

HUMAN CAPITAL AND R&D: UNLOCKING INNOVATIVE ENTREPRENEURSHIP THROUGH HEIS IN ITALY

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Higher Education Institutions (HEIs) are central to fostering innovative entrepreneurship and regional development by increasing human capital and facilitating knowledge transfer through R&D. This paper explores the interplay between graduate supply and R&D in driving innovative startup creation across Italian provinces (2015–2021). The findings highlight a synergy between these factors: public R&D boosts graduate impact in the South, while university R&D complements the dense graduate presence in the North. These dynamics call for tailored strategies to optimize HEIs' roles as engines of economic growth, particularly in lagging regions.

entrepreneurship, higher education, innovation, startups, knowledge spillovers

INTRODUCTION

Higher Education Institutions (HEIs) are critical in fostering regional development and innovation by serving as hubs of knowledge creation, skill development, and entrepreneurial activity. Over the past decades, HEIs have transitioned from traditional roles in teaching and research to active contributors to local ecosystems, directly impacting economic and social outcomes (Benneworth & Fitjar, 2019). This expanded role is particularly relevant in addressing regional disparities, as HEIs catalyze local development by producing human capital and driving innovation. HEIs contribute to regional economies by supplying skilled graduates and facilitating knowledge transfer

through research and development (R&D), fostering innovative entrepreneurship, a key driver of economic growth and competitiveness (Callon, 1994). However, the impact of HEIs on entrepreneurship is uneven across regions, with variations driven by institutional quality, R&D intensity, and absorptive capacity (Rodriguez-Pose & Ganau, 2022).

This paper examines the interplay between graduate supply and R&D activities as complementary factors influencing innovative entrepreneurship in Italian provinces (2015–2021). It investigates HEIs' roles in startup creation by producing skilled human capital and enabling startups' innovation capacity through research and technology transfer mechanisms (Del Monte & Pennacchio, 2020). A novel dataset explores these relationships, accounting for regional heterogeneity and institutional quality as mediators of HEIs' effectiveness.

Italy is an interesting case study, marked by large differences in the rate of innovative entrepreneurship and socioeconomic development across regions and by the prevalence of micro and small firms, whose management strategies and styles have been shown to adversely affect their ability to absorb externally generated knowledge, to the detriment of productivity (Esposito & Ferrante, 2024; Cardullo et al., 2024). Meanwhile, despite having a very low share of graduates in its labor force, Italy is a net exporter of graduates and faces a significant skills mismatch in the graduate labor market (Esposito & Scicchitano, 2022).

HEIs are key contributors to regional development, serving as hubs of knowledge creation, talent cultivation, and innovation. Their influence on local economies operates through direct and indirect mechanisms. Directly, universities produce graduates with the skills and expertise necessary for innovation and entrepreneurship, contributing to the strength of local entrepreneurial ecosystems. Studies have demonstrated a strong correlation between the concentration of skilled graduates and increased entrepreneurial activity, particularly in regions with robust institutional and economic frameworks (Benneworth & Fitjar, 2019; Marques, 2017). Indirectly, HEIs enhance regional innovation by establishing infrastructure to support entrepreneurship, including incubators, spin-offs, and knowledge transfer activities, which build the region's capacity to develop and absorb innovations (Papatsiba & Cohen, 2020; Ferrante et al., 2019). The extent of their impact depends on the quality of local institutions, the availability of complementary resources, and the absorptive capacity of firms (Agasisti et al., 2019; Del Monte

& Pennacchio, 2020).

The interplay between R&D activities and the supply of skilled human capital is central to fostering innovative entrepreneurship. R&D lays the foundation for knowledge spillovers, which drive technological advancement and support the emergence of innovative firms. Public and university R&D systems are essential in promoting startup formation, especially in knowledge-intensive sectors (Aghion et al., 2015). Meanwhile, graduates act as conduits of knowledge, bridging the gap between research and application. Their skills and expertise enable startups to harness R&D outputs effectively, enhancing productivity and competitiveness. This synergy is particularly pronounced in technology-driven industries, where the combination of research and human capital yields substantial economic benefits (Colombo & Piva, 2020).

Our study shows that public R&D is crucial for southern provinces, while university-driven R&D enhances innovation in the North. These insights call for place-based policies to integrate graduates into entrepreneurial ecosystems and address regional R&D disparities. This study makes three key contributions to the literature. First, it provides empirical evidence of the complementarity between graduate supply and R&D in fostering innovative entrepreneurship. Second, it highlights regional disparities in these dynamics, offering insights into how HEIs can tailor their strategies to local needs. Third, it emphasizes the dual role of HEIs as providers of human capital and facilitators of innovation, showcasing their potential to act as agents of local development in diverse economic contexts. The paper is structured as follows. Section 1 describes the dataset and empirical strategy used in the analysis. Section 2 presents the results. Section 3 concludes with policy implications and recommendations for future research.

1. DATA AND METHODOLOGY

The empirical analysis aims to assess the effect of new graduates' supply and its interaction with R&D activities on the propensity to set up innovative business ventures. To this aim, we built a panel dataset of Italian provinces (NUTS-3 level) covering 2015-2021. We ran Fixed Effects regressions by controlling for province characteristics in terms of specialization, level of development, entrepreneurship intensity, and institutional quality. We also control for other channels through which universities can impact the creation of start-ups. The estimated equation is the following:

$$ST_{i,t} = \alpha + \beta_1 LG_{i,t} + \sum_{k=2}^4 \beta_k RD_{i,t}^k + \beta_5 LG_{i,t} * RD_{i,t}^k + \sum_{k=6}^h \beta_k X_{i,t} + \theta_t + \varphi_i + \gamma_1 * \varphi_{i,t} + \varepsilon_{i,t} \quad (1)$$

Where LG is the flow of local graduates; RD_k is R&D expenditure (k=public, private, universities) which is interacted with LG. The vector X includes the following variables: stock of tertiary educated workers (TerStock), Overeducation (OE), number of active spinoffs (SpinOff), research productivity (ResProd), active licenses (Lic), institutional quality index (IQI), Value Added per capita (VApc), number of active enterprises (Enter), shares of manufacturing, ICT and private services (ManSh, ICTsh, and PvtSvcSh). The terms φ_i and θ_t and province and time-specific fixed effects. We interact time dummies with area dummies (area=North-East, North-West, Center, South, and Islands) to control for general heterogeneity.

Data on innovative startups are provided by the Ministry of Enterprises and Made in Italy. As for the supply of new graduates, data come from the Ministry of University and Research (MUR). The stock of graduates in each province is obtained by aggregating individual-level data from the Italian Labour Force Survey. Overeducation is calculated by aggregating individual self-assessed data from the INAPP-PLUS survey. The number of university spinoffs and licenses are obtained from the annual NETVAL Survey on the growth and exploitation of public research results. Research productivity is calculated as the number of publications per researcher. Data on the number of publications are from OpenAlex, the open catalog to the global research system. The number of researchers (professors, assistant professors, or post-docs) is from MUR. Data on R&D expenditure are provided by ISTAT, the Italian National Statistical Institute. As for the context indicators, data on the total number of enterprises and Gross per capita Value Added in each province are provided by ISTAT. The economic structure of provinces is measured as value-added shares of manufacturing, private services, and ICT (source: ISTAT). Finally, the quality of institutions is measured by the Institutional Quality Index built by Nifo and Vecchione (2014). The final dataset includes 107 provinces observed between 2015 and 2021 for a total sample size of 749 observations. All variables except institutional quality, overeducation, and research productivity are standardized to the provincial population.

We estimate the model on the whole sample and perform a heterogeneity analysis by splitting the sample into North and South. The former include the macro-regions North-East and North West as well as Rome and the provinces of

Tuscany and Marche. Southern provinces include the macro-regions of the South Island, the provinces of Umbria, and those of Lazio, excluding Rome. This analysis is critical since it allows for understanding whether university graduates effectively stimulate innovative entrepreneurship in less-developed provinces.

2. RESULTS

Table 1 reports estimation results on the whole sample of Italian provinces. The first column shows that the supply of graduates is positively related to innovative startups independently of the amount of R&D expenditure. Columns 2-4 show the interactions between local graduates and R&D expenditure. The significant interactions are those between LG and, respectively, public and university R&D. These results indicate that the effect of LG increases in regions where R&D expenditure is above average.

Tab. 1. Full sample estimates

	1	2	3	4
LG	0.020** [0.010]	0.007 [0.009]	0.014 [0.014]	0.005 [0.011]
LG*RDpub	0.286**	[0.090]		
LG*RDpriv		0.017	[0.020]	
LG*RDuniv				0.135** [0.067]
RDpub	-0.176 [0.184]	-0.450** [0.157]	-0.172 [0.185]	-0.177 [0.176]
RDpriv	0.077 [0.058]	0.071 [0.056]	0.062 [0.054]	0.076 [0.058]
RDuniv	0.163 [0.143]	0.146 [0.142]	0.162 [0.143]	0.085 [0.146]
SpinOff	0.251* [0.141]	0.268* [0.137]	0.260* [0.142]	0.277* [0.144]
IQI	0.075**	0.074**	0.074**	0.077**

	[0.034]	[0.033]	[0.034]	[0.034]
OE	0.064*	0.056*	0.062*	0.058*
	[0.033]	[0.034]	[0.034]	[0.033]
ResProd	0.029**	0.021	0.028**	0.026**
	[0.013]	[0.013]	[0.013]	[0.013]
TerStock	0.302**	0.270**	0.291**	0.300**
	[0.136]	[0.134]	[0.132]	[0.135]
Lic	0.009**	0.009**	0.009**	0.008**
	[0.004]	[0.004]	[0.004]	[0.004]
VApC	0.079	0.100	0.078	0.076
	[0.064]	[0.062]	[0.064]	[0.063]
Enter	0.075	0.078	0.071	0.097
	[0.458]	[0.426]	[0.452]	[0.443]
MANsh	-0.790**	-0.758**	-0.762**	-0.749**
	[0.379]	[0.377]	[0.373]	[0.376]
ICsh	3.085	3.027	3.076	3.267
	[2.205]	[2.202]	[2.200]	[2.191]
PvtSvcSh	-0.465*	-0.374	-0.450*	-0.381
	[0.273]	[0.266]	[0.269]	[0.259]
R ² w	0.701	0.709	0.702	0.704
N	749	749	749	749

Standard errors in brackets. * significant at 10% level; ** significant at 5** level; *** significant at 1% level.

In Table 2, we report estimation results for Northern and Southern provinces. Estimated impacts are higher in southern provinces, where the interaction between LG and public R&D is also significant. In addition, in the south private and university R&D expenditure is positive and significant independently of the level of graduates. In Northern provinces, the significant interaction is between LG and universities' R&D. The results indicate that Southern provinces benefit more than Northern provinces from the presence of new graduates, particularly when a high level of public R&D expenditure complements it. In Northern provinces, HIEs alone can stimulate innovative entrepreneurship by combining education and research.

Tab. 2. Estimates on northern and southern provinces

	North				South			
	1	2	3	4	5	6	7	8
GradTot	0.018** [0.006]	0.008 [0.009]	0.021* [0.011]	-0.003 [0.010]	0.075** [0.027]	0.049* [0.027]	0.063** [0.027]	0.082** [0.026]
GradTot*RDpub		0.258 [0.190]				0.280** [0.117]		
GradTot*RDpriv			-0.007 [0.020]				0.105 [0.072]	
GradTot*RDuniv				0.179** [0.084]				-0.068 [0.096]
RDpub	-0.342 [0.234]	-0.504 [0.328]	-0.350 [0.240]	-0.271 [0.238]	-1.060** [0.399]	-1.371*** [0.352]	-1.068** [0.408]	-1.061** [0.418]
RDpriv	-0.26 [0.198]	-0.266 [0.199]	-0.263 [0.200]	-0.316 [0.200]	0.558** [0.217]	0.567** [0.212]	0.525** [0.216]	0.607** [0.243]
RDuniv	0.061 [0.067]	0.058 [0.066]	0.068 [0.073]	0.062 [0.067]	0.595** [0.207]	0.603** [0.195]	0.516** [0.170]	0.601** [0.205]
Spinoff	0.198 [0.158]	0.217 [0.154]	0.195 [0.160]	0.237 [0.154]	0.191 [0.265]	0.237 [0.266]	0.190 [0.267]	0.186 [0.271]
IQI	0.090** [0.040]	0.092** [0.040]	0.090** [0.040]	0.085** [0.040]	0.078* [0.042]	0.076* [0.040]	0.082* [0.043]	0.075* [0.041]

OE	0.105**	0.094*	0.107**	0.092*	0.061	0.055	0.060	0.064
	[0.048]	[0.048]	[0.051]	[0.048]	[0.045]	[0.045]	[0.044]	[0.046]
ResProd	0.022	0.015	0.023	0.011	0.016	0.008	0.010	0.015
	[0.016]	[0.016]	[0.017]	[0.017]	[0.015]	[0.015]	[0.015]	[0.016]
TerStock	0.093	0.079	0.098	0.113	0.273	0.243	0.260	0.270
	[0.146]	[0.143]	[0.149]	[0.139]	[0.192]	[0.193]	[0.192]	[0.193]
Lic	0.009	0.008	0.009	0.007	0.003	0.004	0.003	0.004
	[0.006]	[0.006]	[0.006]	[0.006]	[0.003]	[0.003]	[0.003]	[0.003]
VApc	0.111	0.107	0.112	0.100	0.002	0.057	0.024	-0.003
	[0.074]	[0.072]	[0.074]	[0.074]	[0.083]	[0.071]	[0.077]	[0.082]
Enter	8.872**	8.627**	8.937**	8.353**	-0.468**	-0.428**	-0.497**	-0.490**
	[3.505]	[3.456]	[3.564]	[3.529]	[0.210]	[0.208]	[0.208]	[0.214]
MANsh	-0.799**	-0.783**	-0.811**	-0.788**	0.179	0.273	0.121	0.154
	[0.328]	[0.332]	[0.343]	[0.321]	[0.483]	[0.476]	[0.509]	[0.487]
ICsh	3.25	3.259	3.25	3.683	2.138	1.999	2.255	2.148
	[2.654]	[2.668]	[2.653]	[2.608]	[1.599]	[1.595]	[1.576]	[1.594]
PvtSvcSh	-0.672	-0.655	-0.688	-0.56	-0.168	-0.05	-0.154	-0.203
	[0.430]	[0.426]	[0.446]	[0.431]	[0.259]	[0.255]	[0.240]	[0.248]
R ² w	0.757	0.759	0.757	0.76	0.701	0.713	0.704	0.701
N	434	434	434	434	315	315	315	315

Standard errors in brackets. * significant at 10% level; ** significant at 5% level; *** significant at 1% level.

3. CONCLUSIONS

The findings of this study provide compelling evidence for the crucial role of HEIs as drivers of local development through their contributions to innovative entrepreneurship. By increasing the supply of skilled graduates and engaging in R&D activities, HEIs can significantly influence the creation of innovative startups, thereby fostering regional growth and reducing economic disparities. However, the effects are not uniform across regions, underscoring the importance of contextual factors and the complementarity between human capital and R&D investments.

In particular, the analysis demonstrates that the positive impact of graduate supply on innovative entrepreneurship is amplified in regions with strong public or university-based R&D activities. This complementarity highlights the dual importance of human capital as a fundamental input for innovation and R&D as a mechanism for knowledge generation and application. In northern provinces, where university R&D is more prevalent and private-sector ecosystems are better developed, the alignment between graduate skills and research capabilities drives high rates of innovative entrepreneurship. Conversely, in southern provinces, where private-sector R&D is weaker, public R&D investments play a pivotal role in enabling graduates to contribute effectively to entrepreneurial ecosystems. These results underline the differentiated pathways through which HEIs can enhance local innovation depending on regional characteristics (Benneworth & Fitjar, 2019; Agasisti et al., 2019).

The findings point to significant challenges in lagging regions, where the lack of robust institutional frameworks and entrepreneurial support structures constrains the ability of HEIs to leverage their contributions to local development fully. The mismatch between the supply of university-generated knowledge and the capacity of local firms to absorb this knowledge often results in underemployment or outmigration of skilled graduates. This dynamic further exacerbates regional inequalities, highlighting the need for targeted policy interventions to create an enabling environment for innovative entrepreneurship (Evers, 2019).

The implications of this study for policy are twofold. First, there is a clear need to invest in public and university-based R&D in regions with underdeveloped innovation ecosystems, particularly in southern provinces. Such investments can enhance local firms' absorptive capacity and foster graduates' integration into high-value entrepreneurial activities. Second, efforts to strengthen the

quality and alignment of entrepreneurial ecosystems with local labor markets are essential. In this regard, HEIs can lead by fostering collaborations with local stakeholders, offering entrepreneurial training, and supporting startup incubation and technology transfer initiatives (Ferrante et al., 2019; Marques, 2017).

In conclusion, the evidence presented in this study underscores the transformative potential of HEIs as agents of local development. By strategically combining their teaching and research missions with targeted regional engagement, HEIs can drive innovation, foster entrepreneurship, and contribute to sustainable economic growth. Future research should explore the long-term impacts of these interactions, particularly in the context of evolving regional and global challenges, to further elucidate the role of HEIs in shaping equitable and resilient innovation ecosystems.

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