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A general equilibrium analysis of the effects of the 2014-2020 European Cohesion policy in the Portuguese regions

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Abstract. We analyse the impact of the investments related to the European Cohesion policy in Portugal over the 2014-2020 programming period. We use the spatial dynamic general equilibrium model RHOMOLO to identify the direct and indirect effects stemming from a variety of spending categories and economic channels. The policy interventions are modelled with both demand and supply side shocks exerting short and long run effects, the latter being related to changes in labour productivity, transport costs, and total factor productivity. An important part of the analysis deal with the spillovers spreading the effects of the policy outside the borders of the regions in which the investments take place. Our results show that the €30 billion of Cohesion policy investments can increase Portugal's GDP by 3.5% at the end of the implementation period, and that additional benefits in terms of GDP and employment continue to materialise after the end of the monetary injections. Moreover, we present region-, Fund-, and field-of-intervention-specific results to give a complete picture of the impact of Cohesion policy in Portugal.

JEL Codes: C68, R13.

Keywords: RHOMOLO, region, growth, cohesion policy, Portugal.

1. Introduction

The European Cohesion policy is the main investment policy of the European Union (EU). Its objectives include promoting job creation, supporting business competitiveness, and fostering economic growth and sustainable development. The policy also aims at promoting a more balanced territorial development to reduce the disparities between EU regions. The Cohesion policy investments are channelled through the so-called European Structural and Investment Funds (ESIF), made up by the following five different funds: (i) the European Regional and Development Fund (ERDF), (ii) the European Social Fund (ESF) plus the Youth Employment Initiative (YEI), (iii) the Cohesion Fund (CF), (iv) the European Agricultural Fund for Rural Development (EAFRD), and (v) the European Maritime and Fisheries Fund (EMFF).

According to the Regulation (EU) No 1303/2013 of the European Parliament and of the Council (the so-called "Common Provisions Regulation"), the ERDF provides financial support for the development and structural adjustment of regional economies, economic change, enhanced competitiveness, as well as territorial cooperation throughout the EU. The ESF seeks to contribute to the adaptability of workers and enterprises, access to employment and participation in the labour market, social inclusion of disadvantaged people, combating all forms of discrimination, and creating partnerships to manage reforms in employment. Then, the CF supports exclusively less-developed Member States, the EARDF concentrate on the rural areas of the EU for economic, environmental and social development, and the EMFF helps delivering the objectives of the Common Fisheries Policy.

The ESIF budget during the 2014-2020 programming period amounted to more than €355 billion[1] (€200 billion for the ERDF, €94 billion for the ESF and the YEI, €61 billion for the CF, €100 billion for the EAFRD, and almost €6 billion for the EMFF). On top of that, these funds also channel national resources which should be added to the EU ones in order to get an idea of the whole ESIF package. For instance, national resources amount to more than €77 billion for the ERDF, more than €37 billion for the ESF and YEI, about €11 billion for the CF, €50 billion for the EAFRD, and a little more than €2 billion for the EMFF.

Around 70% of the resources go to the economic, social and territorial cohesion objective, with more than half of that targeting less developed regions whose GDP is less than 75% of the EU average. The present paper focuses on Portugal, one of the EU member states benefitting the most from Cohesion policy (receiving more than €26 billion of EU funds, for a total of €30 billion including the national resources) to describe the funds allocated there and present some evidence on their macroeconomic impact. Due to the so called N+2 rule which allows funds to be spent up to two years after the end of the programming period, at the time of writing (early 2021) the 2014-2020 funds are still being spent. Nevertheless, in our analysis we use up-to-date data which go beyond those on the initial allocation foreseen at the beginning of the programming period and include information on actual spending which was carried out in past years.

We use the dynamic spatial general equilibrium model called RHOMOLO in order to estimate the macroeconomic effects of the ESIF interventions in the regions of Portugal. Economic models like RHOMOLO are routinely used for policy impact assessments and evaluations. Ex-ante evaluations are carried out prior to policy implementation, and inform the decision-taking process with regards to the

[1] https://cohesiondata.ec.europa.eu/overview

selection of alternative policy designs. In this case, and due to the nature of the ESIF-related data used as inputs in the analysis, our exercise is closer to an interim/ex-post evaluation since it incorporates updated data on the actual spending made during the programming period at hand.

Macroeconomic models such as RHOMOLO provide coherent and internally consistent frameworks to analyse the channels through which macroeconomic policies affect national and regional economies. The RHOMOLO model has been developed by the European Commission's Joint Research Centre (JRC) in collaboration with the Directorate-General for Regional and Urban Policy (DG REGIO) with the explicit objective of assessing the potential impact of the European Cohesion policy. The structure of the model – calibrated with data for 267 EU NUTS2 regions – makes it a suitable tool for evaluating policies implemented at the regional level, as well as for evaluating the territorial impact of policies implemented at national and European level.

The remainder of the paper is organised as follows: Section 2 sets the stage for the analysis by describing the Portuguese economy and the distribution of the ESIF investments in the regions of the country during the 2014-2020 programming period. Section 3 briefly summarises the main characteristics of the RHOMOLO model used for the evaluation of the economic impact of the ESIF and the modelling strategy adopted to study its macroeconomic impact. Section 4 presents the results of the analysis, and Section 5 concludes.

2. The Portuguese economy and the 2014-2020 ESIF distribution

2.1 Country background

With its 92,212 km^2, Portugal is one of the smallest EU Member States. In 2019, Portugal's GDP was €213.95 billion (€260.23 billion in purchasing power standards) and the population amounted to slightly more than 10.25 million. This results in GDP per capita being equal to €20,800, about 65% of the EU28 average of €32,030 (source: Eurostat). The Portuguese GDP per capita was only 60% of the EU28 average back in 2014, at the end of the negotiation for the allocation of the 2014-2020 ESIF investments, which made Portugal one of the main receivers of Cohesion funds. It was a time in which the Portuguese economy was recovering from the financial crisis of 2008/2009 and from the ensuing economic crisis (Carneiro et al., 2014).

Table 1 reports some Portuguese national and regional statistics (there are seven NUTS 2 regions in the country). The economic data refer to the year 2013 and are taken from the RHOMOLO dataset. 2013 is used as the reference point in the analysis on the impact of the 2014-2020 ESIF investments, whose total Cohesion policy expenditure for 2014-2020, in millions of euros, is shown in the last column.

Table 2 shows the importance of within-country inter-regional trade in Portugal, revealing that even though the capital city region (PT17) is by far the most open to trade, it mostly trades with partners outside Portugal, with only 19% of its imports coming from the rest of the country. This contrasts with the other regions of the country (except PT11), where trade is to a much larger extent intra-country in nature, and with the capital city region being the relatively most important source of imports in all cases apart from PT30. For instance, 58% of PT15 imports come from other regions of the country, and 20% from the Metropolitan Area of Lisbon.

Table 1. Portuguese regional and economic statistics

Territory	Area (km^2)	2013 GDP (mln €)	Imports / Output	Population	Population density	2013 GDP per capita (€)	Cohesion policy expenditure (mln €)
Portugal (PT)	92,212	168,874.76	54.0%	10,487,289	113.73	16,103	30,602.9
Norte (PT11)	21,278	49,149.95	62.5%	3,666,234	172.30	13,406	11,601.3
Algarve (PT15)	4,997	7,326.47	29.8%	444,390	88.93	16,487	827.3
Centro (PT16)	28,462	31,531.67	42.2%	2,298,938	80.77	13,716	8,159.4
Área Metropolitana de Lisboa (PT17)	3,015	62,447.10	72.9%	2,818,388	934.79	22,157	2,690.6
Alentejo (PT18)	31,551	10,437.73	19.2%	748,699	23.73	13,941	4,110.9
Região Autónoma dos Açores (PT20)	2,351	3,703.95	30.2%	247,549	105.30	14,962	2,161.6
Região Autónoma da Madeira (PT30)	801	4,277.89	15.7%	263,091	328.45	16,260	1,051.9

Source: Eurostat (area and population) and RHOMOLO (GDP and imports / output).

Table 2. Regional shares of imports within Portugal

	PT11	PT15	PT16	PT17	PT18	PT20	PT30
Norte (PT11)		9%	12%	7%	12%	4%	3%
Algarve (PT15)	1%		1%	2%	9%	7%	2%
Centro (PT16)	6%	12%		6%	17%	7%	9%
Lisboa (PT17)	8%	20%	15%		26%	13%	7%
Alentejo (PT18)	2%	11%	6%	3%		6%	3%
Açores (PT20)	0%	2%	1%	0%	2%		1%
Madeira (PT30)	0%	4%	1%	0%	4%	7%	
Portgual	**17%**	**58%**	**37%**	**19%**	**71%**	**45%**	**26%**

Source: RHOMOLO. Rows: exporting region. Columns: Importing region. The last row displays the % of total imports of every region coming from the rest of Portugal.

The value added share of labour is an indication of the technology used for production in the various Portuguese regions, and it is displayed in Table 3. Most of the Portuguese economy relies on services, but this is particularly true for the capital city region (PT17), where almost 80% of value added accrues to labour, more than in any of the other region of the country. The high skill share is also the highest in that same region.

Table 3. Value added share of labour (also by skill)

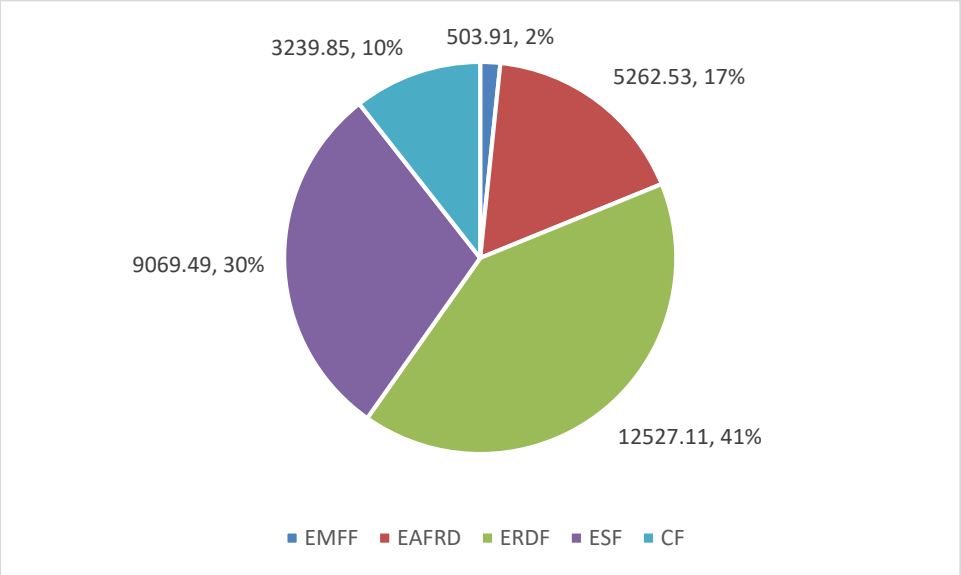
VA share	PT11	PT15	PT16	PT17	PT18	PT20	PT30
Labour (all skills)	76.3%	71.7%	71.2%	79.8%	60.9%	72.9%	76.7%
Low skill	29.0%	28.2%	28.3%	29.6%	26.5%	28.5%	29.1%
Medium skill	14.4%	13.3%	13.1%	15.3%	10.5%	13.6%	14.6%
High skill	32.9%	30.2%	29.8%	34.9%	23.8%	30.8%	33.1%

Source: RHOMOLO.

2.2 The 2014-2020 ESIF in Portugal

For the 2014-2020 programming period, over €26 billion of EU ESIF investments are allocated to Portugal, with the total investments reaching €30.6 billion when national co-financing is included. Figure 1 shows how these resources are distributed across the five ESIF Funds.

Figure 1. Distribution of ESIF resources across the five Funds (millions of €)

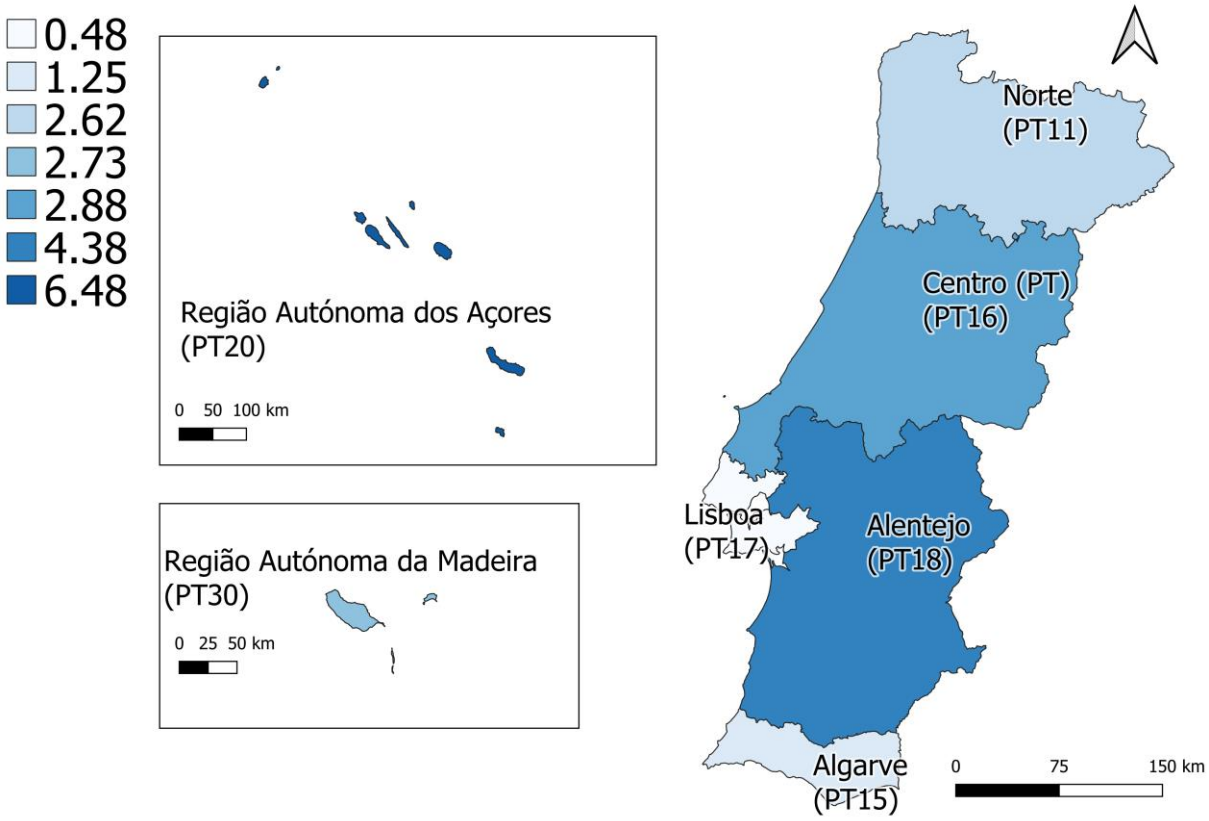


Source: Portuguese Cohesion and Development Agency.

The time profile of the investments differs across the various Funds. For illustrative purposes, we report in Table A1 in the Appendix the profile for the whole Cohesion policy for each region of the country, together with the total investments for the whole programming period. Clearly, the data include investments which are programmed to happen in the future, up to 2023. In fact, more than 50% of the ESIF expenditures is programmed to happen between 2020 and 2023.

The financial resources for the 2014-2020 Cohesion policy programme amount to roughly €30 billion in Portugal in 2011 prices. Not surprisingly, the largest receivers of funds are the three poorest regions in terms of GDP per capita: PT11 (receiving more than one third of the total budget), PT16, and PT18. On average, all the Portuguese regions receive a substantial amount of investments with respect to their GDP, as shown in Figure 2 plotting the investments as an annual average share of GDP. The smallest amount with respect to regional GDP (0.5%) goes to PT17, the capital city region and also the most developed one in the country, while the largest amount in proportion to GDP goes to the islands of Açores PT20 (6.5% every year).

Figure 2. Average allocation of ESIF expenditure as % of annual GDP



Source: own calculations with data from RHOMOLO and from the Portuguese Cohesion and Development Agency. EuroGeographics for the administrative boundaries.

The ESIF are used for different purposes and, according to the legislation, their investments are divided into 123 spending categories. The simulation strategy adopted in order to simulate the effects of the investments pertaining to each of these fields of intervention is illustrated in the following Section, together with a brief presentation of the general equilibrium model used for the analysis. The strategy essentially consists of a series of assumptions on the economic mechanisms and channels through which the various ESIF expenditures will affect the Portuguese economy.

3. Modelling Cohesion policy in Portugal with the RHOMOLO model

3.1 A brief overview of the model

RHOMOLO is a dynamic spatial computable general equilibrium (CGE) model. It was developed by the European Commission's Joint Research Centre (JRC) in collaboration with the Directorate-General for Regional and Urban Policy (DG REGIO) in order to provide scenario analyses with sector-, region-, and time-specific results related to investment policies and structural reforms in the EU. The model is calibrated on a set of fully integrated EU regional Social Accounting Matrices (SAMs) for the year 2013 (Thissen et al., 2019) which is taken as the baseline state of the economy. The SAMs account for all the transactions in the economy: purchasing of intermediate goods, hiring of factors, and current account transactions of institutions including taxes and transfers, consumption and savings, as well as trade flows (Mainar-Causapé et al., 2018). Essentially, a SAM includes more information than a simple Input-Output (IO) table (which contains information on the production and use of goods and services

and the income generated in that production), as it includes information on the secondary distribution of income, detailing the roles of labour and households (Miller and Blair, 2009).

The main distinctive feature of the model lies in its regional dimension, as it is calibrated with data for 267 EU NUTS 2 regions and for a residual region accounting for the rest of the World. In a nutshell, the regional dataset is constructed starting from the Supply and Use tables for the EU countries published by Eurostat. The tables are then trade-linked using information on the trade of both goods and services, and then regionalised using information available at the NUTS 2 level. Finally, the inter-regional IO tables for the NUTS 2 regions of EU-28 are created, taking into account a number of issues such as re-exports and the existence of logistic hubs.

The full mathematical description of the RHOMOLO model is beyond the scope of the present paper and can be found in Lecca et al. (2018). The model economies are disaggregated into ten economic sectors (based on the NACE Rev. 2 industry classification), and firms are assumed to maximise profits and produce goods and services according to a constant elasticity of substitution production function. The remaining agents in the model include utility-maximising households and a government which collects taxes and spends money on public goods and transfers. Capital and labour are used as factors of production, and transport costs are based on the transport model by Persyn et al. (2020). The model is flexible in terms of a number of its behavioural parameters, including its labour market and factor mobility assumptions.

The high dimensionality of RHOMOLO implies that the number of (non-linear) equations to be solved simultaneously is very large, in the order of hundreds of thousands. To keep the model manageable from a computation point of view, its dynamics are kept relatively simple. The model is solved in a recursively dynamic mode, where a sequence of static equilibria is linked to each other through the law of motion of state variables. This implies that economic agents are not forward-looking and their decisions are solely based on current and past information.

The next sub-section is devoted to the illustration of how the Cohesion policy investments are introduced into the model in order to simulate their effects on the economy. Essentially, the detailed information on the numerous spending categories of the 2014-2020 ESIF must be simplified and translated into modelling shocks. This allows us to construct scenarios in which the state of the economy changes according to specific economic mechanisms which are specific to the type of intervention simulated, such as aid to private sector or investments in transport infrastructures.

3.2 Translating Cohesion policy expenditures into model shocks

In order to introduce Cohesion policy in the model, we grouped the 123 spending categories into the following six fields of interventions: transport infrastructure investments (TRNSP); other infrastructures (INFR); investments in human capital (HC); investments in research and innovation (RTD); aid to the private sector (AIS); and technical assistance (TA). Each spending category was assigned to a model shock to simulate an appropriate transmission mechanism, resulting in the fields of interventions being modelled either with single shocks, or with some combinations of shocks according to the nature of the interventions.

Table 4 illustrates the model shocks used for each of the six fields of intervention listed above, together with some brief explanations of the associated economic mechanisms at work both on the

demand-side and on the supply-side. The relative allocation of funding across expenditure items is not identical in all regions, but is tailored to the specific needs of each territory. The demand-side effects are temporary in nature and reflect the transfer of resources resulting from the implementation of the Cohesion policy package. The supply-side effects are structural and capture the long-lasting changes associated to each policy intervention.

Table 4. Description of the model shocks by field of intervention

Field of intervention	Code	Model shock	Demand-side effects	Supply-side effects
Transport infrastructures	TRNSP	TRNSP	Increase in government consumption	Decrease in transportation costs
Other infrastructures	INFR	IG	Increase in public investment	Increase in public capital stock
		G	Increase in government consumption	
Human Capital	HC	HC	Increase in government consumption	Increase in labour productivity
Research and Development	RTD	RTD	Reduction in risk premium stimulating private investment	Increase in total factor productivity (TFP)
Aid to private sector	AIS	RPREMK	Reduction in risk premium stimulating private investment	
		G	Increase in government consumption	
Technical assistance	TA	G	Increase in government consumption	

Source: own modelling assumptions based on the composition of the 2014-2020 Cohesion policy spending categories.

Transport infrastructures (TRNSP) - The resources allocated to transport infrastructure are assumed to generate temporary effects through increases in government consumption in order to account for the purchase of goods and services required to build the actual infrastructures. The associated supply-side and long-lasting effect is simulated through a reduction in transport cost stimulating trade flows. The estimated reduction in costs due to Cohesion policy investments is calculated with a linear approximation of the impact of comparable transport investments estimated with the transport cost model by Persyn et al. (2020).

Other infrastructures (INFR) - Regional investments in non-transport infrastructures are typically related to electricity networks improvements, water treatment, and waste management. These are modelled and implemented in RHOMOLO either as a public investments (IG - when associated with industrial processes) or as a government consumption (G - when aimed at enhancing the quality of life). The IG shock is implemented as an exogenous increase in public investment augmenting the amount of the public capital stock, which enters the production function of the model as an unpaid factor.

Investment in human capital (HC) - The implementation of human capital policies is modelled in RHOMOLO as follows. First of all, in the short run all the HC expenditures are modelled as government

current expenditure. Then, in order to model the long-run productivity-enhancing effects of the policy, we calculate the additional school year-equivalents of training that can be purchased with the Cohesion policy investment in human capital in each region and for each labour skill-group (low, medium, and high). This allows to compute the change in school years embedded in the labour force due to the Cohesion policy. Then, following the empirical literature on Mincer-type regressions (Card 2001), labour efficiency is assumed to increase by 7% for each additional school year gained, with country-specific adjustments related to the PISA score accounting for different returns to education.

A key piece of the required information is the cost per pupil of different levels of schooling, which is obtained from Eurostat. These data are used as an estimate of how much one year of additional training would cost to train one worker in each of the three skill groups. We take one year of the tertiary-level education as the cost of training for all skill levels, because the majority of the Cohesion policy investment in the human capital aims at training workers.

Research and development (RTD) - This expenditure is implemented in RHOMOLO trough a temporary increase in private investment stimulated by a reduction in risk premium (which in turn affects the user cost of capital) to reflect the firms' investments in R&D activities. The supply-side permanent effects associated to this policy are simulated through a TFP improvement. The money injection is translated into TFP shocks via an elasticity estimated with a model à la Kancs and Siliverstovs (2016). The elasticity depends positively on the R&D intensity of each region, a data retrieved from Eurostat.

Aid to private sector (AIS) - Regional governments also use Cohesion policy to support investors who want to engage in risky activities with a high potential for fostering economic growth and employment. These investments are modelled either as increases in government consumption (G), or, like for RTD, they are assumed to stimulate private investments via a reduction in the risk premium and, therefore, in the user cost of capital (RPREMK). However, no long-run effects on productivity are assumed for this field of intervention.

Technical assistance (TA) - The impact of this shock on the economy is modelled with an increase in public current expenditure (G) to account for purchases of goods and services associated with the transfer of resources, with no associated supply-side effects.

It should be noted that all the supply-side long-run effects decay over time. The stock of public capital depreciates at a 5% yearly rate, and both the productivity improvements and the transport cost reductions also decay at a 5% yearly rate. The reason behind this assumption is that even research and development breakthroughs leading to productivity improvements eventually cease to represent an advantage for the regional economy which benefit from them. Also, the model takes into account the fact that the Cohesion policy is financed by contributions of each Member State proportionally to its contribution to the overall EU budget. Each Member State's contribution is assumed to be proportional to its GDP and is financed through lump-sum taxes. The latter decrease household disposable income, thus adversely affecting the economic performance and partly offsetting the positive impact of the programmes.

Table 5 reports the composition in terms of fields of intervention of all the Cohesion policy funds for Portugal analysed in this report resulting from the assumptions made when associating the actual ESIF spending categories with the fields of intervention and model shocks as explained above.[2]

Table 5. Distribution of Funds per field of intervention in Portugal (% of the total expenditure)

	TRNSP	INFR	HC	RTD	AIS	TA	Total
Full ESIF	2.9%	24.4%	29.5%	14.4%	25.2%	3.6%	100%
ERDF	1.5%	28.2%	0.2%	34.8%	31.0%	4.4%	100%
ESF	0.0%	0.0%	99.2%	0.0%	0.0%	0.8%	100%
EAFRD	0.0%	26.5%	0.3%	0.7%	67.9%	4.6%	100%
CF	21.6%	75.5%	0.0%	0.0%	0.0%	2.9%	100%
EMFF	0.0%	16.6%	0.0%	3.1%	53.6%	26.7%	100%

Source: RHOMOLO assumptions made by the authors together with the Portuguese Cohesion and Development Agency. RTD: investments in research and innovation. AIS: aid to the private sector. INFR: other infrastructures. TRNSP: transport infrastructure investment. HC: investments in human capital. TA: technical assistance.

The aggregated data of Table 5 show that on the whole the RHOMOLO modelling assumptions allow for the use of all fields of intervention-specific transmission mechanisms and channels when simulating the impact of Cohesion policy on the regions of Portugal, with transportation infrastructure investment being the only shock with a notably smaller percentage of the total (although its importance is significant for CF). Then, apart from the ESF which is almost exclusively modelled as human capital enhancing investment, the rest of the ESIF are modelled via different combinations of shocks.

4. The simulation results for the Portuguese regions

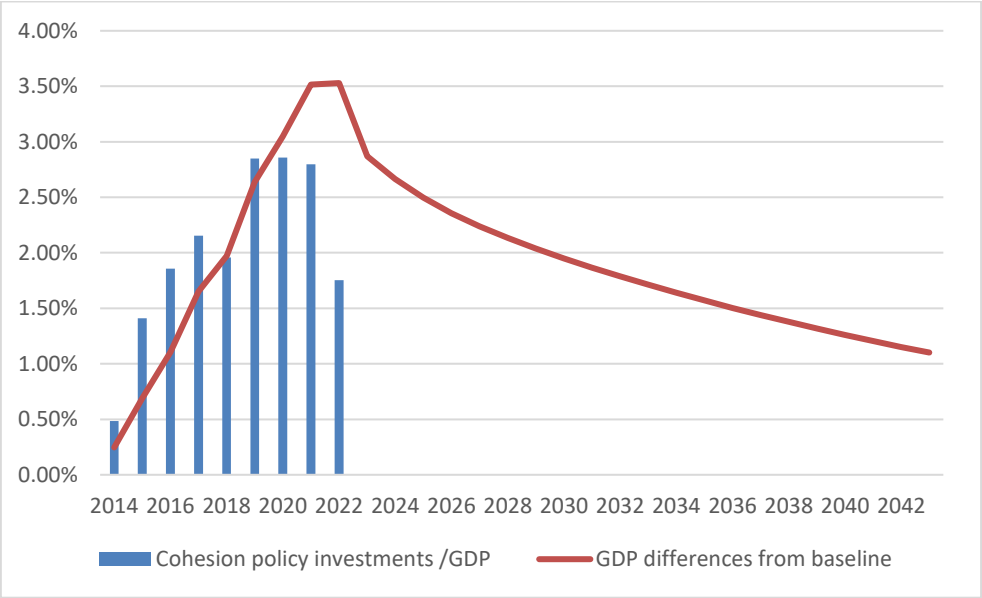
4.1 The macroeconomic impact in Portugal

We present the results of our analysis by starting with those for the full Cohesion policy package. Figure 3 shows that the Portuguese GDP increases both during the nine years of implementation of the programme and after the end of it, with long-lasting effects generated by the simulated structural policies. In the year 2043 (twenty years after the end of the policy, considered here as the long-term of the analysis), GDP is still 1.12% above its base year value, although the peak is reached in 2022, at the end of the financing period. Figure 3 also shows that in the short-run, until 2019, the investment expenditure in Portugal is higher than the benefits in terms of GDP generated in the country. This means the short run GDP multipliers, although positive, are lower than one.[3] Nevertheless, after this period, positive supply-side effects continue to materialise as the interventions durably improve the structure of the Portuguese economy, thus allowing the policy to have an impact even many years after the termination of the programmes. In the long-run, the structural change effects associated with the interventions might be very substantial and able to generate cumulative multipliers greater than 1, as in this case.

[2] The composition in terms of model shocks are available in Table A2 in the Appendix.

[3] The GDP multiplier is the ratio between the changes in national income to the change in government expenditures. Therefore, a multiplier greater than 1 implies that GDP has increased more than the initial stimulus.

Figure 3. Cohesion policy investments as a share of GDP (bars) and GDP impact (line) as % deviations from the baseline GDP in Portugal



Source: RHOMOLO simulations (GDP impact - red line) and Portuguese Cohesion and Development Agency (Cohesion policy investments over time - blue bars).

The simulations reveal a heterogeneous regional response to the structural investment funds in Portugal. Table 6 shows term impact on GDP and employment disaggregated at the NUTS 2 level at 10, 20, and 30 years after the beginning of the policy.

Table 6. GDP and employment impact (% deviations from the baseline) in the seven Portuguese NUTS 2 regions (10, 20, and 30 years after the beginning of the policy)

	GDP (% deviation from baseline)			Employment (% deviation from baseline)		
	2023	2033	2043	2023	2033	2043
PT11	4.03%	2.30%	1.43%	2.09%	1.24%	0.78%
PT15	1.82%	1.31%	0.91%	0.94%	0.80%	0.57%
PT16	3.74%	2.11%	1.31%	1.65%	0.98%	0.62%
PT17	1.14%	0.65%	0.43%	0.45%	0.34%	0.24%
PT18	5.10%	3.39%	2.28%	2.48%	1.77%	1.22%
PT20	5.14%	3.82%	2.64%	2.41%	1.97%	1.42%
PT30	2.86%	2.36%	1.73%	1.52%	1.42%	1.09%

Source: RHOMOLO simulations.

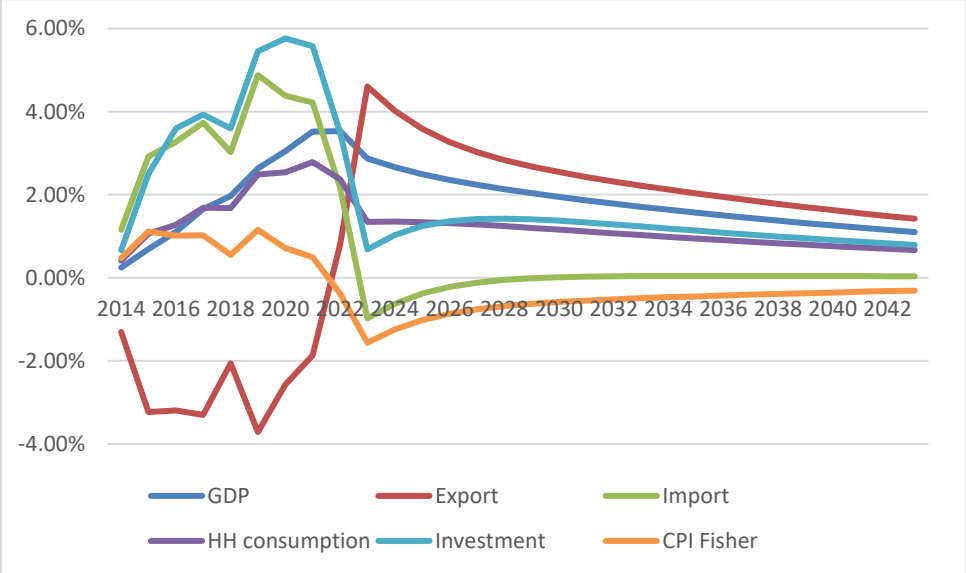
Typically, we observe that the impact is higher in regions receiving relatively more in terms of funds with respect to their GDP (PT20 and PT18 on average receive 6.5% and 4.4% of their yearly GDP, respectively, during the implementation period). The impact is also significant in the two regions receiving the largest absolute amounts of investments that is, PT11 and PT16. Another result emerging from Table 6 is that changes in GDP are greater than changes in employment. This suggests that the capital stock is increasing more than employment, although increases in productivity could also partly explain that. Essentially, it seems that the European policy is targeted to stimulate investments

generating bigger substitution effects in favour of capital.[4] Overall, employment does rise in the long-run, implying that the general equilibrium demand curve for labour is wage-elastic and employment is fully responsive to changes in wages.

One final finding related to Table 6 is that the richest region of the country, PT17, is the one in which GDP and employment change the least with respect to their baseline values. This is mainly due to the fact that PT17 receives the smallest amount of investment funds with respect to regional GDP. This also means that Cohesion policy in Portugal favours a catching up process of the less developed regions of the country with the capital city region, thus fostering regional convergence.

Figure 4 shows the evolution of some macroeconomic variables for Portugal in order to understand the macroeconomic adjustments generated by the European Cohesion policy. The demand shocks lead prices to increase, at least during the implementation period. However, in the long-run, the stimulus to investments is translated into a reduction in the price of capital that puts downward pressure on the price of all commodities. This leads to a real income increase, thereby raising consumption of domestic and foreign goods. Moreover, the fall in prices after the end of the implementation period is positive for international trade, stimulating foreign demand for Portuguese goods and services, increasing output in the economy even further. Exports fall in the short run, because the demand-side effects of the policy interventions dominate the overall impact putting upward pressure on prices and, in turn, generate a reduction in competitiveness. However, in the longer run, this is reversed as the economy fully adjusts and the supply-side effects intrinsically incorporated into the policy shocks materialise.

Figure 4. Evolution of selected macroeconomic variables in Portugal

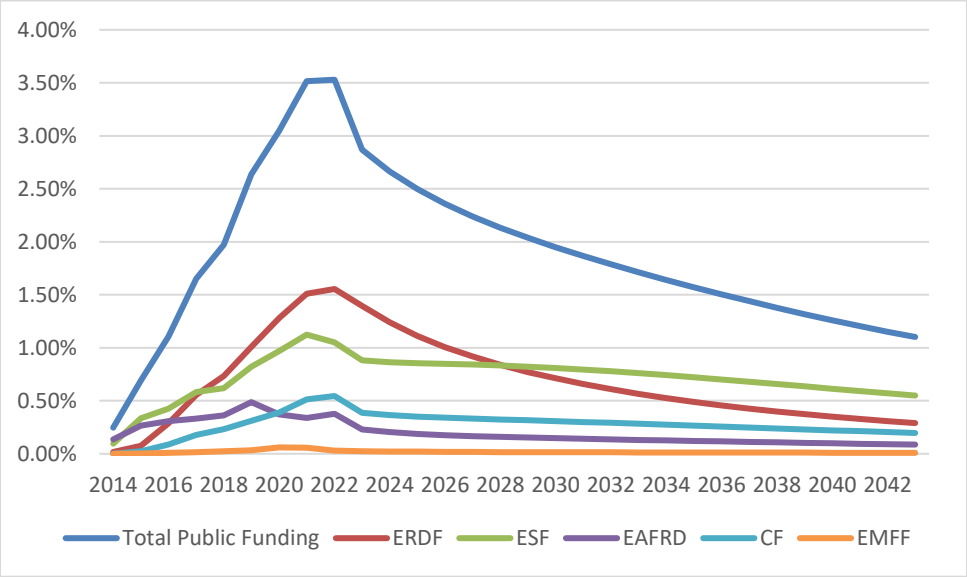


Source: RHOMOLO simulations.

[4] The substitution effect is the change in the demand of factors of production (here capital and labour) due to changes in the relative prices of factors of production. In this case, policy intervention makes the price of capital lower than the price of labour. However, this results may be due to the modelling strategy adopted to simulate the ESF intervention which, in this present analysis, does not include increases in the labour supply. The latter would put downward pressure on wages and could change the relationship between the prices of capital and labour.

We now present the GDP impact by Fund before we dig more into the regional results in terms of spillovers and analysis by field of intervention. The breakdown of the input data used in the analysis allows for a decomposition of the overall impact generated by each of the five ESIF mentioned above. Figure 5 reports the evolution over time of the % deviations from baseline GDP associated both with the full publicly funded policy and with each of the five Funds separately. According to our simulations, the ERDF, despite being the biggest Fund, is not the one generating the highest GDP impact in the very short run nor in the long run (but it is the one generating the biggest impact in the second half of the implementation period and for a few years after). This is related to the time profile of the investments as well as to the fact that the ESF is the Fund producing the most long-term supply-side effects via improvements in labour productivity. The other Funds are associated with smaller GDP effects, which is mainly due to their smaller budgets. As for the CF, its effects materialise only a few years after the beginning of the implementation period as it took some time for its investments do be deployed in the Portuguese regions.

Figure 5. GDP impact by Fund as % deviations from the baseline GDP in Portugal



Source: RHOMOLO simulations.

4.2 Focus on the fields of intervention and on spillovers

In the preceding section, we have illustrated the economic impact that would occur in Portugal as a result of a coordinated effort through which Cohesion policy is implemented simultaneously in all the regions of the country. We are now going to explore two additional issues. The first is the difference in the economic impact across the various fields of intervention explained in Section 3.2. Since each one triggers different economic mechanisms (through the specific modelling shocks used to characterise the interventions), it is interesting to analyse the different impact they have on the economy. We do this by exploring the GDP multipliers associated with the investments pertaining to the various fields at different time intervals (10, 20, and 30 years after the beginning of the policy implementation). We then rely on additional sets of simulations in which the shocks affect only one region at a time rather than the whole country in order to study the intra-country regional spillovers of the policy.

Table 7 presents the GDP multipliers in 2023, 2033, and 2043 obtained by shocking all the regions of Portugal with the ESIF expenditures related to each field of intervention separately. For example, the first three columns of Table 7 show the GDP multipliers obtained by simulating only the TRNSP investments, irrespective of the Fund to which they pertain.

We find substantial regional variation within each spending category, which is maintained across time. In four cases out of six, the multipliers of the capital city region PT17 are the highest in the country, the exceptions being TRNSP and TA for which the highest multipliers are recorded for PT15 and PT11, respectively. This is due to at least two factors. First, the labour share (and the high-skilled labour share in particular) is the highest in the country, suggesting a productive structure more concentrated on services. This would explain why human capital investments enjoy higher returns there, and investments in R&D also seem to benefit from the presence of a relatively large pool of high-skilled workers. Second, PT17 is the region benefitting the most from positive trade spillovers originated in the rest of the country (for all the other region of the country except PT30, PT17 is the main source of within-country imports). The latter is also the reason behind the extremely high multipliers associated with the AIS field of intervention. Very little money is invested for aid to private sector in PT17, which means that even moderate spillovers originated in the rest of the country can, and do, inflate the values of the GDP multipliers of PT17. The same happens with the TRNSP multipliers in PT15.

Across spending categories, TA, which is modelled as current government expenditure, not surprisingly yields the lowest economic impact (with multipliers which remain below one even 30 years after the beginning of the policy intervention). On the other hand, the multipliers associated with the HC, INFR, and RTD shocks are the highest, as well as the TRNSP ones for some specific regions (PT15, PT17, and PT18).

In Table 8 we present another set of results concerning the spatial distribution of spillovers for each spending category. These results are based on additional simulations in which each region is subjected to a particular spending category shock yielding a region-specific multiplier. The positive impact of the policy is not limited to the sole shocked regions, though, due to the existence of spillovers mainly related to interregional trade. **Error! Reference source not found.** shows the region-specific multiplier stemming from a shock (*Reg* columns), while the PT columns record the total country-wide multiplier for that shock. The *sp.* columns show the spillovers associated to each region-specific shock expressed as a percentage of the country-wide multiplier.

Table 7. Country and regional GDP multipliers, country-wide shocks

	TRNSP			INFR			HC			RTD			AIS			TA		
	2023	2033	2043	2023	2033	2043	2023	2033	2043	2023	2033	2043	2023	2033	2043	2023	2033	2043
PT	1.07	1.29	1.35	1.42	2.92	4.03	1.29	2.83	4.04	1.21	2.61	3.17	0.87	1.41	1.56	0.65	0.75	0.77
PT11	1.17	1.43	1.49	1.42	2.91	3.98	1.21	2.74	3.93	1.24	2.61	3.14	0.95	1.60	1.77	0.82	0.94	0.96
PT15	15.11	17.50	18.56	1.49	3.43	4.93	1.47	3.28	4.91	1.24	3.05	3.90	0.69	1.08	1.20	0.52	0.58	0.59
PT16	0.92	1.08	1.12	1.30	2.76	3.82	1.05	2.39	3.43	1.05	2.21	2.64	0.79	1.35	1.49	0.62	0.67	0.68
PT17	3.03	3.96	4.21	2.22	4.29	5.79	3.22	5.68	7.64	1.81	4.06	5.16	5.55	7.79	8.60	0.64	0.78	0.80
PT18	1.51	1.68	1.74	1.38	2.85	3.96	1.10	2.54	3.70	1.00	2.24	2.72	0.56	0.83	0.90	0.54	0.58	0.59
PT20	0.28	0.27	0.26	0.91	1.89	2.64	1.04	2.58	3.81	1.25	2.73	3.40	0.47	0.71	0.77	0.33	0.31	0.29
PT30	0.41	0.41	0.40	1.05	2.27	3.25	1.29	3.13	4.79	1.42	3.42	4.45	0.63	0.90	1.00	0.58	0.62	0.62

Source: RHOMOLO simulations. RTD: investments in research and innovation. AIS: aid to the private sector. INFR: other infrastructures. TRNSP: transport infrastructure investment. HC: investments in human capital. TA: technical assistance.

Table 8. Region-specific (Reg) and country-wide (PT) multipliers, and spillovers (sp.) from region-specific shocks (2033 only)

	TRNSP			INFR			HC			RTD			AIS			TA		
	Reg	PT	sp.	Reg	PT	sp.	Reg	PT	sp.	Reg	PT	sp.	Reg	PT	sp.	Reg	PT	sp.
PT11	1.09	1.33	18%	2.59	2.79	7%	2.62	2.79	6%	2.54	2.62	3%	1.40	1.56	11%	0.50	0.77	35%
PT15	1.09	1.49	27%	3.00	3.52	15%	2.59	3.04	15%	2.53	2.85	11%	0.66	1.06	38%	0.27	0.71	61%
PT16	0.94	1.38	32%	2.47	2.86	13%	2.27	2.59	12%	2.11	2.37	11%	1.22	1.52	20%	0.34	0.74	54%
PT17	2.78	2.94	5%	3.02	3.16	5%	3.79	3.84	1%	3.18	3.20	1%	1.07	1.23	13%	0.50	0.73	31%
PT18	0.85	1.39	39%	2.75	3.37	18%	2.39	2.89	17%	2.14	2.60	18%	0.75	1.25	40%	0.41	0.92	56%
PT20	0.26	0.66	61%	1.83	2.38	23%	2.61	3.15	17%	2.35	2.84	17%	0.67	1.08	38%	0.26	0.66	61%
PT30	0.32	0.55	42%	2.11	2.45	14%	2.89	3.20	10%	2.78	3.15	12%	0.60	0.84	29%	0.32	0.55	42%

Source: RHOMOLO simulations. RTD: investments in research and innovation. AIS: aid to the private sector. INFR: other infrastructures. TRNSP: transport infrastructure investment. HC: investments in human capital. TA: technical assistance.

A key observation that can be made by comparing the 2033 multipliers of Table 7 and the regional ones of Table 8 is that simultaneous investment across all Portuguese regions produces higher regional GDP effects compared to region-specific investments. This is because of the lack of spillovers originated in other regions when the investment is simulated only in one region at a time. Then, the numbers of Table 8 suggest that localisation matters. The capital region PT17 is usually characterised by the highest multipliers, yet the diffusion of benefits from the investment across the country is proportionally low: it generates little spillovers (with respect to the region-specific multiplier) as the capital region does not tend to import much from the rest of the country. The latter characteristic makes the investments targeting PT17 beneficial especially for the region itself, and explains why the differences between the PT17 country-wide multipliers and the rest of the country-wide multipliers are smaller than the differences between the PT17 regional multipliers and the rest of the regional ones. This makes it evident that the magnitude of the spillovers generated by a particular region is correlated with the propensity to import from the rest of the country (see Table 2). Investments in the PT15, PT18, and PT20 regions generate the highest spillovers, implying that investments in these regions can benefit not only the aforementioned regions but the country as a whole.

5. Conclusions

The European Cohesion policy is the EU's main investment policy and targets all regions and cities across the EU to support job creation, business competitiveness, economic growth, and sustainable development. The Cohesion policy aim is to reduce the disparities between EU regions by promoting more balanced and sustainable territorial development. In the 2014–2020 programming period, one third of the EU budget has been allocated to the projects under this policy. This paper analyses the potential effects of the €30 billion of Cohesion policy investments allocated to Portugal during that same period.

The scenario analysis is carried out with the spatial dynamic CGE RHOMOLO model which, in combination with the input ESIF data permits to produce detailed impact assessments of the effects of the policy in all Portuguese regions, as well as for each of the five Funds of the policy and even by specific field of intervention. The latter means that the results take into account the different transmission mechanisms related to investments in various fields like research and development, infrastructures, aid to private sector, human capital, and technical assistance.

Our results show that the European Cohesion Policy the Portuguese GDP would be 3.5% higher than in the absence of the policy at its peak that is, at the end of the nine-year implementation period, in 2022 (being this a scenario analysis, and not a forecast, the impact of events such as the Covid-19 crisis is outside the scope of the present document). The impact is larger in regions receiving relatively more funds with respect to GDP, although the multipliers are not necessarily correlated with the GDP impact (in fact, the largest multipliers are mostly recorded for the capital city region which receives the least amount of funds).

The five Funds through which the policy investments are distributed differ both in terms of investment composition and for the timing with which the investments take place. For instance, it appears that the ESF is the Fund exerting the most long-run effects, thanks to the increase in labour productivity caused by the human capital investments. Interesting results arise from the spillover analysis which

highlights the important economic benefits spreading outside the regional borders of investments such as aid to private sector and transport infrastructures. Due to the within-country trade flows characterising the Portuguese economy, it also appears that investments in the capital city regions are those producing the least spillovers relatively to the region-specific impact. This is due to the fact that a large part of the imports of all the other regions of the country come from the capital city region, while the opposite is not true (only 19% of the capital region's imports come from other Portuguese regions).

All in all, our analysis suggests that Cohesion policy funds are important instruments to increase the wealth and the economic efficiency of Portuguese regions thanks to the investments' capacity of improving the economic structure of the country and its regions with substantial short term and long term benefits.

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Appendix

Table A1. Time profile of ESIF expenditure in Portugal (share of total expenditure)

	Total expenditure (mln €)	2015	2016	2017	2018	2019	2020	2021	2022	2023
Portugal	30,602.9	2.7%	7.8%	10.3%	11.9%	10.8%	15.7%	15.8%	15.4%	9.7%
PT11	11,601.3	2.7%	7.8%	10.9%	11.8%	10.9%	15.5%	15.7%	15.4%	9.3%
PT15	827.3	3.3%	4.6%	10.7%	9.7%	8.7%	15.7%	17.7%	17.5%	11.9%
PT16	8,159.4	2.5%	7.7%	10.1%	11.7%	11.4%	15.0%	15.7%	15.7%	10.1%
PT17	2,690.6	2.2%	1.8%	7.5%	10.1%	9.2%	16.4%	20.3%	20.3%	12.2%
PT18	4,110.9	3.4%	8.7%	9.7%	12.6%	11.4%	15.0%	14.6%	14.0%	10.5%
PT20	2,161.6	2.1%	14.4%	10.3%	13.2%	8.5%	21.5%	13.2%	11.2%	5.7%
PT30	1,051.9	1.9%	8.3%	13.2%	15.0%	12.9%	13.9%	13.6%	14.0%	7.1%

Source: Portuguese Cohesion and Development Agency.

Table A2: Distribution of Funds per model shock in Portugal (% of the total expenditure)

	RPREMK	RTD	IG	G	TCOST	HC	Total
Full ESIF	12.6%	14.4%	17.2%	23.7%	2.9%	29.2%	100%
ERDF	29.7%	34.8%	13.6%	20.3%	1.5%	0.2%	100%
ESF	0.0%	0.0%	0.0%	2.0%	0.0%	98.0%	100%
EAFRD	2.3%	0.7%	20.7%	76.1%	0.0%	0.3%	100%
CF	0.0%	0.0%	74.0%	4.5%	21.6%	0.0%	100%
EMFF	2.0%	3.1%	16.6%	78.3%	0.0%	0.0%	100%

Source: RHOMOLO assumptions made by the authors together with the Portuguese Cohesion and Development Agency.

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