most regions as the negative supply-side effects of taxation offset some of the benefits of government R&D support policies, reversing the sign of the unemployment coefficient.

Finally, the RII shows a negative sign, which is only significant in the long run. This result suggests that regions with higher innovation capacity may experience smaller percentage changes in GDP in the long run than regions starting from a lower level of innovation performance. One possible explanation is that these regions, already operat-

Table 1. Regression results on simulated data: GDP.

	Dependent variable: percentage changes in GDP			
	Short-run period $T = 10$		Long-run period $T = 40$	
	(1)	(2)	(3)	(4)
Shock	0.397***	0.421***	0.278***	0.307***
	(0.034)	(0.050)	(0.048)	(0.054)
Sh. Kap		0.566***		0.831***
		(0.189)		(0.177)
IO linkages		0.015		0.051***
		(0.021)		(0.018)
Open H20		0.062***		0.087***
		(0.024)		(0.021)
Open R&D		0.064***		0.012
		(0.021)		(0.018)
Unemployment rate		−0.386***		0.380***
		(0.128)		(0.127)
RII		−0.057		−0.265***
		(0.069)		(0.064)
Constant	−0.137***	−0.631**	0.095***	−0.519***
	(0.011)	(0.143)	(0.014)	(0.138)
Observations	235	235	235	235
R^2	0.551	0.651	0.327	0.616
Adjusted R^2	0.549	0.640	0.324	0.604

Note: Robust standard errors in parentheses,
$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.
Shock: monetary shock to GDP (in per cent).
Sh. Kap: share of capital to GDP.
Open H20: openness towards regions with large H2020 funds.
Open R&D: openness towards regions with large R&D intensity.
IO linkages: diagonal of Leontief matrix.
RII: Regional Innovation Index.

Table 2. Regression results on simulated data: exports.

	Dependent variable: percentage changes in exports			
	Short-run period $T = 10$		Long-run period $T = 40$	
	(1)	(2)	(3)	(4)
Shock	0.335***	0.351***	0.229***	0.270***
	(0.032)	(0.048)	(0.043)	(0.048)
Sh. Kap		0.452***		0.704***
		(0.163)		(0.138)
Sh. ExpH20		0.093**		0.123**
		(0.043)		(0.035)
Sh. ExpR&D		0.145***		0.021
		(0.041)		(0.035)
Unemployment rate		−0.082		0.790***
		(0.118)		(0.124)
RII		−0.049		−0.236***
		(0.062)		(0.054)
Constant	−0.110***	−0.518***	0.122***	−0.316***
	(0.011)	(0.111)	(0.013)	(0.096)
Observations	235	235	235	235
R^2	0.511	0.632	0.280	0.645
Adjusted R^2	0.509	0.622	0.276	0.636

Note: Robust standard errors in parentheses,
$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.
Shock: monetary shock to GDP (in per cent).
Sh. Kap: share of capital to GDP.
Sh. ExpH20: exports shares towards regions with large H2020 funds.
Sh. ExpR&D: exports shares towards regions with large R&D intensity.
RII: Regional Innovation Index.

ing close to their full economic potential, are less sensitive to policy shocks such as the H2020 intervention. Their advanced industrial structures and higher initial levels of productivity could dampen the relative impact of the shock compared to less innovative regions. This is in line with the evidence presented by Castaldi et al. (2015), Grillitsch et al. (2018) and Barbero et al. (2024), among others.

The determinants of the impact on regional exports

The role of H2020 innovation policy is to increase regional productivity, which ultimately leads to higher competitiveness and stimulates exports of goods and services.[17] In this section, similar to the previous analysis, we examine how the current state of the economy may affect competitiveness as a result of R&D support policies.

We analyse the determinants of the changes in the dependent variable in two periods ($T = 10$ and $T = 40$). Again, we use the shock as a ratio of base year GDP as an explanatory variable to account for the variability reflected in the allocation of funds across regions. In addition, we use the share of capital to see whether better equipped regions naturally export more, and the unemployment rate as a control to summarise excess capacity in the economies. We also include the initial share of exports in GDP, considering two variants: the share of exports to trading partners directly benefiting from H2020 funds, and the share of exports to regions with higher R&D intensity. Similar to the previous analysis, we focus on regional trading partners above the median for H2020 funding and R&D intensity, respectively.

Based on the results presented in Table 2, the relative size of the shock plays a significant role in explaining changes in exports, especially in the short run, where 50% of the regional variability in exports is due to the shock. In the long run, however, the regional distribution of the shock loses its importance, both in terms of the size of the coefficient and in terms of R^2, which falls to 28%. When variables related to the initial state of the economy are included, the R^2 increases to about 63% in the short run and 61% in the long run. Again, this implies that the importance of initial economic conditions increases as the economy transitions to a new equilibrium.

The magnitude of the coefficient associated with the share of capital increases from the short to the long run, confirming that a region's starting point is crucial for fully exploiting H2020 funding. Furthermore, pre-existing trade relations with regional partners more exposed to H2020 funding and with high R&D intensity positively influence the short-run effects on exports. Only initial trade patterns with regions that benefit strongly from H2020 funding remain significant in the long run.

Table 3. Robustness and sensitivity analysis.

	Baseline parameterisation				Alternative parameterisation			
	Distortionary tax		Non-distortionary tax		(a)		(b)	
	T = 10	T = 40	T = 10	T = 40	T = 10	T = 40	T = 10	T = 40
Q1	−0.11	0.07	0.08	0.09	−0.05	0.10	−0.02	0.13
Median	−0.04	0.13	0.15	0.15	0.01	0.18	0.04	0.21
Q3	0.07	0.25	0.27	0.29	0.15	0.32	0.20	0.38

Source: Authors' calculations.
Note: $(a):\{\psi=0.1;\sigma=0.8;\rho=0.2\}$ and $(b):\{\psi=0.12;\sigma=1.2;\rho=0.3\}$. $T=10$ and $T=40$ refer to the short and long term, respectively.

The unemployment rate is found to be positive and significant only in the long run. This suggests that a larger pool of available labour exerts less downward pressure on wages, thereby improving competitiveness through lower commodity prices. Finally, the RII shows a negative coefficient that is statistically significant only in the long run. This result suggests that regions with higher innovation capacity may experience smaller percentage changes in exports following the policy shock, consistent with the previous results using GDP change as the dependent variable.

In conclusion, H2020 funding significantly boosts regional export growth in the short term, and in the long term, the relative size of capital and trade links, together with the increased knowledge stock accumulated as a result of the policy, become key determinants of competitiveness. The importance of capital shares and pre-existing trade patterns suggests that regions that are well-equipped and strategically aligned with appropriate trading partners can better reap the benefits of funding.

Robustness and sensitivity analysis

In this section, we report additional results obtained by first modifying an important aspect of the simulation strategy and then the parameterisation of the model. A crucial factor affecting the final outcome of our analysis is the financing of H2020. So far, we have presented the results obtained by financing the policy through income tax shifts to cover the increased public spending. We have found that this is critical to the sign and magnitude of the final impact because, as mentioned earlier, it introduces negative supply-side effects that counteract the expansionary government stimulus. We have done this to avoid criticism and to compare our modelling strategy with conventional neoclassical growth models, which typically predict low or significantly low fiscal multipliers under distortionary taxation (see Drautzburg and Uhlig, 2015; Uhlig, 2010). However, if we do not use distortionary taxation and instead assume that the fiscal stimulus of innovation policy is offset by reductions in household income through cuts in government transfers to households, the results are likely to be different from those presented earlier.

The parameterisation used in the model and that reported in the Supplementary Appendix are those commonly used in the modelling literature or derived from empirical evidence. However, uncertainty, particularly in the behavioural parameters, can lead to uncertainty in the final result produced by the model. To mitigate these effects, in this section we modify the initial baseline parameterisation by changing the value of key parameters that could alter the regional distribution of impacts. We are particularly interested in those parameters that can even reverse the sign of the impact. For example, the elasticity of output to changes in public capital ψ can play a role in changing the sign and magnitude of the impact, since an increase in this parameter generates higher increasing returns to scale in output. The value of this elasticity in the standard case is 0.08 and reflects conservative estimates based on the meta-analysis by Bom and Ligthart (2014), who find a short-run elasticity of 0.08 and a long-run elasticity of 0.12, although in the case of core infrastructure these estimates are almost doubled. It is therefore possible that this elasticity is higher than 0.08 in some regions.

Another key parameter is the elasticity of substitution between capital and labour σ, which is initially set at 0.4. Again, the estimates found in the literature are contradictory, predicting an elasticity of less than 1, as in Chirinko and Mallick (2017), or greater than 1, as in Duffy and Papageorgiou (2000). In our model, the parameter controlling the R&D spillover is ρ, which takes the value of 0.1 in the default configuration. However, larger values of this elasticity will undoubtedly yield more positive results for all regions.

In Table 3, we show the median, the first and third quartiles of the regional GDP impact for the periods $T=10$ and $T=40$ obtained by adjusting the financing mechanism of the policy (third and fourth columns) and the value of the elasticities discussed earlier (in the remaining columns). We then distinguish two sets of elasticity parameters (a): $\{\psi=0.1;\sigma=0.8;\rho=0.2\}$ and (b): $\{\psi=0.12;\sigma=1.2;\rho=0.3\}$, where the results are obtained under distortionary taxes and are reported in the fifth and sixth and seventh and eighth columns, respectively. For ease of comparison, we report our baseline scenario in the first and second columns.

If the policy stimulus is financed by reducing government transfers to households, the negative impact disappears even in the short run. The median change in GDP is +0.15% and the first quartile is positive, standing at +0.09%. This is because the positive supply-side stimulus dominates over the demand-side effect of a reduction in household income. The loss of competitiveness effects due to upward pressure on wages and thus on commodity prices is no longer in effect. The impact of European innovation policy also increases if we adjust the key elasticities upwards, both in the short and the long run. In the long run, economies experience a substantial impact, with the median change in GDP increasing from +0.13% to +0.21%. Although capacity constraints are present in the short run, the median impact and the first quartile improve with the adjusted elasticity.

Conclusions

We have analysed the macroeconomic impact of the European innovation policy of the H2020 funding programme, the largest science and innovation fund in the world under a single political authority, using a spatial dynamic general equilibrium framework where R&D activities are included in a semi-endogenous growth model. The results show a significant long-run impact of the policy, despite the distortionary taxes introduced in the simulations to finance the policy, which have non-negligible effects on household welfare. The H2020 policy stimulates investment in R&D, which increases the productivity of EU economies and hence their competitiveness.

The output gains from the policy are substantial, but the effects take time to materialise, as would be expected for investments in R&D activities that may take years to lead to a marketable innovation. However, the impact of the policy remains substantial long after the spending has ceased, as it triggers additional private sector investment in both technology and physical capital, reflecting the endogenous growth nature of the modelling approach. Therefore, while the impact of the policy may be negative in the short term for some regions, it is positive in the long term for all regions, even those that receive less funding.

The geographical granularity of the model allows to highlight the fact that the impact of the policy is likely to be highly heterogeneous across EU regions. The results of the analysis show that the impact of the policy could be significantly higher in regions with a relatively more capital-intensive technology and a high degree of trade openness. Similarly, the impact on welfare varies considerably from place to place, being significantly welfare enhancing in the main beneficiaries of the policy, but negative in regions receiving less support. The impact of the policy on the extent of regional disparities may therefore not be negligible.

The results allow us to draw relevant implications for regional development and the potential benefits that EU, national and regional policymakers can derive from innovation policy. In the long run, all EU regions experience positive GDP changes thanks to H2020 funding, including those that do not receive large direct injections but benefit from innovation diffusion and other trade-related spatial spillovers. These findings are relevant given the existing national–regional tensions involved in the implementation of mission-led policies at the regional level regarding the question of where within each country public support for innovation activities should take place.

More specifically, the analysis shows that if support for R&D is necessary to maintain the role of leading regions as key engines of technological progress in the EU, it can also be particularly effective in promoting development and welfare in regions that are moderate or emerging innovators. These regions tend to be further away from the technological frontier, and public policies aimed at promoting R&D and innovation have the potential to significantly improve the fundamentals of economic performance in these regions. The results also feed into the debate on whether resources should be concentrated in economic cores or whether peripheral regions should also be directly involved (Peñalosa and Castaldi, 2024), by looking at where the benefits materialise in both the short and long term. This debate is linked to the focus of innovation policy on the generation of innovation or its diffusion and adoption (Kitson, 2019). If, as argued earlier, investment in R&D can be relevant even in regions that are not innovation leaders, the nature of this investment may prove to be crucial. Indeed, the results highlight the fact that support for R&D returns can generate large spillovers beyond the boundaries of the regions in which it takes place. In particular, intermediate and emerging innovators can more easily benefit from the innovations developed in innovation leaders, and policies to support R&D in these regions can therefore aim at improving the capacity of these regions to absorb and exploit innovations developed by regions closer to the frontier. This aspect is particularly important to promote complementarity between the EU objectives of improving the Union's innovation performance and promoting the balanced development of its regions and territories.

It is worth mentioning some limitations of the analysis. In this paper, we have relied on a spatial general equilibrium model, which we believe provides valuable insights into the effects of the policy. However, we acknowledge that this approach may not fully capture the causal effects of the policy. In order to strengthen the robustness of our findings, alternative methods and modelling strategies, such as a counterfactual impact evaluation framework, should indeed be considered in future work.

The results presented here assume that all funds allocated through H2020 are used efficiently and activate the economic channels used in the model to simulate their impact. The distinction between basic and applied research can be considered as a strong assumption, in particular due to its homogeneity across EU regions. Finally, the results are inevitably affected by the parameterisation of the shocks used to simulate the impact of the policy. We limit the uncertainty of our results by using values that are consistent with the existing literature on the subject, as explained in the "The model and the simulation strategy" section and by providing a dedicated section on sensitivity analysis.

While this analysis provides valuable insights into the impact of the policy on GDP, employment and regional disparities, it does not capture the full breadth of the objectives of the Horizon policy, which include scientific progress and societal benefits. Addressing these broader dimensions would require a more comprehensive approach, combining macroeconomic modelling with methods capable of assessing scientific outputs (for example, publications, patents) and societal outcomes (for example, improvements in health or environmental sustainability). Future research could extend this framework to include these additional dimensions, allowing for a multidimensional assessment of the impact of H2020.

Endnotes

1 For a critical assessment of this view, see Wennberg and Sandström (2022) and Audretsch and Fiedler (2023).

2 In line with the insights of, among others, Hekkert et al. (2020), Janssen et al. (2021), Kattel and Mazzucato (2018), Rosa et al. (2021) and Edquist and Zabala-Iturriagagoitia (2012).

3 Existing evidence on the performance of mission-oriented policies around the world is scarce, but suggests that there are weaknesses that should be addressed in order to make the mission concept stronger and more effective (Batbaatar et al., 2024; Brown, 2021; Larsson, 2022).

4 Celli et al. (2024) and Percoco (2013) examine the impact of the R&D investment included in the EU Structural Funds, rather than that of the Horizon programmes. This is another relevant issue, as Foray (2018) argues that Smart Specialisation, which was a condition for the deployment of the cohesion policy R&D funds for the period 2014–2020, qualifies as a mission-oriented innovation policy.

5 Similar approach as in Butler and Pakko (1998), Diao et al. (1999) and the European Commission's DSGE model called QUEST (Pfeiffer et al., 2024).

6 Dosi et al. (2023) also provide modelling analysis that goes in the same direction.

7 The use of 10 sectors is due to data limitations, as this is the highest level of sectoral detail available in Eurostat data and statistics at the NUTS 2 level in the European Union (Eurostat regional accounts).

8 Our model follows a conventional CGE structure. Similar works share the same production and consumption structure (see, for instance, Allan et al., 2021, and Partridge and Rickman, 2010).

9 To minimise notations, we omit time t and sector i indexes unless strictly required.

10 This is consistent with existing evidence such as that provided by Qiu et al. (2020) and Siller et al. (2021), among others.

11 This is consistent with theoretical models à la Romer (1990) and Jones (1995, 2005), and with the existing empirical evidence on the impact of innovation on productivity—see, among others, Kijek and Matras-Bolibok (2019).

12 For instance, the exogenous effects of the COVID-19 pandemic are not included in the shock.

13 The choice of a 2% discount rate reflects standard practice in the evaluation of long-term public policies with intergenerational impacts. Lower rates are often recommended to ensure that the future benefits of policies, such as those arising from R&D-driven innovation, are not undervalued. Estimates of the social discount rate vary widely in the literature. For example, Florio and Sirtori (2013) estimate social discount rates for several European countries, finding values as low as 1.15% for Italy and Portugal, and as high as 3.8% for Sweden. Similarly, the UK's HM Treasury (2022) Green Book recommends a baseline rate of 3.5% for most policies, but suggests lower rates (for example, 1.5%–2%) for policies with significant intergenerational benefits, such as environmental or innovation programmes.

14 This type of financing is based on the assumption of distortionary taxation. In the "Robustness and sensitivity analysis" section, we present alternative results assuming lump sum taxation.

15 See Deepak et al. (2001) for an example of local government policy objectives.

16 Openness might expand the domestic technology frontier by making available to domestic producers otherwise unavailable inputs and technologies, and by increasing competition in the market.

17 In our modelling setting, it is natural to follow the definition of place competitiveness by Storper (1997) and measure competitiveness in terms of exports, but we are aware that regional competitiveness is a much elusive concept to measure (Gardiner et al., 2012; Kitson et al., 2004).

Supplementary material

Supplementary material is available at *Cambridge Journal of Regions, Economy and Society* online.

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