Grant Agreement number: 101132559
Project acronym: ST4TE
Project title: Strategies for just and equitable transitions in Europe
Type of action: RIA

D1.4 The uneven regional implications of twin transition and globalisation

Deliverable leader	Gran Sasso Science Institute (GSSI)
Authors	Andrea Ascani (Gran Sasso Science Institute) Stefano Basilico (Gran Sasso Science Institute) Giulia Martinelli (Gran Sasso Science Institute) Alberto Marzucchi (Gran Sasso Science Institute)
Contributors-Reviewers	Christina Kakderi (Aristotle University of Thessaloniki) Oscar Y. Romero-Goyeneche (Utrecht University)
Due date	31.08.2025
Actual submission date	31.08.2025
Dissemination Level	Public

Abstract: Regions have different capabilities to transition towards green and digital objectives. The local availability of those skills could make the regions internationally competitive and engaged with globalisation patterns, both in the form of foreign direct investments (FDI) and exports. Global actors may be attracted to invest in the knowledge pools where the green and digital competences are developed. This report assesses the different aspects of the regional endowment of green, digital and twin occupations and their relation to the attractiveness of FDI and exports. We focus on the regional endowment of green, digital and twin skills and the role of the enabling (complementary) skills. We show how regions with different green, digital and twin capabilities can attract FDI or have a high amount of exports. We find positive effects of enabling skills on inward FDI and exports. Focused digital and twin skills are generally not related to a higher level of FDI attractiveness or a higher level of exports. Green skills may even have detrimental effects. Thanks to the insights brought upon by this report, policymakers will be able to target places with complementarities between green, digital and twin competences and a high participation in global dynamics, serving as hubs for twin transition. Finally, they could also support the European regions falling behind the twin transition process, unable to attract international investors, and needing policy support.

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101132559.

Document Revision History

Date	Version	Author/Editor/Contributor	Summary of main changes / Status
19/08/2025	0.1	Andrea Ascani, Stefano Basilico, Giulia Martinelli, Alberto Marzucchi	First draft to be review by Christina Kakderi and Oscar Y. Romero-Goyeneche
25/08/2025	0.2	Oscar Y. Romero-Goyeneche	Minor comments and edits.
30/08/2025	0.3	Christina Kakderi	Minor comments and edits.
31/08/2025	0.4	Andrea Ascani, Stefano Basilico, Giulia Martinelli, Alberto Marzucchi	Final version
31/08/2025	1.0	Christina Kakderi	Submission

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

Contents

1 Introduction 6
2 Literature review 10
2.1 Strategic asset-seeking, foreign direct investments and knowledge 10
2.2 Location choice of foreign direct investments 11
2.3 The twin transition, foreign direct investments and skills 13
2.4 Exports and skills 14
3 Data and main variables 15
3.1 Dependent variables: inward FDI and exports 15
3.2 Skills variables 16
3.3 Control variables 17
4 Mapping foreign direct investments in EU NUTS-2 regions and Exports in Italy 19
4.1 Mapping the origin of FDI 19
4.2 Mapping the destination of FDI 20
4.3 Mapping the total amount of exports in Italy 22
5 The relation between globalisation and skills in the green, digital and twin domains 24
5.1 The inward FDI-skills relation 24
5.2 The export-skills relation 40
6 Econometric analysis 47
6.1 Empirical model and descriptive statistics 47
6.2 Results 48
7 Conclusions 53
Appendix I. Country NUTS-2 presence in each quadrant 55
8 References 59

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

List of Figures

Figure 1 - The spatial distribution of greenfield projects in the NUTS-2 regions of the European Union in 2022. 21
Figure 2 - The spatial distribution of brownfield deals in the NUTS-2 regions of the European Union in 2022. 22
Figure 3 - The spatial distribution of the total amount of exports for the Italian NUTS-2 regions in 2022. 23
Figure 4 - The relation between the endowment of green skills and the number of greenfield projects in NUTS-2 European regions in 2022. 25
Figure 5 - The relation between the endowment of green skills and the number of brownfield deals in NUTS-2 European regions in 2022. 27
Figure 6 - The relation between the endowment of green-enabling skills and the number of greenfield projects in NUTS-2 European regions in 2022. 28
Figure 7 - The relation between the endowment of green-enabling skills and the number of brownfield deals in NUTS-2 European regions in 2022. 29
Figure 8 - The relation between the endowment of digital skills and the number of greenfield projects in NUTS-2 European regions in 2022. 31
Figure 9 - The relation between the endowment of digital skills and the number of brownfield deals in NUTS-2 European regions in 2022. 32
Figure 10 - The relation between the endowment of digital-enabling skills and the number of greenfield projects in NUTS-2 European regions in 2022. 34
Figure 11 - The relation between the endowment of digital-enabling skills and the number of brownfield deals in NUTS-2 European regions in 2022. 35
Figure 12 - The relation between the endowment of twin skills and the number of greenfield projects in NUTS-2 European regions in 2022. 36
Figure 13 - The relation between the endowment of twin skills and the number of greenfield projects in NUTS-2 European regions in 2022. 37
Figure 14 - The relation between the endowment of twin-enabling skills and the number of greenfield projects in NUTS-2 European regions in 2022. 38
Figure 15 - The relation between the endowment of twin-enabling skills and the number of brownfield deals in NUTS-2 European regions in 2022. 39
Figure 16 - The relation between the endowment of green skills and the total exports in NUTS-2 Italian regions in 2022. 41
Figure 17 - The relation between the endowment of green-enabling skills and the total exports in NUTS-2 Italian regions in 2022. 42
Figure 18 - The relation between the endowment of digital skills and the total exports in NUTS-2 Italian regions in 2022. 43
Figure 19 - The relation between the endowment of digital-enabling skills and the total exports in NUTS-2 Italian regions in 2022. 44
Figure 20 - The relation between the endowment of twin skills and the total exports in NUTS-2 Italian regions in 2022. 45
Figure 21 - The relation between the endowment of twin-enabling skills and the total exports in NUTS-2 Italian regions in 2022. 46

List of Tables

Table 1 - The world area of origin of greenfield projects with destination the EU27 countries in 2022. 19
Table 2 - The world area of the investor in brownfield deals with destination the EU27 countries in 2022. 20
Table 3 - Summary statistics – FDI model. 47
Table 4 - Summary statistics – Export model. 48
Table 5 – PPLM regression results: inward FDI and the endowment of green skills. 49
Table 6 - PPLM regression results: inward FDI and the endowment of digital skills. 50
Table 7 - PPLM regression results: inward FDI and the endowment of twin skills. 51
Table 8 – Regression results: exports and skills. 52
Table A1 1 - The share of NUTS-2 regions for the different quadrants in the case of greenfield projects and their relation with the embeddedness of Green, Digital and Twin skills for 2022. 55
Table A1 2 - The share of NUTS-2 regions for the different quadrants in the case of greenfield projects and their relation with the embeddedness of green-enabling, digital-enabling and twin-enabling skills for 2022. 56
Table A1 3 - The share of NUTS-2 regions for the different quadrants in the case of brownfield deals and their relation with the embeddedness of Green, Digital and Twin skills for 2022. 57
Table A1 4 - The share of NUTS-2 regions for the different quadrants in the case of brownfield deals and their relation with the embeddedness of green-enabling, digital-enabling and twin-enabling skills for 2022. 58

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

List of Abbreviations

AI	Artificial Intelligence
ATECO	ATtività ECOnomiche
BvD	Bureau Van Dijk
COEWEB	Commercio Estero Web
EG	Economic Geography
EPO	European Patent Office
ESCO	European, Skills, Competences, Qualifications and Occupations
EU	European Union
EU-LFS	European Labour Force Survey
FDI	Foreign Direct Investments
GDP	Gross Domestic Product
GPT	General Purpose Technology
HDFE	High-Dimensional Fixed Effects
IB	International Business
ICT	Information, Communication Technology
IoT	Internet of Things
ISCED	International Standard Classification of Education
ISCO	International Standard Classification of Occupations
ISTAT	Istituto Nazionale di Statistica
JRC	Joint Research Centre
M&A	Mergers and Acquisitions
MNE	Multinational Entreprise
NUTS	Nomenclature of Territorial Units for Statistics
OCI	Orbis Crossborder Investment
OECD	Organisation for Economic Co-operation and Development
OLI	Ownership Location Internalisation
OLS	Ordinary Least Squares
ONET	Occupational Information Network
PPML	Poisson Pseudo Maximum Likelihood
R&D	Research and Development
SD	Standard Deviation
UNESCO	United Nations Educational, Scientific and Cultural Organization
WTO	World Trade Organization
ZIP	Zone Improvement Plan

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

1 Introduction

The European Union and its member States have implemented initiatives with the aim of accelerating the sustainable transition. This green transition has been often linked with the digital transformation through the EU Industrial Strategy (European Commission, 2020) and the new Green Deal Industrial Plan (European Commission, 2023), where the green and digital transformations are coupled to support the so-called "twin transition". Digitalisation is seen as a factor for increasing or enabling environmental sustainability (JRC, 2022). The transition towards twin technologies can be seen as a possible source of growth for firms, thanks to the innovation processes necessary to introduce sustainable and digital practices. However, these transitions risk increasing the gap between economically advanced and lagging-behind regions, due to the different propensities to adapt. Recently, the European Union has also acknowledged that a shift towards sustainable and digital technologies will succeed only if all the actors involved can benefit from the opportunities this transition brings (European Commission, 2020; European Commission, 2023).

In the academic literature, an increasing amount of work investigates the technological side of the twin transition to understand how a successful green and digital transition brings benefits to regions, or the organisations involved (Basilico et al., 2024; Montresor & Vezzani, 2023; Cicerone et al., 2023; Faggian et al., 2025). Often, those studies neglect an essential aspect associated with the work-related and occupational perspective of these transitions. It is acknowledged that carrying out an occupation requires a worker to perform various tasks. Jobs and tasks are not immutable and can change over time due to different organisational practices, processes, and technologies such as those brought about by automation or digitalisation (Autor et al., 2003; Acemoglu & Autor, 2011). Similar changes are also documented concerning green jobs and skills (Consoli et al., 2016; Vona et al., 2018). The twin transition is not creating entirely new industries, but it is transforming the tasks needed to perform specific occupations. The European Commission (2020) acknowledges that the digital and green transition will require new technologies to create new products, services, markets, and business models. Moreover, those new technologies will be able to change and introduce new jobs in the labour market that do not yet exist, which will need new sets of skills not yet present. The complementarity between skills is an essential factor for the economic value of an occupation (Stephany & Teutloff, 2024). It follows that the capacity to combine skills in the twin domain will create winners and losers among individuals and regions.

Different regions have varying capabilities to manage the transition towards green and digital objectives. These differences stem from their specific industrial structures, knowledge bases, human capital endowment and technological specialisations, which can make the twin transition smoother or more challenging (Basilico et al., 2024). The most economically advanced regions have access to varied capabilities and infrastructures, which could make them prone to the twin transition. Moreover, their specialisation in specific, complex industries can help them find complementary skills that can be used during the twin transition process. Instead, lagging-behind regions might struggle to absorb twin technologies due to their

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

incomplete industrial specialisation profile and less-advanced infrastructures. This dualism could exacerbate the already existing inequalities across regions.

Not only may the local availability of skills enable a smoother and faster transition towards twin green-digital goals, but in the current scenario, it could also make regions more or less internationally competitive and engaged with globalisation patterns, both in the form of foreign direct investments (FDI) and exports. Compared to other types of competences, green and digital knowledge are harder to acquire (Barbieri et al., 2020; Ciarli et al., 2021). Due to the stickiness of knowledge and its strong embeddedness in regional contexts, those twin capabilities may be rather difficult to transfer to other locations (Montresor & Quatraro, 2020; Santoalha et al., 2021; Santoalha & Boschma, 2021). Thus, global actors may be attracted to invest in local knowledge pools where the competences associated with the green and digital transitions are well developed. On this relevant matter, still scant is the literature, though. Indirectly connected insights come from extant studies that investigate how FDI could facilitate the introduction of technologies requiring a complex set of skills, both considering General Purpose Technologies (GPTs) and digital technologies (Diodato et al., 2023; Montresor & Vezzani, 2023). Also, evidence suggests that mixed green-digital capabilities may relate to FDI, especially when those twin skill sets are complementary, introducing technological diversification (Castellani et al., 2022 Santoalha et al., 2021). A region's green and digital skills can also trigger other forms of participation in internationalisation practices. Here, we can expect that skills may signal a regional specialisation at the core of the comparative advantage and that digital and green skills can trigger exports due to higher productivity (Melitz, 2003; Antonietti & Marzucchi, 2014).

Upon those premises, this report assesses different aspects of the regional endowment of green, digital, and twin occupations and their relation to the attractiveness of FDI, and exports. Using the measures developed in the Deliverable 1.3 of the ST4TE project "The geography of the green, digital and twin occupations in Europe. Mapping Digital and Green Occupations and Twin Skill Readiness in EU Regions", we focus on the regional endowment of green, digital and twin skills and emphasise the role of skill complementarity (Neffke, 2019; Farinha et al., 2019). We also consider the role of enabling skills, that is, skills that, *per se*, are not green (digital, twin) but are complementary to green (digital, twin) competences. More precisely, these enabling skills are competences that co-occur with the focal ones and connect them with broader economic applications or tasks.

In detail, through the report:

- We map the destination region of both greenfield projects (instances of a foreign firm that decides to establish a new business operation in a host country) and brownfield deals (cases in which foreign firm acquires an existing facility or business in a host country) using the Orbis Crossborder Investment database by Moody's to assess the FDI attractiveness of each NUTS-2 European region. We also map the amount of exports for each NUTS-2 region in Italy (our focus on exports due to data availability). Therefore, we match the endowment of green, digital and twin skills with the attractiveness of FDI and Export. This analysis enables us to examine how different typologies of regions (e.g.

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

economically advanced vs lagging behind regions) are able to attract FDI and increase exports due to the presence of these skills. This effect could potentially exacerbate (or reduce) the gap in terms of international openness between those two typologies of regions.

- We perform a descriptive analysis showing the relation between the endowment of green, digital and twin skills (as well as green-enabling, digital-enabling and twin-enabling skills) and the amount of FDI or exports in NUTS-2 regions.

- Finally, we perform an econometric analysis to dig deeper into the relation between the endowment of skills and participation in globalisation dynamics (inward FDI and exports), controlling for the socio-economic characteristics of the considered NUTS-2 regions.

The report shows how regions with different green, digital and twin capabilities can attract FDI or achieve a high amount of exports. Descriptively, we find that many economically advanced NUTS-2 regions score low in the endowment of green and enabling-green skills, while being able to attract several inward FDI. Instead, a relevant number of NUTS-2 regions that are not "at the core" of the EU in terms of economic development show a low amount of FDI but tend to have a high level of green and green-enabling skills. Regarding digital skills, the most economically advanced NUTS-2 EU regions tend to have the highest level of digital skills, together with high inflows of FDI. Similarly to the case of green and green-enabling skills, a relevant set of economically advanced NUTS-2 regions tend to score low in the endowment of twin and twin-enabling skills, while they attract many FDI. Regarding exports, we find similar results; Italy's most economically advanced NUTS-2 regions score high in both exports and skills, in the case in which digital skills are considered. From the econometric analysis, we find a positive link between enabling skills and inward FDI, with no evidence that digital or twin skills per se are related to inward FDI attractiveness. Green skills may even play a detrimental role. Also, in the case of exports, enabling skills seem more relevant, even if the limited empirical setting, in this case, casts some doubts on the robustness of the results.

This set of results shows how core green, digital and twin skills are not a factor increasing regional openness, while enabling skills play a more critical role in explaining the participation of regions in globalisation dynamics. These enabling skills more directly represent the capacity of linking green and digital (and twin) priorities to broader economic activities. Through this report, policymakers could better target places with complementarities between green/digital/twin competences and a high participation in globalisation dynamics, which could serve as hubs for the twin transition. Moreover, policymakers could also identify European regions falling behind in this transition that are unattractive to international investors or markets, thus needing policy support. Those regions risk falling behind in the twin transition, which could widen the gap with regions that are progressing more rapidly in the process.

The remainder of this report is as follows. Section 2 reviews the relevant literature to provide a conceptual background to our study. Section 3 presents data and variables. Section 4 provides a mapping of inward FDI (for European regions) and export activities (for Italian regions).

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

Section 5 relates FDI and export to the regional endowment in green, digital and twin skills. Section 6 presents the results of the econometric analysis. Section 7 concludes.

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

2 Literature review

2.1 Strategic asset-seeking, foreign direct investments and knowledge

The Ownership-Location-Internalisation (OLI) paradigm provides a sound and widely accepted framework for explaining firm internationalisation through FDI. The three OLI elements that a firm considers when undertaking foreign activities - ownership ("O"), location ("L") and internalisation ("I") advantages - support its competitive advantage in global markets. While the ownership advantage refers to the unique assets of a firm, the location advantage arises when the firm exploits these assets in a specific foreign location offering a favourable context. The internalisation advantage instead occurs as the firm controls its assets through FDI rather than using independent foreign firms (Dunning & Lundan, 2008). In this setting, cross-border activities are an instrument to strengthen Multinational Enterprises (MNEs) global position and increase their long-term profitability.

In the global economy, "international knowledge and experience [are] as a valuable, unique, and hard to imitate resource that distinguishes the winners from the losers and mere survivors in global competition" (Peng, 2001, p. 820). Indeed, previous literature on MNEs highlights that their competitive edge in global markets is increasingly derived from their knowledge base rather than solely from cost advantages (Iammarino & McCann, 2013). In this perspective, a firm's investment in foreign countries reflects its strategy to maintain and enlarge its competitive advantage in the global markets. MNEs engage in (i) market seeking activities, i.e. demand-oriented investments, to access or enlarge foreign markets; (ii) efficiency seeking activities, i.e. to improve the efficiency of labour or specialisation of the firm; (iii) resource seeking activities, i.e. supply-oriented, to increase their access to resources; and (iv) strategic asset seeking activities, i.e. to protect and/or enhance their competitive advantages (Dunning & Lundan, 2008).

By engaging in cross-border activities to strengthen their global competitive advantage (Cantwell & Hodson, 1991; Iammarino et al., 2008), MNEs often undertake strategic asset-seeking activities looking for the acquisition of new knowledge, which enlarges their unique set of technological assets (Dunning & Lundan, 2008; Delios & Beamish, 2001). Strategic asset-seeking activities in the form of foreign investments provide valuable learning opportunities, expose firms to diverse knowledge environments, and contribute to expanding their knowledge base (Meyer et al., 2009). Ghauri & Park (2012) measured knowledge acquisition by examining how firms acquired product development skills, production technology and manufacturing processes. On a parallel strand of work, Ascani & Prenzel (2023) have instead considered how Chinese companies undertake investments in locations characterised by specific degrees of economic complexity.

Outward FDI provide MNEs access to external complementary innovation resources, helping them overcome innovation constraints, achieve positive returns on innovation, and strengthen their technological capabilities (Fu, 2012). For example, MNEs reinforce their asset base by

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

acquiring diverse product specifications and quality standards and collaborating with foreign businesses and institutions.

Extant studies agree that FDI facilitates the learning and knowledge accumulation process thanks to interacting with several agents in different geographical regions and along the value chain (Dunning, 1980; Johanson & Vahlne, 1977; Kogut & Zander, 1993). FDI grant companies access to foreign knowledge and may enable the transfer of know-how through spatial proximity, social integration, and the movement of skilled professionals (Dhanaraj et al., 2004; Narula & Santangelo, 2009; Polanyi, 1966a, 1966b; Uzzi, 1997). Existing works also underline that proximity – geographical, cultural, and sectoral – to technologically advanced firms is beneficial to MNEs. It gives them access to local knowledge - such as locally embedded innovations, managerial capabilities, and valuable skills - unavailable in their home market and hard to codify and transfer (Fu et al., 2018). Proximity contributes to MNEs' accumulated local experience of a country, which builds up with time and determines the frequency and significance of knowledge production and transfer. Green and digital knowledge are complex and mostly concentrated in advanced firms clustered in developed regions with strong social, capital, and infrastructures (Basilico et al., 2024; Ciarli et al., 2021; Barbieri et al., 2020). Thus, those regions, potentially, can attract FDI to a larger extent than others.

Many knowledge assets are geographically concentrated and can only be effectively utilised by establishing a presence in those locations (Dunning, 1996; Dunning & Lundan, 2008; Dunning & McKaig-Berliner, 2002). However, as highlighted by McCann & Mudambi (2005) and Iammarino & McCann (2013), International Business (IB) literature tends to overlook the growing significance of sub-national geographical factors such as agglomeration processes, urbanisation, and patterns of diversification or specialisation. As a result, the role of regional and sub-regional locations within individual countries is largely neglected.

2.2 Location choice of foreign direct investments

IB literature has been complemented by Economic Geography (EG) studies, which analyse the pull-and-push factors driving MNEs' strategic asset-seeking activities. In particular, EG focuses on the location advantage at the base of strategic asset-seeking, which aligns with the regional economics approach. Agglomeration economies, market access, and labour market conditions are among the most influential factors in the location decisions of MNEs' foreign activities. According to the Marshallian theory (Marshall, 1920), agglomeration forces could have negative consequences due to increased competition and costs. Those adverse effects could deter firms from settling in a location, leading to a dispersed industry. Nevertheless, empirical evidence supports the agglomeration hypothesis versus the dispersion one at a national (Devereux & Griffith, 1998) and sub-national scale (Crozet et al., 2004; Guimarães et al., 2000; Head et al., 1995, 1999). MNE tend also to locate where the demand for a product is higher (Head & Mayer, 2004), and not only where similar firms invest.

In addition to the demand for products, MNEs consider the local labour market in their location decisions. However, previous work shows opposite results according to the proxy of the labour market in the empirical framework and the context of the analysis. On the one hand, when considering wages, higher wages signal high-skilled workers, therefore attracting investments.

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

On the other hand, a high unemployment rate in the local labour market could be interpreted as the availability of the labour force or lack thereof and labour market rigidities. Therefore, the correlation with investments is unclear (Head & Mayer, 2004; Head et al., 1999; Guimarães et al., 2000).

Other than the above-mentioned traditional motives, another strand of literature has investigated how knowledge-related drivers can contribute to the location decisions of MNEs. Namely, a location's human capital and knowledge stock can attract foreign firms. Indeed, human capital represents a significant motive for strategic asset-seeking firms looking to expand internationally via foreign direct investment (Dunning & Lundan, 2008). This concept is also central to urban and regional location theory, and its importance is consistently supported by a wealth of empirical research (e.g., Coughlin & Segev, 2000; Guimarães et al., 2000; Arauzo-Carod & Viladecans-Marsal, 2009). These studies often argue that human capital, among other influential elements, is critical in determining where multinational corporations choose to locate. The underlying principle is that regions boasting a high concentration of specific knowledge and skills tend to attract more foreign direct investment (Chidlow et al., 2009). Human capital has been proxied by the population's level of education. Yet, few existing studies have offered concrete evidence regarding the specific mix of knowledge and skills that ultimately drives a firm's location preferences (such as Arauzo-Carod & Viladecans-Marsal, 2009). Crescenzi et al. (2015) include the percentage of employed workers with tertiary education as a proxy for human capital and some knowledge indicators (e.g. patents, R&D, human capital) when looking at the location choice of MNEs. They find that human capital and knowledge exert a strong and positive effect on investment attraction. Similarly, the knowledge endowment of a region acts as a lever for FDI. Foreign investments can function as asset-seeking strategies, as firms attempt to compensate for their knowledge gaps and broaden their knowledge base in "a dynamic accumulative process of competences and technology" (Ascani, 2018). In this vein, MNEs strategically acquire less productive firms with valuable organisational and cognitive routines, enabling them to access new knowledge bases while lowering the expenses of acquiring foreign assets.

In addition, FDI provides MNEs access to external complementary innovation resources, helping them overcome innovation constraints, compensate for weaknesses in their internal technological capacity (Chesbrough, 2003), and achieve positive returns on innovation (Fu et al., 2018). When choosing a foreign investment location, multinational enterprises might also consider the value chain stage. Agglomeration economies, market access, and the labour market dynamics are expected to affect investment decisions differently according to the value chain stage. Similarly, human capital and knowledge have a heterogeneous effect in attracting FDI (Crescenzi et al., 2015). Fuller & Phelps (2004) state that *"Foreign-based establishments are viewed as having different value chain 'roles' and, therefore, possess distinct firm-specific 'competencies' within complex corporate value chains and are embedded in local socio-institutional conditions, including sources of technology, (tacit) knowledge and learning"*. Crescenzi et al. (2015) indeed find that regional economies attract investments in more advanced stages of the value chain, such as innovation, as long as they can provide valuable knowledge assets.

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

2.3 The twin transition, foreign direct investments and skills

The European Union has been pushing towards a greener, more digitalised society and economy to tackle current societal challenges. The so-called twin transition is key to the EU's strategic industrial, social, and economic policy orientation. The twinning of the green and digital transitions appears substantial in reaching the targets set out in the European Green Deal, the Digital Compass, and the Fit for 55 strategies, among other European policy documents. Urgency has emerged for an integrated and aligned approach to manage the green and digital transitions to successfully deliver the environmental, social and economic targets (European Commission, 2022; Muench et al., 2022).

Green and digital technologies often require more complex knowledge processes than their counterparts (Barbieri et al., 2020; Ciarli et al., 2021). The specific capabilities necessary for the twin transition are locally embedded and path-dependent, especially at a regional scale (Corradini et al., 2023; Corradini et al., 2021; Montresor & Quatraro, 2020; Santoalha et al., 2021; Santoalha & Boschma, 2021). The complexity of these transitions requires firms to increase their knowledge base, which might lead to the need to seek strategic assets outside their home country. Strategic asset-seeking investments are a valuable tool to fill the knowledge gap in the green and digital domains. The extant literature provides some interesting insights into related matters. Investments in General Purpose Technologies (GPT) might facilitate the introduction of more complex technologies required by the twin transition (Ardito et al., 2021; Diodato et al., 2023; Ning et al., 2023). In the same trend, Montresor & Vezzani (2023) show that firms that invest in Industry 4.0 technologies - such as artificial intelligence (AI), big data, the Internet of Things (IoT), additive manufacturing and robotics – have a bigger capacity to invest in green technologies. ICT-driven sectors prioritise digital skills, while greenfield projects in manufacturing and renewable energy lean toward green technological capabilities, underscoring the need for hybrid skill ecosystems in attracting sector-specific FDI (Castellani et al., 2022). Few studies have analysed the reverse spillover effect in green and digital technologies; that is, MNEs use of FDI to increase their knowledge base. Fu et al. (2018) find that Chinese FDI in developed countries are used as an "innovation springboard" to improve technological capabilities.

Existing studies have focused on many aspects, including the link between FDI and firm performance as well as implications for recipient economies, (among others, Cozza et al., 2015; Amendolagine et al., 2023; Javorcik et al., 2018), but scarce is the evidence on whether the location choice of foreign activities is driven by the availability of green and digital knowledge, looking at the presence of green and digital skills in the host region. Previous studies have found that the regional endowment of skills related to ICT technologies predicts the capacity of the region to expand its diversification of green technologies further (Santoalha et al., 2021), and that the pre-existence of green technologies in the regional knowledge endowment reinforces the green tech specialisation of firms (Balland et al., 2019; Montresor & Quatraro, 2020; Santoalha & Boschma, 2021). Moreover, green and digital skills may significantly enhance a region's attractiveness for FDI, as recent descriptive and qualitative evidence suggests (Kimura & Flood, 2025), particularly when these skill sets are complementary, enabling technological diversification and alignment with environmental and digital economies (Santoalha et al., 2021).

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

Based on these premises, we investigate whether the regional availability of green, digital and twin skills attracts foreign direct investments.

2.4 Exports and skills

Not only do skills attract investments of foreign multinationals, but they also represent an asset for the host region. Knowledge and skills are instrumental to the internationalisation of the region through export. International trade theory suggests that countries and regions specialise in sectors with a comparative advantage compared to other countries and regions (Ricardo, 1817). Regions and countries with highly skilled and educated workforce often excel in sectors demanding significant human capital, like advanced manufacturing and service industries. The most performing firms belonging to sectors with a comparative advantage frequently engage in trade activities to increase their profits. Indeed, Melitz (2003) highlights that fixed costs to enter foreign markets and additional fixed costs to export hinder access to international trade. Only the most productive firms can then engage in international trade. Companies involved in international trade often demonstrate greater capabilities than those focusing solely on their domestic market. These enhanced capabilities typically manifest as higher productivity. Numerous studies support this observation, including research by Bernard & Jensen (1999), Pavcnik (2002), Alvarez & Lopez (2005), Trefler (2004), Fernandes (2007), Lileeva & Trefler (2010), Topalova & Khandelwal (2011), De Loecker (2011), and Eslava et al. (2013).

Green investments could induce higher productivity among other factors by combining environmental and increased revenue objectives (Antonietti & Marzucchi, 2014). Similarly, empirical analyses show that improvements in labour and total factor productivity in the medium term could be driven by investments in digital technology (Bijnens et al., 2024). Other research highlights the positive relation between green policies in fostering exports (among others, Costantini & Mazzanti, 2012). Similar insights emerge when focusing on the effects that digital technologies may have (e.g. Nucci et al., 2023; López González et al., 2023; Wang et al., 2024).

In addition, previous studies show that exporters have a skill advantage. Companies engaged in exporting tend to employ a more highly skilled workforce than those serving only domestic markets (e.g., Verhoogen, 2008; Brambilla et al., 2012). This disparity in skill levels might stem from a few factors. One possibility is that international consumers prioritise quality, and a skilled workforce is crucial for producing high-quality goods, as Verhoogen (2008) suggested. Alternatively, the exporting process may demand specific skills that are not necessary for selling similar products within the home country, a concept explored by Matsuyama (2007).

To our knowledge, no previous studies have linked regional green and digital skills with exporting activities. In this report, we thus look at the relation between the regional export performance of NUTS2 Italian regions (due to data availability, see below) and the regional prevalence of green, digital, and twin skills.[1]

[1] As we will detail in the empirical sections of the report, we focus on the Italian NUTS2 region due to data availability issues.

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

3 Data and main variables

The analysis draws upon different data sources: the Orbis Crossborder Investment (OCI) by Moody's, the COEWEB data from Istituto Nazionale di Statistica (ISTAT; in English: Italian National Institute of Statistics), the European Skills, Competences, Qualifications and Occupations classification (ESCO), and the European Labour Force Survey (EU-LFS). For the controls, we use: OECD Regpat (version autumn 2024) and various datasets from Eurostat and the United Nations Educational, Scientific and Cultural Organization (UNESCO).

The reference set comprises the 27 Member States of the European Union. However, we excluded the Netherlands due to the absence of NUTS levels in the occupational data of EU-LFS. Moreover, we have also excluded Bulgaria, Malta, and Slovenia due to a lack of data on the controls. Finally, we have excluded Latvia since the sample size provided in EU-LFS does not pass the necessary reliability threshold. Thus, we end up with a final sample of 22 countries. The period of the analysis comprises the years from 2018 to 2022.[2]

3.1 Dependent variables: inward FDI and exports

This subsection provides information on how we constructed the dependent variables for the subsequent empirical analysis. The main objective of these variables is to assess the level of international openness of the considered NUTS-2 European regions. Firstly, we present the construction of the dependent variables regarding Foreign Direct Investments (FDI). Secondly, we present the construction of the dependent variable regarding exports.

We collected information on FDI from the OCI database for greenfield investments (projects) and mergers and acquisitions (deals). We have restricted the sample only to those brownfield deals and greenfield projects that have as their destination an EU-27 country. We considered, for the case of brownfield deals, only the completed FDI and, for the case of projects, only the FDI that are both completed and new as of the date of data retrieval (November 2024). The raw data on greenfield projects also includes relocation, expansion, and co-location activities. Thus, to isolate the greenfield investments (the FDI concerning the opening of an entirely new branch in a foreign country), we considered only the projects categorised as "new" in the variable "project type". To perform the analysis, we regionalised the greenfield projects and brownfield deals at the NUTS-2 level based on the destination region of the FDI. For the brownfield deals, the regionalisation is based on the target firm being in a foreign country. We extracted the Bureau Van Dijk (BvD) ID of those firms. Then we searched the ORBIS balance sheet data for the corresponding geographical information when available (we searched for ZIP codes, NUTS information, and city names). We regionalised the brownfield deals corresponding to those target firms at the NUTS-2 level.

For the greenfield projects, which entail the establishment of an entirely new branch in a foreign country, it is trickier to identify the destination region; the only information available is

[2] This has a twofold motivation. First, we want to stay as close as possible to the period in which skill-content of occupations is defined by ESCO (2019) to avoid facing issues deriving from within variations of occupations. Second, we have to deal with data limitations for recent years in control variables.

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

about either the destination region or the city. Firstly, to accomplish this task, we used the matched cities and regions with NUTS-2 codes extracted from the brownfield deals to assign projects to regions. Secondly, we used a package in R called "tidygeocoder" for those greenfield projects that were not yet regionalised, which allowed us to extract coordinates (latitude and longitude) when some geographical information on the location is provided. In this case we fed the algorithm with the name of the destination city and the name of the destination country. Then, we overlaid the coordinates of those destination cities with the shape files of NUTS-2 regions provided by the R package "eurostat". With this process, we could assign the corresponding target NUTS-2 region to the retrieved greenfield projects when at least some information on the destination city was provided, increasing the sample of matched greenfield projects. The number of greenfield projects and brownfield deals for each NUTS-2 region constitute our main dependent variables in the empirical framework.

A measure of exports was not available for the whole European Union at the NUTS-2 regional level; we decided to focus only on the Italian market, where this information is available, after request, at the Italian National Institute of Statistics (ISTAT). The COEWEB database provides the amount of exports in Euros of all the activities of Italian firms at the 5-digit level of the ATECO classification (ATtività ECOnomiche; in English: Economic Activities). The ATECO codes are a translation of the NACE codes adapted for the specific characteristics of the Italian economic market. We aggregated this information at the NUTS-2 level, representing the Italian regional authorities, summing up the amount of exports for all the sectors present in the focal region. Afterwards, we took the logarithm of those exports, representing the primary dependent variable for exports in the empirical approach.

3.2 Skills variables

This subsection provides information on how we constructed our main independent variables for the subsequent empirical analysis. The main objective of those variables is to assess the embeddedness of green, digital and twin skills in all NUTS-2 European regions.[3]

We used the ESCO dataset to identify the degree of digital, green and twin skills of each occupation in Europe. In a first step, we focused on the ESCO 5-digit level of occupations to provide enough granularity (example: 3D modeller, 2166.1). To identify the skills associated with each occupation, we collected information only on the ones identified in ESCO as "skill/competence". The ESCO classification provides a list of green and digital skills, which are retrieved using manual labelling, machine learning algorithms and external validation processes (ESCO 2022a; 2022b). This information permits us to identify the number of green and digital skills of each occupation. We counted how many green and digital skills each occupation has and we calculated the shares for green, digital and twin skills. We flag as twin skills those green (digital) skills which co-occur with digital (green) skills in the same occupation. To assess also the potential of other skills, which are not green (digital, twin), but are associated with them,

[3] At the moment of the writing of this report another deliverable of the ST4TE project (D1.3 "The geography of the green, digital and twin occupations in Europe. Mapping Digital and Green Occupations and Twin Skill Readiness in EU Regions") is being prepared and reflects in the detail the work carried out to define this methodology

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

we also calculated a score of "green-enabling", "digital-enabling" and "twin-enabling[4]" for each occupation. This share reflects the number of skills for a focal occupation that at least once occur with a green or a digital skill in another occupation. The higher this score is, the higher the probability that this occupation can bridge the focal (i.e. green, digital and twin) competences with a wider set of tasks and economic applications. In this sense, we have six scores for each occupation (three for the share of green, digital, and twin skills; three for the share of green-enabling, digital-enabling, and twin-enabling skills). Subsequently, we aggregated the ESCO 5-digit level of occupations results to the ISCO 3-digit level to permit the analysis of the distribution of green, digital and twin skills in Europe through EU-LFS. Using the six measures developed previously, we calculated the average share for the occupations at the 3-digit level. In this sense, we moved from 1795 occupations at the ESCO 5-digit level to 125 occupations at the ISCO 3-digit level.[5] Afterwards, using EU-LFS, we calculated the share of weighted employment for each ISCO 3-digit occupation and each NUTS-2 region.[6] We multiplied the obtained score by the share of (enabling) greenness, (enabling) digitalness, and (enabling) twinness from ESCO to get the level of green, digital, and twin skill (including enabling ones) embeddedness in European regions. We considered an average over a 3-year time window (for example, the score for the year 2018 of a focal NUTS-2 region is composed of the average of the years 2016, 2017 and 2018 of the same NUTS-2 region) to show better how the endowment of green and digital skills affects a region's propensity to attract FDI (and export).

3.3 Control variables

This subsection shows how we constructed the control variables for our empirical analysis. Those variables pertain to different datasets provided by both OECD and Eurostat. OECD Regpat (version autumn 2024) provides all the patents filed at the European Patent Office (EPO). We used it to map the innovation activities for all the NUTS-2 regions in Europe. The location of the inventor allowed us to "regionalise" the patent. We used fractional counts if there are multiple inventors from different locations across Europe.

The other control variables we included in the analysis are the regional working population, the regional gross domestic product per inhabitant, and the share of the working population with tertiary education. The working population comprises all inhabitants of a NUTS-2 region aged 15-64 years, expressed in thousands of people. The Regional Gross Domestic Product (GDP) is the total value of all goods and services produced, less the value of goods and services used for intermediate consumption in the production process. The GDP is expressed in euros per capita and harmonised at purchasing power parity to account for price differences across regions. Our proxy for the regional (general) level of human capital is captured through the share of the

[4] In the case of twin-enabling skills, we consider all the skills occurring with at least one green and one digital skill in the same occupation.

[5] The occupations at ISCO 3-digit level with the codes: "224", "631", "632", "633", "634" are not included since do not have any sub-occupation at ESCO 5-digit level.

[6] For the case of Germany and Austria EU-LFS provides data only at NUTS-1 level. Thus, we use this regional specification in those cases for our analysis.

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

working population with tertiary education (ISCED education level between 5 and 8[7]). The total regional working population, regional patents and GDP per capita are registered in the same year as the number of brownfield deals and greenfield projects. To control for the general endowment of skilled labour in the region over the same time window of our focal variables, the share of the working population with tertiary education refers to a three-year average.

[7] The International Standard Classification of Education (ISCED) is a framework developed by UNESCO to categorize and compare educational programs and qualifications across different countries. ISCED organizes education into a series of levels, from early childhood education to doctoral studies. ISCED 5 refers to short-cycle tertiary education and ISCED 8 refers to doctoral or equivalent education level.

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

4 Mapping foreign direct investments in EU NUTS-2 regions and Exports in Italy

This section provides an overview of the distribution of brownfield and greenfield investments by area of origin and destination in the EU NUTS2 regions. We also map the exporting activities of Italian regions. Our mapping and descriptive evidence reported below (and in Section 5) focuses on the year 2022, the last year of our working dataset.

4.1 Mapping the origin of FDI

In this subsection, we offer a general mapping of the places in the world from which FDI targeting EU regions originate. We use the classification provided by the World Trade Organisation (WTO) to group the countries and regions of origin. Those mappings contain all the successfully regionalised greenfield projects and brownfield deals using a NUTS-2 European region as a destination. [8]

Table 1 shows the number and the share of greenfield projects in 2022 targeting the EU27 by world region of origin. Most identified greenfield projects are from the European area, amounting to around 70 percent of greenfield projects (summing together Northern, Southern, Western Europe[9] and Eastern Europe[10]). The second most important player is Northern America and the third is Eastern Asia. This result is in line with how the commercial partners of European Union countries are spread across the world. Only around 10 percent of the projects originate from a different area of the world.

Table 1 - The world area of origin of greenfield projects with destination the EU27 countries in 2022.

World Region	N Greenfield Projects	Share
Northern, Southern and Western Europe	2002	67,77
Northern America	506	17,13
Eastern Asia	113	3,83
Latin America and the Caribbean	106	3,59
Eastern Europe	76	2,57
South-Eastern Asia and the Pacific	54	1,83
Central and Western Asia	46	1,56
Sub-Saharan Africa	25	0,85
Southern Asia	17	0,58
Arab States	9	0,30

[8] The full dataset of the successfully identified destination region of brownfield deals and greenfield projects has been used for producing Table 1 and Table 2. From the next subsection (4.2) only the restricted form with the 22 EU countries correctly matched with controls is used.

[9] As Northern, Southern and Western Europe other than some EU27 countries in this area are also included: Albania, Andorra, Bosnia and Herzegovina, Channel Islands, Faroe Islands, Gibraltar, Guernsey, Iceland, Isle of Man, Jersey, Kosovo, Monaco, Montenegro, North Macedonia, Norway, San Marino, Serbia, Switzerland and United Kingdom.

[10] As far as Eastern Europe is concerned non EU27 countries are also included: Belarus, Republic of Moldova, Russian Federation and Ukraine.

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

Table 2 shows the share of brownfield deals in 2022 with destination an EU27 country, sorted by world region of the investor.[11] Similarly to what emerges from Table 1, the very large majority of deals has an investor either from the European area or Northern America. Only around 10 percent of brownfield investments come from other areas. As in the case presented for greenfield projects, Table 2 shows a clear association between the usual European commercial partners and the number of investments performed.

Table 2 - The world area of the investor in brownfield deals with destination the EU27 countries in 2022.

World Region	N Brownfield Deals	Share
Northern, Southern and Western Europe	1632	70,04
Northern America	436	18,71
Eastern Europe	69	2,96
Eastern Asia	63	2,70
Central and Western Asia	47	2,02
South-Eastern Asia and the Pacific	35	1,50
Latin America and the Caribbean	21	0,90
Southern Asia	11	0,47
Arab States	10	0,43
Sub-Saharan Africa	5	0,21
Northern Africa	1	0,04

4.2 Mapping the destination of FDI

In this subsection, we show the distribution of FDI based on the EU27 NUTS-2 destination region. Figure 1 shows the spatial distribution of the number of greenfield projects in the NUTS-2 EU regions in the year 2022. The NUTS-2 regions with the highest number of greenfield projects are either among each country's most economically advanced ones based on the yearly GDP per capita or the NUTS-2 regions hosting the capital city. In the first case, there are regions like Lombardy (ITC4), Catalunya (ES51) and Bayern (DE20). In the second case there are regions like Comunidad de Madrid (ES30; Madrid), Île de France (FR10; Paris), Eastern and Midland Region (IE06; Dublin), Berlin (DE30), Warszawski stołeczny (PL91; Warsaw), Prague (CZ01), Attica (EL30; Athens), Uusimaa (FI1B; Helsinki), Stockholm (SE11), Área Metropolitana de Lisboa (PT17; Lisbon) and Bucharest-Ilfov (RO32; Bucarest). In this sense, foreign companies worldwide may be attracted by the possible economic returns of economically advanced areas in the continent. We should also stress the attractiveness of specific NUTS-2 regions in Romania and Poland with a non-negligible presence of greenfield investments. For Romania, the regions Nord-Vest (RO11) and Centru (RO12) score high in greenfield investments, the same holds for the regions Śląskie (PL22) and Dolnośląskie (PL51) in Poland.

[11] Not all the brownfield deals contain information on the origin of the investment. The presented table contains only the brownfield deals in which this information is provided. Moreover, there are some brownfield deals which are identified as origin of investment "supranational". Those investments are from international organizations or banks without a clear origin country. Therefore, also those investments were excluded from Table 2. All the excluded brownfield investments in Table 2 are included in the subsequent analysis.

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

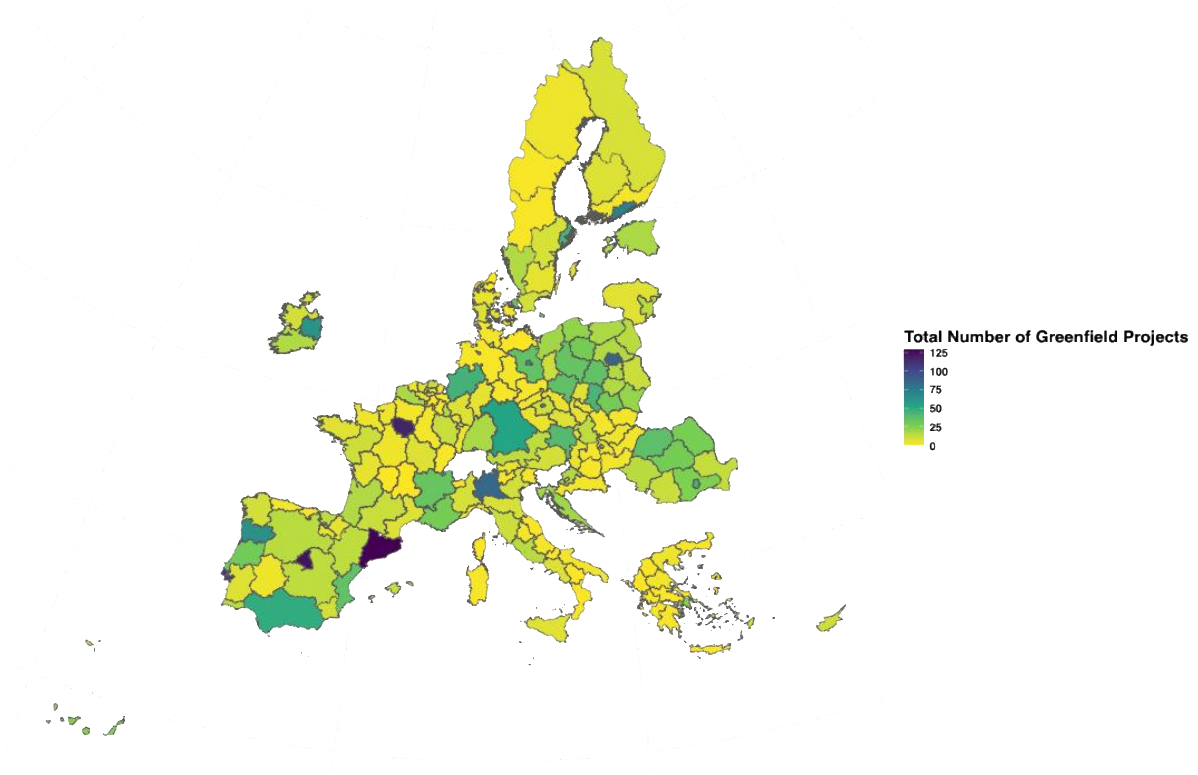

Figure 1 - The spatial distribution of greenfield projects in the NUTS-2 regions of the European Union in 2022.

Figure 2 shows the spatial distribution of the number of brownfield deals in the EU NUTS-2 regions in 2022. The spatial distribution of the brownfield deals is similar to the one observed in the case of greenfield projects. Nevertheless, in some specific countries in Western Europe (especially in Italy and Germany), brownfield deals are more geographically diffused than observed in greenfield projects (Figure 1). Instead, brownfield deals in Eastern Europe have a higher concentration in regions that host the capital cities.

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

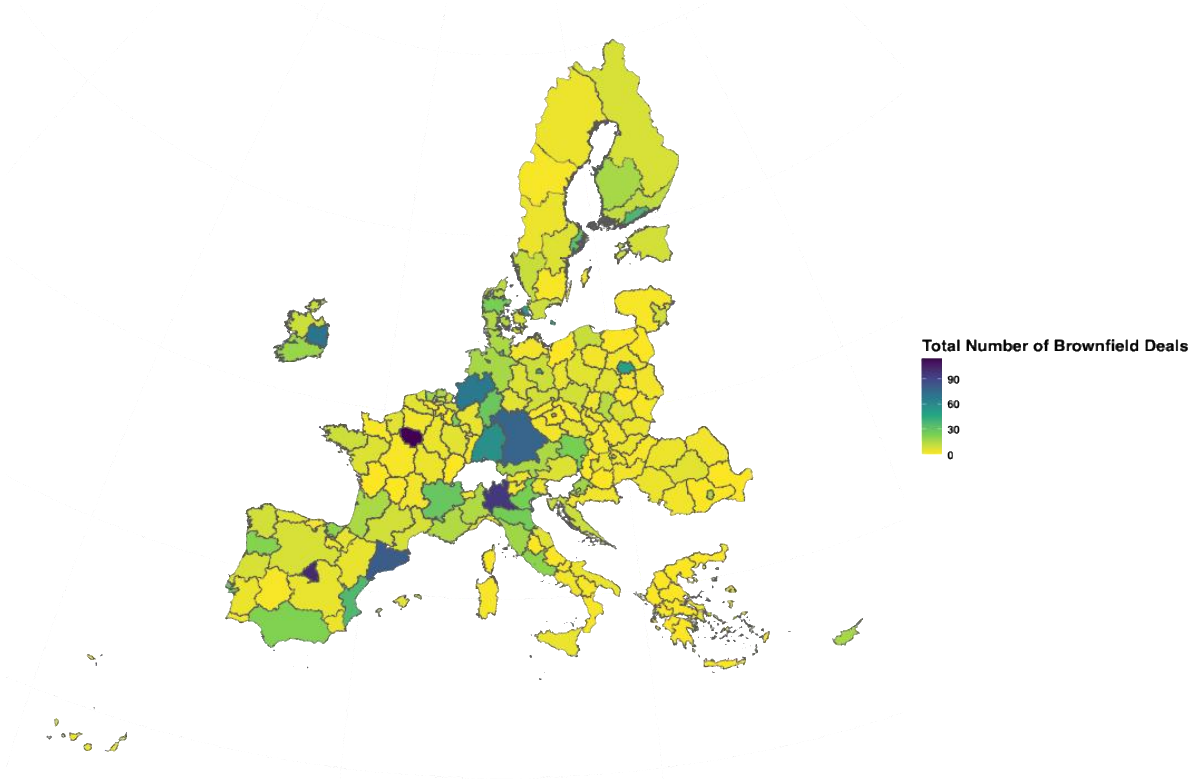

Figure 2 - The spatial distribution of brownfield deals in the NUTS-2 regions of the European Union in 2022.

4.3 Mapping the total amount of exports in Italy

We now map export volumes, the other dependent variable of our analysis, for the regions of Italy. The case of Italy permits us to explore the export dynamics and how these are associated with the regional pool of green and digital skills. We concentrate our analysis on Italy due to data availability. Figure 3 shows the total export amount (in Euros) for the different NUTS-2 Italian regions in 2022. This indicator of internationalisation appears to be intensely concentrated. Most of the exports are concentrated in the country's economically advanced regions in the North. The regions with an exceptionally high amount of exports are Lombardy (ITC4), Veneto (ITH3) and Emilia-Romagna (ITH5). The centre of Italy shows a medium amount of exports with some outliers, such as Tuscany (ITI1) and Lazio (ITI4), which show a level of exports close to the northern regions. Finally, the southern and insular areas of Italy show a low level of exports. Italian southern and insular regions are not all the same; for example, there is a non-negligible amount of export activities in Sicily (ITG1) and Campania (ITF3). However, more generally, this spatial distribution of exports reflects the North-South divide typical of Italy.

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

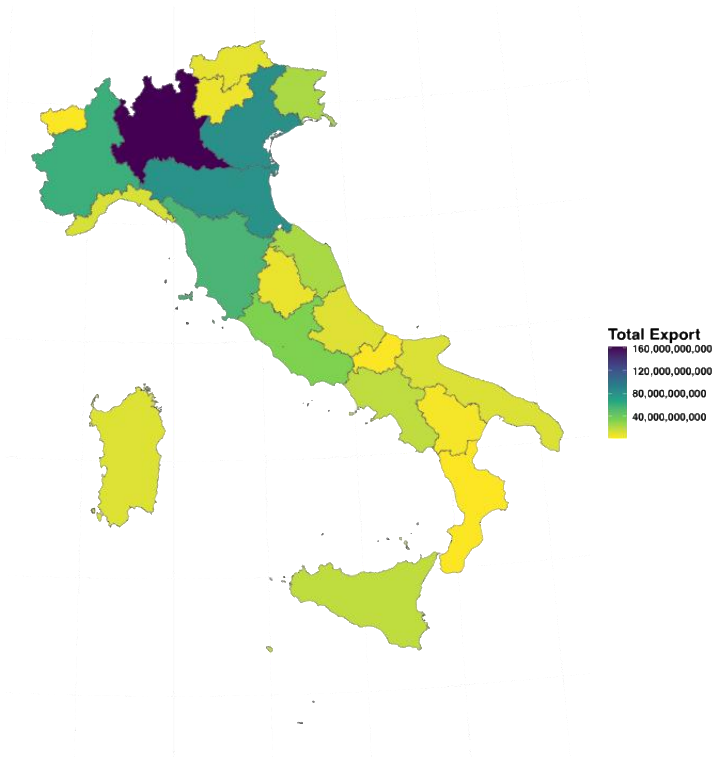

Figure 3 - The spatial distribution of the total amount of exports for the Italian NUTS-2 regions in 2022.

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

5 The relation between globalisation and skills in the green, digital and twin domains

In this section, we begin exploring the main relations between the variables used in the subsequent econometric application. We will show the relations between the dependent variables (number of greenfield projects, number of brownfield deals and amount of exports in Euros) and the main independent variables (endowment of green, digital and twin skills; endowment of green-enabling, digital-enabling and twin-enabling skills) for all NUTS-2 regions in Europe, in the case of the FDI, and for all NUTS-2 regions of Italy, in the case of exports. All subsequent graphs will show lines centred on the average for the dependent and independent variables. This allows us to locate NUTS-2 regions in quadrants based on their performance. That is: in the High-High quadrant, regions are performing above the average in both variables; in the Low-Low quadrants, regions are performing below the average in both variables; in the intermediate quadrants, we have regions performing above average in just one of the two considered variables. For each graph in the case of FDI, a corresponding table (reported in Appendix I) shows the five best countries in terms of share of NUTS-2 region for each quadrant to have a more in-depth analysis of the EU countries' performance.

5.1 The inward FDI-skills relation

Figure 4 shows the relation between the number of greenfield projects and the endowment of green skills in all considered NUTS-2 European regions. The overall relation between those two variables is negative, meaning regions with many greenfield projects tend to have a low endowment of green skills. This is reflected in the negatively sloped bivariate regression fit line. An interesting type of region in this case is made of those that are located in the quadrant named as Low-High: that is, territories with a number of greenfield projects above the average but a low endowment of green skills. Notable examples belonging to this category are: Lombardy (Italy, ITC4), Catalunya (Spain, ES51), Bayern (Germany, DE20), Comunidad de Madrid (Spain, ES30), Île de France (France, FR10), Eastern and Midland Region (Ireland, IE06) and Berlin (Germany, DE30). Located in the High-High quadrant are regions (especially from Eastern Europe) with a number of greenfield projects and a share of green skills higher than the average. Some of these regions are: Nord-Est (Romania, RO21), Sud-Muntenia (Romania, RO31), Kujawsko-Pomorskie (Poland, PL61) and Łódzkie (Poland, PL71). Those regions are performing well in green skills and are in countries (Romania and Poland) that are primarily involved in low-skilled green occupations. Many other regions from Eastern and Mediterranean Europe are in the High-Low quadrant, meaning they have a high endowment of green skills but a low level of greenfield foreign direct investments. Some examples belonging to this category are: Lubelskie (Poland, PL81), Creete (Greece, EL43), Western Greece (Greece, EL63), Southern Transdanubia (Hungary, HU23), Northern Great Plain (Hungary, HU32). Finally, some regions from Western Europe are scoring low both in the endowment of green skills and in the number of greenfield projects belonging to the Low-Low quadrant. Some examples of regions belonging to this category are: Hamburg (Germany, DE60), Bremen (Germany, DE50), Flemish Brabant (Belgium, BE24), Walloon Brabant (Belgium, BE31). Our econometric analysis, provided below, will shed further light on a significant relation between green skills and greenfield FDI.

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

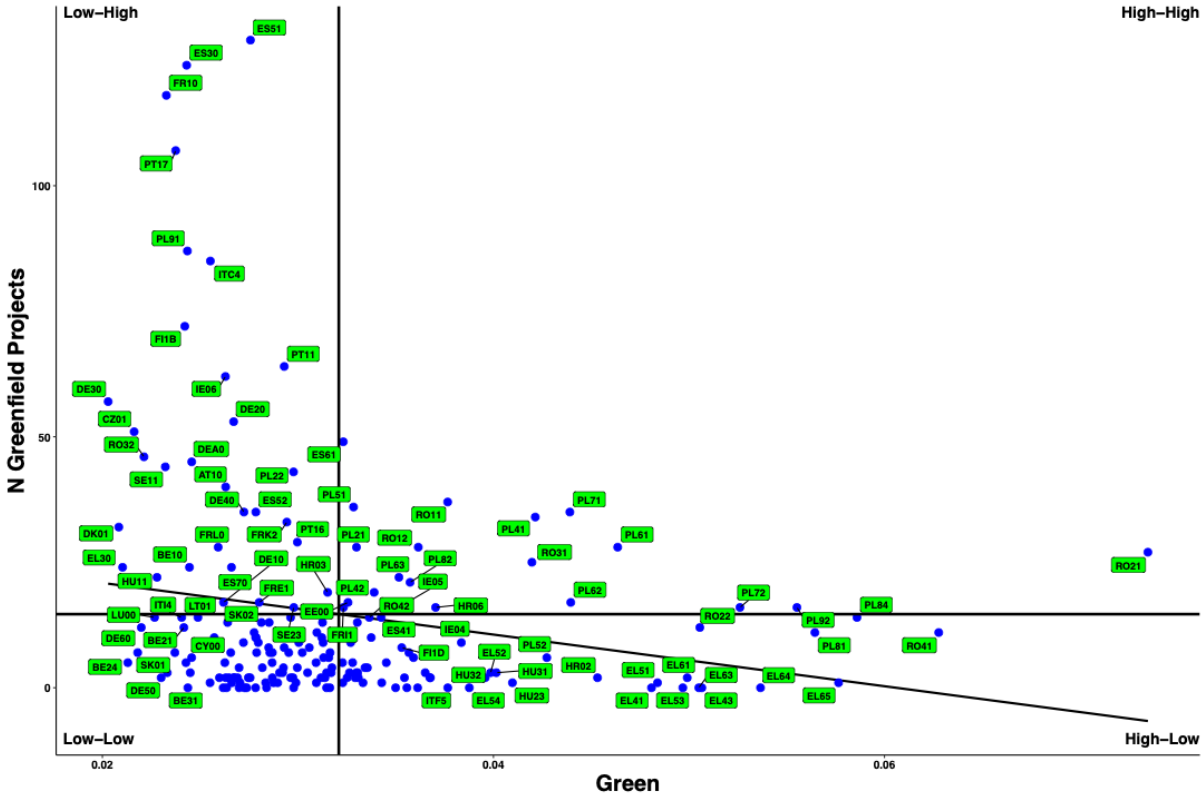

Figure 4 - The relation between the endowment of green skills and the number of greenfield projects in NUTS-2 European regions in 2022.

Table A1 1 shows the top five countries by share of regions for each quadrant, as shown previously in Figure 4. The countries with the highest presence in the High-High quadrant are Poland (PL) and Romania (RO), with 65% and 50% of NUTS-2 regions, respectively. Subsequently, there are countries from Western Europe represented with only 1 NUTS-2 region, like Ireland (IE), Croatia (HR), Spain (ES) and France (FR). The majority of regions of Greece (EL) and Hungary (HU) are in the High-Low quadrant, together with some regions of Lithuania (LT), Portugal (PT) and Romania (RO). In the Low-Low quadrant, there are many regions, in some cases, almost entire countries like Slovakia (SK), Belgium (BE), Denmark (DK), the Czech Republic (CZ) and Italy (IT). Finally, in the Low-High quadrant, the majority are Western and Northern European countries, like Portugal (PT), Austria (AT), Ireland (IE), Germany (DE) and Sweden (SE). Overall, Eastern European countries perform better in terms of the endowment of green skills and taken together with greenfield investments, in some cases, regions are above the average in both variables. In the case of Western European countries, most regions are either in the Low-High or Low-Low quadrant, showing in some cases only a high amount of greenfield investments but generally a low endowment of green skills.

Figure 5 shows the relation between the number of brownfield deals and the endowment of green skills for all NUTS-2 European regions. Similarly to what has been observed in Figure 4, there is a negative relationship between the number of brownfield deals and the endowment of green skills in the NUTS-2 European regions. In this case, the slope of the regression line is even more negative, meaning that if the NUTS-2 region has a high presence of green skills, the number of deals is even lower than in the case of greenfield projects. There are only 4 NUTS-2

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

regions in Europe scoring High-High in this case, those are located in Western Europe: Southern Region (Ireland, IE05), Andalusia (Spain, ES61), Aquitaine (France, FRI1) and Sjeverna Hrvatska (Croatia, HR06). The NUTS-2 regions in the High-Low quadrant are mainly from Eastern Europe, with a high endowment of green skills but a very low level of brownfield deals. This result partially contrasts with the one shown in Figure 4, where some of those regions were in the High-High quadrant, showing a higher level of foreign direct investments in the case of greenfield projects. The NUTS-2 regions in the Low-Low quadrant are sparse across space, involving Western and Eastern European regions. Some examples of NUTS-2 regions belonging to the Low-Low category are: Attica (Greece, EL30), Saarland (Germany, DEC0), Bremen (Germany, DE50) and Budapest (Hungary, HU11). In the Low-High quadrant, most of the NUTS-2 regions from Western Europe, and many economically advanced regions of the continent, are present. They receive a large amount of brownfield deals, but they endow a low share of green skills, similar to the case of greenfield projects. Some examples of NUTS-2 regions belonging to the Low-High category are: Île-de-France (France, FR10), Madrid (Spain, ES30), Lombardy (ITC4, Italy) and Catalonia (Spain, ES51). From these descriptive results, it seems that having an economic structure based on green competences is not attractive for foreign direct investments in Europe.

Table A1 3 shows the five countries with the highest share of NUTS-2 regions in each quadrant for the endowment of green skills and the presence of brownfield deals. Regarding the High-High quadrant, there are only four NUTS-2 regions, all from Western European countries. In the High-Low quadrant, mostly Eastern and Mediterranean European regions are present, showing very high percentages. Those countries are: Poland (PL), Romania (RO), Greece (EL), Hungary (HU) and Lithuania (LT). In the case of the Low-Low quadrant, there are countries scattered around Europe. Those countries with the highest presence of regions scoring low both in the endowment of green skills and in the brownfield deals are: Slovakia (SK), Czech Republic (CZ), Belgium (BE), France (FR) and Sweden (SE). In the case of the quadrant showing a high level of brownfield deals and a low level of the endowment of green skills, there are Denmark (DK), Austria (AT), Finland (FI), Germany (DE) and Ireland (IE).

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

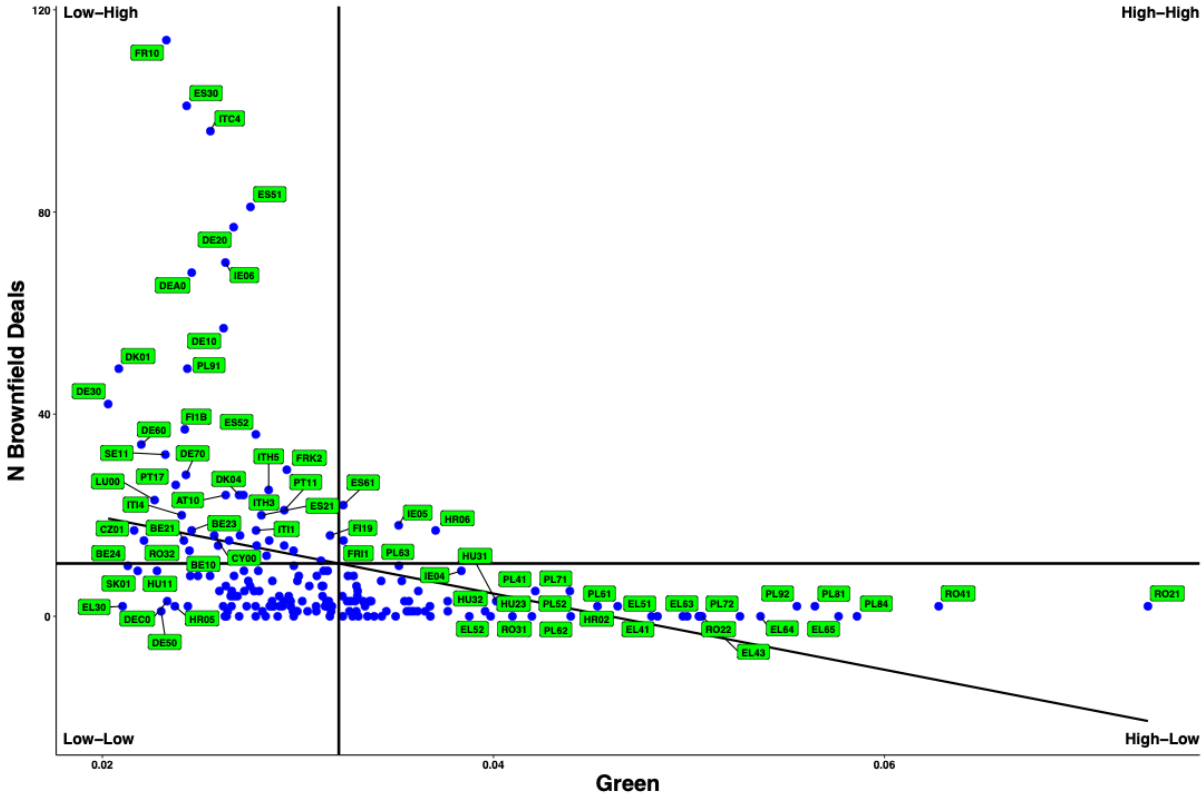

Figure 5 - The relation between the endowment of green skills and the number of brownfield deals in NUTS-2 European regions in 2022.

Figure 6 shows the relationship between the endowment of green-enabling skills and the number of greenfield investments for all NUTS-2 regions in 2022. Overall, the graph shows a negative relationship between the two variables. Similarly to Figure 4, the NUTS-2 regions in the High-High quadrant are mainly from Eastern Europe, even if there are some notable exceptions. In this case, in the High-high quadrant, we have regions that can connect green competences with other skills pertaining to wider economic activities and are attractive for international investors, possibly also due to a higher adaptability to future challenges related to the green transition. Some of those NUTS-2 regions scoring high in both FDI and green-enabling skills are: Centro (Portugal, PT16), Norte (Portugal, PT11), Catalonia (Spain, ES51) and Andalusia (Spain, ES61). In the quadrant representing a high level of endowment of green-enabling skills but a low level of greenfield projects, there are NUTS-2 regions distributed in space. Some examples of the regions belonging to the group High-Low are: La Rioja (Spain, ES23), Central Transdanubia (Hungary, HU21), Northern Hungary (Hungary, HU31) and Cantabria (Spain, ES13). In the quadrant representing both a low level of the endowment of green-enabling skills and a low level of greenfield projects, there are regions from Western and Mediterranean Europe. Some notable examples belonging to the Low-Low category are: Campania (ITF3, Italy), Midi-Pyrénées (France, FRJ2), Schleswig-Holstein (Germany, DEF0) and Sjælland (Denmark, DK02). Finally, in the Low-High quadrant, economically advanced regions of the EU are listed. These have a low endowment of green-enabling skills, even if they have many greenfield projects. Some examples of the regions belonging to this category are: Île-de-France (France, FR10), Madrid (Spain, ES30), Área Metropolitana de Lisboa (Portugal, PT17) and

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

Lombardy (Italy, ITC4). In general, the distribution of the NUTS-2 regions in this case seems less skewed than in the case of the green skills.

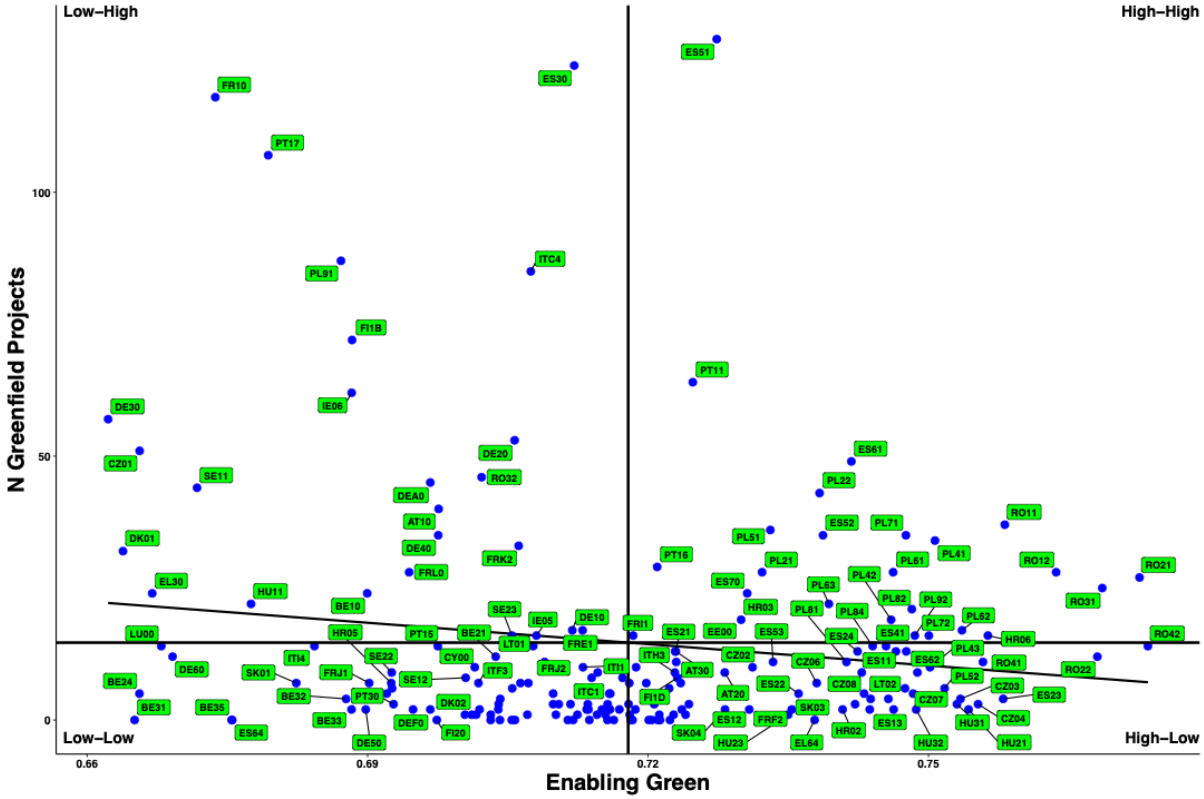

Figure 6 - The relation between the endowment of green-enabling skills and the number of greenfield projects in NUTS-2 European regions in 2022.

Table A1 2 shows the five countries with the highest share of NUTS-2 regions belonging to a single quadrant in the green-enabling variables and the number of greenfield projects. The countries with both a high level of green-enabling skills and number of greenfield projects are: Poland (PL), Croatia (HR), Romania (RO), Portugal (PT) and Spain (ES). The countries with the most regions scoring high in the endowment of green-enabling skills but low in the number of greenfield projects are: Czech Republic (CZ), Hungary (HU), Slovakia (SK), Austria (AT) and Spain (ES). The countries with the highest percentage of regions scoring low in both greenfield projects and in the endowment of green-enabling skills (Low-Low) are: Belgium (BE), Denmark (DE), Sweden (SE), Italy (IT) and Germany (DE). In the case of countries with the highest percentage of regions scoring low in the endowment of green-enabling skills and high in the case of greenfield investments, there are many Western European countries: Ireland (IE), Austria (AT), Germany (DE), Sweden (SE) and Denmark (DK).

Looking at both Table A1 2 and Figure 6, we notice a divide between Western and Eastern European countries. The former includes many NUTS-2 regions located either in the Low-Low quadrant or in the Low-High quadrant. On the other side, NUTS-2 regions of Eastern European countries are mainly located either in the High-High quadrant or in the High-Low quadrant, showing a high level of endowment of green-enabling skills.

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

Figure 7 shows the relation between the endowment of green-enabling skills and the number of brownfield deals. The relation between the two variables is once again negative: regions with a high level of green-enabling skills tend to show a low level of brownfield deals and vice-versa. This result is like the one already shown in Figure 6. In the High-High quadrant, there is a high presence of regions from Southern countries: Catalonia (Spain, ES51), Valencian Community (Spain, ES52), Veneto (Italy, ITH3) and Norte (Portugal, PT11). In the High-Low quadrant, there are mainly regions from Eastern Europe, like: Vest (Romania, RO42), Nord-Est (Romania, RO21), Jihovýchod (Czech Republic, CZ06) and Southern Transdanubia (Hungary, HU23). In the Low-Low quadrant, there are many NUTS-2 regions from Western Europe. Some examples include: Rhineland-Palatinate (Germany, DEB0), Liège (Belgium, BE33), Limburg (Belgium, BE22) and Algarve (Portugal, PT15). In the Low-High quadrant, similarly to what has been observed in Figure 6, there are economically advanced regions, including: Île de France (France, FR10), Madrid (Spain, ES30), Lombardy (Italy, ITC4) and Bavaria (Germany, DE20).

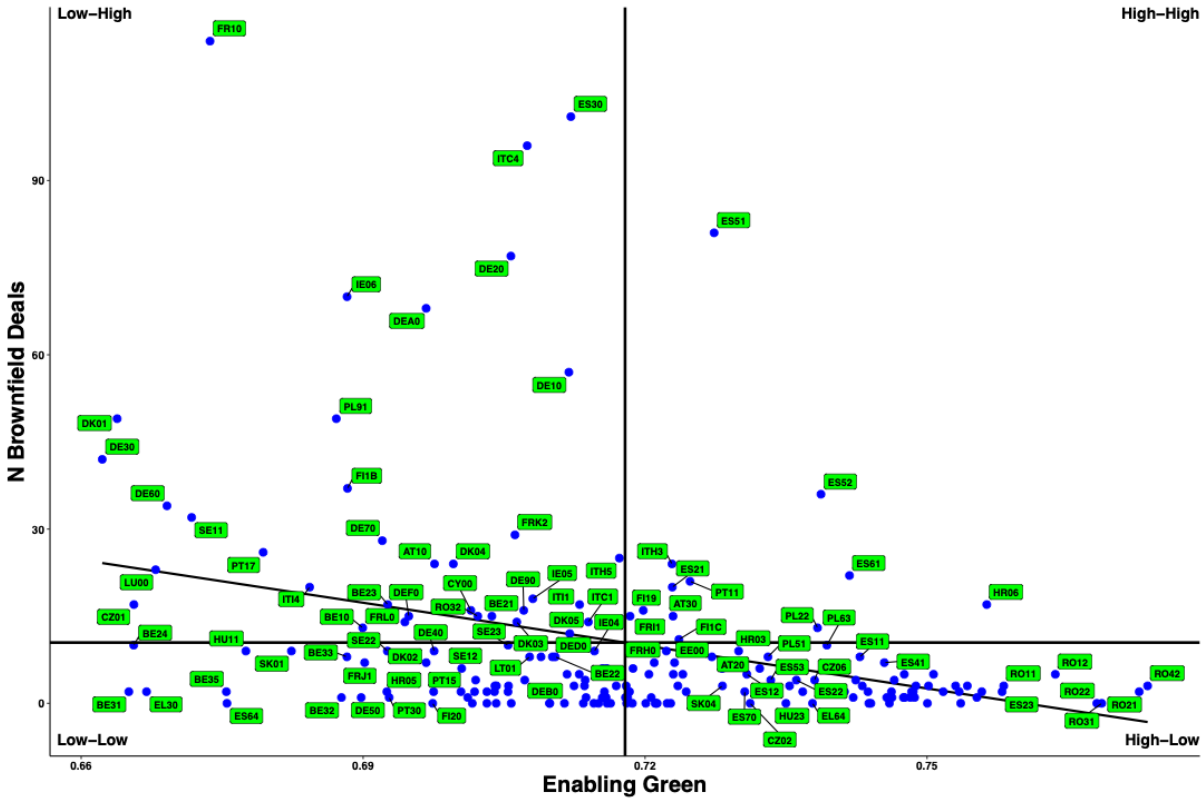

Figure 7 - The relation between the endowment of green-enabling skills and the number of brownfield deals in NUTS-2 European regions in 2022.

Table A1 4 shows the top regions in each quadrant. In the High-High quadrant, there are NUTS-2 regions from a varied set of countries: Finland (FI), Austria (AT), Croatia (HR), Spain (ES) and Portugal (PT). In the High-Low quadrant, the countries showing a high share of NUTS-2 regions are from Eastern Europe: Poland (PL), the Czech Republic (CZ), Hungary (HU), Romania (RO) and Slovakia (SK). In the Low-Low quadrant, the countries showing the highest share are: Sweden (SE), Belgium (BE), Greece (EL), Italy (IT) and Lithuania (LT). Finally, in the Low-High quadrant, the countries with the highest share of NUTS-2 regions belonging to this category are: Denmark (DK), Ireland (IE), Germany (DE), Austria (AT) and Belgium (BE). Similarly to Table A2, those

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

results show how NUTS-2 regions from Western European countries can have either a high number or a low number of brownfield deals, but in many cases, they do not embed a high share of green-enabling skills.

Takeaway	**#1**
Economically advanced NUTS-2 regions tend to score low in the endowment of green and enabling-green skills, while they attract many FDI. A relevant set of less economically developed NUTS-2 regions show a low amount of FDI but tend to have a high level of green and green-enabling skills.	

Figure 8 shows the relation between the endowment of digital skills and the number of greenfield projects in NUTS-2 European regions in 2022. In this case, unlike what has been shown in the case of green skills and green-enabling skills, there is a positive relationship between the two variables. In the High-High quadrant, there are NUTS-2 regions, which are among the most economically advanced of Europe, including: Madrid (Spain, ES30), Île de France (France, FR10), Área Metropolitana de Lisboa (Portugal, PT17) and Lombardy (Italy, ITC4). Instead, in the High-Low quadrant, other regions from Western Europe are highly digitalised but with a low degree of greenfield projects. For example, those regions that pertain to this category are: Hamburg (Germany, DE60), South Sweden (Sweden, SE22), Walloon Brabant (Belgium, BE31) and Veneto (Italy, ITH3). In the Low-Low quadrant, regions spread across different parts of Europe show a low level of digital skills and greenfield projects. For example, here we find: Aragon (Spain, ES24), Northern and Western Region (Ireland, IE04), Vest (Romania, RO42) and Lubelskie (Poland, PL81). In the Low-High quadrant showing NUTS-2 regions with a low endowment of digital skills but a high level of greenfield projects, there are also regions from different part of the EU, including for example: Andalusia (Spain, ES61), Centro (Portugal, PT16), Nord-Vest (Romania, RO11) and Wielkopolskie (Poland, PL41). Overall, Western Europe's most advanced NUTS-2 regions score high regarding the endowment of digital skills and the number of greenfield projects. This result shows that foreign companies tend to invest where the digital transition unfolds.

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

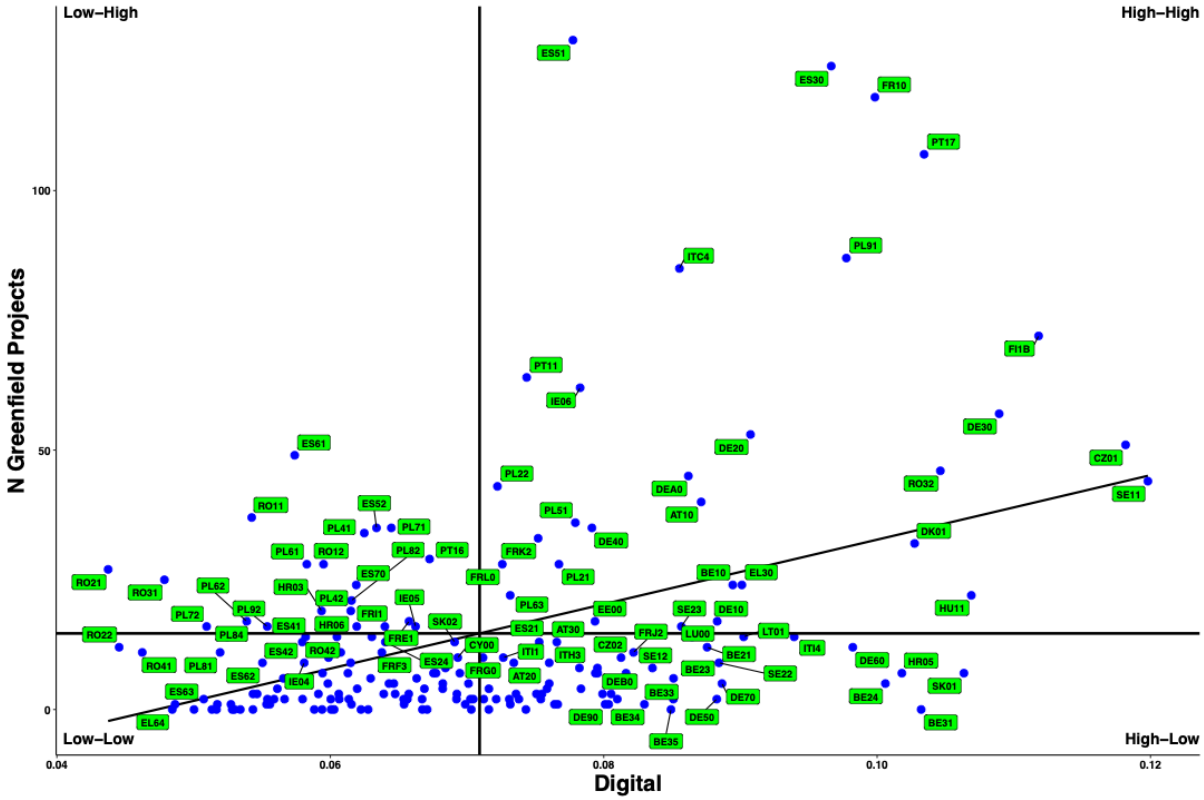

Figure 8 - The relation between the endowment of digital skills and the number of greenfield projects in NUTS-2 European regions in 2022.

Table A1 1 shows the percentage of NUTS-2 regions for each country in the different quadrants. The countries with the highest share of NUTS-2 regions scoring high in both the endowment of digital skills and the number of greenfield projects are in Western Europe: Austria (AT), Ireland (IE), Germany (DE) and Portugal (PT). The only country with a high share of regions scoring high in both variables, and in Eastern Europe, is Poland (PL). In the High-Low quadrant, the countries with the highest shares of NUTS-2 regions are from Western Europe, such as Belgium (BE), Austria (AT), Finland (FI) and Germany (DE). Those countries show a high degree of digitalness but a low degree of greenfield investments. The countries with the highest share of NUTS-2 regions belonging to the Low-Low quadrant are: Greece (EL), Hungary (HU), Spain (ES), France (FR) and Denmark (DK). In the Low-High quadrant, the countries with the highest share of NUTS-2 regions are: Croatia (HR), Romania (RO), Poland (PL), Ireland (IE) and Spain (ES). An interesting case is that of Poland. On average, the country can attract inward greenfield FDI (13 out of 17 regions exceed the mean). Nevertheless, when it comes to digital skills endowment, there is a sort of internal polarisation: out of those 13 territories, five are above the mean and eight are below the average level. Another specific example extracted from this table is that of Germany, almost all the regions are above the average regarding digital skills (14 NUTS-2 regions out of 16), but only a few of those regions (5) receive a high number of greenfield projects.

Figure 9 shows the relationship between the endowment of digital skills and the number of brownfield deals. In general, the relation between those two variables is positive. In this case, the NUTS-2 regions receiving brownfield deals are also characterised by a higher endowment of digital skills. Not surprisingly, in the High-High quadrant, we find economically advanced

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

regions like: Île de France (France, FR10), Madrid (Spain, ES30), Lombardy (Italy, ITC4) and Bavaria (Germany, DE20). The NUTS-2 regions belonging to the High-Low quadrant, i.e. with a high degree of digital skills but a low degree of brownfield deals, are in a diverse set of countries. In this group, we find: Budapest (Hungary, HU11), Walloon Brabant (Belgium, BE31), Bremen (Germany, DE50), and South Sweden (Sweden, SE22). Likewise, diverse is the set of countries with regions in the Low-Low quadrant. In this group, we find: Nord-Est (Romania, RO21), Galicia (Spain, ES11), Northern and Western Region (Ireland, IE04) and Jadranska Hrvatska (Croatia, HR03). The remaining NUTS-2 regions are in the Low-High quadrant and are mainly located in Western European countries: Valencian Community (Spain, ES52), Andalusia (Spain, ES61), Southern Region (IE05, Ireland) and Southern Denmark (Denmark, DK03).

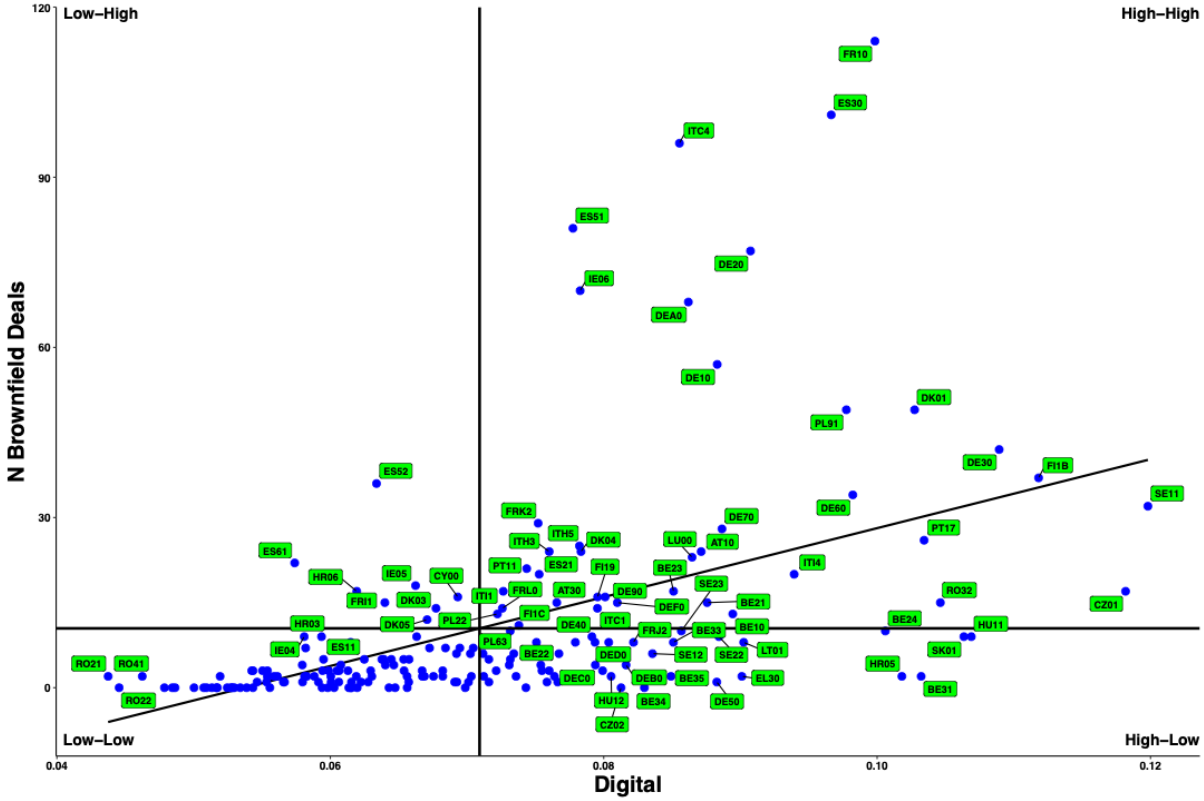

Figure 9 - The relation between the endowment of digital skills and the number of brownfield deals in NUTS-2 European regions in 2022.

Table A1 3 shows the five countries with the highest share of NUTS-2 regions for each quadrant, as represented in Figure 9. The countries having a high share of NUTS-2 regions scoring high in both the endowment of digital skills and the number of brownfield deals are Austria (AT), Finland (FI), Germany (DE), Denmark (DK) and Ireland (IE). In the category High-Low, showing a high degree of digitalness but a low attractiveness of brownfield deals, there are both countries from Eastern and Western Europe, like Slovakia (SK), Belgium (BE), Sweden (SE), the Czech Republic (CZ) and Lithuania (LT). In the Low-Low quadrant, there are: Greece (EL), Romania (RO), Hungary (HU), Spain (ES) and Portugal (PT). Finally, in the Low-High quadrant, there are mainly countries from Western Europe, like Denmark (DK), Ireland (IE), Croatia (HR), Spain (ES) and France (FR). A particular case is that of Spain, where almost all NUTS-2 regions (16) show a level of digitalisation below the average, and only two regions show a number of brownfield

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

deals above the average. This is a country profile with a relatively concentrated attractiveness of FDI in the form of deals and a somewhat diffuse absence of digital skills.

Figure 10 shows the relationship between the number of greenfield projects and the digital-enabling skills. In this case, a slightly negative relationship exists between the number of greenfield FDI and the endowment of digital-enabling skills. This result means that being a destination region for greenfield investments does not necessarily go hand in hand with having a high share of digital-enabling skills, which can be seen as linking core digital competences with broader applications. In the High-High quadrant, there is a mixed set of regions located in varied countries: Norte (Portugal, PT11), Eastern and Midland Region (Ireland, IE06), Śląskie (Poland, PL22) and Nord-Vest (Romania, RO11). Likewise, diverse is the set of countries where High-Low regions are located. For instance, here we find: North Middle Sweden (Sweden, SE31), Thüringen (Germany, DEG0), Lubuskie (Poland, PL43) and Střední Morava (Czech Republic, CZ07). In the Low-Low quadrant, there are many NUTS-2 regions from the Mediterranean area, such as Italy and Greece. Those NUTS-2 regions showing a low level of digital-enabling skills and a low level of greenfield projects attractiveness are: Liguria (Italy, ITC3), Campania (Italy, ITF3), Central Macedonia (Greece, EL52) and North Aegean (Greece, EL41). Finally, the NUTS-2 regions showing a high level of greenfield projects, but a low level of digital-enabling skills are some capital regions or economically advanced ones, where probably digital skills per se are at the core of the economic specialisation, rather than their link with wider applications. For example, the NUTS-2 regions belonging to this category are: Catalonia (Spain, ES51), Île-de-France (France, FR10), Área Metropolitana de Lisboa (Portugal, PT17) and Lombardy (Italy, ITC4). In general, Figure 10 shows different results than Figure 8; the most economically advanced NUTS-2 regions are no longer in the High-High quadrant, like in the case of digital skills, but in the Low-High quadrant.

Table A1 2 shows the five countries with the highest share of NUTS-2 regions for each quadrant. In the High-High quadrant, the countries showing a high share of NUTS-2 regions belonging to this category are: Poland (PL), Ireland (IE), Croatia (HR), Romania (RO) and Portugal (PT). In the High-Low group, we find: Czech Republic (CZ), Hungary (HU), Denmark (DK), Finland (FI) and Sweden (SE). Most of the NUTS-2 regions scoring low in digital-enabling skills and greenfield investments are in Western Europe, particularly in the Mediterranean area. The countries representing those regions are: Greece (EL), Italy (IT), Austria (AT), Spain (ES) and Portugal (PT). Finally, the countries showing a high number of NUTS-2 regions in the Low-High quadrant are: Austria (AT), Spain (ES), Romania (RO), Denmark (DK) and Finland (FI). An interesting case is that of Portugal because most of the NUTS-2 regions either belong to the High-High quadrant or the Low-Low quadrant, showing a sort of polarisation in the capacity to link digital-enabling skills and greenfield FDI attractiveness.

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

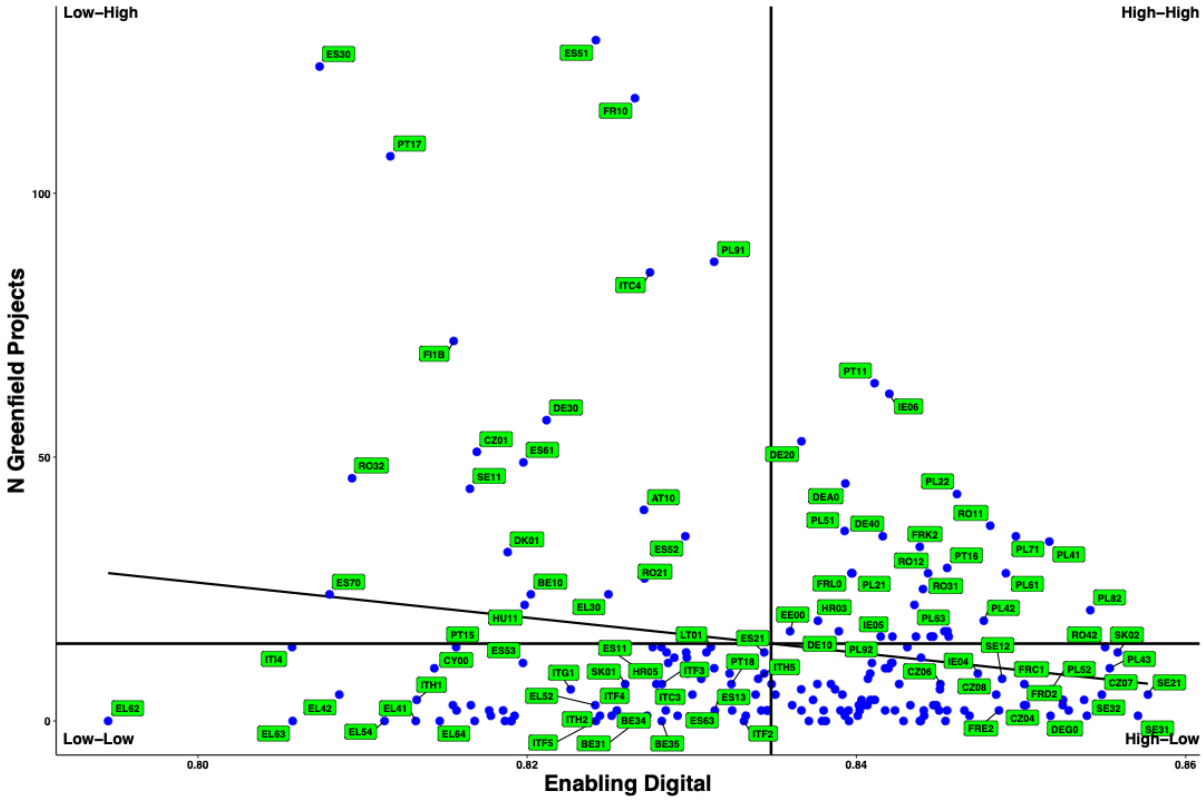

Figure 10 - The relation between the endowment of digital-enabling skills and the number of greenfield projects in NUTS-2 European regions in 2022.

Figure 11 shows the relation between the endowment of digital-enabling skills and the number of brownfield deals in the NUTS-2 European regions. Generally, the relation between the two variables is slightly negative, meaning that on average, NUTS-2 regions with a high level of digital-enabling skills show a low level of brownfield deals. In the High-High quadrant, many NUTS-2 regions from Western Europe show both a high level of digital-enabling skills and a high level of brownfield deals. Those regions are: Bavaria (Germany, DE20), Eastern and Midland Region (Ireland, IE06), Baden-Württemberg (Germany, DE10) and Norte (Portugal, PT11). In the High-Low quadrant, there is a set of regions from different types of countries. Here we find, for instance, Småland and the islands (Sweden, SE21), Sachsen-Anhalt (Germany, DEE0), Northern and Western Region (Ireland, IE04) and Jadranska Hrvatska (Croatia, HR03). In the Low-Low quadrant, showing both a low level of digital-enabling skills and a low level of brownfield deals, there are mainly NUTS-2 regions from Mediterranean Europe. Those NUTS-2 regions are, for example, Cantabria (Spain, ES13), Sicily (Italy, ITG1), Balearic Islands (Spain, ES53) and South Aegean (Greece, EL42). In the Low-High quadrant, there are economically advanced NUTS-2 regions, like: Île de France (France, FR10), Madrid (Spain, ES30), Lombardy (Italy, ITC4) and Catalonia (Spain, ES51). Once again, these are probably regions where digital skills per se are at the core of the economic specialisation, rather than their link with wider applications.

Table A1 4 shows the five countries with the highest share of NUTS-2 regions in each quadrant. The countries with the highest shares of NUTS-2 regions in the High-High quadrant are: Ireland (IE), Denmark (DK), Finland (FI), Germany (DE) and Croatia (HR). In the High-Low quadrant, we find: Poland (PL), Czech Republic (CZ), Hungary (HU), Sweden (SE) and France (FR). In the Low-

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

Low quadrant, the countries with the highest share of NUTS-2 regions in this category are from Southern and Mediterranean Europe, those are: Greece (EL), Italy (IT), Spain (ES) and Croatia (HR). Finally, the countries with the highest share of NUTS-2 regions in the Low-High quadrant are: Austria (AT), Italy (IT), Spain (ES), Denmark (DK) and Finland (FI). Some countries have a peculiar distribution of NUTS-2 regions, in particular there are Spain and Italy which have, in general, a low endowment of digital-enabling skills (for Spain 16 NUTS-2 regions out of 19 and for Italy 19 NUTS-2 regions out of 21) but also a low level of brownfield deals (for Spain 11 NUTS-2 regions and for Italy 13 NUTS-2 regions). Only a few exceptions exist in those countries with an above-average level of brownfield deals.

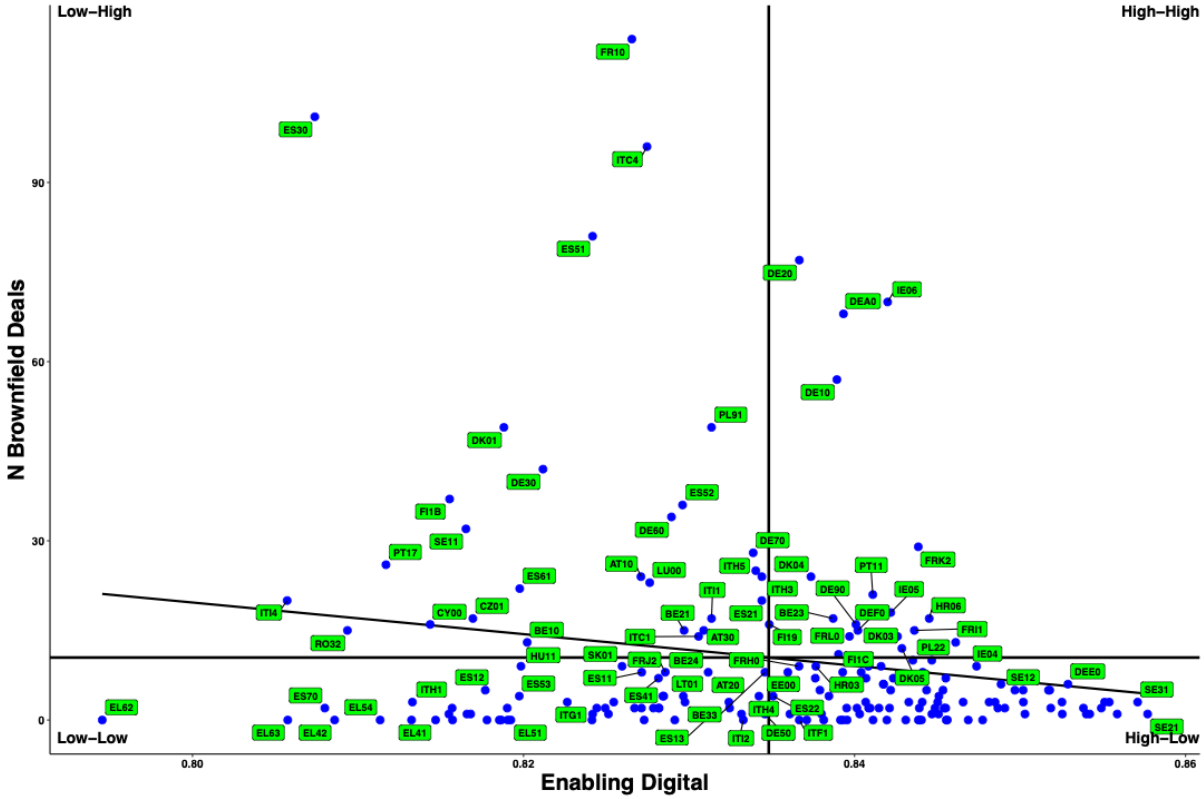

Figure 11 - The relation between the endowment of digital-enabling skills and the number of brownfield deals in NUTS-2 European regions in 2022.

Takeaway **#2**

Many economically advanced NUTS-2 EU regions have high levels of digital skills and inward FDI. Instead, a low level of digital skills and FDI is more typically found in the NUTS-2 EU regions that are not "at the core" in terms of economic development.

Regarding twin skills, Figure 12 shows the relationship between this set of competences and the number of greenfield projects in NUTS-2 European regions in 2022. In general, there is a slightly negative relationship between the two variables. In the High-High quadrant, we find regions like Catalonia (Spain, ES51), Warszawski stołeczny (Poland, PL91), Helsinki-Uusimaa (Finland, FI1B) and Norte (Portugal, PT11). In the High-Low quadrant, there are many NUTS-2 regions from Eastern Europe, some examples of those are: Lubuskie (Poland, PL43), Střední Čechy (Czech Republic, CZ02) and Western Transdanubia (Hungary, HU22). In the Low-Low quadrant, there are NUTS-2 regions from Western Europe that do not host capital cities, which

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

show a low level of both twin skills and greenfield projects. Those NUTS-2 regions are: Ceuta (Spain, ES63), Flemish Brabant (Belgium, BE24), Hainaut (Belgium, BE32) and Lorraine (France, FRF3). In the Low-High quadrant, there are mainly capitals or economically advanced regions like: Madrid (Spain, ES30), Île-de-France (France, FR10), Área Metropolitana de Lisboa (Portugal, PT17) and Lombardy (Italy, ITC4). Those NUTS-2 regions show a high level of greenfield projects but a low level of twin skills.

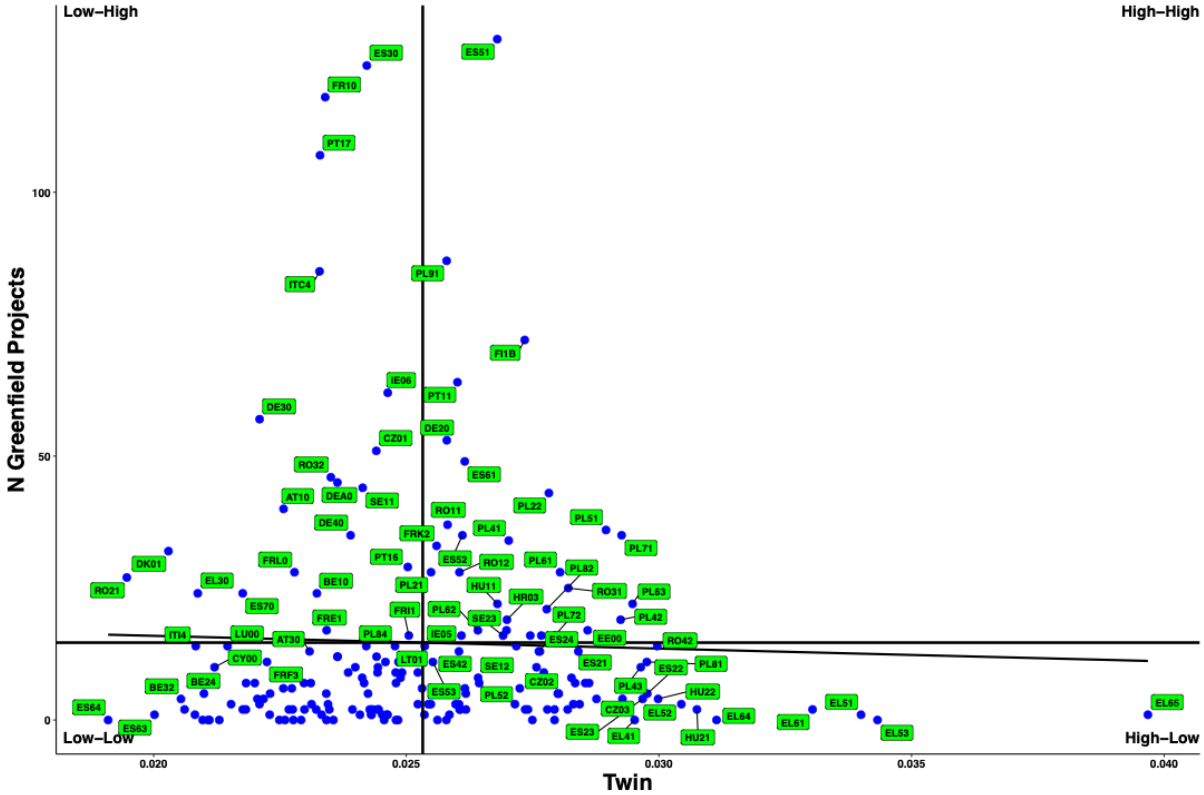

Figure 12 - The relation between the endowment of twin skills and the number of greenfield projects in NUTS-2 European regions in 2022.

Table A1 1 shows the five countries with the highest share of NUTS-2 regions for each quadrant presented in Figure 12. The countries with the highest share of NUTS-2 regions in the High-High quadrant are Poland (PL), Croatia (HR), Romania (RO), Ireland (IE) and Finland (FI). Countries with the highest share of NUTS-2 regions located in the High-Low quadrant are mainly from Eastern Europe: Lithuania (LT), Czech Republic (CZ), Hungary (HU), Greece (EL) and Finland (FI). In the Low-Low quadrant, all countries with the highest share of NUTS-2 regions are from Western Europe: Belgium (BE), Italy (IT), Denmark (DK), Austria (AT) and Germany (DE). In the Low-High quadrant, the countries with the highest presence of NUTS-2 regions are: Austria (AT), Ireland (IE), Portugal (PT), Romania (RO) and Denmark (DK).

Figure 13 shows the relation between the endowment of twin skills and the number of brownfield deals. The general relation between the two variables is more negative than the relation between twin skills and greenfield projects (Figure 12). However, the results are somewhat similar. In particular, the NUTS-2 regions located in the High-High quadrant are from Western European countries or NUTS-2 regions hosting the capital city. A sample of those NUTS-2 regions is Catalonia (Spain, ES51), Bavaria (Germany, DE20), Baden-Württemberg

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

(Germany, DE10) and Warszawski stołeczny (Poland, PL91). In the High-Low quadrant, there are many NUTS-2 regions from Greece and some from Finland and Spain. Some examples of those NUTS-2 regions are Peloponnese (Greece, EL65), Western Macedonia (Greece, EL53), North & East Finland (Finland, FI1D) and Castile-Leon (Spain, ES41). In the Low-Low quadrant, there are NUTS-2 regions from Western Europe, in particular: Brandenburg (Germany, DE40), Sjælland (Denmark, DK02), Ceuta (Spain, ES63) and Hainaut (Belgium, BE32). Finally, in the Low-High quadrant, there are mainly economically advanced NUTS-2 regions from Western countries like: Île-de-France (France, FR10), Madrid (Spain, ES30), Lombardy (Italy, ITC4) and North Rhine-Westphalia (Germany, DEA0).

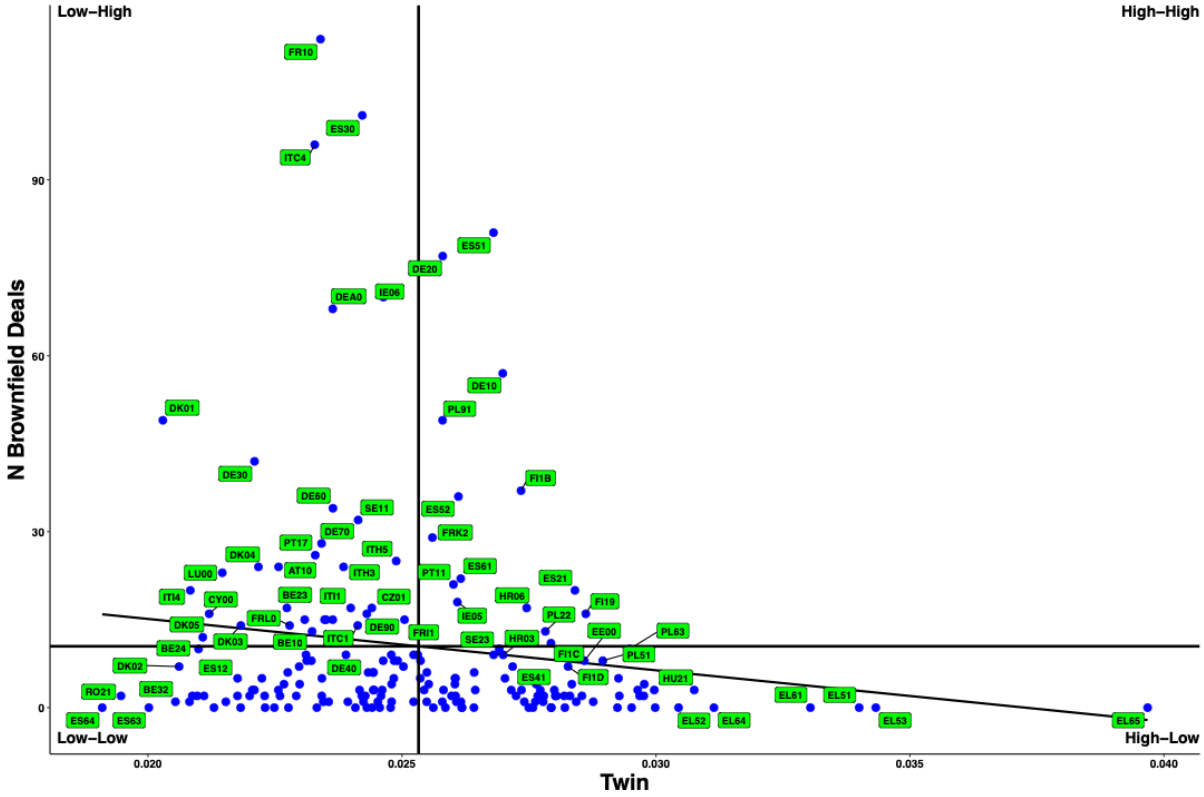

Figure 13 - The relation between the endowment of twin skills and the number of greenfield projects in NUTS-2 European regions in 2022.

Table A1 3 shows the countries with the highest share of NUTS-2 regions in one of the four quadrants, as shown in Figure 13. For the case of the countries in the High-High quadrant, those are: Finland (FI), Ireland (IE), Croatia (HR), Spain (ES) and Portugal (PT). The countries showing the highest number of NUTS-2 regions in the High-Low quadrant are: Hungary (HU), Lithuania (LT), Czech Republic (CZ), Poland (PL) and Greece (EL). The countries having many NUTS-2 regions with a low level of both twin skills and brownfield deals are: Belgium (BE), France (FR), Italy (IT), Portugal (PT) and Sweden (SE). Countries with a high presence in the Low-High quadrant are Denmark (DK), Austria (AT), Germany (DE), Ireland (IE) and Italy (IT).

Figure 14 shows the relation between the endowment of the twin-enabling skills and the number of greenfield projects in the NUTS-2 European regions for 2022. Generally, there is a slightly negative relationship between the two considered variables, which means that the NUTS-2 regions with many greenfield projects do not tend to have similarly high endowments

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

of twin-enabling skills. In the High-High quadrant, there are NUTS-2 regions like: Catalonia (Spain, ES51), Norte (PT11, Portugal), Andalusia (Spain, ES61) and Śląskie (Poland, PL22). In the High-Low quadrant, there are many NUTS-2 regions from Eastern Europe, with few exceptions from Western Europe: Sud-Est (Romania, RO22), Opolskie (Poland, PL52), Galicia (Spain, ES11) and Veneto (Italy, ITH3). In the Low-Low quadrant, many Western European NUTS-2 regions are not among the most economically advanced ones. Those regions are: Campania (Italy, ITF3), Southern Denmark (Denmark, DK03), Åland (FI20, Finland) and Midi-Pyrénées (France, FRJ2). In the Low-High quadrant, there are the NUTS-2 regions belonging to the category of the most economically advanced regions of the continent, like: Madrid (Spain, ES30), Île-de-France (France, FR10), Área Metropolitana de Lisboa (Portugal, PT17) and Warszawski stołeczny (Poland, PL91). In general, the results show how the regions of Eastern Europe have a higher potential to integrate twin capabilities, but this does not always come together with a higher number of greenfield projects.

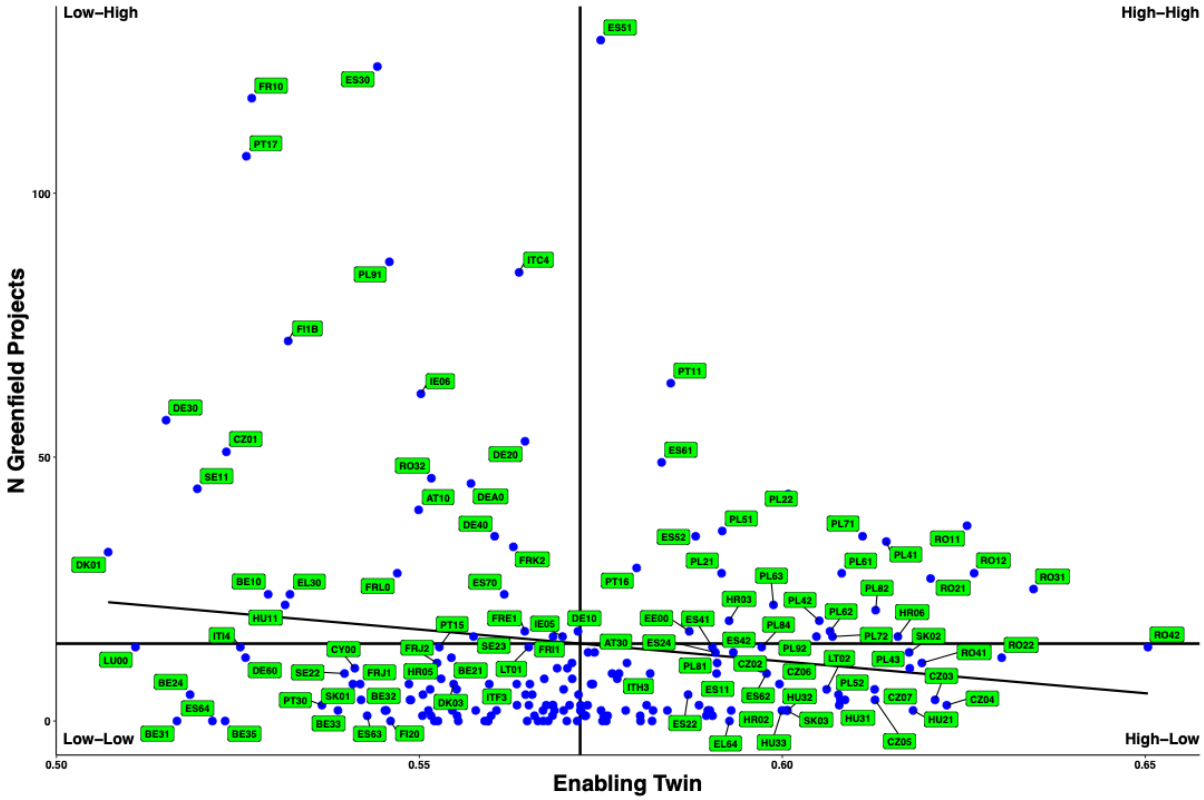

Figure 14 - The relation between the endowment of twin-enabling skills and the number of greenfield projects in NUTS-2 European regions in 2022.

Table A1 2 shows the top five countries with the highest share of NUTS-2 present in each quadrant related to the specification presented in Figure 14. In the High-High quadrant, the countries with the highest share of NUTS-2 regions are the following: Poland (PL), Croatia (HR), Romania (RO), Portugal (PT) and Spain (ES). In the High-Low quadrant, the countries with the highest share of NUTS-2 regions are: Czech Republic (CZ), Hungary (HU), Slovakia (SK), Austria (AT) and Spain (ES). In the Low-Low quadrant, there are countries with the highest share of NUTS-2 regions that belong to Western Europe: Belgium (BE), Denmark (DK), Finland (FI), Sweden (SE) and Italy (IT). Similarly, in the Low-High quadrant, there are mainly countries from Western Europe: Ireland (IE), Austria (AT), Germany (DE), Sweden (SE) and France (FR). A special

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

case is that of Spain, which has many NUTS-2 regions with a high twin potential (14 NUTS-2 regions out of 19 above the average in twin enabling). Still, only a few (3) are above the average regarding greenfield investments.

Figure 15 shows the relation between the endowment of twin-enabling skills and the number of brownfield deals in NUTS-2 European regions in 2022. In general, there is a negative relation between the two variables, which implies that the NUTS-2 regions performing well in embedding twin-enabling skills are not attracting many brownfield deals. The NUTS-2 regions in the High-High quadrant are mainly from Italy and Spain. Those NUTS-2 regions are: Catalonia (Spain, ES51), Valencian Community (Spain, ES52), Emilia-Romagna (Italy, ITH5) and Veneto (Italy, ITH3). In the High-Low quadrant, there are mainly regions from Eastern Europe, like: Vest (Romania, RO42), Nord-Vest (Romania, RO11), Wielkopolskie (Poland, PL41) and Łódzkie (Poland, PL71). In the Low-Low quadrant, there are many Western European NUTS-2 regions like Brandenburg (Germany, DE40), Sjælland (Denmark, DK02), Bremen (Germany, DE50) and Languedoc-Roussillon (France, FRJ1). Finally, the rest of Western European NUTS-2 regions are in the Low-High quadrant. Those regions are among the most economically advanced in Europe, which, similarly to Figure 14, show a high level of FDI but a low level of twin-enabling skills: Île de France (France, FR10), Madrid (Spain, ES30), Lombardy (Italy, ITC4) and Bavaria (Germany, DE20).

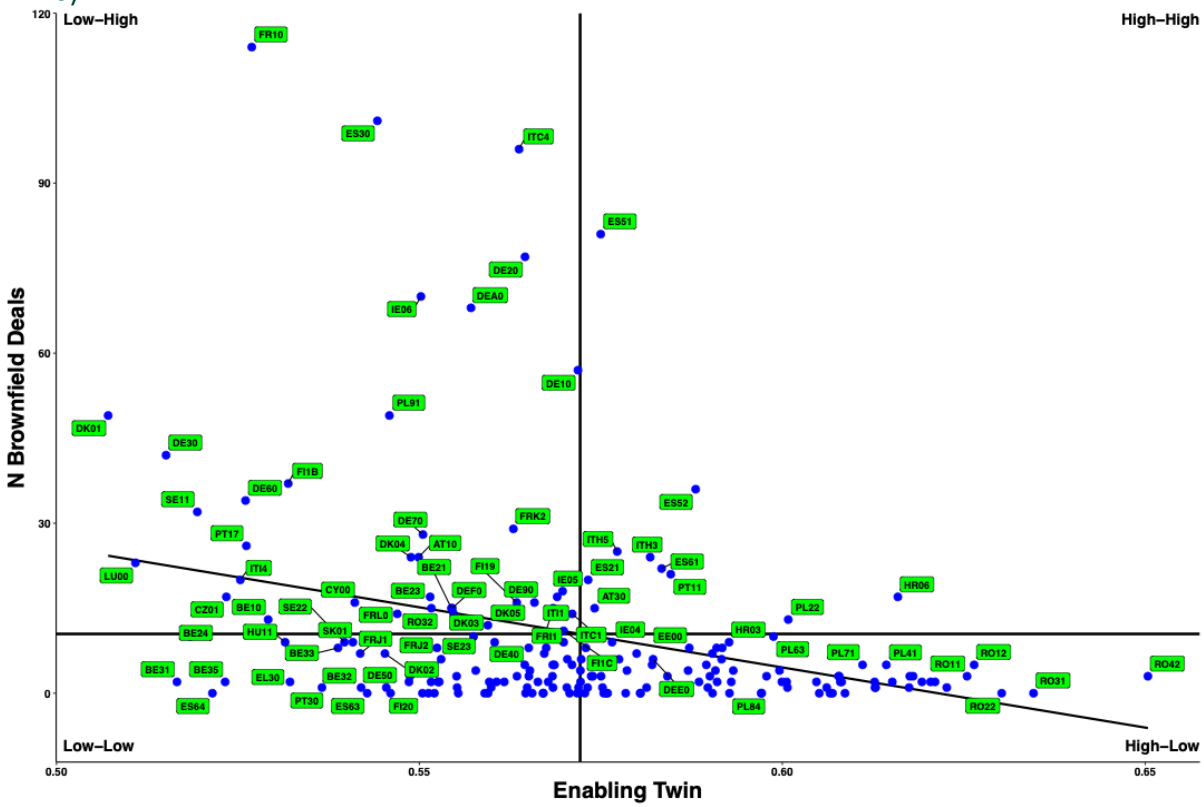

Figure 15 - The relation between the endowment of twin-enabling skills and the number of brownfield deals in NUTS-2 European regions in 2022.

Table A1 4 shows the top five countries regarding the percentage of NUTS-2 regions for each quadrant. In the High-High quadrant, the countries with the highest share are those from Western Europe, even if the absolute numbers are pretty low, meaning there are very few

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

NUTS-2 regions in this quadrant. The countries in the High-High quadrant are: Austria (AT), Croatia (HR), Spain (ES), Portugal (PT) and Italy (IT). Countries with the highest share of NUTS-2 regions in the High-Low quadrant are from Eastern Europe: Poland (PL), the Czech Republic (CZ), Hungary (HU), Romania (RO) and Slovakia (SK). The countries with the highest share of NUTS-2 regions in the Low-Low quadrant are mainly from Western Europe: Sweden (SE), Belgium (BE), Greece (EL), France (FR) and Lithuania (LT). The countries with the highest share of NUTS-2 regions in the Low-High quadrant are from Western Europe: Denmark (DK), Ireland (IE), Finland (FI), Germany (DE) and Austria (AT). A particular case is Austria (AT), which has 2 NUTS-1 regions (out of 3) with a high level of brownfield deals but only one region with a high level of twin-enabling skills.

Takeaway **#3**
Similarly to the case of green and green-enabling skills, a relevant set of advanced NUTS-2 regions tend to score low in the endowment of twin and twin-enabling skills, while they attract many FDI.

5.2 The export-skills relation

In this subsection, we show the relationship between the amount of exports and the endowment of green, digital and twin skills (including their enabling counterparts) in the NUTS-2 Italian regions.

Figure 16 shows the relationship between the green skills and the total export amount for each NUTS-2 Italian region in 2022. The overall relation between green skills and the total export amount is negative. Similarly to what was observed in the case of the relation between endowment of green skills and FDI (Figure 4 and Figure 5), the regions with a higher amount of exports tend to perform worse in terms of the endowment of green skills. The regions with the highest share of green skills also have few exports. There are no NUTS-2 regions in the High-High quadrant: in Italy, no NUTS-2 regions are characterised by high export and green skills endowment levels. The High-Low quadrant mainly has regions from the South and insular Italy. Particularly, the regions which show a high amount of green skills but a low amount of exports are: Basilicata (ITF5), Molise (ITF2), Calabria (ITF6) and Abruzzo (ITF1). In the Low-Low quadrant, there are NUTS-2 regions from different parts of the country. The ones that show both a particularly low amount of exports and a particularly low amount of green skills are: Valle d'Aosta (ITC2), Liguria (ITC3), Friuli-Venezia Giulia (ITH4) and Marche (ITI3). In the Low-High quadrant showing a low degree of green skills and a high degree of exports, there are NUTS-2 regions from North and Centre Italy, which are the most economically advanced NUTS-2 regions: Lombardy (ITC4), Veneto (ITH3), Emilia-Romagna (ITH5) and Piedmont (ITC1). Overall, Figure 16 shows that the country's most economically advanced NUTS-2 regions tend to have a high amount of exports but a low share of green skills. Whereas, less economically advanced NUTS-2 regions tend to have a high share of green skills but a low amount of exports.

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

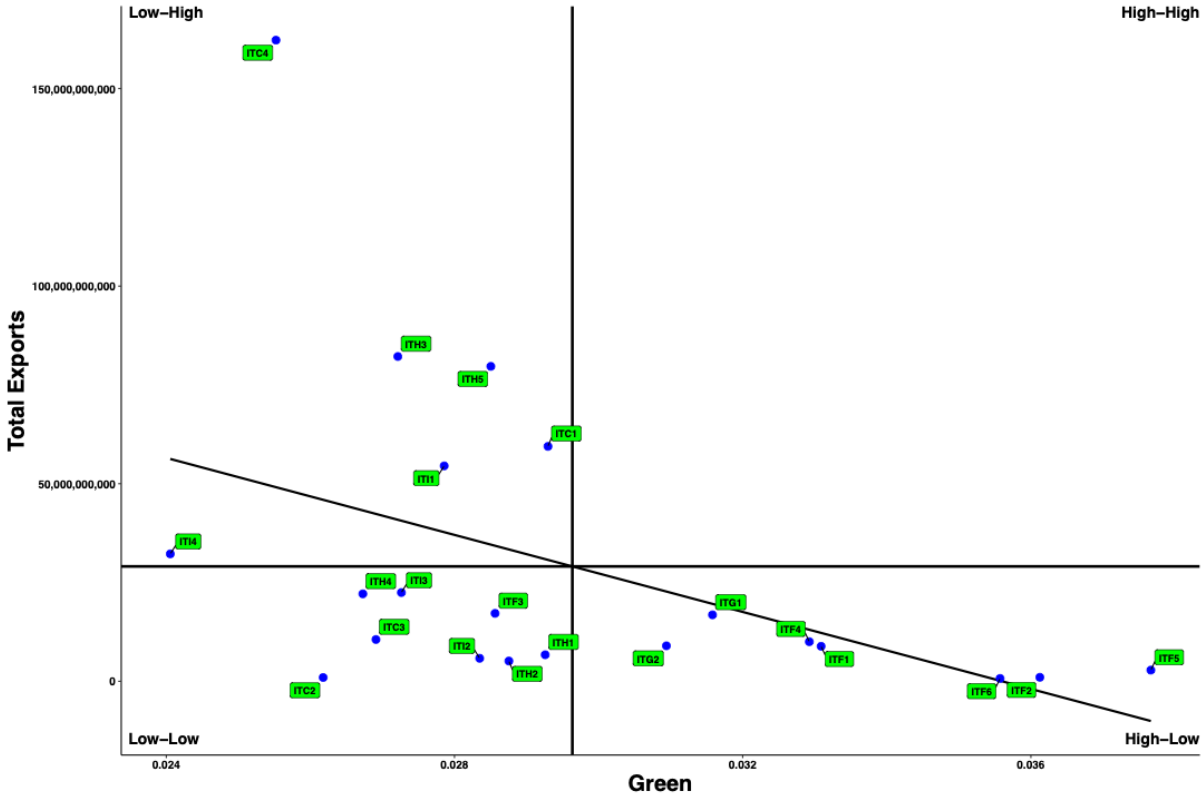

Figure 16 - The relation between the endowment of green skills and the total exports in NUTS-2 Italian regions in 2022.

Figure 17 shows the relation between the endowment of green-enabling skills and the total exports in NUTS-2 Italian regions in 2022. Generally, there is a slightly positive relationship between the capacity to have competences that link the green domain with broader applications and the amount of exports. The NUTS-2 regions belonging to the High-High quadrant, showing both a high level of green-enabling skills and a high level of exports, are some regions from North and Central Italy. Those NUTS-2 regions are: Veneto (ITH3), Emilia-Romagna (ITH5), Piedmont (ITC1) and Tuscany (ITI1). The regions showing a high level of share of enabling skills and a low level of exports belonging to the category High-Low are from different areas of Italy. Some examples are: Marche (ITI3), Abruzzo (ITF1), Umbria (ITI2) and Apulia (ITF4). The same is the case of the NUTS-2 regions located in the Low-Low quadrant, some examples are: Sicily (ITG1), Province of Bolzano (ITH1), Valle d'Aosta (ITC2) and Liguria (ITC3). In the Low-High quadrant, there are only two NUTS-2 regions representing the capital region and one of the most economically developed regions of the country: Lazio (ITI4) and Lombardy (ITC4).

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

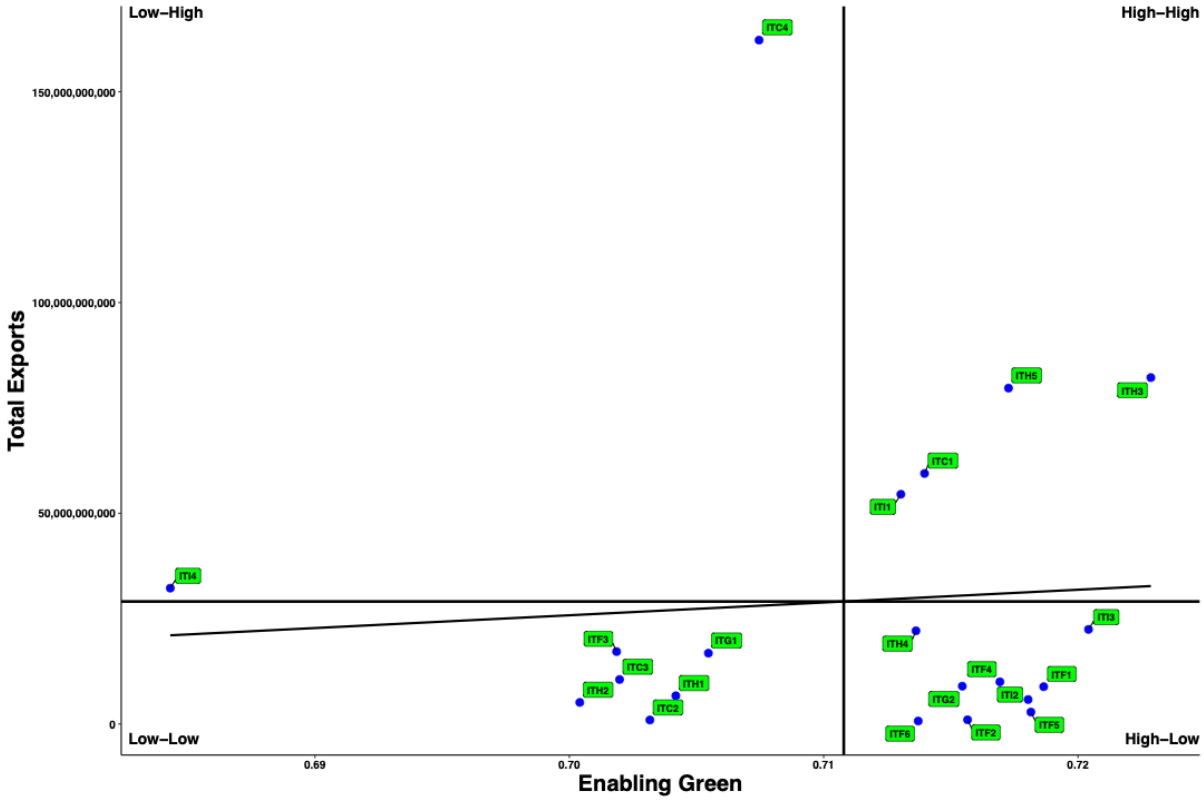

Figure 17 - The relation between the endowment of green-enabling skills and the total exports in NUTS-2 Italian regions in 2022.

Figure 18 shows the relation between the total exports for each NUTS-2 Italian region and the endowment of digital skills. In this case, unlike what was shown in Figure 16 with the case of green skills, the regions with the highest amount of exports are also the regions that can embed digital skills to a higher extent. There is a general positive relationship between the amount of exports and the embeddedness of digital skills in the Italian NUTS-2 regions. In the High-High quadrant, there are mainly regions from Northern Italy and the Centre. Some examples of those NUTS-2 regions are: Lombardy (ITC4), Veneto (ITH3), Emilia-Romagna (ITH5) and Tuscany (ITI1). A particular case is that of Lazio (ITI4), showing a very large share of digital skills and a slightly above-average amount of exports. Some other NUTS-2 regions from the North and the Centre of Italy are in the High-Low quadrant. Those NUTS-2 regions showing above-average digital skills and below-average amounts of export are: Marche (ITI3), Province of Trento (ITH2), Friuli-Venezia Giulia (ITH4) and Liguria (ITC3). The NUTS-2 regions which have below-average digital skills and below-average exports are mainly from the Southern part of Italy: Campania (ITF3), Abruzzo (ITF1), Basilicata (ITF5) and Sicily (ITG1).

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

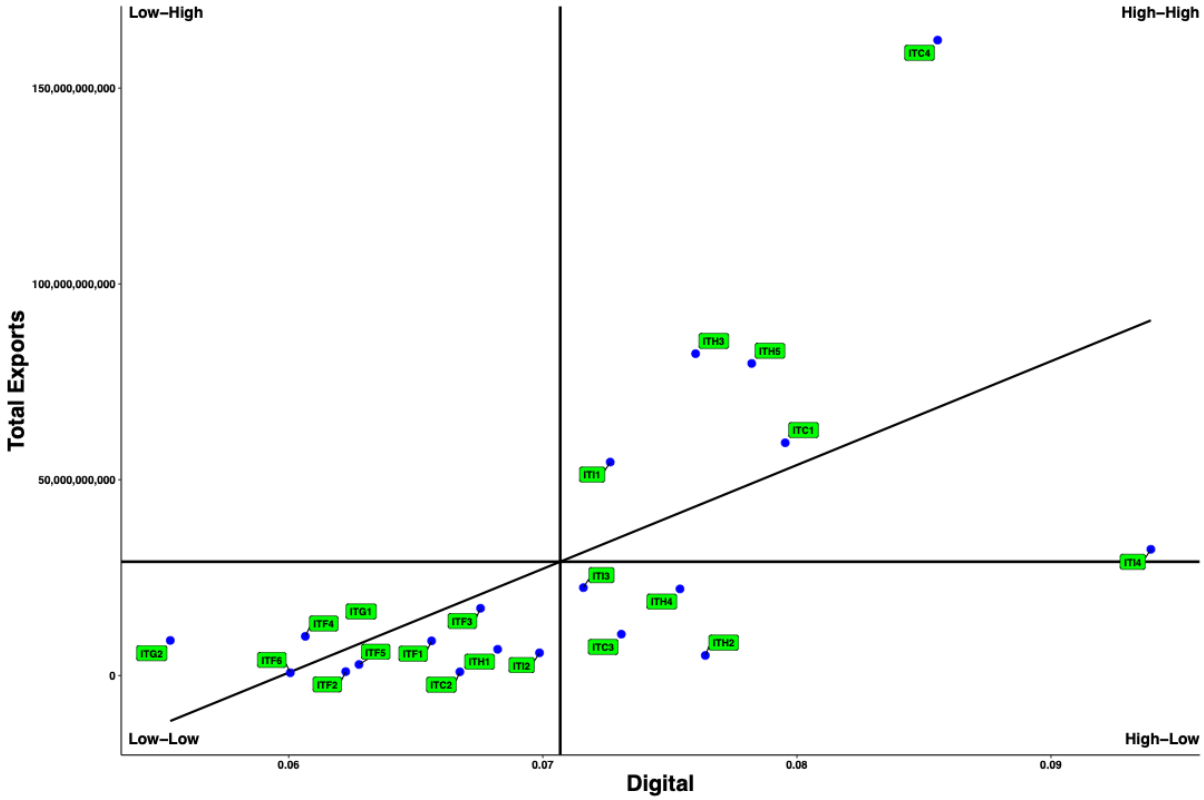

Figure 18 - The relation between the endowment of digital skills and the total exports in NUTS-2 Italian regions in 2022.

Figure 19 shows the relation between the endowment of digital-enabling skills and the total exports in NUTS-2 Italian regions in 2022. The relation between those two variables is still positive, but not as high as in the case of the digital skills. This result means that the top exporting regions are somehow characterised by the capacity to link digital competences with wider skills, potentially to further progress in the digital transition. The NUTS-2 regions in the High-High quadrant are mainly from the Northern and Central part of Italy, like Lombardy (ITC4), Veneto (ITH3), Emilia-Romagna (ITH5) and Piedmont (ITC1). The NUTS-2 regions in the High-Low quadrant are mainly in the Northern and Central regions of Italy; these regions are: Marche (ITI3), Friuli-Venezia Giulia (ITH4), Abruzzo (ITF1) and Umbria (ITI2). In the Low-Low quadrant, there are the rest of the NUTS-2 regions like: Apulia (ITF4), Sardinia (ITG2), Province of Trento (ITH2) and Basilicata (ITF5). The only region present in the Low-High quadrant is Lazio (ITI4).

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

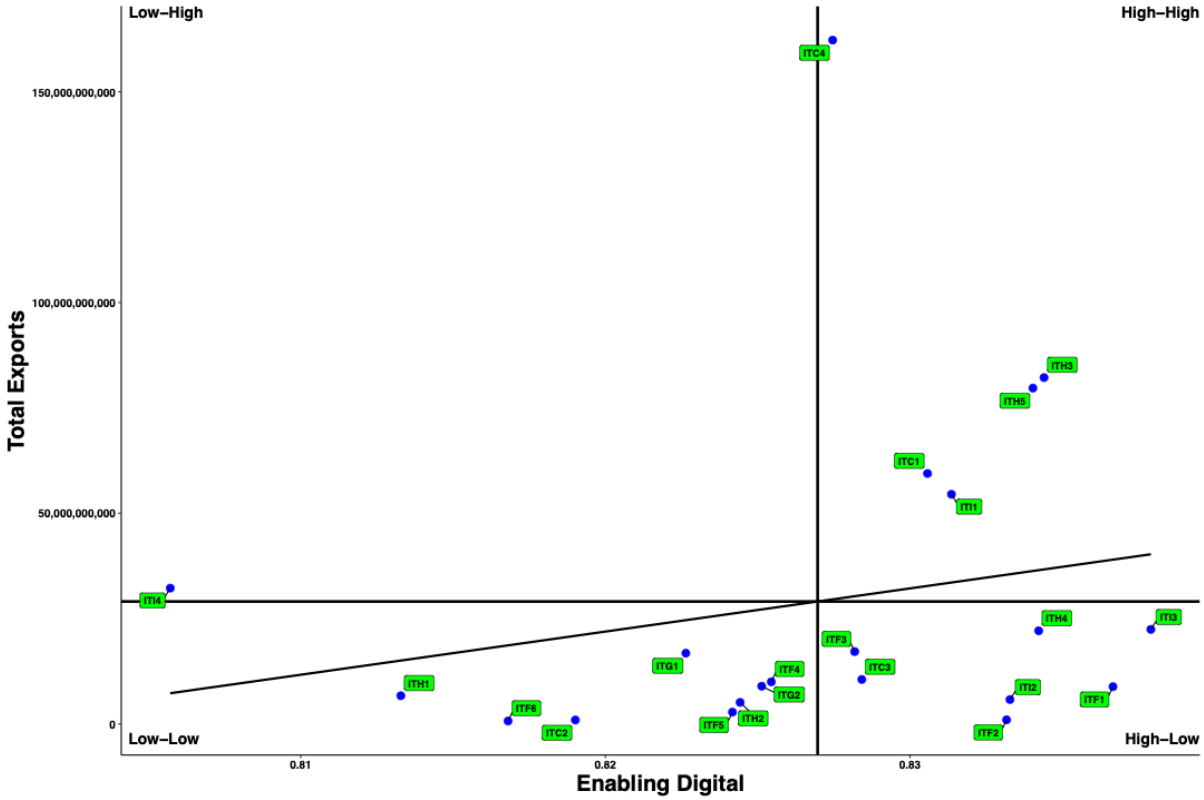

Figure 19 - The relation between the endowment of digital-enabling skills and the total exports in NUTS-2 Italian regions in 2022.

Figure 20 shows the relationship between the amount of exports and the endowment of twin skills in Italian regions in 2022. In general, a slightly positive relationship is present, which means that the NUTS-2 regions with higher exports also tend to embed twin skills to a larger extent. The NUTS-2 regions in the High-High quadrant are from North or Central Italy. Those NUTS-2 regions are: Veneto (ITH3), Emilia-Romagna (ITH5), Piedmont (ITC1) and Tuscany (ITI1). The NUTS-2 regions in the High-Low quadrant, showing a high level of twin skills but a low level of exports, are the ones mainly from Southern Italy: Abruzzo (ITF1), Molise (ITF2), Campania (ITF3) and Basilicata (ITF5). The regions in the Low-Low quadrant are from Northern Italy and Insular Italy, like Friuli-Venezia Giulia (ITH4), Sicily (ITG1), Liguria (ITC3) and Province of Trento (ITH2). Similarly to the case of green-enabling skills, the only two NUTS-2 regions in the Low-High quadrant are the capital region and one among the most economically advanced regions: Lombardy (ITC4) and Lazio (ITI4).

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

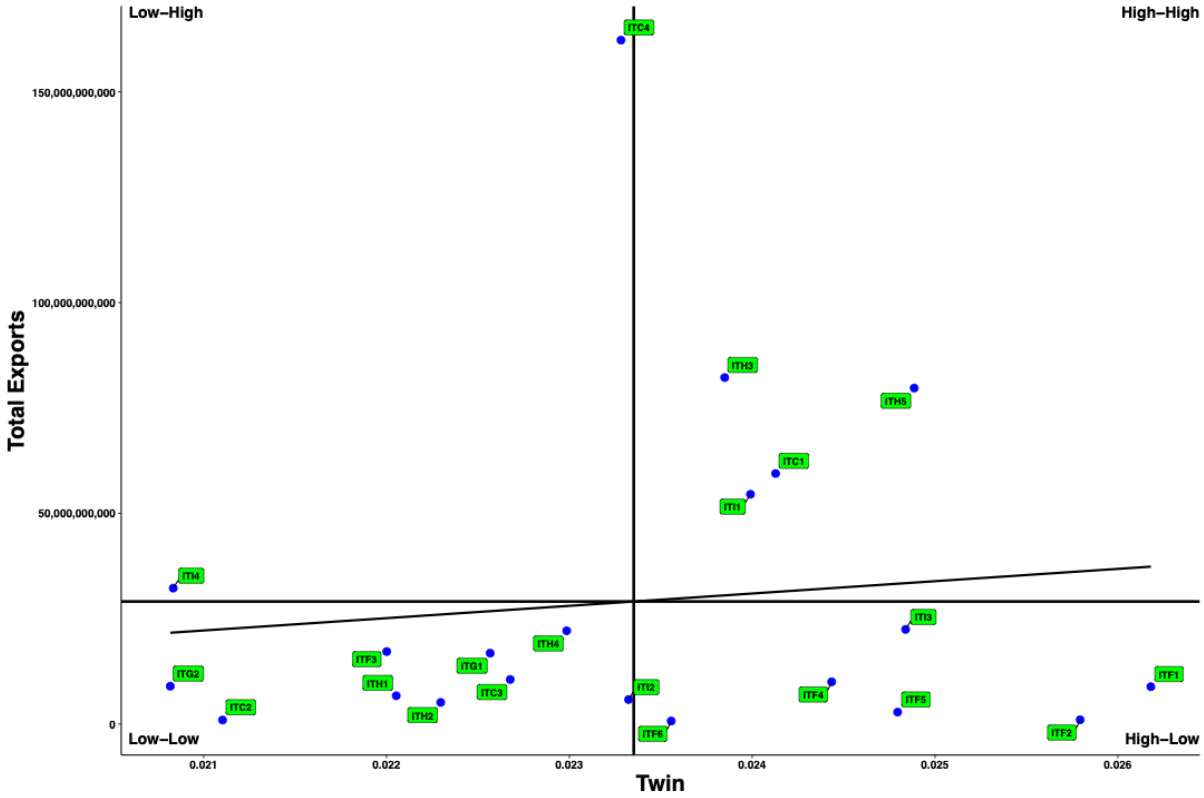

Figure 20 - The relation between the endowment of twin skills and the total exports in NUTS-2 Italian regions in 2022.

Figure 21 shows the relationship between the endowment of twin-enabling skills and the amount of exports in Italian regions for 2022. The general relation of the two variables is slightly positive, which means that the NUTS-2 regions with a higher amount of exports can also embed twin-enabling skills to a higher extent. In the High-High quadrant, there are NUTS-2 regions from North and Centre Italy: Veneto (ITH3), Emilia-Romagna (ITH5), Piedmont (ITC1) and Tuscany (ITI1). The NUTS-2 regions with a high level of twin skills but low exports are from either the Centre or South Italy. Some examples of those NUTS-2 regions are: Marche (ITI3), Abruzzo (ITF1), Umbria (ITI2) and Apulia (ITF4). In the Low-Low quadrant, there are many NUTS-2 regions scattered around Italy; these regions are: Calabria (ITF6), Sardinia (ITG2), Campania (ITF3) and Liguria (ITC3). In the Low-High quadrant, there are only two regions, and as in Figure 20, those are: Lazio (ITI4) and Lombardy (ITC4).

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

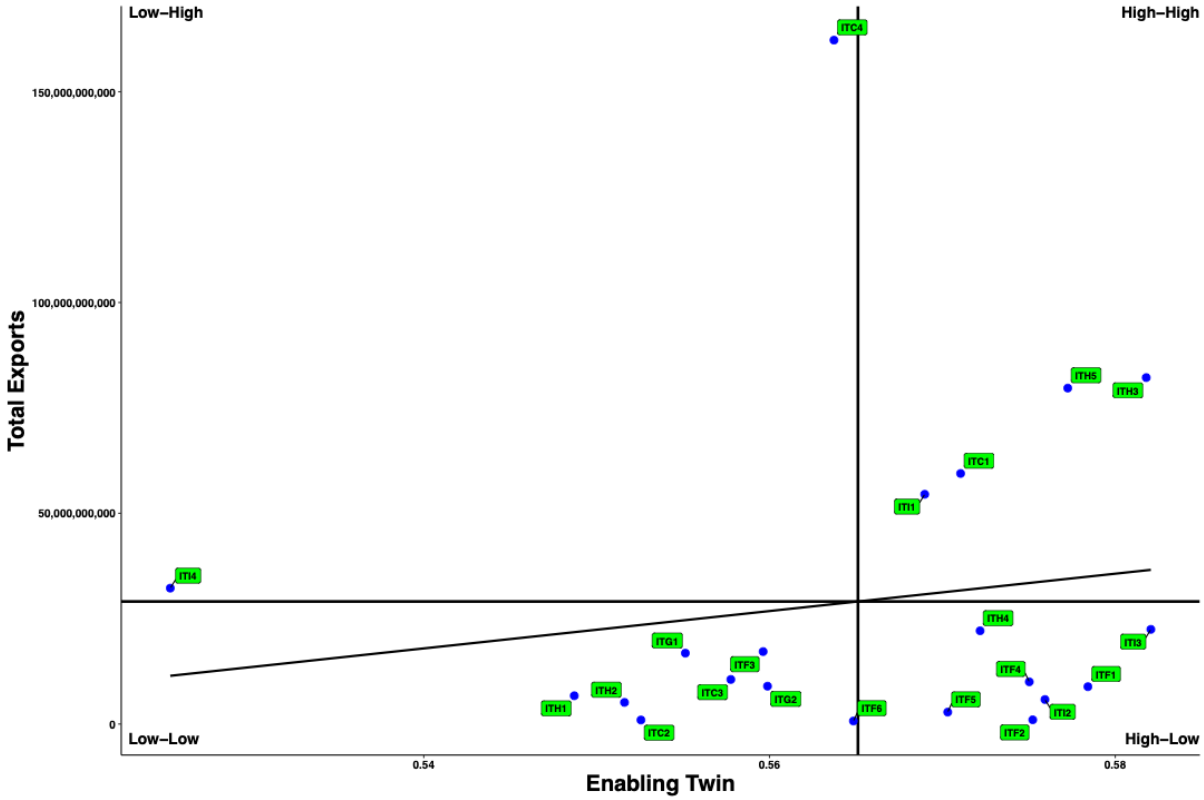

Figure 21 - The relation between the endowment of twin-enabling skills and the total exports in NUTS-2 Italian regions in 2022.

Takeaway	**#4**
Economically advanced areas are those that combine high export performance and high endowment of skills, if digital ones are considered.	

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

6 Econometric analysis

6.1 Empirical model and descriptive statistics

We run two sets of empirical analyses, considering the FDI and the exports, respectively. The first group of estimation considers the number of greenfield projects and brownfield deals targeting each NUTS-2 region as the main dependent variables. Meanwhile, the endowment of green and green-enabling, digital and digital-enabling, and twin and twin-enabling skills are the main independent variables. Given the count nature of the dependent variable, we employ a Poisson pseudo-maximum likelihood regression with region and time fixed effects.

The estimated equation is the following:

$$FDI_{it} = \alpha + \beta Skill_{it} + \gamma EnablingSkill_{it} + \delta Controls_{it} + \eta_i + \theta_t + \varepsilon$$

Where FDI_{it} is the number of either greenfield projects or deals coming to region i in the year t, $Skill_{it}$ is either the green, digital or twin skill endowment for each NUTS-2 region i. $EnablingSkill_{it}$ are either the green-enabling, digital-enabling or twin-enabling skills endowment for each NUTS-2 region i. $Controls_{it}$ include the NUTS-2 regional working population, the NUTS-2 regional GDP per inhabitant and the NUTS-2 regional share of working population with tertiary education. Fixed effects η_i and θ_t control for region- and year-specific shocks, respectively. Standard errors are clustered at the NUTS-2 regional level. Table 3 reports the summary statistics of the sample used in this analysis. The number of deals ranges between 0 and 133, with an average number of 10. Greenfield investments vary between 0 and 526, with an average of 15 projects.

Table 3 - Summary statistics – FDI model.

Variable	Obs	Mean	Std. Dev.	Min	Max
No. of deals	935	9.992513	18.01519	0	133
No. of greenfield projects	935	14.82995	31.09197	0	526
Green skills	935	0.032711	0.009826	0.020013	0.110465
Digital skills	935	0.067894	0.014611	0.031282	0.119808
Twin skills	935	0.025211	0.003146	0.014446	0.039678
Green-enabling skills	935	0.720898	0.023826	0.658628	0.780556
Digital-enabling skills	935	0.834826	0.013067	0.792866	0.860409
Twin-enabling skills	935	0.575119	0.027014	0.503216	0.652807
Population (thousands)	935	1413.85	1544.014	16.3	11670.8
GDP per capita (euro)	935	29451.27	12593.94	0	96700
Tertiary education (share)	935	0.409790	0.124688	0.140138	0.781080
Patents (log)	935	2.934376	2.043842	0	8.669362

The second empirical analysis considers the amount of export of each Italian NUTS-2 region as the main dependent variable. The endowment of green, digital and twin skills and the endowment of green-enabling, digital-enabling, and twin-enabling skills are the main independent variables. A linear regression is run based on the following equation:

$$Export_{it} = \alpha + \beta Skill_{it} + \gamma EnablingSkill_{it} + \delta Controls_{it} + \theta_t + \eta_i + \varepsilon$$

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

Where $Export_{it}$ is the amount in Euros of the export by region i in the year t, $Skill_{it}$ and $EnablingSkill_{it}$ are either green, digital or twin skill and enabling skill endowment of region i. $Controls_{it}$ include the regional working population, the regional GDP per inhabitant and the regional share of the working population with tertiary education. Fixed effects η_i and θ_t control for region- and year-specific shocks, respectively.[12] Given the limited number of observations (21 regions) and time period (5 years), the variation upon which coefficients are estimated may be limited in case of a fixed-effect estimation. Therefore, we also present a set of results emerging from a pooled OLS approach with time fixed effects. Table 4 reports the summary statistics of the sample used in the analysis considering the Italian export.

Table 4 - Summary statistics – Export model.

Variable	Obs.	Mean	Std. Dev.	Min	Max
Export (log) (Euros)	105	22.98484	1.476198	19.83512	25.8124
Green skills	105	0.029516	0.003598	0.023427	0.03809
Digital skills	105	0.068896	0.008618	0.05412	0.09393
Twin skills	105	0.023292	0.001578	0.019773	0.026576
Green-enabling skills	105	0.711218	0.009355	0.683354	0.72738
Digital-enabling skills	105	0.828014	0.007728	0.805717	0.839853
Twin-enabling skills	105	0.566295	0.013835	0.524492	0.588513
Population (thousands)	105	1797.7	1581.386	77.1	6350.9
GDP per capita (euro)	105	30492.38	8879.121	16700	58300
Tertiary education (share)	105	0.292090	0.035660	0.199048	0.388109
Patents (log)	105	3.385357	2.031299	0	7.302665

6.2 Results

Our insights extend beyond the descriptive and mapping evidence provided in the previous section. In particular, we offer an econometric analysis to investigate in detail how green, digital and twin skills, together with their enabling complements, attract FDI in European regions and trigger export performance in Italian NUTS-2 areas.

Starting from the analysis of the FDI attractiveness, we employ three main models focusing, respectively, on green, digital and twin skills, together with their enabling counterparts. The results are reported in Tables 5, 6 and 7. These three sets of estimations employ the number of mergers and acquisitions deals and greenfield investments as dependent variables (Columns 1 and 2, respectively).

Starting from Table 5, we should notice that the economic development of the region and its technological base, captured by the GDP per capita and the log-transformed number of patents, increase the attractiveness of FDI in the form of greenfield investments. Interestingly, the number of deals depends less on regional features and is possibly more directly related to the characteristics of targeted companies. In addition, the general endowment of high-skilled

[12] Given the small number of observations (21 Italian regions) in the panel (below the usual threshold of 50), we decide not to cluster standard errors at the regional level.

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

workers – captured by the share of workers with a tertiary degree - does not affect the FDI attractiveness of the region, contrary to our focal skills variables. In fact, the green-skill orientation exerts an effect in attracting FDI, but with interesting nuances. While green skills *per se* are associated with a lower number of projects and are non-significantly (albeit negatively) related to the number of deals, green-enabling skills correlates with a higher number of greenfield FDI and deals. The contrasting effect is not entirely surprising, though. A focus on purely green capabilities may not be that attractive for foreign investors. Allegedly, some of these skills are associated with remediating negative environmental externalities and could support efforts to fight the climate crisis. While they may be driven by, or consistent with, policy and regulations, they can also pose a burden to economic activities and reduce the attractiveness for profit-seeking investors. The latter are instead much more attracted by the availability of green-enabling skills. These allow for the connection of green competences with broader and wider economic activities, associated with tasks that are not necessarily oriented towards environmental sustainability. It should be noted that the large magnitude of the coefficients is associated with the scale of the variable that (theoretically and by definition) varies between 0 and 1. The two extremes capture situations in which: no worker has any focal skill (green or green-enabling in this case), or, on the contrary, all workers possess only skills of the focal types (e.g. the entire employment of the region is characterised by totally green-skilled workers). Although it is not the scope of our correlational analysis, to provide a more meaningful interpretation, one may more reasonably look at the estimated effect of a standard deviation (SD) increase. For instance, in the case of the number of greenfield FDI, an SD increase in the green-enabling skills would lead to a great, more than two-fold surge of foreign investment projects. This would not be independent, given the skill co-occurrences, to the reduction of inward of about 22% in the number of greenfield FDI, associated with an SD increase in green skills.

Table 5 – PPLM regression results: inward FDI and the endowment of green skills.

	No. of deals	No. of greenfield projects
Green skills	-29.66	-22.54*
	(19.73)	(12.74)
Green-enabling skills	12.79**	36.83***
	(5.766)	(12.62)
Population (thousands)	0.000373	0.00202
	(0.000638)	(0.00139)
GDP per capita (euro)	0.00000327	0.0000153***
	(0.00000239)	(0.00000395)
Tertiary education (share)	0.353	2.977
	(2.238)	(2.806)
Patents (log)	0.00602	0.147**
	(0.0867)	(0.0642)
Constant	-6.542	-31.35***
	(4.051)	(11.97)
N	855	900
Pseudo R²	0.8074	0.7726

Clustered standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6 focuses on the effect of digital and digital-enabling skills in attracting FDI. Unlike the case of green skills with the number of greenfield FDI, a significant and negative relation between digital skills and the number of greenfield projects is not in place, possibly due to the

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

absence of a clash between profit-seeking strategies and digitalisation. Once again, it is only the capacity to connect focused skills with broader applications, through digital-enabling competences, that attracts investments. Such a result resonates with the general-purpose nature of digitalisation, also in its recent forms (Cockburn et al., 2018). With the above-spelled caveat, we can notice a sharp increase in the number of deals coming from the digital-enabling skills endowment. An SD increase would lead to a more than 80% rise in the number of mergers and acquisitions. Surprisingly, it appears that digitalisation does not influence the decision to start up a new facility abroad, possibly in line with the highly codifiable and thus easy-to-travel nature of knowledge associated with digitalisation. This would translate into the possible reliance on digitalisation-related skills available in home countries.

Table 6 - PPLM regression results: inward FDI and the endowment of digital skills.

	No. of deals	No. of greenfield projects
Digital skills	0.775	-9.167
	(13.84)	(23.00)
Digital-enabling skills	48.11***	5.730
	(13.35)	(14.10)
Population (thousands)	0.000453	0.00292
	(0.000552)	(0.00186)
GDP per capita (euro)	0.00000837*	0.0000168***
	(0.00000487)	(0.00000568)
Tertiary education (share)	-1.065	-1.776
	(2.235)	(3.425)
Patents (log)	-0.0262	0.178**
	(0.0663)	(0.0785)
Constant	-38.05***	-10.77
	(10.45)	(12.54)
N	855	900
Pseudo R²	0.8099	0.7665

Clustered standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7 focuses on the results pertaining to twin and twin-enabling skills. Once again, the most important driver of FDI attractiveness is the availability of enabling skills, which is likely to be associated with the capacity to connect twin competences with broader operations and activities. In the case of twin-enabling skills, a positive relation is in place both in the case of the number of deals and greenfield investments. Again, such a relation appears sizeable, an SD increase in greenfield projects, for instance, leads to an almost threefold increase in the number of projects. The negative effect of purely focused skills somehow vanishes compared to what emerged in Table 5, possibly considering the mixed green-digital nature of these competences, which attenuates the distance from profit-seeking applications.

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

Table 7 - PPLM regression results: inward FDI and the endowment of twin skills.

	No. of deals	No. of greenfield projects
Twin skills	-67.77	-83.97
	(49.68)	(70.79)
Twin-enabling skills	18.01**	50.22***
	(8.325)	(14.70)
Population (thousands)	0.000312	0.00190
	(0.000605)	(0.00134)
GDP per capita (euro)	0.00000444	0.0000173***
	(0.00000276)	(0.00000428)
Tertiary education (share)	0.827	3.281
	(2.128)	(2.571)
Patents (log)	0.0195	0.144**
	(0.0840)	(0.0587)
Constant	-6.867	-31.96***
	(4.297)	(10.46)
N	855	900
Pseudo R^2	0.8076	0.7758

Clustered standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Takeaway **#5**
There is a positive link between enabling skills and inward FDI, with no evidence that digital or twin skills *per se* are related to inward FDI attractiveness. On the contrary, green skills are negatively associated with greenfield FDI attractiveness.

We can now turn our attention to the relation between exports and skills in the green, digital and twin transitions (Table 8). We are focusing on a rather limited number of observations (amounting to the Italian regions only) and for a relatively short period of time. Hence, the variation in both the dependent and the key regressors may be limited: a within estimator would have a limited amount of variation to exploit. Given this circumstance, we also present pooled OLS estimations. Both in the case of OLS and fixed effect estimation, we cannot employ clustered standard errors due to the number of groups (i.e. 21), which is below the "30-50" rule of thumb. Starting from pooled OLS estimation, we observe a negative relation between exports and green skills, while a positive association is in place if we focus on green-enabling skills. Purely green skills do not increase exports; in fact, they reduce them. Such skills may be directly related to environmental externality remediation or environmental regulation compliance. These kinds of skills are associated with activities that may represent a net cost and a consequent loss of competitiveness for the firm's export profile. On the contrary, it is the merger between green skills and other types of competences that allows for the operationalisation of the former and the match of environmental and non-environmental objectives (including productivity-oriented ones). Only these enabling skills appear to trigger international competitiveness: a result which is consistent with the evidence provided by Antonietti & Marzucchi (2014). Such a trade-off between focal and enabling skills is not in place for digital skills, which appear to be positively connected with export, possibly due to the likely productivity-enhancing effects. Twin skills and their enabling counterpart do not show any significant relationship. It is worth mentioning that the inclusion of fixed effects (Table 8 Column 1-3-5) makes all significant relations disappear. The caveat mentioned above, related

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

to the limited number of observations and variation, should be considered when focusing on these final results, which we trat with caution.

Table 8 – Regression results: exports and skills.

	Green skills		Digital skills		Twin skills	
	Fixed Effect	**Pooled OLS**	**Fixed Effect**	**Pooled OLS**	**Fixed Effect**	**Pooled OLS**
	Export					
Skills	26.99	-70.44**	-8.662	75.87***	-1.507	29.89
	(26.06)	(33.55)	(13.85)	(16.85)	(46.26)	(96.87)
Enabling skills	-6.643	37.05***	-11.83	39.34***	0.397	10.96
	(11.06)	(10.15)	(14.33)	(11.06)	(9.701)	(10.94)
Population	-0.000601	0.000375***	-0.000680	0.000358***	-0.000710	0.000342***
	(0.000768)	(0.0000849)	(0.000761)	(0.0000697)	(0.000810)	(0.0000847)
Gdp per capita	-0.00000148	0.0000136	-0.00000477	-0.0000402***	-0.00000470	0.0000110
	(0.0000148)	(0.0000169)	(0.0000154)	(0.0000142)	(0.0000150)	(0.0000174)
Tertiary education	-2.623	0.344	-2.186	-11.77***	-3.586	-1.206
	(3.729)	(2.524)	(3.473)	(2.980)	(3.681)	(2.275)
Patents	-0.0617*	0.423***	-0.0679*	0.307***	-0.0644*	0.539***
	(0.0356)	(0.127)	(0.0378)	(0.115)	(0.0385)	(0.122)
Year FE	yes	yes	yes	yes	yes	yes
Nuts 2 FE	yes	no	yes	no	yes	no
N	105	105	105	105	105	105
R^2	0.996	0.814	0.996	0.851	0.996	0.797

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Takeaway **#6**

While there are some concerns about the stability of the results, in the case of exports, enabling skills appear to be more relevant. In contrast, digital skills (*per se*) and twin skills do not seem to play any significant role. Green skills (*per se*) might even be detrimental to international competitiveness.

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

7 Conclusions

In this report, we have analysed the complex interplay between the level of international openness of European regions (NUTS-2) and locally embedded green, digital and twin skills. We considered regional international openness regarding both FDI and trade linkages, thus providing a broad analysis of different extra-local ties and their connection with localised twin skills. This is an important research objective for policy purposes to understand whether and how the twin transformation of the European labour force is accompanied by a distinctive participation in global markets through flows of capital, goods and services. Very scant academic effort has focused on the possible links between evolving regional labour markets in terms of skill acquisition in the green and/or digital domains and the capacity of an economy to engage with international markets and agents; this appears even more the case concerning regional economies across countries, for which it is particularly problematic to collect and compile reliable, harmonised and time-varying data on twin skills, FDI and exports.

To support our analysis theoretically, we have formulated an original conceptual framework linking the emerging literature on green, digital and twin transitions with more traditional perspectives in international business studies and economic geography, emphasising the joint role of location, strategic assets, and regional competitiveness as crucial elements leading to a region's exposure to global markets through inward FDI and exporting. In this context, we conceptualised green, digital and twin skills as regional assets that potentially provide an opportunity for attracting the operations of foreign firms (i.e. multinationals), either through greenfield projects and M&A, or as a facilitator of regional exporting. By attracting FDI and increasing exports, lagging behind regions could close the gap with more advanced regions in terms of their openness to international trade. However, on the other side, complex green and digital skills might only be available in the highly economically advanced locations. The risk is that economically advanced regions would widen the gap with the less economically advanced ones.

From the empirical standpoint, we combined a wide array of data, including ESCO, LFS, Orbis Crossborder, EPO, OECD statistics and Eurostat to construct an original and comprehensive database for EU regions, their green, digital and twin skills, their inward FDI and other regional characteristics. Concerning the analysis of exports, we focused on the case of Italian regions, due to a lack of harmonised regional export data for the rest of the EU. Besides green, digital and twin skills, we were also able to consider different sets of green-, digital- and twin-related enabling skills, that is: skills associated with the capacity to connect green, digital and twin competences with a broader set of activities, tasks and operations in a region. Hence, these enabling skills can act as connectors for more narrowly green, digital or twin skills and integrate them in broader sets of occupational and task contexts.

On these premises, we provided a rich set of descriptive outputs pointing to the uneven geography of inward FDI in European regions as well as unequal capacity of regions to engage in exporting operations. This evidence suggests that establishing and retaining these typologies of extra-regional connections may be subject to structural differences across space. In particular, we found striking differences in the endowment of green and digital skills in relation

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

to FDI for different NUTS-2 regions. A relevant set of economically advanced NUTS-2 regions, which tend to have a high amount of FDI, score low in the endowment of green and enabling-green skills. Meanwhile, many NUTS-2 regions that are not at the core of the European economic development show a low amount of FDI and tend to have a high level of green and green-enabling skills. This resonates well with the better representation that ESCO data offer of low-skilled green occupations, compared to the US-based ONET, which tends to represent mainly high-skilled green occupations (Maldonado et al., 2024; Landini et al., 2025). Instead, in the case of digital skills, many economically advanced NUTS-2 EU regions are characterised by high levels of digital skills and inward FDI. Similarly to the case of green and green-enabling skills, a relevant set of economically advanced NUTS-2 regions tend to score low in the endowment of twin and twin-enabling skills, while they attract many FDI. Regarding exports, we find that the most economically advanced NUTS-2 regions of Italy score high in both export and skills when digital ones are considered.

These profound regional differences in inward FDI and export offer a mixed picture of unconditional correlations with green, digital and twin skills, suggesting that a more encompassing methodological approach that accounts for confounding factors should be implemented. Hence, for the case of FDI, we estimated PPML models with regional and time fixed effects, next to a vector of control variables. For the case of exports, we estimated a fixed effect model together with pooled OLS, using the same vector of control variables. The results of our estimations provided various key takeaways. First, we observe a strong positive link between enabling skills and inward FDI. This suggests that these competence connectors act as triggers to facilitate regional participation in the global arena. We find no evidence that digital or twin skills *per se* are related to inward FDI attractiveness. On the contrary, green skills are negatively associated with greenfield FDI attractiveness. We contend that green skills may be driven by, or consistent with, policy and regulations, but relate to tasks that can either be a net cost or a burden to the attractiveness of profit-seeking investors. Regarding our results on exports, while there are some concerns about the stability of the results, enabling skills seem to be more relevant. In contrast, digital skills (*per se*) and twin skills do not play any significant role. Green skills (*per se*) might even be detrimental to international competitiveness. Once again, we suggest that this result may be explained by the potential cost - and the consequent loss of competitiveness - that tasks purely associated with environmental sustainability may entail.

Taken together, this set of results entails that the green, digital and twin transitions have multifaceted implications in terms of the local-global dynamics associated with inward FDI in regions and local export propensity: while core green, digital and twin skills remain loosely tied up to regional openness (or are even negatively related to the latter, like in the case of green skills), the enabling skills integrating green, digital and twin tasks with other activities play a significant role. While we offer a primer into the different skill-bases of different globalisation patterns and modes of entry (greenfield vs M&A and export) we hope that future research, also with qualitative approaches, further disentangles heterogenous dimensions in the skill groups (within green, digital and twin domains), the role of skill supply and the consequences of globalisation-driven labour market dynamics on inequalities.

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

Appendix I. Country NUTS-2 presence in each quadrant

Table A1 1 - The share of NUTS-2 regions for the different quadrants in the case of greenfield projects and their relation with the embeddedness of Green, Digital and Twin skills for 2022. [13]

Green			
Country	N Reg	N Tot Reg	Share
High-High			
PL	11	17	0,65
RO	4	8	0,5
IE	1	3	0,33
HR	1	4	0,25
ES	1	19	0,05
FR	1	22	0,05
High-Low			
EL	11	13	0,85
HU	6	8	0,75
LT	1	2	0,5
PT	3	7	0,43
RO	3	8	0,38
Low-Low			
SK	4	4	1
BE	10	11	0,91
DK	4	5	0,8
CZ	6	8	0,75
IT	15	21	0,71
Low-High			
PT	3	7	0,43
AT	1	3	0,33
IE	1	3	0,33
DE	5	16	0,31
HR	1	4	0,25
SE	2	8	0,25

Digital			
Country	N Reg	N Tot Reg	Share
High-High			
AT	1	3	0,33
IE	1	3	0,33
DE	5	16	0,31
PL	5	17	0,29
PT	2	7	0,29
High-Low			
BE	9	11	0,82
SK	3	4	0,75
AT	2	3	0,67
FI	3	5	0,6
DE	9	16	0,56
Low-Low			
EL	12	13	0,92
HU	6	8	0,75
ES	13	19	0,68
FR	14	22	0,64
DK	3	5	0,6
Low-High			
HR	2	4	0,5
RO	4	8	0,5
PL	8	17	0,47
IE	1	3	0,33
ES	3	19	0,16

Twin			
Country	N Reg	N Tot Reg	Share
High-High			
PL	13	17	0,76
HR	2	4	0,5
RO	3	8	0,38
IE	1	3	0,33
FI	1	5	0,2
High-Low			
LT	2	2	1
CZ	7	8	0,88
HU	7	8	0,88
EL	10	13	0,77
FI	3	5	0,6
Low-Low			
BE	10	11	0,91
IT	18	21	0,86
DK	4	5	0,8
AT	2	3	0,67
DE	10	16	0,63
Low-High			
AT	1	3	0,33
IE	1	3	0,33
PT	2	7	0,29
RO	2	8	0,25
DK	1	5	0,2

[13] For this table and the subsequent ones we have excluded the countries that are formed by just one region, because they would have always scored 1 (100%) in one of the quadrants. Those countries are: Cyprus, Estonia and Luxemburg.

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101132559.

Table A1 2 - The share of NUTS-2 regions for the different quadrants in the case of greenfield projects and their relation with the embeddedness of green-enabling, digital-enabling and twin-enabling skills for 2022.

Green-enabling			
Country	N Reg	N Tot Reg	Share
High-High			
PL	12	17	0,71
HR	2	4	0,5
RO	4	8	0,5
PT	2	7	0,29
ES	4	19	0,21
High-Low			
CZ	7	8	0,88
HU	7	8	0,88
SK	3	4	0,75
AT	2	3	0,67
ES	12	19	0,63
Low-Low			
BE	10	11	0,91
DK	4	5	0,8
SE	6	8	0,75
IT	15	21	0,71
DE	10	16	0,63
Low-High			
IE	2	3	0,67
AT	1	3	0,33
DE	5	16	0,31
SE	2	8	0,25
DK	1	5	0,2

Digital-enabling			
Country	N Reg	N Tot Reg	Share
High-High			
PL	12	17	0,71
IE	2	3	0,67
HR	2	4	0,5
RO	3	8	0,38
PT	2	7	0,29
High-Low			
CZ	7	8	0,88
HU	7	8	0,88
DK	4	5	0,8
FI	4	5	0,8
SE	6	8	0,75
Low-Low			
EL	12	13	0,92
IT	18	21	0,86
AT	2	3	0,67
ES	11	19	0,58
PT	4	7	0,57
Low-High			
AT	1	3	0,33
ES	5	19	0,26
RO	2	8	0,25
DK	1	5	0,2
FI	1	5	0,2

Twin-enabling			
Country	N Reg	N Tot Reg	Share
High-High			
PL	12	17	0,71
HR	2	4	0,5
RO	4	8	0,5
PT	2	7	0,29
ES	3	19	0,16
High-Low			
CZ	7	8	0,88
HU	7	8	0,88
SK	3	4	0,75
AT	2	3	0,67
ES	11	19	0,58
Low-Low			
BE	9	11	0,82
DK	4	5	0,8
FI	4	5	0,8
SE	6	8	0,75
IT	12	21	0,57
Low-High			
IE	2	3	0,67
AT	1	3	0,33
DE	5	16	0,31
SE	2	8	0,25
FR	5	22	0,23

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

Table A1 3 - The share of NUTS-2 regions for the different quadrants in the case of brownfield deals and their relation with the embeddedness of Green, Digital and Twin skills for 2022.

Green			
Country	N Reg	N Tot Reg	Share
High-High			
IE	1	3	0,33
HR	1	4	0,25
ES	1	19	0,05
FR	1	22	0,05
High-Low			
PL	15	17	0,88
RO	7	8	0,88
EL	11	13	0,85
HU	6	8	0,75
LT	1	2	0,5
Low-Low			
SK	4	4	1
CZ	6	8	0,75
BE	8	11	0,73
FR	14	22	0,64
SE	5	8	0,63
Low-High			
DK	4	5	0,8
AT	2	3	0,67
FI	3	5	0,6
DE	8	16	0,5
IE	1	3	0,33

Digital			
Country	N Reg	N Tot Reg	Share
High-High			
AT	2	3	0,67
FI	3	5	0,6
DE	8	16	0,5
DK	2	5	0,4
IE	1	3	0,33
High-Low			
SK	3	4	0,75
BE	7	11	0,64
SE	5	8	0,63
CZ	4	8	0,5
LT	1	2	0,5
Low-Low			
EL	12	13	0,92
RO	7	8	0,88
HU	6	8	0,75
ES	14	19	0,74
PT	5	7	0,71
Low-High			
DK	2	5	0,4
IE	1	3	0,33
HR	1	4	0,25
ES	2	19	0,11
FR	1	22	0,05

Twin			
Country	N Reg	N Tot Reg	Share
High-High			
FI	3	5	0,6
IE	1	3	0,33
HR	1	4	0,25
ES	4	19	0,21
PT	1	7	0,14
High-Low			
HU	8	8	1
LT	2	2	1
CZ	7	8	0,88
PL	14	17	0,82
EL	10	13	0,77
Low-Low			
BE	8	11	0,73
FR	14	22	0,64
IT	13	21	0,62
PT	4	7	0,57
SE	4	8	0,5
Low-High			
DK	4	5	0,8
AT	2	3	0,67
DE	6	16	0,38
IE	1	3	0,33
IT	6	21	0,29

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

Table A1 4 - The share of NUTS-2 regions for the different quadrants in the case of brownfield deals and their relation with the embeddedness of green-enabling, digital-enabling and twin-enabling skills for 2022.

Green-enabling			
Country	N Reg	N Tot Reg	Share
High-High			
FI	2	5	0,4
AT	1	3	0,33
HR	1	4	0,25
ES	4	19	0,21
PT	1	7	0,14
High-Low			
PL	15	17	0,88
CZ	7	8	0,88
HU	7	8	0,88
RO	7	8	0,88
SK	3	4	0,75
Low-Low			
SE	7	8	0,88
BE	8	11	0,73
EL	7	13	0,54
IT	11	21	0,52
LT	1	2	0,5
Low-High			
DK	4	5	0,8
IE	2	3	0,67
DE	8	16	0,5
AT	1	3	0,33
BE	3	11	0,27

Digital-enabling			
Country	N Reg	N Tot Reg	Share
High-High			
IE	2	3	0,67
DK	3	5	0,6
FI	2	5	0,4
DE	5	16	0,31
HR	1	4	0,25
High-Low			
PL	15	17	0,88
CZ	7	8	0,88
HU	7	8	0,88
SE	7	8	0,88
FR	17	22	0,77
Low-Low			
EL	13	13	1
IT	13	21	0,62
ES	11	19	0,58
PT	4	7	0,57
HR	2	4	0,5
Low-High			
AT	2	3	0,67
IT	6	21	0,29
ES	5	19	0,26
DK	1	5	0,2
FI	1	5	0,2

Twin-enabling			
Country	N Reg	N Tot Reg	Share
High-High			
AT	1	3	0,33
HR	1	4	0,25
ES	4	19	0,21
PT	1	7	0,14
IT	2	21	0,1
High-Low			
PL	15	17	0,88
CZ	7	8	0,88
HU	7	8	0,88
RO	7	8	0,88
SK	3	4	0,75
Low-Low			
SE	7	8	0,88
BE	7	11	0,64
EL	8	13	0,62
FR	13	22	0,59
LT	1	2	0,5
Low-High			
DK	4	5	0,8
IE	2	3	0,67
FI	3	5	0,6
DE	8	16	0,5
AT	1	3	0,33

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

8 References

Acemoglu, D., & Autor, D. (2011). Skills, tasks and technologies: Implications for employment and earnings. In *Handbook of Labor Economics* (Vol. 4, pp. 1043-1171). Elsevier.

Alvarez, R., & López, R. A. (2005). Exporting and performance: evidence from Chilean plants. *Canadian Journal of Economics/Revue Canadienne D'économique*, *38*(4), 1384-1400.

Amendolagine, V., Hansen, U. E., Lema, R., Rabellotti, R., & Ribaudo, D. (2023). Do green foreign direct investments increase the innovative capability of MNE subsidiaries?. *World Development*, *170*, 106342.

Antonietti, R., & Marzucchi, A. (2014). Green tangible investment strategies and export performance: A firm-level investigation. *Ecological Economics*, *108*, 150-161.

Arauzo-Carod, J. M., & Viladecans-Marsal, E. (2009). Industrial location at the intra-metropolitan level: The role of agglomeration economies. *Regional Studies*, *43*(4), 545-558.

Ardito, L., Raby, S., Albino, V., & Bertoldi, B. (2021). The duality of digital and environmental orientations in the context of SMEs: Implications for innovation performance. *Journal of Business Research*, *123*, 44-56.

Ascani, A. (2018). The takeover selection decisions of multinational enterprises: empirical evidence from European target firms. *Journal of Economic Geography*, *18*(6), 1227-1252.

Ascani, A., & Prenzel, P. (2023). Economic complexity and the global asset-seeking strategies of Chinese multinationals. *Industry and Innovation*, *30*(5), 556-584.

Autor, D. H., Levy, F., & Murnane, R. J. (2003). The skill content of recent technological change: An empirical exploration. *The Quarterly Journal of Economics*, *118*(4), 1279-1333.

Balland, P. A., Boschma, R., Crespo, J., & Rigby, D. L. (2019). Smart specialization policy in the European Union: relatedness, knowledge complexity and regional diversification. *Regional Studies*, *53*(9), 1252-1268.

Barbieri, N., Marzucchi, A., & Rizzo, U. (2020). Knowledge sources and impacts on subsequent inventions: Do green technologies differ from non-green ones?. *Research Policy*, *49*(2), 103901.

Basilico, S., Marzucchi, A., & Montresor, S. (2024). *Combining digital and green technologies in regions: How to close the gap with respect to the frontier?* (PEEG Discussion Paper No. 2440). Utrecht University, Department of Human Geography and Spatial Planning.

Bernard, A. B., & Jensen, J. B. (1999). Exceptional exporter performance: cause, effect, or both?. *Journal of International Economics*, *47*(1), 1-25.

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

Bijnens, G., Botelho, V., Falck, E., Labhard, V., Lamo, A., Röhe, O., Schroth, J., Sellner, R., & Strobel, J. (2024). *Digitalisation and productivity: A report by the ESCB expert group on productivity, innovation and technological change* (Occasional Paper No. 339). European Central Bank.

Brambilla, I., Lederman, D., & Porto, G. (2012). Exports, export destinations, and skills. *American Economic Review*, *102*(7), 3406-3438.

Cantwell, J., & Hodson, C. (1991). Global R&D and UK competitiveness. In M. Casson (Ed.), *Global Research Strategy and International Competitiveness* (pp. 133–182). Basil Blackwell.

Castellani, D., Marin, G., Montresor, S., & Zanfei, A. (2022). Greenfield foreign direct investments and regional environmental technologies. *Research Policy*, *51*(1), 104405.

Chesbrough, H. W. (2003). *Open innovation: The new imperative for creating and profiting from technology*. Harvard Business Press.

Chidlow, A., Salciuviene, L., & Young, S. (2009). Regional determinants of inward FDI distribution in Poland. *International Business Review*, *18*(2), 119-133.

Ciarli, T., Kenney, M., Massini, S., & Piscitello, L. (2021). Digital technologies, innovation, and skills: Emerging trajectories and challenges. *Research Policy*, *50*(7), 104289.

Cicerone, G., Faggian, A., Montresor, S., & Rentocchini, F. (2023). Regional artificial intelligence and the geography of environmental technologies: does local AI knowledge help regional green-tech specialization?. *Regional Studies*, *57*(2), 330-343.

Cockburn, I. M., Henderson, R., & Stern, S. (2018). The impact of artificial intelligence on innovation: An exploratory analysis. In *The economics of artificial intelligence: An agenda* (pp. 115-146). University of Chicago Press.

Consoli, D., Marin, G., Marzucchi, A., & Vona, F. (2016). Do green jobs differ from non-green jobs in terms of skills and human capital?. *Research Policy*, *45*(5), 1046-1060.

Corradini, C., Morris, D., & Vanino, E. (2023). Towards a regional approach for skills policy. *Regional Studies*, *57*(6), 1043-1054.

Corradini, C., Santini, E., & Vecciolini, C. (2021). The geography of Industry 4.0 technologies across European regions. *Regional Studies*, *55*(10-11), 1667-1680.

Costantini, V., & Mazzanti, M. (2012). On the green and innovative side of trade competitiveness? The impact of environmental policies and innovation on EU exports. *Research Policy*, *41*(1), 132-153.

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

Coughlin, C. C., & Segev, E. (2000). Foreign direct investment in China: a spatial econometric study. *World Economy*, *23*(1).

Cozza, C., Rabellotti, R., & Sanfilippo, M. (2015). The impact of outward FDI on the performance of Chinese firms. *China Economic Review*, *36*, 42-57.

Crescenzi, R., Gagliardi, L., & Iammarino, S. (2015). Foreign multinationals and domestic innovation: Intra-industry effects and firm heterogeneity. *Research Policy*, *44*(3), 596-609.

Crozet, M., Mayer, T., & Mucchielli, J. L. (2004). How do firms agglomerate? A study of FDI in France. *Regional Science and Urban Economics*, *34*(1), 27-54.

De Loecker, J. (2011). Product differentiation, multiproduct firms, and estimating the impact of trade liberalization on productivity. *Econometrica*, *79*(5), 1407-1451.

Delios, A., & Beamish, P. W. (2001). Survival and profitability: The roles of experience and intangible assets in foreign subsidiary performance. *Academy of Management Journal*, *44*(5), 1028-1038.

Devereux, M. P., & Griffith, R. (1998). Taxes and the Location of Production: Evidence from a Panel of US Multinationals. *Journal of Public Economics*, *68*(3), 335-367.

Dhanaraj, C., Lyles, M. A., Steensma, H. K., & Tihanyi, L. (2004). Managing tacit and explicit knowledge transfer in IJVs: the role of relational embeddedness and the impact on performance. *Journal of International Business Studies*, *35*(5), 428-442.

Diodato, D., Huergo, E., Moncada-Paternò-Castello, P., Rentocchini, F., & Timmermans, B. (2023). Introduction to the special issue on "the twin (digital and green) transition: handling the economic and social challenges". *Industry and Innovation*, *30*(7), 755-765.

Dunning, J. H. (1980). Toward an Eclectic Theory of International Production: Some Empirical Tests. *Journal of International Business Studies*, *11*(1), 9–31.

Dunning, J.H. (1996). The geographical sources of competitiveness of firms: some results of a new survey. *Transnational Corporations*, *5*(3), 1-29.

Dunning, J. H., & Lundan, S. M. (2008). *Multinational enterprises and the global economy*. Edward Elgar Publishing.

Dunning, J., & McKaig-Berliner, A. (2002). The geographical sources of competitiveness: the professional business service industry. *Transnational Corporations*, *11*(3), 1-38.

Eslava, M., Haltiwanger, J., Kugler, A., & Kugler, M. (2013). Trade and market selection: Evidence from manufacturing plants in Colombia. *Review of Economic Dynamics*, *16*(1), 135-158.

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

European Commission (2020). A new industrial strategy for Europe. COM(2020) 102 final.

European Commission (2022). 2022 Strategic Foresight Report. Twinning the Green and Digital Transitions in the New Geopolitical Context. COM(2022) 289 final.

European Commission (2023). The European Green Deal Industrial Plan. COM(2023) 62 final.

European Skills Competences and Occupations (ESCO) (2019). ESCO Handbook. Technical Report February 2019. European Commission – Employment Social Affairs and Inclusion. Available at (August 2025): https://esco.ec.europa.eu/system/files/2021-07/Handbook.pdf

European Skills Competences and Occupations (ESCO) (2022a). Digital Skills and Knowledge Concepts: Labelling the ESCO classification. Technical Report October 2022. European Commission – Employment Social Affairs and Inclusion. Available at (August 2025): https://esco.ec.europa.eu/system/files/2022-10/Digital%20Skills%20and%20Knowledge%20-%20Labelling%20ESCO.pdf

European Skills Competences and Occupations (ESCO) (2022b). Green Skills and Knowledge Concepts: Labelling the ESCO classification. Technical Report January 2022. European Commission – Employment Social Affairs and Inclusion. Available at (August 2025): https://esco.ec.europa.eu/system/files/2025-01/Green%20Skills%20and%20Knowledge%20-%20Labelling%20ESCO.pdf

Farinha, T., Balland, P. A., Morrison, A., & Boschma, R. (2019). What drives the geography of jobs in the US? Unpacking relatedness. *Industry and Innovation*, *26*(9), 988-1022.

Fernandes, A. M. (2007). Trade policy, trade volumes and plant-level productivity in Colombian manufacturing industries. *Journal of International Economics*, *71*(1), 52-71.

Fu, X. (2012). Foreign direct investment and managerial knowledge spillovers through the diffusion of management practices. *Journal of Management Studies*, *49*(5), 970-999.

Fu, X., Hou, J., & Liu, X. (2018). Unpacking the relationship between outward direct investment and innovation performance: evidence from Chinese firms. *World Development*, *102*, 111-123.

Faggian, A., Marzucchi, A., & Montresor, S. (2025). Regions facing the 'twin transition': combining regional green and digital innovations. *Regional Studies*, *59*(1), 2398555.

Fuller, C., & Phelps, N. (2004). Multinational enterprises, repeat investment and the role of aftercare services in Wales and Ireland. *Regional Studies*, *38*(7), 783-801.

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

Ghauri, P. N., & Park, B. I. (2012). The impact of turbulent events on knowledge acquisition: comparison of cross-border acquisitions formed before and after the crisis. *Management International Review*, *52*(2), 293-315.

Guimarães, P., Figueiredo, O., & Woodward, D. (2000). Agglomeration and the location of foreign direct investment in Portugal. *Journal of Urban Economics*, *47*(1), 115-135.

Head, K., Ries, J., & Swenson, D. (1995). Agglomeration benefits and location choice: Evidence from Japanese manufacturing investments in the United States. *Journal of International Economics*, *38*(3-4), 223-247.

Head, C. K., Ries, J. C., & Swenson, D. L. (1999). Attracting foreign manufacturing: Investment promotion and agglomeration. *Regional Science and Urban Economics*, *29*(2), 197-218.

Head, K., & Mayer, T. (2004). Market potential and the location of Japanese investment in the European Union. *Review of Economics and Statistics*, *86*(4), 959-972.

Iammarino, S., & McCann, P. (2013). *Multinationals and economic geography: Location, technology and innovation*. Edward Elgar Publishing.

Iammarino, S., Padilla-Pérez, R., & Von Tunzelmann, N. (2008). Technological capabilities and global–local interactions: the electronics industry in two Mexican regions. *World Development*, *36*(10), 1980-2003.

López González, J., Sorescu, S., & Kaynak, P. (2023). *Of bytes and trade: Quantifying the impact of digitalisation on trade* (OECD Trade Policy Paper No. 273). OECD Publishing.

Javorcik, B. S., Lo Turco, A., & Maggioni, D. (2018). New and improved: does FDI boost production complexity in host countries?. *The Economic Journal*, *128*(614), 2507-2537.

Johanson, J., and Vahlne, J.-E. (1977). The internationalization process of the firm – a model of knowledge development and increasing foreign market commitments. *Journal of International Business Studies*, *8*, 23-32.

Kimura, Y., & Flood, M. (2025). *Attracting FDI in regions: Green and strategic opportunities* (OECD Regional Development Paper No. 122). OECD Publishing.

Kogut, B., & Zander, U. (1993). Knowledge of the firm and the evolutionary theory of the multinational corporation. *Journal of International Business Studies*, *24*(4), 625-645.

Landini, F., Lunardon, D., & Marzucchi, A. (2025). *Green jobs and meaningful work* (SEEDS Discussion Paper No. 0625). SEEDS – Sustainability Environmental Economics and Dynamics Studies.

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

Lileeva, A., & Trefler, D. (2010). Improved access to foreign markets raises plant-level productivity… for some plants. *The Quarterly Journal of Economics*, *125*(3), 1051-1099.
Maldonado, J. E., Vandeplas, A., Vanyolos, I., Vigani, M., & Turrini, A. (2024). *Assessing green job dynamics in the EU: A comparison of alternative methodologies*. Publications Office of the European Union.

Marshall, A. (1920). *Principles of economics* (8th ed.). Macmillan.

Matsuyama, K. (2007). Beyond icebergs: Towards a theory of biased globalization. *The Review of Economic Studies*, *74*(1), 237-253.

McCann, P., & Mudambi, R. (2005). Analytical differences in the economics of geography: the case of the multinational firm. *Environment and Planning A*, *37*(10), 1857-1876.

Melitz, M. J. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica*, *71*(6), 1695-1725.

Meyer, K. E., Wright, M., & Pruthi, S. (2009). Managing knowledge in foreign entry strategies: a resource-based analysis. *Strategic Management Journal*, *30*(5), 557-574.

Montresor, S., & Quatraro, F. (2020). Green technologies and Smart Specialisation Strategies: a European patent-based analysis of the intertwining of technological relatedness and key enabling technologies. *Regional Studies*, *54*(10), 1354-1365.

Montresor, S., & Vezzani, A. (2023). Digital technologies and eco-innovation. Evidence of the twin transition from Italian firms. *Industry and Innovation*, *30*(7), 766-800.

Muench, S., Stoermer, E., Jensen, K., Asikainen, T., Salvi, M. & Scapolo, F. (2022). *Towards a green & digital future: key requirements for successful twin transitions in the European Union*, Publications Office of the European Union.

Narula, R., & Santangelo, G. D. (2009). Location, collocation and R&D alliances in the European ICT industry. *Research Policy*, *38*(2), 393-403.

Neffke, F. M. (2019). The value of complementary co-workers. *Science Advances*, *5*(12), eaax3370.

Ning, J., Jiang, X., & Luo, J. (2023). Relationship between enterprise digitalization and green innovation: A mediated moderation model. *Journal of Innovation & Knowledge*, *8*(1), 100326.

Nucci, F., Puccioni, C., & Ricchi, O. (2023). Digital technologies and productivity: A firm-level investigation. *Economic Modelling*, *128*, 106524.

Pavcnik, N. (2002). Trade liberalization, exit, and productivity improvements: Evidence from Chilean plants. *The Review of Economic Studies*, *69*(1), 245-276.

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.

Peng, M. W. (2001). The resource-based view and international business. *Journal of Management*, *27*(6), 803-829.

Polanyi, M. (1966a). The logic of tacit inference. *Philosophy*, *41*(155), 1-18.

Polanyi, M. (1966b). *The tacit dimension*. Routledge & Kegan Paul.

Ricardo, D. (1817). *On the principles of political economy and taxation*. John Murray.

Santoalha, A., & Boschma, R. (2021). Diversifying in green technologies in European regions: does political support matter?. *Regional Studies*, *55*(2), 182-195.

Santoalha, A., Consoli, D., & Castellacci, F. (2021). Digital skills, relatedness and green diversification: A study of European regions. *Research Policy*, *50*(9), 104340.

Stephany, F., & Teutloff, O. (2024). What is the price of a skill? The value of complementarity. *Research Policy*, *53*(1), 104898.

Topalova, P., & Khandelwal, A. (2011). Trade liberalization and firm productivity: The case of India. *Review of Economics and Statistics*, *93*(3), 995-1009.

Trefler, D. (2004). The long and short of the Canada-US free trade agreement. *American Economic Review*, *94*(4), 870-895.

Uzzi, B. (1997). Social Structure and Competition in Interfirm Networks: The Paradox of Embeddedness. *Administrative Science Quarterly*, *42*(1), 35–67.

Verhoogen, E. A. (2008). Trade, quality upgrading, and wage inequality in the Mexican manufacturing sector. *The Quarterly Journal of Economics*, *123*(2), 489-530.

Vona, F., Marin, G., Consoli, D., & Popp, D. (2018). Environmental regulation and green skills: an empirical exploration. *Journal of the Association of Environmental and Resource Economists*, *5*(4), 713-753.

Wang, Y., Wang, T., & Wang, Q. (2024). The impact of digital transformation on enterprise performance: An empirical analysis based on China's manufacturing export enterprises. *Plos One*, *19*(3), e0299723.

This project has received funding from the European Union's Horizon Europe under grant agreement No 101132559.