The economic effects of entrepreneurship policy

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JEL Codes: C63, L26, M13, O10, R58

Keywords: Entrepreneurship policy, economic growth, GMR models, REDI index, regional development

Abstract

Recent findings suggest that policies supporting entrepreneurship should be considered in the palette of public interventions promoting economic growth. However, it is still unknown how much a concrete policy intervention would affect economic growth in a particular country or a region and how these impacts might change over time. These effects can be estimated with economic impact models. GMR-Europe is the first available model that estimates the economic impacts of entrepreneurship policy. In this paper we introduce the most recent version of GMR-Europe. To illustrate the capacity of GMR-Europe model the paper provides a detailed policy impact assessment analysis.

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1. Introduction

Economic impact assessment provides important information about how policy interventions affect certain variables (like GDP, employment or unemployment) representing the economy of a country or region. This information may serve the policy design stage in a useful way when potential alternative interventions are weighted against each other and impact analysis also supplies relevant knowledge for ex-post policy evaluation. Economic models are commonly used instruments of impact evaluation. The QUEST (Ratto et al. 2009) and the HERMIN (Bradley 2006) models have been the most frequently used tools of European Cohesion Policy impact assessment whereas the REMI model (Treyz et al. 1992) is a widely applied instrument of regional policy evaluation in the United States.

Recently published papers deliver increasing evidence on the positive influence of entrepreneurship on economic growth. Lafuente et al. (2016) emphasize that efficiency at the national level is largely supported by a healthy system of entrepreneurship. This finding gets further support in a cross-country study of Acs et al. (2017), which concludes that entrepreneurship triggers productivity. Prieger et al. (2016) and Acs et al. (2018) test the entrepreneurship-growth nexus and find that national entrepreneurial ecosystems positively and significantly influence economic growth in developing countries. In Szerb et al (2017a) entrepreneurship ecosystem positively influences Gross Values Added and employment growth in 125 European Union regions.

Current findings in the literature therefore suggest that policies supporting entrepreneurship should be considered in the palette of public interventions promoting economic growth such as R&D, human capital, infrastructure or investment subsidies. Despite growing evidences, it is still unknown to what extent a given policy intervention (e.g., the support of entrepreneurial culture, increased financial support to entrepreneurs) would affect economic growth in a particular country or region and how these effects might change over time. Furthermore it is still not clear what is the position of entrepreneurship policy among traditionally applied instruments like R&D or human capital promotion. Is entrepreneurship policy a complement of or a substitute to those instruments? How would a policy combining entrepreneurship promotion and those traditional instruments affect economic growth? The relevant answers to these queries can be found only with the application of specifically constructed economic impact models..

Nevertheless, at least two major challenges have to be solved in order to successfully estimate the growth effects of entrepreneurship policy with an economic impact model. The first is measuring the level of entrepreneurship in relation to the different interventions that aim to promote it. To date there exists only one measure of this kind, the recently developed Regional Entrepreneurship and Development Index (REDI) (Szerb et al. 2017b). The other challenge is to integrate the entrepreneurship measure into an economic impact model, which is capable of estimating the productivity effects of entrepreneurship policy at the relevant spatial scale together with the effects of traditional growth-promoting policy instruments. Estimating the productivity effect is crucial since entrepreneurship is considered to be a key factor of innovation (Acs et al. 2009). Since firm-formation is dominantly affected by locally available factors (Szerb et al. 2017b) sub-national regions are the relevant units of the suitable economic impact models.

In this paper we introduce the most recent version of GMR-Europe, which is the first available model that estimates the economic impacts of entrepreneurship policy. The distinctive feature of this version is that it incorporates economic impact assessment of interventions targeting entrepreneurship development. GMR-Europe integrates the REDI index and estimates the economic impacts of entrepreneurship policy at regional, national and EU-levels. In the following section the REDI index is positioned among the currently available measures of entrepreneurship. The third section gives a concise (non-technical) outline of GMR-Europe. In a section that follows we illustrate the capacities of the GMR-Europe model with a detailed policy impact assessment analysis. Summary concludes the paper.

2. Measuring entrepreneurship

If we want to examine the effect of entrepreneurship on any performance indicator like productivity, economic growth, or development we should have a clear definition, a proper measurement unit, and a suitable model. Amongst entrepreneurship scholars, there is no agreement on any of these pre-conditions (Landström and Harirchi 2018). According to Wennekers and Thurik (1999) entrepreneurship is an ill-defined concept, others view it eclectic (Audretsch et al 2015), and it is hard to find even a minimum agreement on even to frame the phenomenon (Shane and Ventakaraman 2000). Albeit, a distinctive feature of entrepreneurship is its focus on the individual person as opposed to firms or markets. Some identify entrepreneurs based on specific psychological traits (Baum et al 2014), others associate it with new venture creation (Gartner 1985), and some with its economic and societal effects (Baumol 1996).

Entrepreneurship is also used by many different disciplines (Low and MacMillan 1988, Parker 2018). Here we follow mainly the economics approach by examining how entrepreneurship affects the economic output from the measurement perspective (Acs et al 2014). Some believe that entrepreneurial attitudes - preferences for self-employment, assertiveness toward entrepreneurs and entrepreneurial careers, perceptions of entrepreneurial skills - play an important role in the startup process and ultimately in economic growth. However, attitudes are not actions and the exploration of the mechanism that leads attitudes to action and to economic growth has not been unveiled and understood (Autio et al 2013). A popular approach is to identify entrepreneurship with some output measures like startup rate or the Global Entrepreneurship Monitor (GEM) total-early-phased entrepreneurial activity ratio. The drawback of the output view is that they mix very different measures that all have varying effect on economic outcomes (Nightingale and Coad 2014, Vivarelli 2013). Moreover, entrepreneurial outputs and their composition vary over development (Naudé 2010). Since Baumol (1996) we know that the effect of entrepreneurship is regulated by its context. Framework measures like the World Bank Doing business or the Index of economic freedom aim to quantify the effect of the widely interpreted institutions on entrepreneurship outputs; albeit better institutions do not directly linked to some entrepreneurial actions. While the maturity of the institutions is closely correlated with long term economic development their predictive power on growth or productivity is only partially understood (Acs et al 2014). Besides, institutions are geographically bounded, and place-based, many of them are effective and worth measuring in a smaller territorial unit than a country (Qian et al 2013).

In the 2010s, a new research direction, the entrepreneurship ecosystem (EE) approach started to emerge focusing on the systemic (framework) conditions that lead to the occurrence of potentially high impact entrepreneurial output like fast growing gazelles (Malecki 2018, Stam 2015). While EE as a scientific concept is still in a very early stage of development, its approach is useful for examining the economic effect of entrepreneurship (Alvedalemn and Boschma 2017). Szerb et al (2017a) identifies the basic features of EE as (1) the clear distinction of entrepreneurial environment and entrepreneurial outputs (2) the performance of the EE depends on the systemic interaction between institutions and the various players (3) agglomeration economies, networking, and spillover effects are the basic features and mechanisms of the ecosystems and (4) ecosystems are very different resulting of a path dependent development process with forward and backward linkages.

There is an agreement amongst EE followers that each entrepreneurship ecosystem is unique and trying to replicate successful examples is not possible. Some even believe that EEs are so unique that it is impossible to measure them. Consequently, EEs should be examined by individual case studies and their development strategy should be unique, place- and case-based (Spigel 2017). Partially contradicting to this approach, we do believe that there are some common elements of EE and a common measurement can be a useful tool for not general but tailor-made policy recommendations. Presently, there exists only one tool, the Regional Entrepreneurship and Development Index (REDI), that provides a measure of EE for a mix of 125 NUTS1 and NUTS2 European Union regions (Szerb et al 2017b). REDI is a regional version of the well-known Global Entrepreneurship Index (GEI) defining the system of entrepreneurship (SE) as '…the dynamic, institutionally embedded interaction between entrepreneurial attitudes, ability, and aspirations, by individuals, which drives the allocation of resources through the creation and operation of new ventures' (Acs et al. 2014, p. 119). As compared to GEI, REDI is not simply a more precise but also a more appropriate measure of EE because it incorporates a different set of institutional variables reflecting the regional forces of agglomeration, connectivity and clustering.

The REDI index includes three sub-indices, 14 pillars, 28 variables (14 institutional and 14 individual), 44 indicators and 60 sub-indicators. Unlike other EE approaches REDI clearly defines how the different elements are interrelated and connected to each other. REDI elements can have an additive (indicator level) or a multiplicative (variable level) influence on the system performance. A unique feature of REDI is its capacity to demonstrate how resource allocation can be optimized along the 14 pillars to improve the REDI score and, ultimately, the regional entrepreneurship system performance. Moreover, the systemic combination of the pillars influences the effectiveness of the ecosystem. An improvement in the weakest pillar would produce an increase in the overall REDI score. An EE with a same level, homogeneous pillar configuration is viewed to be the optimal (Szerb et al 2017b).

3. Economic impact assessment of entrepreneurship policies: the GMR modeling approach

In this section we give a brief and non-formal description of the GMR modeling approach as a tool for the impact assessment of entrepreneurship-related policies. For a detailed and formal exposition of the model the reader is directed to Varga et al. (2018). First the general features of the GMR approach are exposed together with an account of its previous applications. Then, we provide a basic overview of the building blocks of the model and the intuition behind their capability of evaluating specific policy interventions. Finally, we discuss the integration of entrepreneurship policy into the model in a more extensive way.

3.1 General features of the GMR approach

The geographic macro and regional (GMR) modeling framework was established and has been continuously improved to better support development policy decisions by ex-ante and ex-post scenario analyses. The focus of the GMR approach is on policy instruments like R&D subsidies, human capital development, entrepreneurship policies or the promotion of innovation-related collaboration of actors.

Traditional models of development policy analysis follow a national level of spatial aggregation.[1] A novel feature of the GMR approach is that it incorporates geographic effects (e.g., agglomeration, interregional trade, migration) while both macro and regional impacts of policies are simulated. Geography plays a critical role in development policy effectiveness for at least four major reasons. First, interventions are applied at specific points in space and their impacts might spill over to proximate locations to a considerable extent. Second, the initial impacts can be amplified or reduced by short run (static) agglomeration effects significantly. Third, labor and capital migration may further amplify or reduce the initial impacts possibly reshaping the spatial structure of the economy (dynamic agglomeration effects). Forth, as a consequence of the above effects, different spatial patterns of interventions might result in significantly different growth and convergence/divergence performances at the national and regional levels.

Regions constitute the spatial reference points in the GMR approach, being sub-national spatial units ideally at that level of aggregation which is appropriate to capture proximate relations in innovation. By explicitly modeling regions, it is able to capture interregional interactions such as knowledge flows exceeding the regional border (scientific networking or spatially mediated spillovers), interregional trade and the mobility of production factors. Although having a clear regional focus, the macroeconomic level is also important with respect to development policies: fiscal and monetary policy, national regulations or various international effects all shape the effects of local policy interventions. As a result of this two-level setup, the model system simulates the effects of policy interventions both at the regional and the macroeconomic levels. With such an approach different scenarios can be compared on the basis of their impacts on (macro and regional) growth and interregional convergence.

The first realization of the GMR approach was the EcoRET model built for the Hungarian government for ex-ante and ex-post evaluation of the Cohesion policy (Schalk and Varga 2004). This was followed by the GMR-Hungary model, which is currently used by the Hungarian government for Cohesion policy impact analyses (Varga 2007). GMR-Europe was built in the IAREG FP7 project (Varga et al. 2011, Varga 2017) and further developed in the GRINCOH FP7 project (Varga et al. 2015). The most recent version of GMR-models is GMR-Turkey (Varga et al. 2013, Varga and Baypinar 2016) and the recently updated version of the GMR-Europe model (Varga et al. 2018).

3.2 The logical setup of the GMR-Europe model

As emphasized previously, the GMR approach reflects the challenges of incorporating regional, geographic and macroeconomic dimensions into development policy impact modeling. From the methodological point of view, this means the integration of different traditions in economics (Varga 2006). Spatial patterns of knowledge flows and the role of agglomeration in knowledge transfers build on insights and methodologies developed in the field of the geography of innovation (e.g., Anselin et al. 1997, Varga 2000). Interregional trade and factor mobility together with dynamic agglomeration effects is based on the tradition of the new economic geography through applying an empirical general equilibrium model (e.g., Krugman 1991, Fujita et al. 1999). Finally, modeling policy impacts at the macroeconomic level draws on specific macroeconomic theories.

[1] These models either follow the tradition of macroeconometric modeling (like the HERMIN model - ESRI 2002), the tradition of macro CGE modeling (like the ECOMOD model – Bayar 2007) or the most recently developed DSGE approach (QUEST III – Ratto et al., 2009).

These three theoretical traditions also characterize the formal setup of the GMR models, which are structured around the mutual interactions among three sub-models, which are the Total Factor Productivity (TFP), Spatial Computable General Equilibrium (SCGE) and macroeconomic (MACRO) model blocks. In what follows, we provide a brief account of these three model blocks.

3.2.1 The TFP (productivity) block

Total factor productivity (TFP), i.e. the overall productivity level of regions is one of the most crucial variables in the GMR models. It represents the main point through which different aspects of innovation and innovation policy interventions in particular interact with other parts of the model. The TFP block is the part in the GMR system where different factors behind innovation are modeled and their interaction shapes regional productivity levels.

Figure 1 illustrates the setup of the TFP block. TFP is the focal variable here, which then transfers impacts generated in the TFP block over to the other parts of the model. The TFP block is based on the knowledge production function approach of Paul Romer (Romer 1990). New knowledge, represented by patent applications in our model setup, is produced using knowledge production factors, namely R&D efforts and labor (employment), as well as already existing knowledge which is represented by national patent stocks. In addition to these standard factors we also include the role of knowledge available through interregional networks, which is assumed to affect the productivity of R&D in knowledge creation. New knowledge, i.e. patent applications at the regional level then feed back into knowledge creation in a dynamic way by building up national patent stock.

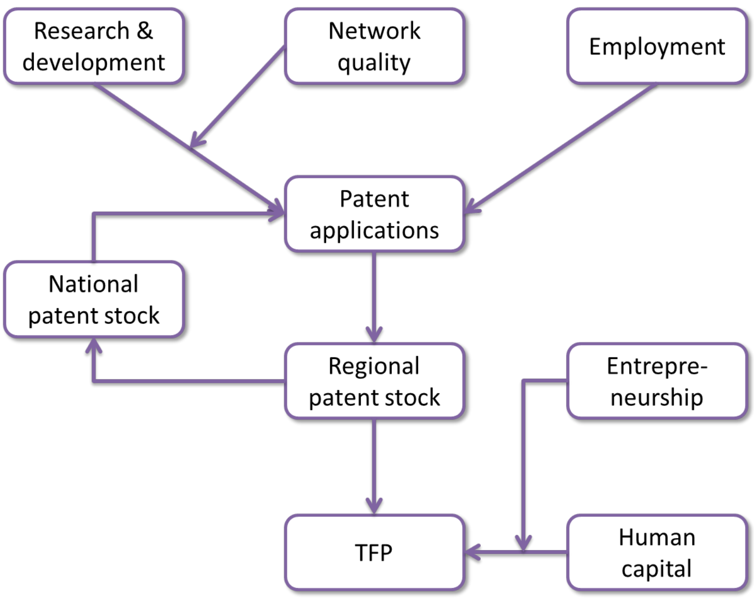

Figure 1 – The schematic structure of the TFP block

TFP is primarily linked to regional knowledge levels as described before, but two factors are added to the determination of regional TFP. First, the level of human capital in the region is supposed to affect productivity and second, a focal element of this setup of the GMR model, we added the entrepreneurial environment (measured by the REDI index) in the model which is also assumed to have a positive influence on productivity, via enhancing the contribution of human capital to TFP. Our formulation is influenced by the knowledge spillover theory of entrepreneurship (Acs et al. 2009). Entrepreneurs transfer knowledge to economic applications therefore a better entrepreneurial climate in a region intensifies new firm formation. A higher level of entrepreneurship in a region helps to better exploit the knowledge embodied in human capital, which eventually leads to increasing total factor productivity. The TFP impact of entrepreneurship is tested in a panel data econometric model where human capital interacts with entrepreneurship. Estimated parameters of the model are highly significant and the model fits extremely well to data.

As it is clear from the setup of the TFP block, this is the part of the model where most of the policy interventions can be handled. Support to research and development activities, human capital accumulation as well as promotion of network formation affects variables in this model block and the relationships in this block determine the effect of these policies on regional productivity levels. Also, policies affecting entrepreneurship are accounted for in this model block, through the REDI index, which represents entrepreneurship in our model setup. A more detailed account of how entrepreneurship is handled in the model is given in section 3.3.

From a methodological point of view, the TFP block consists of econometrically estimated equations describing the relationship between the variables mentioned above. Using interaction terms in these equations and through a regional-level recalibration process of estimated model parameters, the TFP block is able to supply region-specific impacts of specific policy interventions on regional productivity levels.

3.2.2 The SCGE block

The TFP model block simulates the likely effects of different innovation-related policies within the regional innovation system. Finally, these effects affect regional productivity in some way, which is then the most important point through which events in the TFP block influences the other two model blocks. First of these, the SCGE (spatial computable general equilibrium) model block draws on regional productivity changes and then simulates the likely impacts of these changes on regional economic variables like output, prices, wages, employment, etc. The most important feature of this block is that it takes into account interactions across regions through trade of goods and services as well as the mobility of production factors. Also, transportation costs are explicitly accounted for and (positive and negative) agglomeration effects are also part of the model structure.

The SCGE model block accounts for equilibrium adjustment in two time dimensions. In the short run, which means a year in our setting, the equilibrium nature of the model block ensures that all markets clear, given the productivity level and available quantity of production factors (labor and capital) within each region. This results in an equilibrium allocation of production and trade together with market clearing goods, capital prices and wages, taking into account the exogenous transportation costs. In the long run, differing utility levels across regions (depending on consumption and population density) give rise to labor migration changing the setup of market mechanisms which mean that there is a long run adjustment even to a one time shock to productivity levels. Labor migration is also followed by capital migration through a mechanism in which capital stock is gradually reallocated into those regions where productivity grows at a higher rate. In the long run this model block drives the economy to a state where interregional utility differences are eliminated.

3.2.3 The MACRO block

The macroeconomic block of the GMR approach serves two purposes. First, this is the point, where aggregate relationships and policies can be handled (exchange rate towards the rest of the world, inflation, monetary and fiscal policy) and second, it provides dynamics to the otherwise static SCGE block. In the latter regional productivity, labor and capital stocks are exogenous. The TFP block provides the dynamics of regional productivity levels, but in order to account for the possible employment and investment effects of the simulated policies we need to provide dynamics for labor and capital stocks of the regions. This is done by the MACRO block, which gives an aggregate estimation of the likely employment and capital-stock impacts of the simulated policies, which are broken down to the regions in function of the regional productivity growth rates.

In line with the general equilibrium setup of the SCGE block, the MACRO block uses a dynamic stochastic general equilibrium (DSGE) model, which is a standard tool of macroeconomic analysis. In the GMR-Europe model we use the QUEST III model developed by the European Commission for the Euro area (see Ratto et al., 2009), and reestimated it on fresh data for the Eurozone and some additional countries relevant in the GMR setup. Using a dynamic macroeconomic model, which builds on intertemporal optimization of economic agents we significantly improve the dynamic behavior of traditional SCGE models that rely on an iterative application of otherwise static equilibrium allocation mechanisms.

3.2.4 Integration of model blocks and policy impacts

Figure 2 illustrates how the three model blocks are integrated and interact with each other to simulate the impacts of different policy interventions with respect to different variables of interest. First, as already described before, different innovation policy instruments affect model variables in the TFP block. The main focus of this paper, entrepreneurship policies, also affect the TFP block having a direct effect on regional productivity levels in the first place.

The productivity impacts induced by policy interventions then feed into the interregional SCGE model which simulates the likely effect of these policies on regional level economic variables like output, prices, labor and capital stocks according to market equilibrium conditions across all regions. Also, some standard policy instruments like direct investment support or public infrastructure development can be handled in this model block directly.

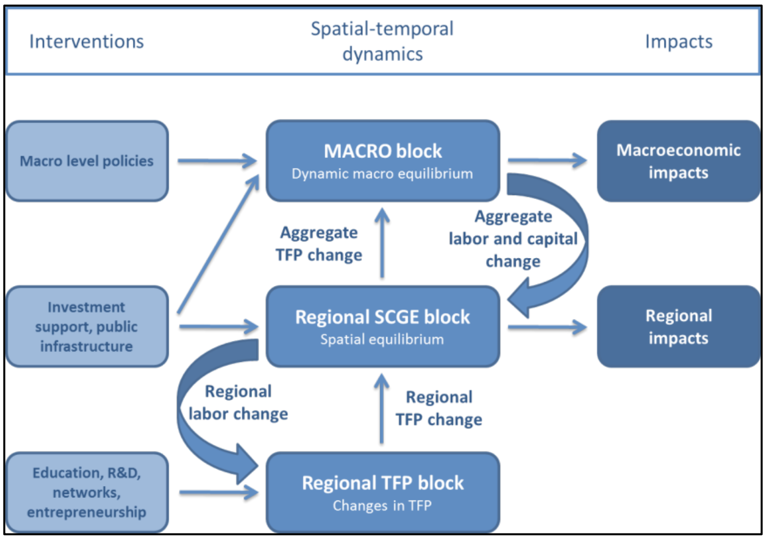

Figure 2: Regional and macroeconomic impact mechanisms in the GMR-Europe model

Regional productivity impact, aggregated to the macroeconomic level, also provide the input to the MACRO block, which simulate the likely effects of these productivity impacts on aggregate level macroeconomic variables taking into account dynamic relationships on the basis of intertemporal optimization. The dynamics of aggregate labor and capital, reallocated to the regions then drive the dynamic adjustment of the regional variables in interaction with productivity changes coming from the TFP block. Also, regional changes in employment through the dynamic employment impacts of policies and labor migration feed back into the TFP block contributing to agglomeration effects which results in higher productivity levels due to a concentration of economic activity.

To sum up, the model is able to track the likely impacts of different policy interventions (entrepreneurship policies specifically) through the dynamic interaction of the three model blocks: the TFP block simulates regional productivity impacts, on the basis of which the SCGE block generates market clearing allocation of production and consumption taking into account transportation costs and the dynamics of economic variables is driven by the MACRO block. As a result, the model tracks policy impacts both at the regional and aggregate levels for various important variables.

3.3 Entrepreneurship-related policies in the GMR-Europe model

Although the GMR-Europe model is able to simulate the likely impacts of many different innovation policies, this paper focuses on its ability to integrate policies specifically designed to enhance entrepreneurship in a given region. In this section we discuss in more detail how these policies are reflected in the model.

3.3.1 The REDI index

The Regional Entrepreneurship and Development Index (REDI) has been constructed to capture the regionally embedded contextual features of individual entrepreneurship efforts and initiation across EU regions. The REDI method builds on the National Systems of Entrepreneurship Theory and provides a way to profile Regional Systems of Entrepreneurship. REDI is a multi-level comprehensive index, which reflects several aspects of the entrepreneurial context of a region. Upon constructing the index, a six level index-building methodology was followed: sub-indicators (1) are merged into indicators (2) which are then reflected by variables (3), then these construct pillars (4), contributing to sub-indices (5) which finally constitute the REDI super-index (6). With respect to its content, at the sub-index level we differentiate between entrepreneurial attitudes, abilities and aspirations[2] that are then broken down to 4-5 pillars, quasi-independent building blocks of this entrepreneurship index. Every pillar is obtained by multiplying an individual with an associated institutional variable capturing the combined effect of individual initiations and regional institutional context. The key idea behind this systemic index is that system performance is "co-produced" by its interrelated elements. Table 1 provides a detailed picture of the REDI down to the variable level.

A particularly important aspect of the REDI method is the Penalty for Bottleneck (PFB) methodology, which helps identifying constraining factors in the Regional Systems of Entrepreneurship. A bottleneck is the worst performing element or binding constraint and is defined as a shortage or the lowest level of a particular entrepreneurial pillar as compared to the other thirteen pillars. Then, the value of each pillar is penalized as a result of linking it to the score of the pillar with the weakest performance in the region (Acs et al. 2013, Rappai and Szerb 2011, Szerb et al. 2017). As a result, if the weakest pillar was raised, it would have a multiplicative effect to improve the other pillars and the whole REDI while raising a non-

[2] The attitude sub-index aims to identify the attitude of the people towards entrepreneurship (like the level of opportunity recognition or start-up skills within the population). Abilities are principally concerned with measuring certain important characteristics of both entrepreneurs and start-ups with high growth potential (e.g. the extent to which new opportunities motivate business startups, the share of technology intensive and creative sectors in the region). The entrepreneurial aspiration sub-index refers to the distinctive, qualitative, strategy-related nature of entrepreneurial start-up activity (i.e. the degree of innovativeness and the extent to which high growth, internationalization and good access to finance characterize entrepreneurial businesses).

bottleneck pillar would have only a minor effect. The idea here is that systems with strong weaknesses cannot fully leverage their strengths, or in other terms weakly performing bottleneck pillars hold back the performance of the whole entrepreneurship ecosystem. The novelty of this method is that it portrays the entrepreneurial disparities amongst EU regions and provides country and regional level, tailor-made public policy suggestions to improve the level of entrepreneurship and optimize resource allocation over the different pillars of entrepreneurship.

Table 1: **The structure of the Regional Entrepreneurship Development Index**

	Sub-indexes	**Pillars**	**Variables (*individual*/institutional)**
REGIONAL ENTREPRENEURSHIP ADEVELOPMENT INDEX	ENTREPRENEURIAL **ATTITUDES** SUB-INDEX	Opportunity Perception	*Opportunity Recognition*
			Market Agglomeration
		Startup Skills	*Skill Perception*
			Quality of Education
		Risk Acceptance	*Risk Perception*
			Business Risk
		Networking	*Know Entrepreneurs*
			Social Capital
		Cultural Support	*Carrier Status*
			Open Society
	ENTREPRENEURIAL **ABILITIES** SUB-INDEX	Opportunity Startup	*Opportunity Motivation*
			Business Environment
		Technology Adoption	*Technology Level*
			Absorptive Capacity
		Human Capital	*Educational Level*
			Education and Training
		Competition	*Competitors*
			Business Strategy
	ENTREPRENEURIAL **ASPIRATION** SUB-INDEX	Product Innovation	*New Product*
			Technology Transfer
		Process Innovation	*New Technology*
			Technology Development
		High Growth	*Gazelle*
			Clustering
		Globalization	*Export*
			Connectivity
		Financing	*Informal Investment*
			Financial Institutions

Entrepreneurship enters the GMR-Europe model in the TFP block, through the REDI index. This means that as a single variable, describing the entrepreneurial climate/ecosystem in a region, it contributes to productivity through enhancing the efficiency of human capital. As a result, an intervention positively contributing to the entrepreneurial ecosystem in a region (reflected by an increase in the REDI index) positively affects regional productivity and sets in motion all the other parts of the model which is thus able to track the effect of this policy on several variables of interest.

The real strength of using the REDI index in our setup is that although the REDI index uses one number to describe regional entrepreneurship, its detailed structure with the 14 pillars allows us to analyze different policy mixes at this level of detail. Also, building on the PFB methodology, there is not a single linear relationship between the pillars and the REDI index, but the system is able to give a sophisticated description and analysis of how different policies affect the overall entrepreneurial climate in a region and through this effect their impact on local and aggregate economic performance.

3.3.2 Policy optimization

As reflected by the REDI, entrepreneurship is a complex phenomenon, which emerges in the context of system-wide interactions amongst its different components (Acs et al. 2014). As a result, mutually interconnected policies could potentially strengthen or weaken each other, so the design of a suitable policy mix to target the intensification of regional entrepreneurial discoveries is an extremely complicated process. The GMR-Europe policy impact model, through the integration of the REDI into its setup, is particularly suitable to support policy makers in designing these policies.

Relying on the PFB analysis embedded in the REDI methodology, optimal entrepreneurship policies can be designed on a region-specific basis, taking into account the weaknesses of the local entrepreneurial context. In sum, the optimal allocation of inputs to entrepreneurship policies is attained when all the bottlenecks are alleviated in a given region. As a result, the search for an optimal policy means decreasing the retraction influence of the bottleneck pillar(s).

In the following section we provide an analysis of policy simulations designed on the basis of the previous principles showing the abilities of the GMR-Europe model in estimating the likely impacts of policies targeting entrepreneurship.

4. Growth or convergence? Simulations on the effects of alternative regional entrepreneurship policies

It is crucial for policy makers to understand the possible economic impacts of different entrepreneurship development strategies. Changes of REDI indicate the effects of policies on regional entrepreneurship levels but understanding economic development requires a broader, more general analysis of economic circumstances and processes. The GMR-Europe model incorporates several interrelated mechanisms through which initial REDI changes evolve into regional, national and EU-level economic effects.

The economic impacts of entrepreneurship development policies are determined by a number of important factors in GMR-Europe. *First*, the initial level of REDI is crucial in terms of economic growth since a relative increase in REDI implies a higher absolute change in entrepreneurially more developed regions, resulting in a more intensive change in productivity. *Second*, the level of human capital in a region also plays a crucial role in the determination of how effectively entrepreneurship can influence productivity. *Third*, the trends of human capital development enhance the efficiency of entrepreneurship in the long-run increasing productivity even when entrepreneurship supports are exhausted. *Fourth*, the interaction of changes in employment and capital also play a crucial role in generating economic impacts. Whereas the model shows a negative employment impact due to substitution effects, investment, which builds up capital stock and contributes also to aggregate demand, exhibits an intensive growth rate during the shock period, getting lower when the shock period is over. This decrease in the growth rate of investment puts a less intensive upward pressure on output while the negative effect of employment dominates thus the aggregate output impact slightly decreases. As the employment effect loses its strength over the long run, the aggregate output impact stabilizes. *Fifth*, changes in economic growth will influence migration, which in some regions can be a further source of growth while for other areas it can be a leakage of resources. *Sixth*, changes in interregional trade play further significant role in the development of regional economies. The relative size, and direction of all those forces will eventually determine economic growth of regions and nations.

Through the lens of a policy problem we track the economic impact mechanisms of different interventions targeting entrepreneurship development in this section. The problem is widely known in regional policy circles and can be put in words as follows. What are the costs of an entrepreneurship policy that targets national growth in terms of regional convergence? And, alternatively, what are the costs of an entrepreneurship policy targeting regional convergence in terms of a loss in economic growth? Are there country-specific differences in the impacts of the two policies?

In what follows we explore the growth and convergence effects of entrepreneurship development policies using the REDI index and the GMR-Europe economic impact assessment model. Following the Penalty for Bottleneck method we set up three scenarios for three selected countries in the EU: Germany (representing Western Europe), Hungary (a country from Central Europe) and Italy (a southern European country). In the basic scenario we allocate additional efforts (resources) in the optimal way among the pillars of REDI in each region to reach uniformly a 10% increase in REDI. This is called the *uniform solution*. In the second case, called *policy optimization* each country starts with the level of resources of the "uniform" solution and reallocate resources among regions and pillars in order to maximize country averages of the REDI index. Finally, in the *poorest regions* scenario we again start from the uniform solution and reallocate resources to the poorest regions of the three countries until the resources are exhausted. In our terminology poorest regions are those where the REDI scores are the lowest in the country. Economic impacts of the respective entrepreneurship policies are investigated at the regional, national and EU levels. Economic impacts are measured in terms of gross value added (GVA) whereas the effects on cohesion are quantified by the GINI index.

4.1. Uniform improvement of entrepreneurship

In this basic scenario we uniformly increased the value of the REDI in each region by 10%. The additional efforts required to reach this goal were distributed according to the PFB method at the regional level. Optimization results show significantly different patterns for each country (Figure 3). In general, the uniform solution of REDI for Germany concentrates resources extremely on three pillars: *risk perception*, *human capital*, *product innovation* and partially to two other: and *process innovation*, *technology absorption*. However, we must note that in some cases lower value pillars pillars were highly important for some regions (e.g., globalization in Bremen and financing in Mecklenburg-Vorpommern). Furthermore, the allocation of additional efforts in Germany is the most evenly distributed compared to the other three countries. It means that REDI can be increased by the simultaneous development of numerous pillars, and practically there are no extremely weakly performing pillars in Germany.

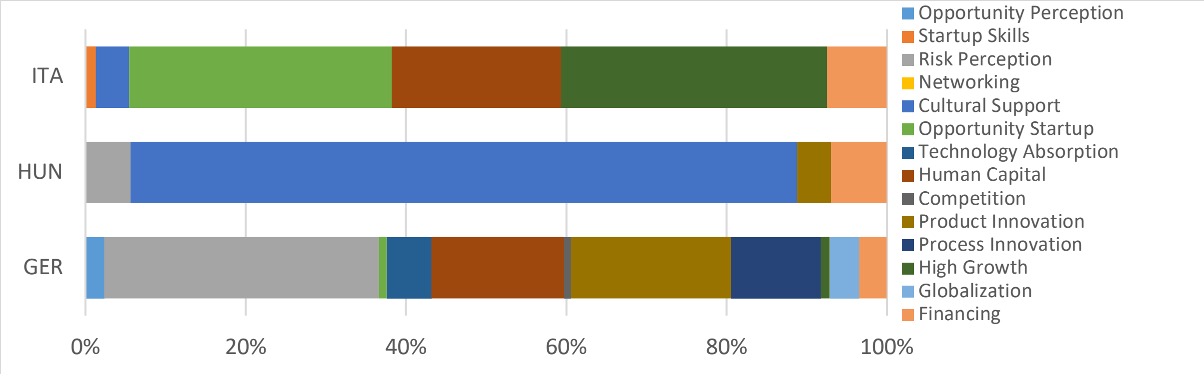

Figure 3: The distribution of additional efforts in REDI among the 14 pillars at the country level in case of uniform solution

In less developed countries, such as Hungary the distribution of additional efforts shows a more concentrated structure. On average, 83% of additional efforts were allocated to *cultural support,* which was responsible for the majority of REDI growth. Apart from that, *financing* and *risk perception* played a modest role in the optimization. In regional perspective the concentration can be even stronger: the REDI in Budapest increased exclusively as a result of the cultural support pillar. Italy on the other hand shows again a slightly more evenly distributed structure of pillars. Additional resources were mainly concentrated in *opportunity startup*, *high growth* and *human capital*. In addition, financing gained relatively large improvement of REDI in Northeast and Central Italy. The amount of resources required to increase REDI by 10% is different in each country (and region): 4.354 units in Germany, 1.798 in Italy 0.764 in Hungary.

In our economic impact analysis changes in REDI are distributed evenly over 5 years between 2014 and 2018 in each scenario. This policy shock period represents the first five years of the current EU Cohesion Policy. Estimated impacts of policy interventions then span from 2015 to 2031. The economic impact of a uniform 10% increase in entrepreneurship varies depending on several regional factors most importantly the initial level of entrepreneurship and human capital. Based on that in Germany *Berlin* and *southern German regions* both with high initial REDI and human capital stocks are expected to increase the most in terms of value added. However, in other areas where the distribution of human capital and REDI does not show the same pattern the potential change of value added is not self-evident. Following a similar logic in Hungary the highest growth is expected in *Budapest*. Similarly, in Italy human capital and entrepreneurship is concentrated in the *northern part of the country* thus the shock will have a more significant value added effect in those areas. The short-run results in 2019 can be seen in Figure 4.

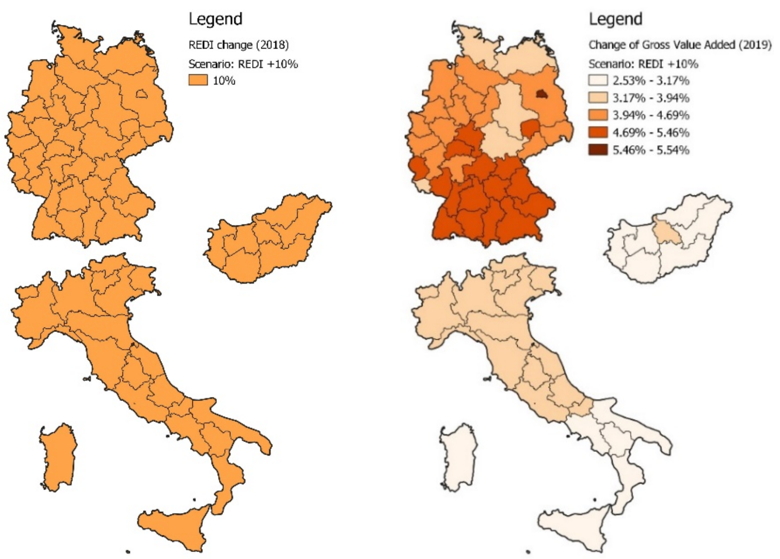

Figure 4: Spatial distribution of REDI shocks (left-hand panel) and their impacts on gross value added (right-hand panel) in the case of the uniform solution scenario in 2019

Figure 5 depicts the country-level dynamic effects of regional REDI shocks. Temporal paths of regional human capital significantly influence the dynamic impacts of entrepreneurship on regional GVA. Furthermore this effect is augmented by migration and interregional trade in the long run. The effect of REDI on TFP is lagged in time by one period thus initial REDI shocks in 2014 will have productivity and economic impacts one year later. This also means that the five-year period of REDI interventions expires in 2018 while direct economic impacts continue after this year.

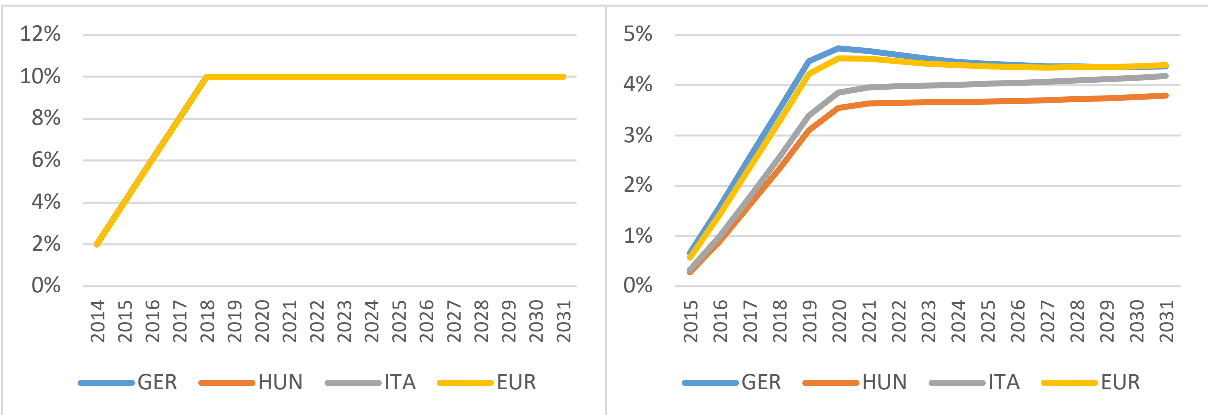

Figure 5: The national impact on national average REDI (left-hand panel) and value added (right-hand panel) in case of uniform solution

The level of human capital influences the immediate economic impacts of the uniform REDI change, this is why in 2015 Germany gains the most economic growth and Hungary benefits the least. Though after 2018 the regional REDI scores remain the same there are different further changes in the long-run paths of national value added. In addition to the differences influenced by temporal paths of human capital, migration and interregional trade, we have to highlight the role of investment. In 2020 we observe a further increase of value added compared to the baseline, which cannot be resulted by a direct shock to REDI. Actually as REDI improves productivity, production and income, it also changes investment decisions, which will have positive impacts on regional investment volumes. Because REDI shocks in 2018 affect value added and investment in 2019, the additional investment increases regional capital stocks in

2020. Thus, through investment, REDI has another effect on value added which is lagged by two years. After 2019 however the direct productivity effect is exhausted and only this investment effect goes on. As a result, in the long-run growth path Germany converges to the European average from above, while Italy and Hungary converge to the European average from below. Again Italy converges faster since it has higher human capital stock and it increases at a higher rate.

4.2. Country optimization of entrepreneurship development: the growth effects

The second scenario reflects the economic impacts of country level optimization of the REDI. This means that the additional efforts used in the uniform solution are spent among different regions of the country with the goal to generate the highest possible growth of country average REDI scores. By doing so, in principle we expect that economic growth can be further promoted.

As a result, in Germany the country average REDI score was increased by 10.63%. The inner structure of pillars changed slightly, but the five most important pillars almost kept their share of efforts. In Germany growth was achieved by concentrating more efforts in *Product Innovation* and *Technology absorption* and partially in *High growth* pillars in general. On the other hand, this means that less effort was allocated to Human capital, Risk perception and Opportunity startup pillars (in order of significance). Regionally, efforts have been reallocated in favor of relatively efficient regions (Brandenburg, Rheinland-Pfalz and Sachsen-Anhalt) in terms of human capital and/or entrepreneurship at the expense of lower amount of allocated resources in Niedersachsen and Thüringen.

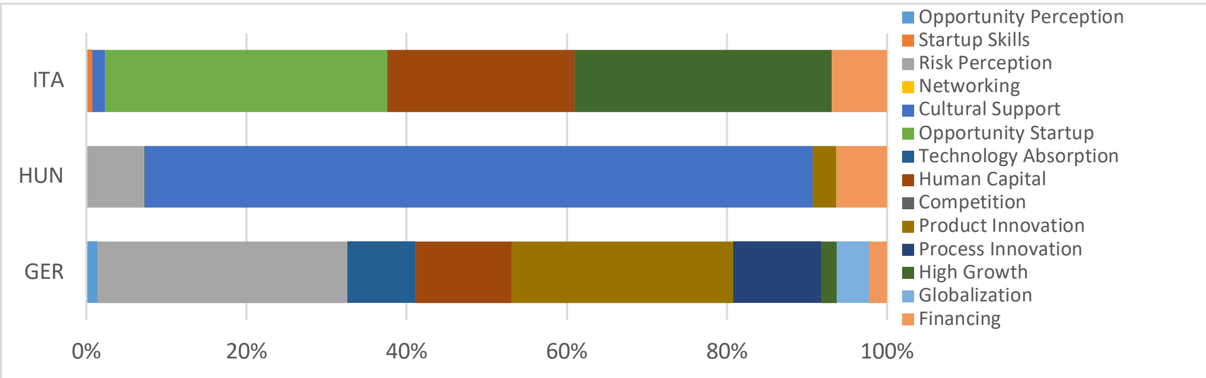

Figure 6: The distribution of additional efforts in REDI among the 14 pillars at the country level in case of country optimization

The largest increase in the country average of REDI (10.40%) can be achieved in Hungary by allocating even more efforts to *Cultural support*, *Risk perception* and slightly to *Networking*, at the expense of Financing and Product innovation pillars. Interestingly Budapest seems to be an exception, since in this case efforts have been reallocated from Cultural support in favor of Risk perception. The regional distribution of efforts was mainly reallocated to the most developed parts of the country: the Capital, and slightly to Western Hungary. Finally, in Italy the increase of REDI national average (10.19%) resulted by higher concentration of efforts in *Opportunity startup* and *Human capital* pillars, while reducing efforts mainly in the Cultural Support pillar (Figure 6). In this case however efforts were mainly reallocated in favor of the southern underdeveloped regions.

In this scenario the relative change of REDI will be different in each region as a consequence of country optimization which makes the analysis even more difficult since we have to account for the initial size of REDI, its shock and the level of human capital stock in the region because the combination of the three will determine the TFP change in regions. Finally, the change of gross value added is mainly driven by the changes of TFP and in the long-run other factors may play a role (e.g. migration, trade, investment).

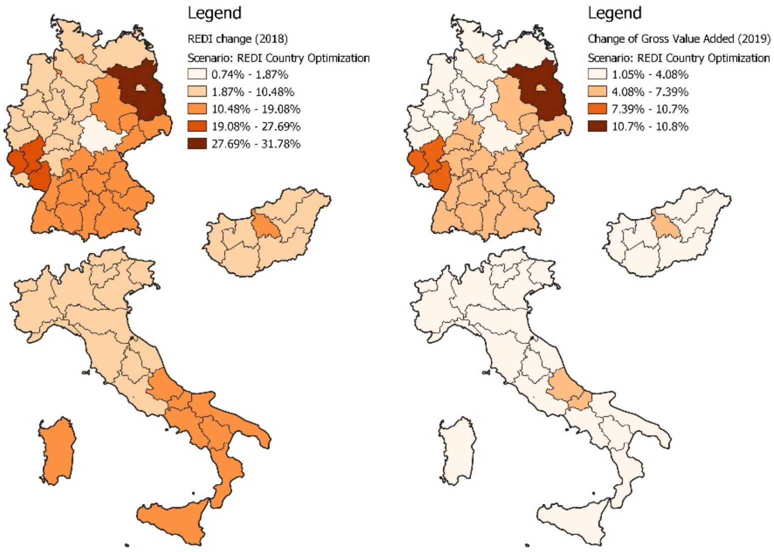

Figure 7: The spatial distribution of REDI shocks (left-hand panel) and their impacts on gross value added (right-hand panel) in case of the country optimization scenario

The regional impacts on gross value added are depicted in Figure 7. There are strong country-specific characteristics in the spatial pattern of value added growth. In Germany and Hungary country optimization coincides with developed regions with high level of human capital, which amplified the total change of value added in the *short-run*. In Italy however the largest national average REDI growth occurred by allocating resources to poor southern regions with low levels of human capital. Compared to the uniform solution in 2019 both Germany (+0.02%) and Hungary (+0.50%) reached higher value added over the simulation period by focusing resources on highly efficient regions. Italy on the other hand reaches lower value added (-0.10%) since resources were concentrated in lagging regions, which serves as another proof of the tensions between economic growth and regional convergence.

In the *long-run* there is a slow convergence to EU average even in the case of Italy (Figure 8). We must note that in Germany from 2025 the growth path slightly goes below the growth of the uniform solution. The reason for that can be found in the interrelation of employment and investment effects described above, which slightly drives down EU average growth after the shock and then turns it around. This cyclic behavior is overcompensated by the high growth rate of Hungarian and Italian human capital but in Germany the slow growth of human capital was not enough to compensate this impact. On the other hand, however it also highlights the fact that changing entrepreneurship is not a sufficient predictor of economic growth without consideration of the broader regional environment.

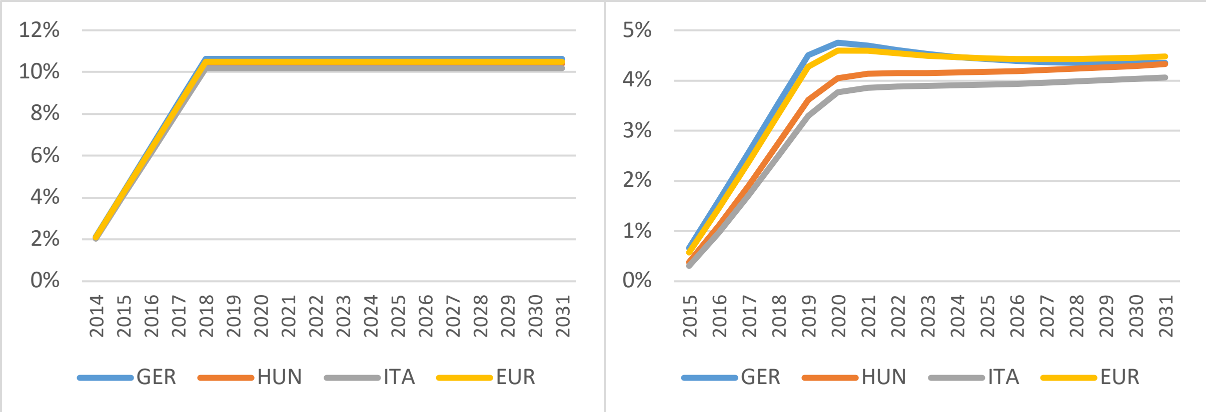

Figure 8: The national impact on national average REDI (left-hand panel) and value added (right-hand panel) in case of the country optimization scenario

4.3. Entrepreneurship development in underdeveloped regions: the growth effects

In the last scenario we turn our attention towards poor regions in each country and we assess the extent of possible economic growth that can be achieved by concentrating more efforts in those regions. In this case the additional effort required by the uniform solution is allocated to regions that are considered the poorest in each country. Practically, it results in a decrease of the regional differences of REDI scores since higher REDI score regions receive no additional efforts while poorer regions can utilize all the resources. Figure 9 indicates the result of optimization in terms of the 14 pillars.

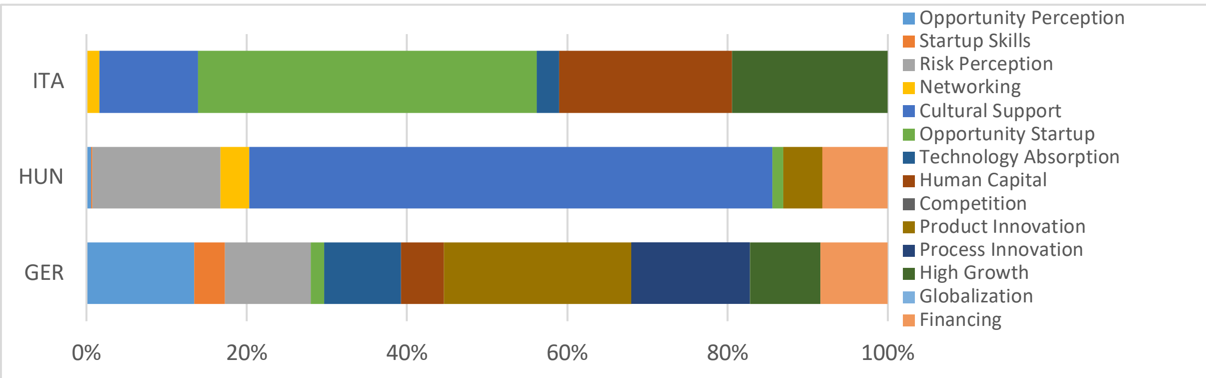

Figure 9: The distribution of additional efforts in REDI among the 14 pillars at the country level in case of poor regions

In Germany a broad diversification characterizes the optimization: originally large pillars (e.g. Risk perception, Human capital) were decreased in favor of many smaller pillars. Strengthening Cultural support in Hungarian poor regions does not result in the highest REDI growth. On the contrary efforts in Cultural support were decreased by the PFB method mainly in favor of *risk perception* and *networking* pillars. Apart from Southern Transdanubia, all regions diversified in Hungary in favor of the above-mentioned pillars, while in Southern Transdanubia cultural support was further supported by the optimization. In Italy some of the largest pillars were weakened (High growth, Human capital), but another important pillar (Opportunity startup) was significantly improved. Still the largest improvement occurred in *Cultural support*, which was not significant nationally in the previous scenarios. These results underline again the important connection between human capital, cultural support, entrepreneurship and economic growth in underdeveloped areas.

Figure 10 indicates the change of REDI averages in the three countries, which is now clearly lower than in the other scenarios. It can also be observed that Italy and Hungary benefited the most of this intervention in terms of REDI change and Germany is lagging behind. Thus it seems that entrepreneurship development in poorer regions may be more successful in less developed countries.

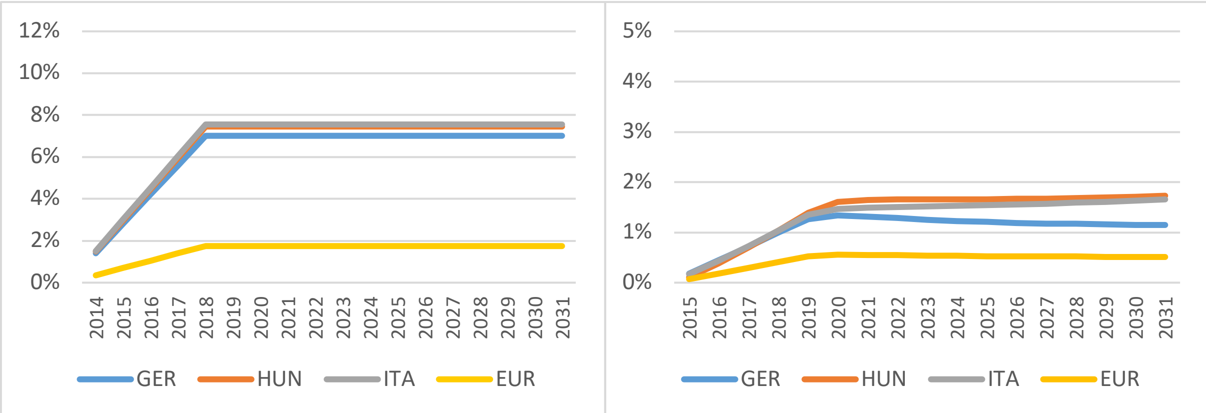

Figure 10: The national impact on national average REDI (left-hand panel) and value added (right-hand panel) in case of poor regions

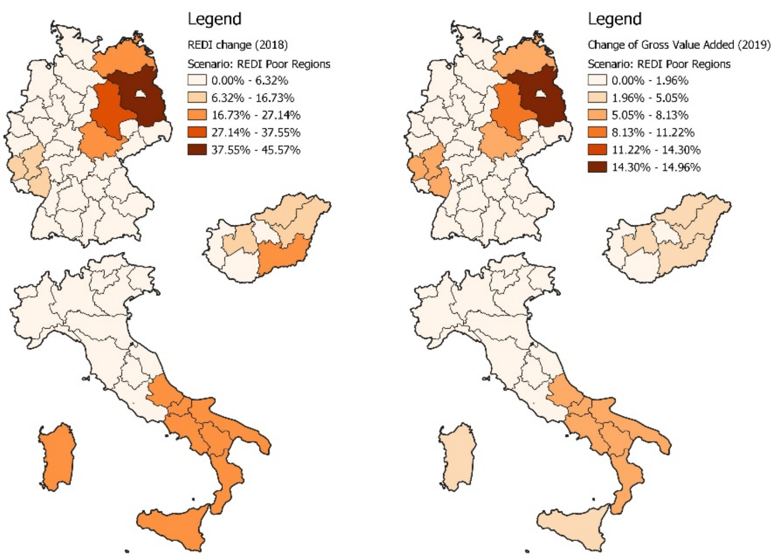

Figure 11: The spatial distribution of REDI shocks (left-hand panel) and their impacts on gross value added (right-hand panel) in case of the poor regions scenario

In this scenario national average values do not show us a clear picture of the economic impact mechanism. Since intervention takes place in poor regions (Figure 11) local human capital promote economic growth dominantly, which is much lower than the national average, thus economic impacts are expected to be modest. Also the relative size of "relevant" human capital in poor regions between countries can differ significantly. In case of Italy for example, it can be seen that the general level of human capital is much larger than in Hungary although when only less developed regions are considered, this relation turns around. In terms of human capital, the southern regions of Italy are less developed than Hungarian poor regions, while the national value is much higher thanks to the highly developed northern dynamic regions. German poor regions seem to be significantly more developed than regions in the other two countries. Thus the immediate economic effects are then the combination of REDI change and the level of local human capital. Based on that, short-run immediate economic growth appears to be the largest in Germany and Italy, and then in Hungary. With time however economic impacts are dominantly influenced by the change of human capital stock in poor regions. As a consequence, the initial low Hungarian economic impact soon overtakes all the other countries and, with the high growth rate of human capital, Italy follows Hungary.

4.4. Country optimization and the support of underdeveloped regions: convergence effects

In this sub-section the costs of growth in terms of convergence are taken into account. Figure 12 suggests that in the case when country optimization targets regions where economic activities are highly concentrated (such as in Hungary) convergence costs of growth can be significant whereas in Germany and Italy the GINI coefficient decreases a little bit (indicating a slightly increasing convergence). Considering the other option when entrepreneurship policy targets less developed regions a similar pattern occurs. Though convergence happens in each country, this effect is the highest in Hungary. This is again the consequence of the high concentration of economic activities in Budapest. Moving significant amounts of resources from the core to the periphery therefore strongly impacts the patterns of inequality.

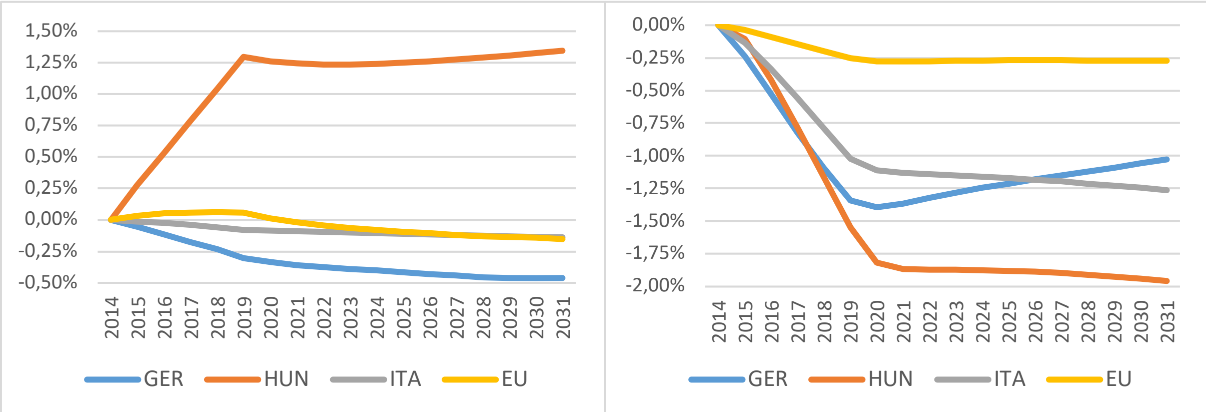

Figure 12: The impact on convergence: country optimization (left-hand panel) and poor regions (right-hand panel)

4.5. Lessons learned from the simulations

The results of our simulations extend our knowledge on the efficiency of entrepreneurship policies in the growth-convergence axis in two dimensions.

First, with respect to the growth focused policy we learned that country optimization of entrepreneurship policy becomes successful to promote growth if high REDI change occurs in regions where large human capital stock is paired with high entrepreneurship levels. Considering the factors that influence the dynamic impacts (human capital growth, interregional trade, migration, the interplay between employment and capital accumulation), the combination of all those components results in further boost in economic performance. Otherwise, the lack of one or more of those components can overcompensate the total effect of policy interventions, as it happens in the case of Italy. However, promoting growth by country optimization does not necessarily imply the emergence of costs in terms of convergence. While the Hungarian experience supports the generally expected growth-convergence trade-off (with a 1.25% cost in terms of increasing inequality) in Germany and Italy a slight convergence is materialized.

Second, regarding the convergence-oriented policy we experienced that a focus on entrepreneurship support in underdeveloped regions more efficiently promotes growth in generally less developed countries (Hungary and Italy). This happens partially because the same rate of growth of REDI costs less "efforts" in those countries and partially because in the long run, these regions are characterized by higher growth rates of human capital, which enables them to capitalize more on the same change of REDI than lagging regions of a more developed country. We observed increasing convergence in the three countries, which is in accordance with expectations. However, there are country-specific differences in this respect as well: the effect is the highest in Hungary followed by Germany and Italy. The growth cost of the convergence policy is around 2.5 % with some variation across the countries.

5. Summary and conclusions

Economic impact assessment of entrepreneurship policies has been hindered by two major challenges: the measurement of the impacts on entrepreneurship and the estimation of economic effects in the context of a policy impact model. With REDI and the novel developments of the GMR-Europe model the possibility of estimating the economic effects of entrepreneurship policy emerged recently. In this paper we outlined the structure of the GMR-Europe model and provided sample simulations to illustrate model features.

Differences in regional and national economic impacts are related to a multitude of factors, most importantly to the initial level of the REDI index, the level and the dynamic change of human capital in the region, migration patterns of factors of production and changes in interregional trade initiated with the policy. The relative size, and direction of all those forces will eventually determine economic growth of regions and nations.

Our impact scenarios led us to some policy conclusions. (1) A successful high-growth entrepreneurship development requires the allocation of additional support to regions characterized by both high initial level of entrepreneurship (REDI) and skilled human capital. (2) Promoting entrepreneurship in underdeveloped regions can successfully decrease regional inequalities, and increase convergence at the cost of lower national economic growth. (3) There is no clear 'best practice' recipe of entrepreneurship development. Countries/regions with different levels of economic and entrepreneurial performance can be developed by focusing additional support on different sources (pillars) of entrepreneurship, as indicated by the REDI index. (4) It needs to be clearly determined whether regional convergence or economic growth is the main objective function of policy interventions. Areas with high potential for entrepreneurship development do not necessarily coincide with areas with high potential for economic growth. Policy makers should treat economic and entrepreneurial development together to find an optimal balance between the two targets to come up with the best solution. As our study highlights such a complex decision can be supported by economic impact assessment modeling.

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