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Abstract: This paper uses a general equilibrium framework to evaluate the macroeconomic impacts of the legislative measures contained in the third strand of the Investment Plan for Europe. Differently from most of the existing European policies evaluated with economic impact assessments, these measures do not involve any funds or money injections in the economy. Rather, they aim at either lowering or removing the remaining obstacles to a fully functioning European single market. We find that the removal of those barriers may lead to substantial economic gains for the regions in the European Union. Our results indicate considerable heterogeneity in economic impact across regions.

Keywords: Investment Plan for Europe, impact assessment, general equilibrium model.

JEL classification: C54, C68, O52.

1. Introduction

In the European Union (EU), goods and services can travel freely without any internal borders or other regulatory barriers. This is commonly thought of having the potential to promote economic growth thanks to economies of

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scale, increased competition, and innovation, via increased trade and better allocations of production factors and capital flows (Melitz, 2003; Resmini, 2020). Despite the high level of integration among the EU Member States, some cross-border barriers do exist (Mariniello *et al.*, 2015). Non-tariff barriers such as different regulatory regimes pose obstacles to the free movement of goods, services and investments (Springford, 2012). At the end of 2014, the European Commission adopted the Investment Plan for Europe which, among other things, aimed at tackling some of these barriers as a response to the 2008 economic and financial crisis.

The Plan consisted of a combination of public and private investments with the initial objective to reach a total direct monetary injection of € 315 billion (a target that was met and exceeded four years after the adoption of the Plan, European Commission, 2018a). The initiative was structured along the following three strands or pillars (European Commission, 2014): *i*) the European Fund for Strategic Investments (EFSI), providing an EU guarantee to mobilise private investment; *ii*) technical assistance and visibility for investment opportunities; *iii*) the removal of regulatory barriers to investment both nationally and at the EU level.

This paper contains an ex-ante macroeconomic assessment of some of the measures of the third strand related to the development of the European common market. We concentrate here on measures related to the Capital Markets Union (CMU), the Single Market Strategy (SMS), and the Energy Union. We separately evaluate the system-wide economic impact of each initiative identifying for each case an appropriate transmission channel, that is the process through which the initiatives are expected to affect the behaviour of economic agents.

To the best of our knowledge, there have been no other attempts at evaluating the macroeconomic effects of the measures analysed here in a general equilibrium framework. These initiatives are regulatory proposals not directly involving monetary injections into the economy. Rather, they are designed to lower barriers to investment and to improve the management of resources and the system-wide efficiency in the economic and financial systems by modifying the regulatory frameworks of each area of intervention accordingly. The analysis is carried out with the dynamic spatial computable general equilibrium (CGE) model called RHOMOLO (Lecca *et al.*, 2018; 2020) and with its Input-Output (IO) version RHOMOLO-IO (Mandras *et al.*, 2019). Note that a version of RHOMOLO is routinely used for the yearly impact assessment of EFSI, which is the first strand of the Investment Plan (Christensen *et al.*, 2019; European Investment Bank, 2018).

The RHOMOLO model includes 267 EU and UK regions interlinked through trade subject to transportation costs. This rich regional specification introduces spatial heterogeneity into the model at the level of consumption and production. This allow us to consider the impact from regional differences in income, factor endowments, and trade exposures. Inclusion of agent heterogeneity has been put forward as one of the main recommendation for enhancing macroeconomic models (see e.g. Vines, Wills, 2018)[1]. Using a regional model also allow us to consider the region specific impacts of the policies we assess. Hence, our analysis relates to the literature on regional impact of respectively spatially targeted government policies and spatially blind policies. The latter being considered to be those that are universal in their coverage such as those associated with trade, regulation of land use or labour (Hewings, 2014). The policies we are examining in this paper may be considered spatially blind in design but are not spatially blind in effect. The policies we consider change the regulatory burden and affect factor prices and production costs of firms unevenly across regions and result in spatial heterogeneity of economic impact. We find that the regulatory changes that we consider leads to a rise in aggregate EU GDP and Employment. However, because of the spatial heterogeneity in impact some regions gain largely while other experience only modest gains or even loses as a result of the regulatory changes.

Clearly, the analysis hinges upon the ability to identify the appropriate transmission channels for the policy change and in quantifying their effects on productivity and production costs. This becomes further difficult due to the fragmentation of the value chain across regions (Hewings, 2014; Temursho, Miller, 2020). In our analysis we therefore consider a range of possible impacts represented by three alternative scenarios; low, medium and high.

This report is structured as follows. In Section 2 we present an overview of the building blocks and theoretical foundations of the RHOMOLO model and of its IO counterpart. Sections 3 describes the policy initiatives and identify their appropriate transmission channels. Results are presented in Section 4. Finally, Section 5 concludes.

2. An introduction to RHOMOLO and RHOMOLO-IO

2.1. The RHOMOLO model in a nutshell

In this section, we present an overview of the RHOMOLO-V3 model whose full mathematical exposition can be found in Lecca *et al.* (2018). The theoretical structure of the model is common to other numerical general equilibrium models, with its key distinguishing feature being its geographical granularity. The economy consists of a set of 267 EU and UK NUTS2 regions plus one single exogenous region representing the rest of the World (ROW). Spatial interactions between regional economies are captured through trade of goods and services, income flows, and factor mobility.

[1] Although allowing for spatial heterogeneity the version of RHOMOLO used here adopt the assumption of regional representative households and firms.

Table 1: List of NACE Rev. 2 sectors in RHOMOLO

Code NACE Rev. 2	Sectors' description
A	Agriculture, Forestry and Fishing
B-D-E	Mining and Quarrying + Electricity, Gas, Steam and Air Conditioning Supply + Water Supply; Sewerage, Waste Management and Remediation Activities
C	Manufacturing
F	Construction
G-I	Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles + Transportation and Storage + Accommodation and Food Service Activities
J	Information and Communication
K-L	Financial and Insurance Activities + Real Estate Activities
M-N	Professional, Scientific and Technical Activities + Administrative and Support Service Activities
O-Q	Public Administration and Defence; Compulsory Social Security + Education + Human Health and Social Work Activities
R-U	Arts, Entertainment and Recreation + Other Service Activities + Activities of Households As Employers; Undifferentiated Goods- and Services-Producing Activities of Households for Own Use + Activities of Extraterritorial Organisations and Bodies

Source: Lecca *et al.* (2018).

The model has a set of ten different economic sectors (industries), with a subset operating under monopolistic competition à la Dixit and Stiglitz (1977). In each region, the monopolistic sectors contain a number of identical firms each producing a differentiated variety that is considered as an imperfect substitute for the other varieties produced within the same region and elsewhere. The number of varieties in the sectors is endogenous and determined from the zero-profit equilibrium condition (according to which profits must be equal to fixed costs). In turn, this means that, in equilibrium, prices equal average costs. In the remaining sectors, firms operate under perfect competition. The version of the model used in this paper employs the following ten aggregations of NACE 2 economic sectors: A, B-E, C, F, G-I, J, K-L, M-N, O-Q, and R-U (see Table 1). All are treated as imperfectly competitive sectors except A, O-Q, and R-U which are modelled as perfectly competitive.

Final goods are consumed by households and government (in the form of private and public capital goods), whilst firms consume intermediate inputs. Regional goods are produced by combining value added (labour and capital) with domestic and imported intermediates, creating vertical linkages between firms. Trade both between and within regions is costly, implying that the shipping of goods entails transport costs assumed to be of the iceberg type as in Krugman (1991)[2]. Transport costs are identical across varieties but spe-

[2] The Iceberg type trade costs is a simple way to generate costly trade in the model. However,

cific to sectors and trading partners (region pairs). The spatial configuration of the system has a direct impact on regions' competitiveness because firms located in regions that are more accessible can source their intermediate inputs at lower prices and thus gain larger market shares in local markets.

Regarding the labour market setup, the model distinguishes three different labour categories corresponding to the level of skill or education: low, medium, and high. For each labour type, the default wage setting relationship is represented by a wage curve (Blanchflower, Oswald, 1994), whose implication is that lower levels of unemployment increase the workers' bargaining power, thereby increasing real wages.

Government expenditure includes current consumption on goods and services, capital expenditures dedicated to public infrastructure, and net transfers to households. Revenues are generated by labour and capital income taxes on household income and indirect taxes on production. In the simulations reported here, government spending is considered an exogenous policy variable.

The model is recursively dynamic with myopic expectations, and it is solved sequentially with stocks being upgraded at the beginning of each year. The model is calibrated to a steady-state baseline with no changes in policy. The RHOMOLO model briefly described here is used in the next sections to evaluate the policy initiatives related to the CMU and to the SMS. For the case of Energy Union, we adopt a modified version of RHOMOLO where all supply constraints are removed and direct input substitution effects are neglected. The model is thus transformed to a conventional Inter-Regional IO model (RHOMOLO-IO) where the price elasticity of supply is infinite and the price elasticity of demand is zero.

2.2. The RHOMOLO-IO framework

The RHOMOLO-IO framework uses data organised in IO tables with sectoral disaggregated regional economic accounts (see Mandras *et al.*, 2019, for more details). The IO tables represent a snapshot of the flows of products and services produced and consumed within the economy in a single year. The basic principle of the IO tables is to identify and disaggregate all the monetary flows between industries (inter-industry expenditure flows), consumers and supplies of factors in the economy.

Under a number of assumptions, IO tables can be used as the basis for an economic model where exogenous final demands drives total output (Leontief, 1986; Miller, Blair, 2009). Supply is infinitely elastic and the determination of inputs is based on fixed technical coefficients. The transmission

the iceberg assumption has the limitation that it is difficult to assessment regulatory and innovation improvements in the transportation sector.

mechanisms linking changes in exogenous demands to changes in aggregate and sectoral activities are called multipliers. These represent the knock-on effects throughout the economy, generated by the change in final demand. In other words, IO multipliers allow us to measure to what extent an increase/decrease in final demand of one sector, entail expansionary/contractionary effects in the output of all sectors, the perturbed sector included. The activity generated by each sector resulting from the initial demand disturbance is known as the indirect effect. In computational terms the multiplier effect is thus given by the direct plus indirect effects divided by direct effect.

IO multipliers can be used to quantify the economic impact derived from a demand-side shock assuming that the average relationships in the IO table apply at the margin. Finally, the two key assumptions in IO are: *a*) the supply-side of the economy is entirely passive and, *b*) the production technology for all sectors is represented by fixed coefficients (i.e. an increase in the production of any one sector's output means a proportional increase in that sector's input requirements). This means that inputs substitutability is neglected.

3. The simulation strategy

3.1. The cross-border investments initiatives

We evaluate the macroeconomic impact of removing national regulatory barriers to facilitate cross-border activity and investment within the CMU. In particular, we concentrate on the evaluation of the following proposals:

i) the proposal for a Regulation on crowdfunding[3];

ii) the proposal to facilitate cross-border distribution of investment funds;

iii) the proposal on the assignment of financial claims and a guidance on third party effects of securities to improve legal security for cross-border investment.

The broad idea behind such a proposed regulatory framework is to create the necessary incentives to improve the market-based financial system as a complement to bank-based finance of investments (Veron, Wolff, 2015; Quaglia *et al.*, 2016). This should improve the efficiency of the whole EU financial market and reduce the price of capital, as postulated by most of the theoretical constructions adopted in the current economic literature on the deepening and integration of the EU capital market. Essentially, standard neoclassical theory predicts positive growth effects from more integrated financial markets based on the reduction of capital cost driven by capital

[3] With a corresponding amendment to Directive 2014/65/EU on the Markets in Financial Instruments MiFID II.

flows moving from capital-abundant regions towards capital-scarce ones. However, the existing empirical evidence does not unambiguously confirm this theoretical prediction and tends to conclude that there are only limited effects at best. For instance, Bekaert *et al.* (2005) and Quinn and Toyoda (2008) find positive growth effects, but Edison *et al.* (2002) only find mixed effects. On the contrary, Neumann *et al.* (2009), Stiglitz (2004), and Levchenko *et al.* (2009) find negative effects of financial integration on growth through the reduction of the cost of capital.

According to Gehringer (2013), financial openness generated a strong positive impact on economic growth and factor productivity in Europe. Other studies affirm that financial openness directly affects factor productivity by stimulating financial development (see, among others, Rajan, Zingales, 2003). According to Gourinchas and Jeanne (2006), analysing the effects of international financial integration on productivity is more important than examining its investment growth effects. Typically, financial openness is expected to have a positive impact on productivity via a better and more efficient allocation of resources (Kose *et al.*, 2009), as well as due to easier access to investment opportunities (Giannetti *et al.*, 2002). Furthermore, financial openness may result in less capital constraints, permitting the economy to engage in more productive investments (Acemoglu *et al.*, 2006). In addition, capital account openness may spur financial development (Baltagi *et al.*, 2009). A well-developed financial system contributes to a better risk diversification and encourages foreign investors to shift at least part of their investments from safe and low-yield to risky but more profitable locations (Obstfeld, 1994; Sandri, 2010).

In line with the economic literature summarised above, productivity shocks appear to be the most appropriate transmission channel to evaluate the potential impact of more integrated capital markets in the EU. Thus, we frame our simulation strategy in accordance with this approach within RHOMOLO. In particular, we aim at capturing the system-wide impact of greater financial openness within the EU through permanent changes in total factor productivity (TFP).

The TFP shock we implement is based on Gehringer (2013) who estimates the impact of financial openness on TFP growth, which is the TFP elasticity to financial openness. To the best of our knowledge, this study is the most up-to-date analysis measuring such elasticity in relationship with the EU capital market. The estimated elasticity is equal to 0.043 with a standard error of 0.012 (Gehringer, 2013, Table 2). Applying such elasticity to the time series index of financial openness by Chinn and Ito (2008) and data on TFP levels for the 28 EU countries from 1996 to 2017 (AMECO database), we are able to reconstruct the evolution of TFP up to 2017 for each country solely driven by financial integration.

We simulate three alternative scenarios, Low, Central, and High, based on the uncertainty attached to the estimated TFP elasticity to financial openness quantified via the standard deviation associated to the point estimate by Gehringer (2013). Namely, for the construction of the Central scenario we use the point estimate of 0.043, while the Low and High scenarios use the point estimate -/+ two standard deviations, respectively. The three newly created TFP series (one for each scenario) are then taken as benchmark and used to construct the TFP shocks for the model.

The idea behind our simulation is the following: We assume that the development of the capital markets union associated to the regulatory proposals on cross-border activities may exert effects comparable to those observed during the 3 years either before the adoption of the euro (for the old EU Member States) or before the entrance into the EU (for newer members). Thus, for the Member States that adopted the euro in 1999, the TFP shock is defined as the period by period percentage changes computed during the period 1997-1999 with respect to the 1996 TFP level (bear in mind that such changes are solely due to financial openness by construction, as explained above). The third period's TFP change is then kept as a permanent shock in the model. We use the same approach for the countries Denmark, Sweden and the UK that have negotiated the right to opt-out from participation to the Eurozone. For the countries that joined the EU at a later stage, and are therefore still in the adjustment phase, the TFP shock is created using a different reference period which is the three years preceding the entrance in the EU[4]. For instance, Romania joined the EU in 2007, it is currently outside the Eurozone, but committed to the adoption of the euro once it fulfils the necessary conditions. In this case, the reference period is 2005-2007.

3.2. The Start-up and Scale-up initiative

The Start-up and Scale-up EU initiative aims to create a favourable environment to innovation, entrepreneurship, and competitiveness (European Commission, 2016a; 2016b). With this initiative, the European Commission is determined to eliminate the administrative and regulatory barriers currently existing in the fragmented EU Single Market that may particularly constraint start-up and scale-up companies in their growth potential. We focus here on the part of the initiative built to improve access to finance for start-ups in the EU.

The European Commission and the EIB Group launched a Pan-European Venture Capital Fund of Funds to attract private funding from institutional

[4] We thus approximate the potential gain from the cross-border investments initiatives for newer Member States by changes in their financial openness index three years prior to entrance in the EU. An alternative approach could be to assume an increase in TFP similar to that observed (on average) in the Member of the EU before the introduction of the euro. This would result in a higher TFP growth in seven of the newer Member States and result in lower TFP growth in six of the newer Member States.

investors into the EU venture capital asset with the aim to help innovative start-up to scale up, create sustainable jobs, and increase the value of firms in the market. The EU provided an initial investment of € 400 million which was expected to trigger around € 1.6 billion in venture capital funding over the period 2018-2020 (European Commission, 2018b);

The increased access to finance for start-up companies should increase direct investments and help these companies to scale-up, generating in turn additional positive impacts on the whole economy. We identify a change in the model's calibrated risk premium (RP) as the most appropriate transmission channel to evaluate the potential economic impact of greater accessibility to finance for small and innovative companies. The RP is a parameter calibrated as the difference between the market return and the risk free rate[5]. By reducing this gap, we immediately impose a fall in the user cost of capital, which increases the profitability of capital. The direct impact therefore entails a less expensive capital that stimulates investments, capital accumulation and raises the capital/labour ratio in regional economies.

The Fund-of-Funds is expected to trigger in the future an estimated € 6.5 billion of new investment in breakthrough innovation projects by start-ups with potential to grow across Europe (European Commission, 2016a). We therefore translate a potential availability of funds of around € 500 million per year into a fall in the actual price of capital through a reduction in the market RP. We then run the shock forward up to year 2030 implicitly assuming a total cumulative investment shock of € 6.5 billion.

It has been estimated that only few start-ups survive beyond the critical phase of three years (European Commission, 2016b). In order to reflect the current and potential survival rates we build the following Low, Central and High scenarios. In the High scenario we assume that all firms will be able to survive and scale-up. Under the Central scenario we instead assume that, after three years, 25% of start-up companies will face bankruptcy and will dissipate all the accumulated assets. Under the Low scenario, we assume that there would be an additional 25% of start-ups unable to survive beyond the sixth year.

3.3. The large procurement projects package

The European Commission launched an initiative to help national governments and local authorities in managing large procurement projects (European Commission, 2017a) by assisting them in the phases of initial procurement procedures, projects' evaluation, and applications of best practices to handle major cross-border projects. The aim of this ex-ante

[5] Although in the calibration each regions start with the same risk free return, the market return is different across regions in order to accommodate capital terminal conditions. Therefore, each region has a different level of RP in the initial steady-state.

mechanism is to improve both the effectiveness and the attractiveness of public spending of Member States. The implementation and application of this initiative has the potential of generating substantial benefits in terms of growth and jobs driven by efficiency improvements in the public sector that are expected to spread to all the other sectors of the economy. According to the economic literature (Aschauer, 1985; 1988), the productivity of public investment has a powerful impact on the productivity of the whole economic system.

We initially run a baseline scenario that consists of a permanent increase in public capital expenditures. In the baseline, the efficiency of public capital, defined as the output elasticity of public capital, is set to its default model value of 0.1[6]. We then compare the baseline with a set of counterfactual scenarios involving an increase in efficiency of public capital that is assumed to be a result of the large procurement projects package. The magnitude of the efficiency gains is based on the potential efficiency gains in public investments estimated in IMF (2015) and on the cost saving estimates of public procurement made by Europe Economics (2006) and Vogel (2009). Our objective is to evaluate and explore the effects of the increase in public sector productivity by manipulating the output elasticity of public capital in the production function. Higher values of this elasticity generate positive output and income effects, thereby increasing the attractiveness of public investments.

We construct three alternative scenarios, Low, Central, and High, depending on the assumed changes in efficiency of public capital. Our hypotheses are based on estimated potential efficiency gains in public investments and costs savings in public procurements. In an assessment of the quality of public investment management practices, the IMF (2015) finds that the average efficiency gap in public investment efficiency for the EU28 countries is 15%. Hence, the average EU28 country is 15% from an estimated public investment efficiency frontier[7]. In its analysis, the IMF suggests that up to two-thirds of the efficiency gap could be closed by strengthening the public investment management institutions. A survey-based analysis contained in Europe Economics (2006) estimates that cost savings related to transparency and competition in public procurement can range between 2.5%-10%[8].

We translate the estimated efficiency gains and cost savings into changes in public capital efficiency by taking into account two additional measures: the country-specific share of large cross-border procurement projects over total public procurement, and a country index of administrative performance.

[6] Estimates of the output elasticity of public capital are taken from Bom and Ligthart (2014).

[7] Gerd Schwartz and Geneviève Verdier from the IMF kindly provided estimates of the public investment efficiency index and the efficiency gap for the EU28 Member States based on IMF (2015).

[8] These estimates are based on 2002 contract values (Europe Economics, 2006).

This means that the efficiency improvement η that we assume in the simulation scenarios, that is the change that we apply to the output elasticity of public capital, is defined as $\eta = \rho\alpha q$. ρ is the efficiency improvement that we expect with the fully operative new regulation on public procurement; α is the share of the value of the procurement projects over total procurement that may benefit by the ex-ante mechanism; and q is a parameter employed to allow for larger positive effects to countries currently characterised by relatively worse administrative performances, and lower positive effects to well-performing countries which are therefore already close to the efficiency frontier.

To the best of our knowledge, there are no estimates on the numbers and values of the large procurement projects that are expected to be directly impacted by the policy. For this reason, α is proxied with the direct and indirect cross-border procurement projects' shares of the total value of contracts awarded between 2009 and 2015. We report such numbers (found in European Commission, 2017b) in the first two columns of Table 2.

The parameter q is derived from an index of country administrative performances. The numbers reported in the third column of Table 2 are taken from Afonso *et al.* (2005) for the older EU Member States and from Afonso *et al.* (2010) for the newer EU Members. We create cut-off points for the distribution of the performance index across regions by splitting the sample into quintiles. We then assign the following values to q: 0.6 to the 1st quintile (good performers, that is associated with the highest values of the index), 0.8 to the 2nd quintile, 1.0 to the 3rd quintile, 1.2 to the 4th quintile and 1.4 to the 5th quintile (bad performers, that is associated with the lowest values of the index). This allows public investment to be more attractive in countries where public sector efficiency is relatively lower. Essentially, we expect larger marginal benefits in those Member States that currently are relatively bad performers.

In the construction of the three simulation scenarios, the parameters α and q remain fixed while the efficiency improvement ρ varies as follows: 0.055 in the Low scenario, 0.0775 in the Central scenario, and 0.10 in the High scenario, reflecting alternative hypotheses on the expected efficiency increase related to the implementation of the policy (with 10% being the maximum expected increase). The full changes implemented in our model simulations can be found in the last three columns of Table 2.

Given the estimates reported in Table 2 and applying the shares of expected public investments directly affected by the ex-ante mechanism on the calibrated public investments in RHOMOLO, the cost saving associated to the policy analysed here amounts to € 4 billion under $\rho = 0.1$ (High scenario), to € 3 billion under $\rho = 0.0775$ (central scenario), and to € 2 billion under $\rho = 0.055$ (Low scenario). These numbers are consistent with the estimates made by European Commission (2015), from which we quote the following:

Table 2: Data used in the construction of the scenarios and estimated changes in the output elasticity of public capital

	Indirect cross-border share of value of awards	Direct cross-border share of value of awards	Index of admin. performance	Scenarios: Changes in output elasticity %		
				Low	Central	High
Austria	19.8	5.2	1.2	0.8	1.2	1.5
Belgium	36.1	5.1	0.7	2.9	4.5	5.8
Bulgaria	15.4	4.5	0.8	1.4	2.2	2.8
Croatia	17.4	4.7	0.8	1.3	2.1	2.7
Cyprus	5.9	13.8	1.3	0.6	0.9	1.2
Czech R.	30.2	3.0	1.1	1.7	2.6	3.3
Denmark	16.7	4.8	1.2	0.9	1.3	1.7
Estonia	22.3	7.4	1.3	0.9	1.4	1.8
Finland	24.0	2.9	1.3	0.8	1.3	1.6
France	12.2	1.8	0.7	1.0	1.5	2.0
Germany	16.0	2.1	1.0	0.9	1.4	1.8
Greece	11.5	3.4	1.0	0.9	1.4	1.8
Hungary	22.5	3.6	1.1	1.3	2.0	2.6
Ireland	20.8	10.0	1.2	1.2	1.9	2.5
Italy	24.2	2.6	0.5	1.9	2.9	3.8
Latvia	16.0	3.2	1.0	1.0	1.5	1.9
Lithuania	20.9	7.1	1.0	1.7	2.6	3.4
Luxembourg	18.7	13.3	1.1	1.6	2.5	3.2
Malta	6.0	19.6	1.1	1.0	1.6	2.0
Netherlands	17.5	2.8	1.2	0.8	1.3	1.6
Poland	23.2	1.9	0.9	1.5	2.3	3.0
Portugal	25.9	6.8	1.1	1.3	2.0	2.6
Romania	24.0	7.1	0.6	2.2	3.4	4.4
Slovakia	24.4	6.4	1.0	1.8	2.9	3.7
Slovenia	17.4	7.8	1.1	1.3	2.0	2.5
Spain	27.0	1.2	0.8	2.0	3.1	3.9
Sweden	20.4	3.4	1.2	1.0	1.5	1.9
UK	22.3	2.5	1.0	1.5	2.3	3.0

Source: RHOMOLO calculations.

Public procurement uncertainties contribute to the general cost overruns. Considering that 9 out of 10 big transport infrastructure projects run over budget on average by 28%, the overall cost increase of projects above € 700 million registered in TED could amount up to € 4 billion per year. Although the factors leading to overruns are many, improving this situation even marginally, due to better public procurement procedures, can imply large savings for taxpayers (European Commission, 2015, p. 67).

Our scenarios are built specifically for the 28 countries. However, the RHOMOLO model is disaggregated into 267 NUTS2 regions, therefore all the regions belonging to the same country received the same country-specific shock.

3.4. Energy efficiency

The Energy Union strategy has been identified as a clear European priority project by the European Commission (European Commission, 2017c). One of its key elements is energy efficiency and it is regarded as the most effective way to support the transition to a low carbon economy and to sustain growth and creation of new jobs (European Commission, 2016c). The Energy Union strategy is built around an energy efficiency target of 30% to be achieved by 2030 (European Commission 2016c; 2016d; 2017c). The target is expected to be met through a 1.5% increase per year in energy savings by energy suppliers and distributors.

We quantify the system-wide economic impact of reaching the 30% reduction in the consumption of energy for the whole EU in terms of additional GDP growth and number of jobs created by means of the RHOMOLO-IO model illustrated in Section 2. For evaluating energy efficiency policies, we adapt the sectoral classification of the RHOMOLO-IO model by disaggregating the B-D-E composite sector into three distinctive sectors (B, D, and E) and we take out from the manufacturing sector the C19 sector which identifies the manufacture of coke and refined petroleum products. Furthermore, we aggregate sectors O-Q and R-U into one composite services sector (O-U).

However, what distinguishes our analysis from the former impact assessments is the specific focus on energy efficiency as a result of the behavioural changes by economic agents mainly driven by the policy framework developed in the Energy Union. The assumption is that the European Commission's proposals aimed at improving energy efficiency are able to create a set of incentives that would positively modify the attitude of consumers towards low-carbon and more sustainable consumption patterns.

Our simulations are based on the impact of energy consumption as predicted by the PRIMES energy model and reported in the impact assessment of the energy system in European Commission (2016d). According to the European Council reference baseline 2016 projection (EUCO-Ref-2016), the gross energy consumption should equate to 1,554 Mtoe by 2030. An alternative target of 27% energy efficiency (EUCO-27) results in a gross energy consumption of 1,486 Mtoe, while with the more ambitious 30% target (EUCO-30), consumption of energy should be equal to 1,321 Mtoe in 2030. Rebasing these energy consumption targets into changes in the use of energy from 2015 values, the expected increase in energy savings is equal to 6.9% under the EUCO-Ref-2016, 10.8% under the EUCO-27, and 13.7% for the EUCO-30 scenario. We consider the EUCO-Ref-2016 as our Low scenario,

Table 3: Energy efficiency targets under the PRIMES projections and final use of energy targets adopted in RHOMOLO-IO

	EUCO-Ref-2016 Low scenario	EUCO-27 Central scenario	EUCO-30 High scenario
2030 PRIMES energy efficiency projections	1,554 Mtoe	1,486 Mtoe	1,321 Mtoe
IO model energy saving targets	6.9%	10.8%	13.7%

Source: RHOMOLO calculations.

the EUCO-27 as the Central scenario, and EUCO-30 as the High (most ambitious) scenario. Targets and related scenarios are reported in Table 3.

Given the above targets on the overall consumption of energy for the EU, we apply the energy efficiency shock only on residential energy use increasing energy savings in the production of capital energy-type goods.

In all three scenarios, the corresponding amount of energy savings is redistributed to the consumption of other goods and services other than energy, maintaining income fixed. The idea behind this simulation is to allow consumers to use the resources saved through well-implemented energy efficiency policy in the consumption of non-energy goods and services. In line with previous input–output studies (Freire-González, 2017; Lecca *et al.*, 2014), we assume that households re-spend all their saved income from reduced energy use on consumption goods therefore the income of households is kept constant.

We furthermore assume that final users keep preferences unchanged. This means that reallocation of resources is performed using the initial calibrated consumption shares.

4. Results

4.1. The cross-border investments initiatives

The immediate effect of a positive TFP shock is a fall in the price of both capital and labour. Lower production costs cause an increase in the demand for labour and capital increasing therefore production in real terms. The lower cost of the primary factors of production drives a general reduction in the price of commodities producing positive terms of trade effects particularly towards the ROW increasing exports, stimulating economic growth even further.

The adjustment mechanisms described above are reflected in the numbers reported in Table 4. The table shows the percentage deviations from the initial steady-state of some key economic variables for selected years that illustrates the transition towards the new steady-state: 2020, 2025, and 2030. We observe a sharp increase in GDP and employment by 2020, two

Table 4: Macroeconomic impact of the cross-border investments initiatives (percentage changes from baseline) – Low, Central, and High scenarios

	2020	2025	2030
Low			
GDP	0.15	0.19	0.21
Employment	0.03	0.06	0.07
Household consumption	0.09	0.13	0.15
Export to the ROW	0.29	0.34	0.37
CPI	-0.09	-0.10	-0.10
Central			
GDP	0.35	0.44	0.48
Employment	0.08	0.14	0.17
Household consumption	0.20	0.29	0.33
Export to the ROW	0.66	0.76	0.83
CPI	-0.21	-0.22	-0.23
High			
GDP	0.54	0.68	0.75
Employment	0.12	0.21	0.26
Household consumption	0.32	0.46	0.52
Export to the ROW	1.03	1.19	1.30
CPI	-0.33	-0.34	-0.36

Source: RHOMOLO calculations.

years after the implementation of the policy[9], in all three scenarios. Then, the economy expands further year by year through capital accumulation. In 2030, the GDP is likely to increase by between 0.21% and 0.75%, with the central estimates being equal to +0.48% relative to the initial steady-state. As for employment, our modelling simulations suggest a minimum impact of +0.07% and a maximum impact of +0.26% from the initial steady-state (corresponding to 157 and 547 thousand FTEs respectively), with the central estimate being equal to +0.17% (equivalent to 353 thousand FTEs).

Interestingly, in percentage term the rise in employment is less than the rise of GDP, meaning that capital is increasing proportionally more than GDP. This reflects substitution effects in favour of capital generated by a relatively greater reduction of the price of capital compared to the price of labour, both measured in efficiency units.

To examine the regional impact of the TFP shock, Figure 1 shows box-plots of the percentage changes relative to the initial steady-state for selected

[9] Recall that we assume the reform to yield three consecutive years of TFP improvement after which the TFP gain becomes permanent.

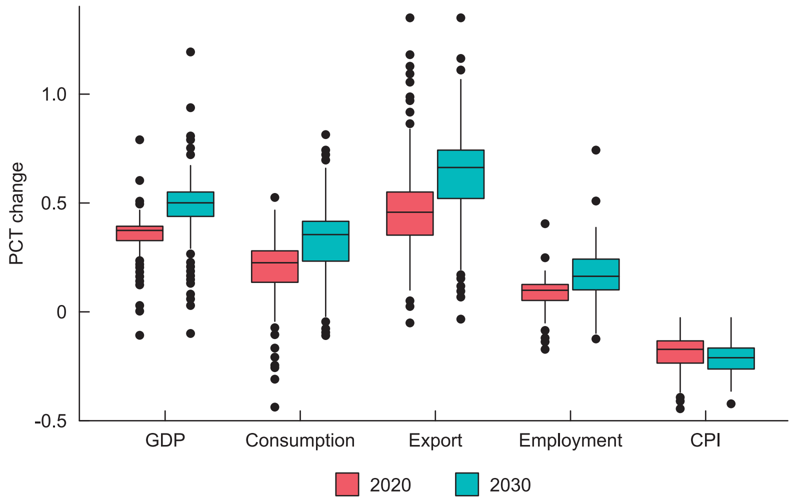

Figure 1: Regional impact of the cross-border investments initiatives – Central scenario.
Source: Authors' calculation on RHOMOLO.

variables in the central scenario for the years 2020 and 2030. Lower factor prices causes a general decline in the consumer price index (CPI) for all regions with the median regions experience a decline in CPI of 0.22% in 2030. Improved competitiveness results in higher export, GDP, consumption and employment for most regions. We notice considerable regional variation in impacts from the TFP shock. While most regions benefit from the change in regulation, a small number of regions suffer losses. For example, the median region experience a rise in GDP of 0.49% in 2030 with the regional change in GDP varying from -0.11% to 1.19%. The rise in employment for the median regions is 0.15% in 2030 with the change in employment ranging from -0.13% to 0.74%. The largest gains in GDP and employment are found in the Baltic countries, and in regions in Romania and Ireland (as shown for GDP in Figure 2). Swedish regions also experience some of the largest gains in GDP. Malta experiences a loss in GDP while Cyprus and regions in Poland experience only modest gains in GDP. We also find modest gains in GDP in Greece and Southern Italy. Losses in employment are found in regions in South, Insular and North-West Italy, and in Malta. Typically, regions placed in the lower quartile of GDP gains are also placed in the lower quartile of employment gains.

With the aim of identifying the sources of the increased competitiveness at the regional level, in Figure 3 we plot changes in the regional GDP (horizontal axes) against changes in exports (vertical axes) obtained under the Central scenario. We show result for the short run i.e. after one year (panel *a*) and the long run i.e. the new steady-state (panel *b*). Both in the short run and in the long run we observe a positive correlation between changes in

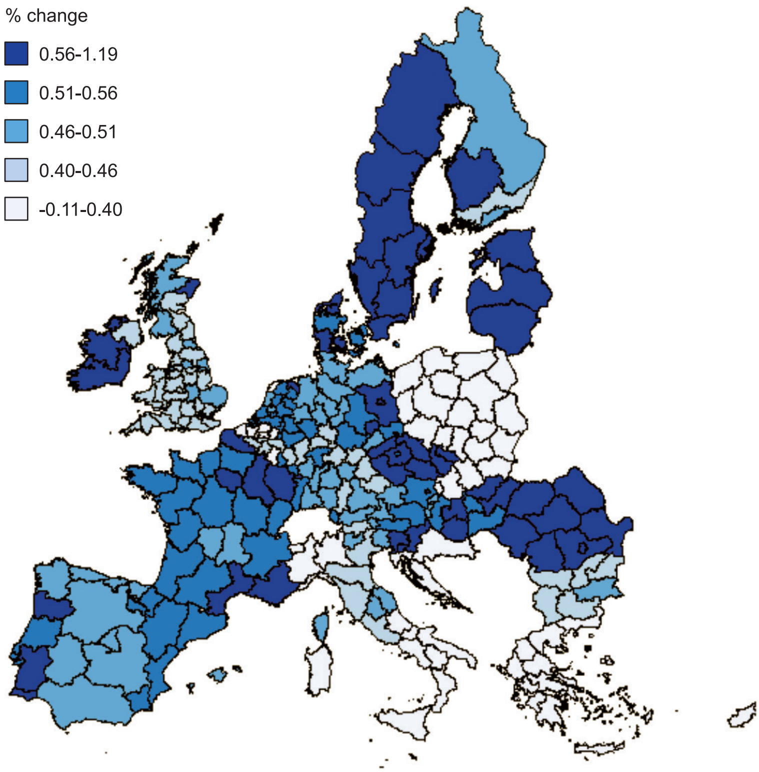

Figure 2: Regional GDP impact in 2030 of the cross-border investments initiatives – Central scenario.
Source: Authors' calculation on RHOMOLO.

the GDP and exports, with the correlation being weaker in the short run as supply constraints are in place to mimic adjustment delays of firms. As explained above, the fall in the price of primary factors generates a fall in commodity prices boosting regional competitiveness particularly with the ROW. It is worth noticing that the regions above the fitting lines are those benefiting the most from such improved competitiveness effects, while the rest of the regions experience smaller changes in export.

In Table 5 we divide the regions into quartiles based on GDP per capital in the baseline, the regions with the lowest GDP per capital in quartile one and the regions with the highest GDP per capital in quartile four. For each quartile group we calculate the average change in GDP per capita relative to the baseline. We find that all quartile groups on average benefit from the reform proposal, with the riches EU regions befitting the most in terms of GDP (on average a rise of 0.51% relative to the baseline). This suggests that the cross-border investments initiatives would contribute to economic growth in the EU but would not lead to economic convergence across regions.

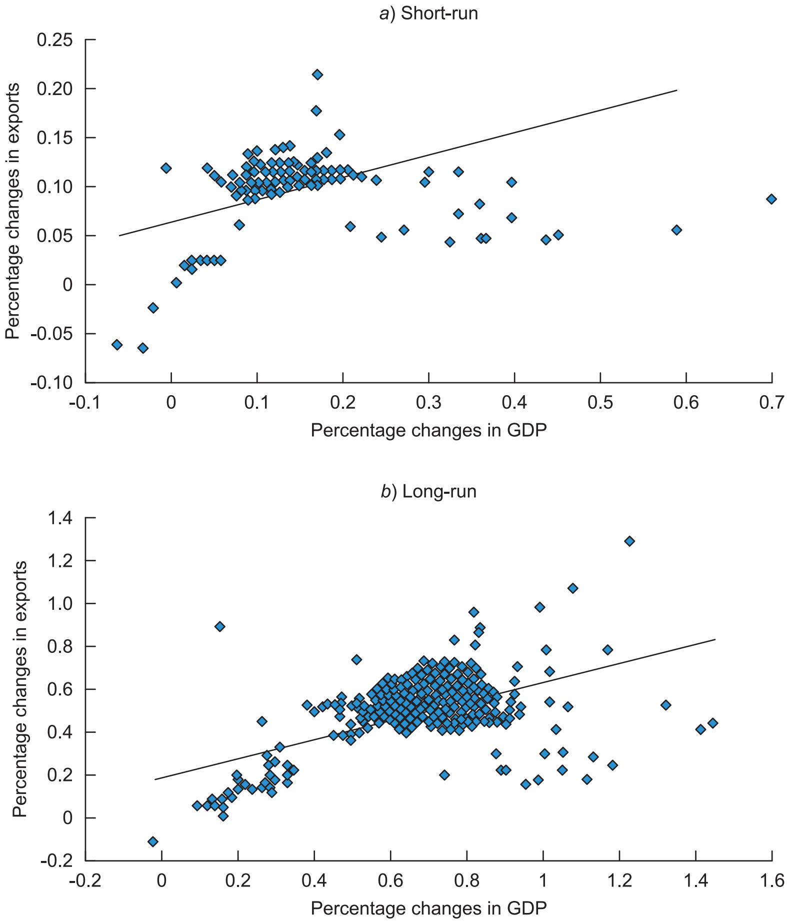

Figure 3: Impact on the relative competitiveness of regions: short-run and long-run – Central scenario.
Source: Authors' calculation on RHOMOLO.

Table 5: Relative change in GDP per capita by baseline quartile groups – Central scenarios

	2020	2025	2030
Quartile 1	0.240	0.329	0.379
Quartile 2	0.322	0.403	0.443
Quartile 3	0.361	0.448	0.489
Quartile 4	0.367	0.464	0.510

Source: RHOMOLO calculations.

4.2. The Start-up and Scale-up initiative

Figure 4 plots the percentage changes of EU GDP from the initial steady-state obtained under the three scenarios. We observe a permanent economic

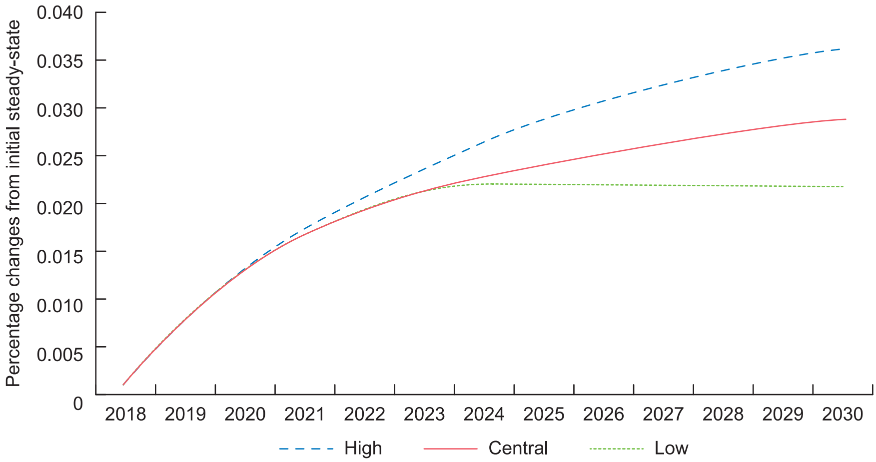

Figure 4: Macroeconomic impact on GDP (Percentage changes from baseline) – Low, Central, and High scenarios.
Source: Authors' calculation on RHOMOLO.

expansion in all three scenarios, with the GDP increase between 0.022% and 0.036% above baseline values in year 2030 (corresponding to € 2.8 and € 4.7 billion added to EU GDP, respectively). For the first three simulation years the assumed survival rate of start-up firms is identical for all scenarios. After three years the assumed survival rate of start-ups declines in the low and central scenario resulting in lower GDP impact. After six years, the assumed survival rate of start-up firms in the low scenario declines further and this results in the lower GDP increase.

Table 6 sheds light on the adjustment mechanism by reporting the percentage deviation from the initial steady-state of selected variables for the years: 2020, 2025, 2030. We can see that GDP, employment and household consumption all increase year by year eventually settling to a new steady-state where all variables grow at a constant rate. The reduction in the risk premium spurs a rise in investments and accumulation of capital. At first, the one-year time to build assumption on productive capital impose a short-run capacity constraint. This means that in the first simulation year the economy responds to the shock as if it was a conventional demand-side shock with no direct supply-side response. The higher investment demand puts initial upward pressure on factor prices and domestic commodity prices resulting in a decline in exports to ROW. The EU is running a current account deficit to help finance the rise in investments. However, as capital accumulates in the medium to long term direct supply-side effects through increased capital stock accompany the demand-side effect of the shock. Capital accumulation puts downward pressure on commodity prices and these falls below the initial steady-state and the gain in competitiveness leads to a rise in exports to

Table 6: Macroeconomic impact of the large procurement projects package (percentage changes from baseline) – Low, Central, and High scenarios

	2020	2025	2030
Low			
GDP	0.0129	0.0217	0.0216
Employment	0.0090	0.0139	0.0141
Household consumption	0.0132	0.0181	0.0186
Export to the ROW	-0.0410	0.0107	0.0073
CPI	0.0108	-0.0031	-0.0016
Central			
GDP	0.0129	0.0237	0.0282
Employment	0.0090	0.0154	0.0184
Household consumption	0.0132	0.0206	0.0244
Export to the ROW	-0.0410	-0.0028	0.0042
CPI	0.0108	0.0006	-0.0009
High			
GDP	0.0129	0.0288	0.0362
Employment	0.0090	0.0188	0.0237
Household consumption	0.0132	0.0253	0.0315
Export to the ROW	-0.0410	-0.0086	0.0035
CPI	0.0108	0.0021	-0.0007

Source: RHOMOLO calculations.

ROW. We note that the rise in GDP is higher than the rise in employment as capital accumulation leads to a fall in the price of capital and a substitution away from labour. Employment in 2030 rises between 0.014% and 0.024% (corresponding to an increase by between 30 and 50 thousands FTEs with the central estimates being equal to 39 thousands FTEs).

Figure 5 depicts the distribution of regional changes in selected variables in the central scenario for the years 2020 and 2030. Capital accumulation gradually raises regional GDP, exports and employment. In 2030, all regions experience a rise in GDP and employment relative to the initial steady-state. The increase in GDP and employment for the median region is respectively 0.03% and 0.02%. Household consumption rises in most regions. However, regional divergence means that a few regions experience relative large increases in household consumption (North-Eastern Scotland, Bucharest and Helsinki) while other regions suffers small declines in household consumption (Cheshire, Merseyside, the Finnish region of Åland and regions in North-East Italy). We find the lowest gains in GDP and Employment in Cyprus, Estonia and Spanish regions (see Figure 6). The highest gains in GDP and employment can be found in a geographically dispersed group of regions

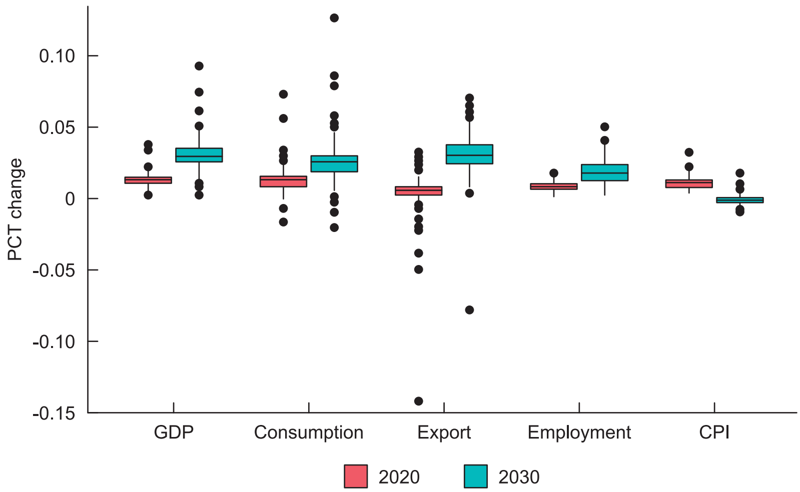

Figure 5: Regional impact of the Start-up and Scale-up initiative – Central scenario.
Source: Authors' calculation on RHOMOLO.

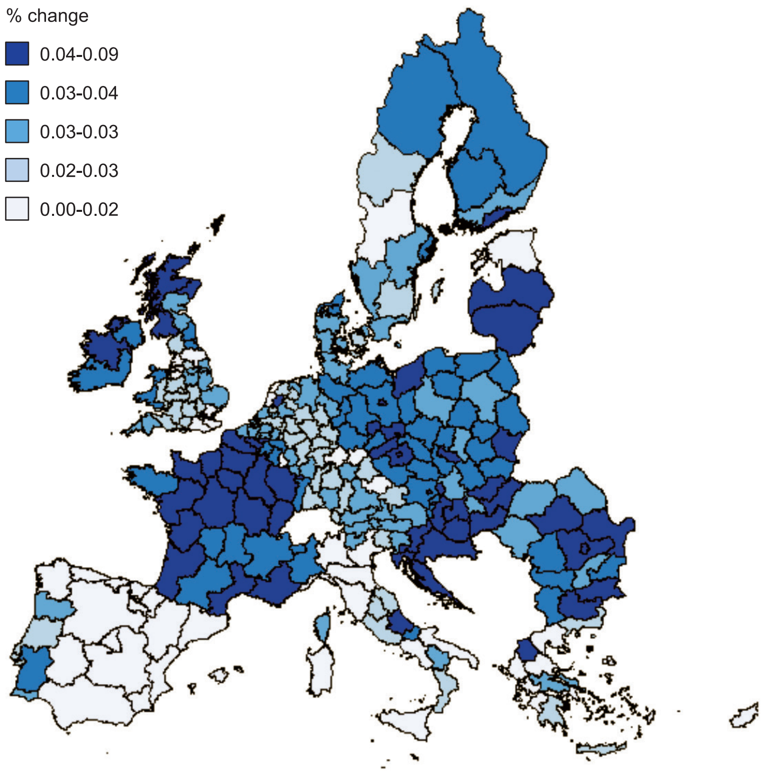

Figure 6: Regional GDP impact in 2030 of the Start-up and Scale-up initiative – Central scenario.
Source: Authors' calculation on RHOMOLO.

Table 7: Relative change in GDP per capita by baseline quartile groups – Central scenarios

	2020	2025	2030
Quartile 1	0.013	0.027	0.034
Quartile 2	0.013	0.022	0.026
Quartile 3	0.014	0.024	0.029
Quartile 4	0.013	0.024	0.029

Source: Authors' calculation on RHOMOLO.

(including Latvia, Northern Scotland, Bucharest and Bratislava region) characterised by having relatively low calibrated risk premia. We formulate the simulated policy shock as a uniform percentage point reduction in the risk premia across all regions. Hence, the lower the regional initial pre-shock risk premium the higher the resulting relative change in regional user cost of capital. Regions with lower initial risk premia will therefore experience the largest relative rise in private investments.

In Table 7, we consider the average change in GDP per capita by quartile groups. The table reveal that all quartile groups experience a rise in GDP per capita relative to the baseline. We observe the largest rise in GDP per capita in year 2030 for quartile one (the regions with the lowest GDP per capital in the baseline). However, the variation in average GDP per capita deviations relative to the baseline are modest across quartile groups. This suggest a modest economic convergence across EU regions from the Start-up and Scale-up initiative.

4.3. The large procurement projects package

Table 8 contains the results of the three scenarios expressed in percentage changes from the initial steady-state for selected variables for the years 2020, 2025, and 2030.

The aggregate economic gains from the large procurement projects package are relatively small. Our simulations suggest that improvements in public procurement procedures could result in GDP rise by 2030 of between 0.0041% and 0.0074% relative to the initial steady-state. The central estimate being a rise in GDP by 2030 of 0.0057%. Employment by 2030 rises by between 0.0014% and 0.0025% (correspond to increase by between 3 and 5 thousands FTEs). The increase in public capital efficiency generates system-wide efficiency gains. Services from public capital enters as an unpaid factor in production and improved public capital efficiency therefore reduces production costs. This means that the economy becomes more competitive through positive terms of trade effects leading to a rise in exports to ROW and an improvement in the current account.

Table 8: Macroeconomic impact on key economic variables (percentage changes from baseline) – Low, Central, and High scenarios

	2020	2025	2030
Low			
GDP	0.0010	0.0026	0.0041
Employment	0.0002	0.0008	0.0014
Household consumption	0.0005	0.0016	0.0026
Export to the ROW	0.0019	0.0048	0.0073
CPI	-0.0006	-0.0015	-0.0022
Central			
GDP	0.0013	0.0037	0.0057
Employment	0.0003	0.0011	0.0020
Household consumption	0.0008	0.0023	0.0037
Export to the ROW	0.0027	0.0067	0.0103
CPI	-0.0009	-0.0021	-0.0031
High			
GDP	0.0017	0.0047	0.0074
Employment	0.0004	0.0015	0.0025
Household consumption	0.0010	0.0030	0.0048
Export to the ROW	0.0034	0.0087	0.0132
CPI	-0.0011	-0.0027	-0.0040

Source: Authors' calculation on RHOMOLO.

We find that the increase in public capital efficiency benefit relatively more the primary (A and B-E) and the manufacturing sectors than the service sectors as suggested by Figure 7 plotting the percentage changes from the steady-state for the central scenario for the years 2020, 2025, and 2030.

Figure 8 shows the regional changes in selected variables in the central scenario. All regions benefit from lower CPI and in turn a rise in total export and GDP. Our results suggest that the rise in GDP for the median region is 0.0055% in 2030. Most regions also experience a rise in employment and household consumption. However, regional variation exists with the highest gains in GDP and employment found in regions in Belgium, Romania and Spain (as illustrated for GDP in Figure 9). We find modest gains in Cyprus, and regions in Greece and Finland. Regions in North-West, South and Insular Italy experience modest gains in GDP paired with a modest decline in employment and household consumption.

Table 9 compares the relative changes in GDP per capita across quartile groups. We find modest gains in GDP per capital across all regions.

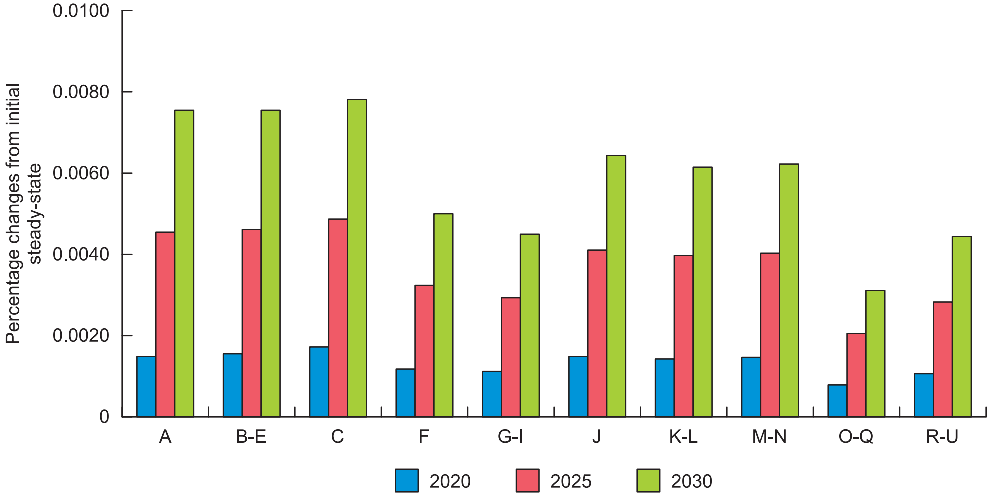

Figure 7: Sectoral output effects (percentage changes from baseline) – Central scenario.
Source: Authors' calculation on RHOMOLO.

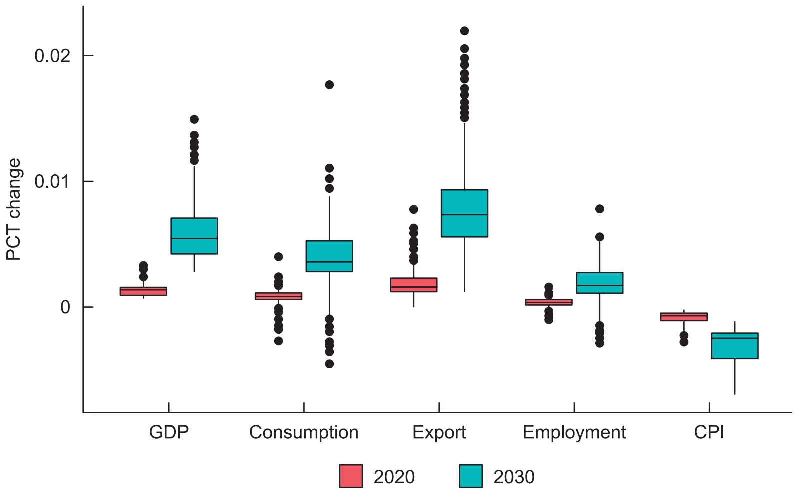

Figure 8: Regional impact of the large procurement projects package – Central scenario.
Source: Authors' calculation on RHOMOLO.

Regions in quartile one (the regions with the lowest GDP per capita in the baseline) experience marginally higher long run gains in GDP per capita than other quartile groups.

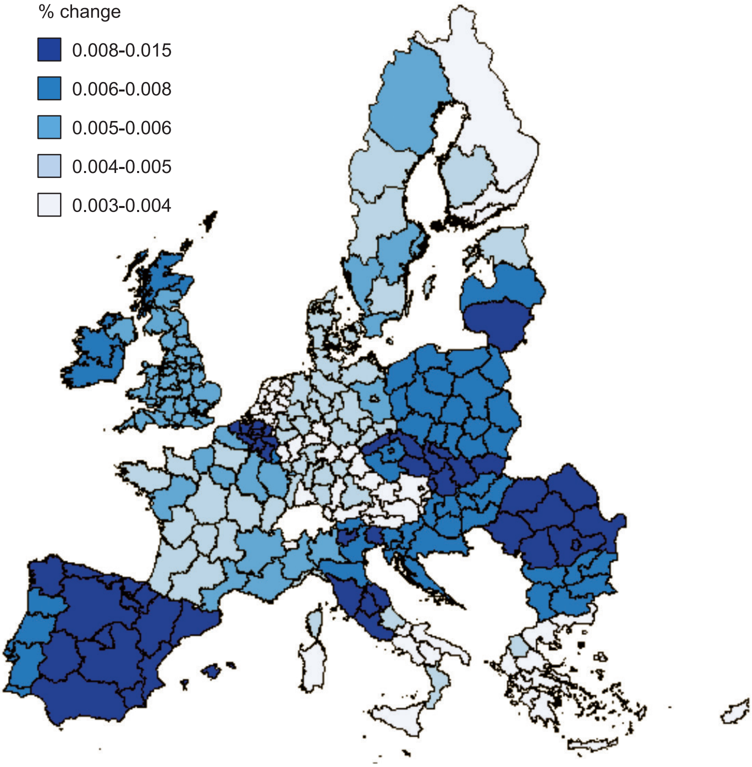

Figure 9: Regional GDP impact in 2030 of the large procurement projects package – Central scenario.
Source: Authors' calculation on RHOMOLO.

Table 9: Relative change in GDP per capita by baseline quartile groups – Central scenarios

	2020	2025	2030
Quartile 1	0.001	0.004	0.007
Quartile 2	0.001	0.004	0.006
Quartile 3	0.001	0.004	0.005
Quartile 4	0.001	0.003	0.005

Source: Authors' calculation on RHOMOLO.

4.4. Energy efficiency

Our consumption switching exercise is expected to return positive output effects as long as non-energy-intermediate sectors have higher backward linkages than the energy supply sectors[10]. Table 10 shows the impact on

[10] Note that the implementation of energy efficiency policies generates rebound effects. The

Table 10: Macroeconomic impact (percentage change from base year values) – Low, Central, and High scenarios

	Low	Central	High
GDP	0.250	0.380	0.480
Employment	0.053	0.080	0.101

Source: Authors' calculation on RHOMOLO.

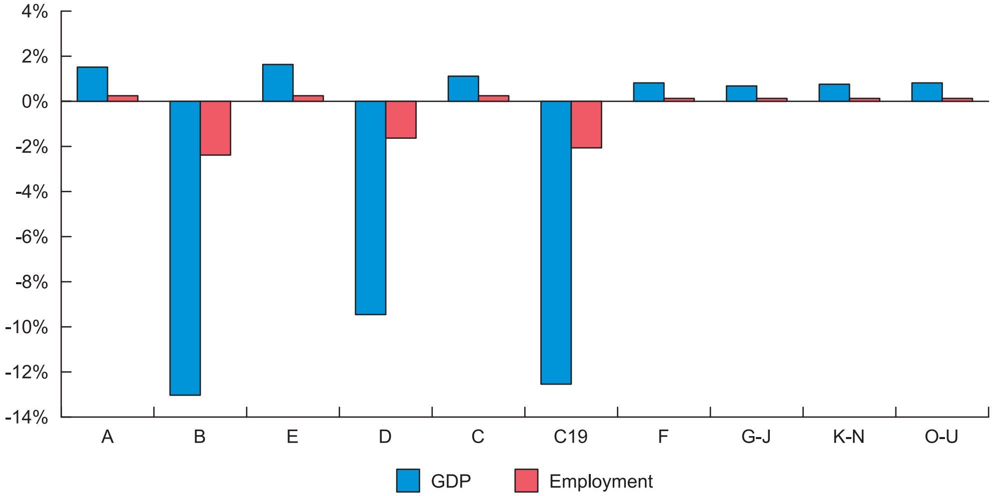

Figure 10: Impact at the sectoral level on GDP and employment – Central scenario.
Source: Authors' calculation on RHOMOLO-IO.

GDP and employment under the Low, Central and High scenarios. We observe larger impacts under the High energy efficiency scenario whilst lower economic impacts are associated to less ambitious and more conservative energy targets. We find a rise in GDP that is substantially higher than the rise in employment.

We estimate the additional jobs created for the EU as whole to 225, 178, 118 thousand FTE under the High, Central, and Low scenarios, respectively. Our results suggest heterogeneity in impact across economic sectors. As depicted in Figure 10, where only the outcomes for Central scenario are reported, the energy sectors (B, D and C19) experience a large reduction in output and employment. However, this is more than compensated by the growth registered in the other sectors.

consumption of non-energy goods has increased and the rebound effect is larger the greater is the consumption shift towards goods that require energy in the production of these goods and services .

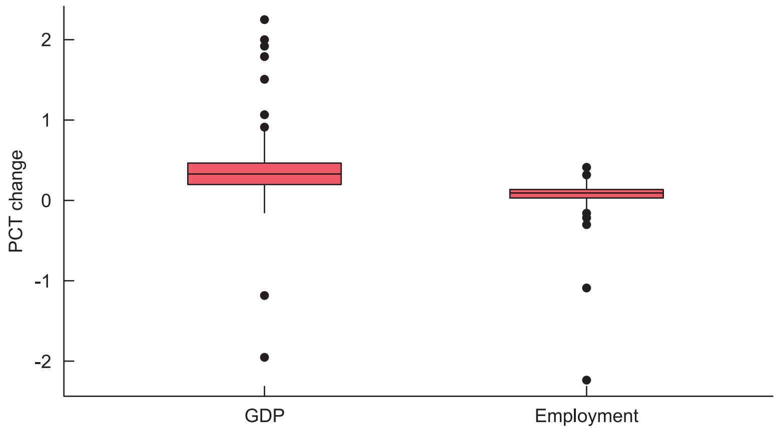

Figure 11: Regional impact of the energy union – Central scenario.
Source: Authors' calculation on RHOMOLO-IO.

Figure 11 plots the percentage deviations from baseline of the GDP and employment obtained for all the 267 NUTS2 regions under the Central scenario. Almost all regions experience growth in GDP and increase in number of jobs created. The rise in GDP and employment for the median regions is respectively 0.35% and 0.09% relative to the baseline. A few regions experience large gains in GDP with the highest gains in North and East Finland and Eastern Romania. We also observe large gains in GDP for regions on the Iberian Peninsula, Bulgaria, Austria, Slovenia and Slovakia (Figure 12). We register few regions where output and employment are crowded out. This includes regions in North-West Romania and the UK. In these regions, the energy supply sectors are typically more labour intensive. The fall in employment and output in these energy sectors is excessively large to be fully offset by positive changes in the other sectors of the economy[11].

Table 11 compares the relative changes in GDP per capita across quartile groups. We find that all quartile groups on average benefit from higher energy efficiency. Regions in quartile one (the regions with the lowest GDP per capita in the baseline) experience slightly higher gains in GDP per capita than other quartile groups.

[11] Recall that the RHOMOLO IO model used in this simulation rules out any substitution of production factors. This reduces the capacity for other sector to absorb labour freed up in the energy sectors.

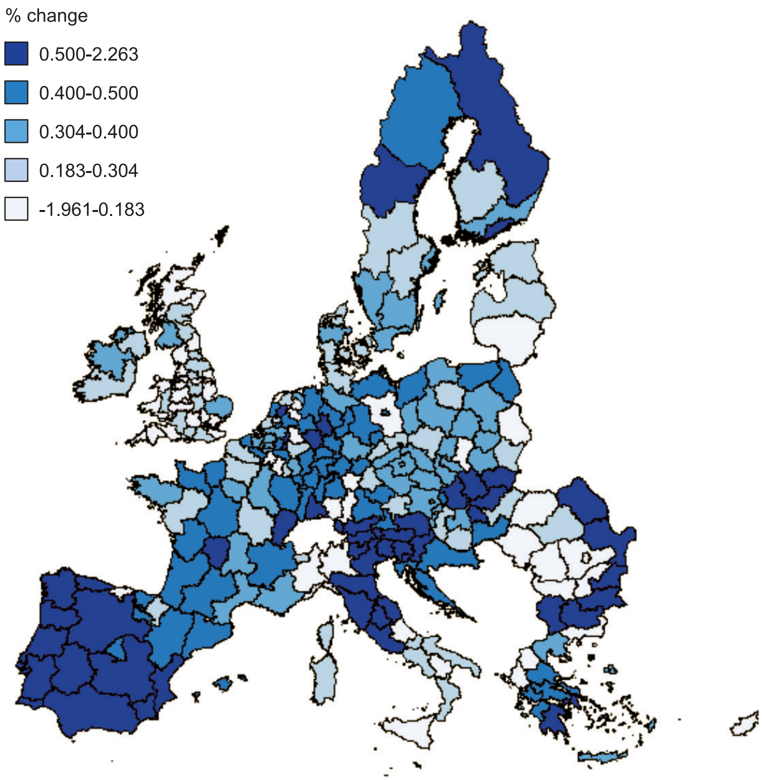

Figure 12: Regional GDP impact of the energy union – Central scenario.
Source: Authors' calculation on RHOMOLO-IO.

Table 11: Relative change in GDP per capita by baseline quartile groups – Central scenarios

	GDP capita
Quartile 1	0.391
Quartile 2	0.312
Quartile 3	0.374
Quartile 4	0.384

Source: Authors' calculation on RHOMOLO.

5. Conclusions

The purpose of this paper is to study the potential macroeconomic impact of some of the measures contained under the third strand of the Investment Plan for Europe aimed at removing barriers to investment in the European common market. The total macroeconomic impact of the measures analysed in this paper using the RHOMOLO and the RHOMOLO-IO modelling frameworks amount to an increase in EU GDP of about 0.9% by 2030 (according to the Central scenario), and potentially up to 1.3% (according to the High scenario) by the same year. These two numbers translate to a potential increase of about 575,000 jobs and more than 825,000 jobs, respectively.

These results suggest that removing barriers to investment such as red-tape and regulatory bottlenecks can be beneficial for the EU economy, and strengthens the necessity for EU countries to address the existing investment barriers at the national level. Our results suggest regional heterogeneity in economic impact. While most regions would benefit from the removal of barrier, the economic impact varies and some regions experience only small gains or may even suffer losses of competitiveness and in turn a decline in GDP and employment.

The rich regional specification in the model used for our analysis allow us to consider the effect of spatial heterogeneity on economic outcome. However, the version of RHOMOLO used here adopt the assumption of regional representative households and firms. Extending the analysis to introduce agent heterogeneity within regions would allow us to consider effects from variation in productivity across firms and to examine distributional effects of the policy reforms for the EU and within regions. This could be interesting paths for future research.

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