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# **Do global value chains and local capabilities matter for economic complexity in EU regions?**

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## **Abstract**

This paper combines insights from the literatures on Global Value Chains (GVC), Economic Complexity and Evolutionary Economic Geography to assess the role of GVC participation and regional capabilities in fostering economic complexity in EU NUTS-2 regions. Our results suggest there is no such thing as a common path towards economic complexity across EU regions. Low-income regions manage to benefit from both regional capabilities and GVC participation. In contrast, high-income regions rely more on their existing local capabilities rather than on GVC participation.

**JEL codes:** B52, F23, O19, O33, R10

**Keywords:** Economic complexity, evolutionary economic geography, global value chains, relatedness, economic upgrading, EU regions

## 1 Introduction

Nowadays, uneven development across and within regions in the European Union (EU) represents a challenging topic for researchers and policymakers alike (Feldman et al. 2021). For a long time, since the early studies of Hayek (1945), researchers have addressed this issue, by investigating the reasons of these territorial imbalances, by underlining the importance of knowledge, among other factors, in triggering economic development.

The literature of Evolutionary Economic Geography (EEG) claims that regional economies heavily rely on their own capabilities to expand into new activities. Building on the principle of relatedness (Boschma 2017; Hidalgo et al. 2018), empirical studies show that regions have different opportunities to upgrade their economies, and they do so along different trajectories. High-income regions, which tend to host a wider range of capabilities, have higher chances to develop new activities, while low-income regions, which usually have a much narrower set of capabilities, show lower capacity to diversify towards new activities (Hidalgo et al. 2007). Besides relatedness, the concept of economic complexity captures the level of sophistication of economic activities, and tells us how difficult it is for a region to master capabilities required for producing complex activities (Hidalgo & Hausmann, 2009). Complex industries, technologies or occupations are usually associated with higher economic growth. Moreover, it has been shown that diversification opportunities in high-income regions are in more complex, sophisticated activities, while such opportunities in low-income regions are restricted to less complex activities (Pinheiro et al., 2022). As highly complex activities tend to bring higher economic benefits than low-complex activities (Hidalgo and Hausmann 2009; Mewes and Broekel 2020; Pintar and Scherngell 2020; Davies and Maré 2021; Rigby et al. 2022), this is likely to result in widening economic disparities across regions (Pinheiro et al. 2022). Therefore, lagging regions that will rely primarily on their own internal capabilities may see their gap with frontrunners expanding. However, the literatures on relatedness, complexity and regional diversification have overlooked the role of inter-regional linkages until recently (Boschma and Iammarino 2009; Miguelez and Moreno 2018; Trippel et al. 2018; Balland and Boschma 2021; Kogler et al. 2023). The role of external connections for regional diversification has been investigated by a growing stream of studies which has looked at MNCs (e.g. Ascani et al. 2020; Castellani et al. 2022; Javorcik et al. 2018; Neffke et al. 2018; Elekes et al., 2019; Cortinovis et al. 2020; Ascani and Prenzel 2022), inter-regional inventors'

collaboration (Balland & Boschma, 2021; Kogler et al. 2023) and migration flows (Migueluez and Morrison, 2023), among others.

The literature on Global Value Chains (GVC) has extensively shown how territories can benefit from joining value chains both in terms of developing new value added activities and for upgrading existing ones (Humphrey & Schmitz 2002; Giuliani et al. 2005; Morrison et al. 2008; Pietrobelli & Rabellotti 2011; Bolea et al. 2022). In this regard, GVCs represent not only flows of goods and services, but can also act as important sources of external knowledge for regions (Morrison et al., 2008, 2013; De Marchi et al. 2018; Jona-Lasinio et al., 2019; Lema et al., 2019). The benefits from participating in GVCs get higher when this participation involves higher value-added sectors of GVCs (Gereffi et al., 2011), which helps triggering upgrading processes (Giuliani et al., 2005; Gereffi, 2019; Almazán-Gómez et al. 2023). However, these mechanisms might be uneven across territories (De Propris 2024), depending mostly on the capacity of countries and regions to exploit the opportunities given by GVCs (Rodrik, 2018; Pietrobelli et al., 2021; Capello et al. 2024; Capello & Dellisanti 2024). Recent literature explores this connection, for example assessing the impact of GVC participation on productivity of countries (Pahl and Timmer, 2020), or pointing out the importance of GVCs for technological upgrading (Kergroach, 2019; Gehl Sampath and Vallejo, 2018; Deng et al 2022).

In this work, we bridge the EEG and GVC literatures, with the aim of unveiling the role of GVCs as a potential channel for regions to upgrading their economic structure (Boschma 2022). The objectives of the paper are as follows. First, we assess the effect of GVC participation on the economic complexity of NUTS-2 regions in the EU covering a period of 13 years (2000-2012). We follow the argument of the Economic Complexity literature (Hidalgo and Hausmann 2009; Hausmann et al. 2014; Balland et al. 2022) that differentiates economic activities according to their level of sophistication or complexity. We test whether GVC participation enhances the capacity of regions to build a more complex economic structure. Second, we test this effect of GVC participation in a relatedness framework. Recent evidence shows that regions with higher relatedness density are more capable of moving into more complex activities (Balland et al. 2019). This implies that not all regions may be able to gain – in terms of production sophistication – from participation in GVCs to the same extent. Third, we test whether this effect of GVC participation differs between regions. We expect low-income regions to profit more from GVC participation since they face harder restrictions

to upgrade their economies based on their existing capabilities, while high-developed regions already have sophisticated structures and skills that permit them to depend less on GVC linkages.

The paper aims to contribute to the literature in a number of ways. First, we connect the literature on Economic Complexity to the GVC literature, by coupling the concept of upgrading with the complexity of activities and looking at the importance of external linkages through GVCs for the economic complexity of regions. Second, we embed this complexity approach on GVC in an evolutionary framework, by assessing the relative importance of local capabilities and GVC participation for regional complexity, and how these are inter-related. Third, we follow recurrent calls from scholars (e.g. MacKinnon 2012; Rodríguez-Pose 2021; Yeung 2021, 2024; Boschma 2022, 2024) to link more tightly Evolutionary Economic Geography to the study of GVCs and more in general to extra-regional linkages (Ascani et al. 2020; Elekes et al. 2019). Fourth, we investigate the regional specificities of such relationships and study them on regions in the European Union.

This work is structured as follows. In Section 2, we discuss our theoretical framework and state our hypotheses. Section 3 presents the data, variables and methodology. Section 4 discusses the main findings. Section 5 concludes.

## **2 Literature review**

Extra-regional linkages are taking a more central stage in Evolutionary Economic Geography, in particular among those studies that investigate the link between regional diversification, economic complexity and relatedness (Boschma 2017; Balland and Boschma 2021). The main tenet is that regions can nurture and expand their capabilities by tapping into extra-regional resources and knowledge. A variety of channels can serve this purpose, such as international R&D collaborations, migration flows, FDI, and export relations, and recent empirical works are providing fresh evidence supporting this claim. For example, by looking at MNEs in Italian provinces, Ascani et al. (2020) show that they complement local capabilities by fostering regional innovation. Likewise, Elekes et al. (2019) find that MNEs can act as agents of structural change in Hungary by triggering processes of unrelated diversification. In the context of EU regions, Castellani et al. (2022) show that foreign investments enable green technological diversification. With a focus on migration flows, Miguelez and Morrison (2023) also find that these extra-regional channels help host regions to tap into missing capabilities.

By looking at technological collaboration, Balland and Boschma (2021) further confirm this idea by stressing that knowledge from extra-regional linkages complements the local one (see also Uhlbach et al. 2022). Some other studies have looked more specifically at the link between external linkages and complexity. In the case of Turkey, Lo Turco & Maggioni (2019) show that MNEs bring to regions missing capabilities that enhance product complexity. Ascani and Prenzel (2022) suggest that economic complexity drives the location decision of Chinese MNEs. Javorcik et al., (2018) show that vertical linkages provided by FDI can generate spillovers relevant for product complexity. Against this backdrop, this paper focuses on Global Value Chains as a specific extra-regional linkage. In what follows, we present three streams of empirical research that can help to understand the link between GVC and regional complexity, namely: studies on global value chains; studies on economic complexity; studies on relatedness and diversification.

## **2.1 Global value chains**

A burgeoning literature in this field has made key contributions to explain the capacity of countries and firms to develop new value chains, or to upgrade within existing value chains. A first stream of case-based studies has focused on identifying opportunities for local producers to learn from global leaders in value chains (Gereffi 1999; Humphrey and Schmitz 2002; Blažek 2016), and how global linkages foster upgrading in clusters (Guerrieri et al. 2001; Giuliani et al. 2005; Pietrobelli and Rabellotti 2007, 2011). More quantitative oriented analyses have used input-output tables to build GVCs integration measures. For instance, Colozza and Pietrobelli (2023) examine the integration in global value chains of EU regions using the Borin and Mancini (2017) gross export's decomposition measure. By building on a similar approach, Montalbano and Nenci (2022) analyse the integration of emerging economies in agricultural and food GVCs. They find that this is associated to growing workers' productivity. Other studies have shown that GVCs integration boosts firm-level productivity and generate both intra and inter-sectoral spillovers (Antràs 2020). Another stream of empirical studies addresses the role of GVCs in facilitating different forms of upgrading. Pahl and Timmer (2020) find that integration into GVCs trigger functional upgrading. Kordalska and Olczyk (2023) point out that the integration in GVCs has a positive role in enhancing functional upgrading. For the case of developing economies, Tajoli and Felice (2018) investigate whether integrating into GVCs generate positive effects and territorial spillovers to enhance economic upgrading.

Overall, the main focus of attention has been on upgrading along the vertical dimension, that is, from low to high value-added activities along the same VC), rather than the horizontal dimension (chain or inter-sectoral upgrading) (Gereffi and Fernandez-Stark 2011). However, at the horizontal dimension the meaning of upgrading is not always immediately clear (Boschma 2022).

## **2.2 Economic complexity**

The Economic Complexity literature (Hidalgo and Hausmann 2009; Hausmann et al. 2014; Balland et al., 2022) has made efforts to differentiate products in terms of their complexity. According to Hidalgo and Hausmann (2009), complexity captures the difficulty of mastering capabilities that are required to excel in a product or service. This is reflected by the non-ubiquity of the product on the one hand, and the diversity of capabilities that need to be brought together to produce such product on the other hand. Advanced products demand a diverse set of expertise, which requires strong coordination capabilities. Horizontal upgrading can then be reconceptualized as the introduction of a new product in a territory that is more complex than the average complexity of all its existing products<sup>1</sup>.

There has been little interaction between the GVC and Complexity literatures (Boschma, 2022). To integrate the concepts of upgrading and complexity and to apply it to the study of GVCs might be a first step. A next step is to account for the role of GVC participation in enhancing economic complexity in countries (Cheng et al. 2015). GVC participation is conceived to give regions access to knowledge and information (Morrison et al., 2008, 2013; Lema et al., 2019). Morrison et al. (2008) argued that GVCs promote knowledge exchange between territories and thus represent a potential knowledge-channel that transfers capabilities across space (Pietrobelli and Rabellotti 2011). Nowadays, GVCs constitute a substantial part of global innovation networks and may contribute to cross-border innovation (Pietrobelli 2022). This may trigger a process of knowledge accumulation, innovation and economic upgrading in regions (Giuliani et al. 2005; Gereffi et al. 2011; Jurowetzki et al. 2018; Fagerberg et al. 2018; Lee et al. 2018; Lema et al. 2018; Gereffi, 2019). GVC participation generates spillover effects both within and across sectors (Antràs 2020). In particular, inter-sectoral spillovers can materialise via vertical relations, for example with improvements embodied in

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<sup>1</sup> We acknowledge though that the GVC literature has often considered various modes of upgrading, including for example process upgrading, i.e. higher productivity in producing the same goods, or product upgrading (Humphrey and Schmitz 2002, Giuliani et al. 2005, Gereffi 2019)

inputs and components purchased from suppliers (Los and Verspagen 2002) or via user-producer interactions (Isaksson et al. 2016). Spillovers can also emerge via competition and imitation effects in both the technology as well as the market space (Griliches, 1979; Bloom et al., 2013). Nevertheless, the impact of GVCs can be also detrimental to the development of the host economy. Indeed, the benefits of GVCs might be mitigated by the quality of institutions (Gereffi and Fernandez-Stark, 2016; Kergroach, 2019; Koval et al., 2019), but also by strength of the innovation system (Pietrobelli and Rabellotti, 2011; Fischer et al. 2024) and the overall structure of the economy (Engel and Taglioni, 2017). For instance, Werner and Bair (2019) point out that GVCs can affect territories unevenly, creating negative effects, or leading to downgrading (Choksy et al., 2017), especially for those with weak domestic capabilities.

### **2.3 Regional capabilities**

Evolutionary Economic Geography (Boschma and Frenken 2006; Martin and Sunley 2006) has shed light on the importance of local capabilities for the ability of a region to upgrade their economies, and how it might be dependent on the stage of development (Van Dam et al. 2022). Capabilities are embodied in economic activities (such as products or industries) that consist of specific sets of knowledge, skills and institutions that activities need as inputs for their production. Some activities share similar capabilities, while other activities do not. This is captured by the concept of relatedness (Breschi et al. 2003; Hausmann and Klinger 2007; Hidalgo et al. 2007; Boschma 2017; Hidalgo et al. 2018). Some regions are specialized in activities that are closely related to each other (their structure shows high coherence), while other regions are specialized in activities that are related to a lesser extent (the composition of their economies is more fragmented, with a lower average relatedness). Though other measures of diversification are available (Dissart, 2003), relatedness has proved to be well suited to evaluate the proximity across economic assets (Hidalgo et al., 2018). Relatedness turns out to be a relevant indicator to identify diversification potentials of regions (Neffke et al. 2011; Balland et al. 2019). The higher the average relatedness of local activities, the more spillovers across local activities, the more diversification opportunities regions have (Frenken et al. 2007). What is more, hosting a high variety of closely related activities (high relatedness density) makes regions also more capable of moving into complex products (Balland, 2016). In other words, the relatedness density of a region captures its ‘opportunity space’ or ‘ease of entry’ into new activities (e.g. industry, technology, occupation), which can be either more complex or less complex than the existing ones (Balland et al, 2019). Regions that have been

able to develop a wide range of activities locally and with high relatedness density, are then likely to establish several upgrading trajectories. Instead, for regions whose (average) relatedness density is low, the range of possible choices will be limited. For these regions, it will be relatively more difficult to diversify into more complex activities than for regions with high relatedness density (Balland et al., 2019). To the best of our knowledge, no study yet exists that has jointly examined the role of relatedness and GVC participation for regional complexity.

## **2.4 Hypotheses**

The above discussion provides some clues about the relationship between GVCs and economic complexity, which we use in this section to formulate the following three hypotheses. The first hypothesis is defined as follows:

**H1:** Relatedness density and GVC participation enhance the economic complexity of regions

As argued in the previous section, relatedness density measures the probability of a region to move into new “related” economic activities and in turn expand its set of capabilities. Therefore, regions with a larger and more coherent pool of capabilities are better positioned to develop more complex activities. This outcome cannot be given for granted however, as regions can move along specialisation that are related, but at low level of complexity (Balland et al. 2019). Similarly, the second part of H1 builds on the GVC literature reviewed above. GVCs provide learning opportunities to domestic firms through intra and inter sectoral spillovers. Through direct investment they can also directly contribute to innovation in destination countries. All these mechanisms augment local capabilities and increases the chances that host regions develop more complex activities. Therefore, we expect that greater integration in GVC can be associated to higher level of complexity. As pointed out in the previous section, GVCs can also be detrimental, and lead to processes of downgrading rather than upgrading. Whether GVC or relatedness are conducive to higher complexity crucially depends on the differences between regions. Therefore, we formulate the following hypothesis:

**H2:** GVC participation enhances economic complexity in low-income regions more than in high-income regions

Not all regions have in fact the same capacity to benefit from GVC participation and increase the complexity of their economies. Likewise, not all firms may have such capabilities, and

therefore benefit from integration into GVCs (Morrison et al., 2008). Complex activities tend to be spatially concentrated and sticky, that is, they do not move easily across space. This is one of the reasons why only few regions are able to specialize in high-complex activities, while the majority focus on low-complexity activities (Balland and Rigby 2017; Balland et al. 2020; Mewes and Broeckel 2020; Davies and Maré 2021). For example, Pinheiro et al. (2022) explore the diversification potentials of regions with varying income and complexity levels. They find that many low-complexity regions have diversification potentials primarily in low-complexity activities, while high-complexity regions have diversification potentials primarily in high-complexity activities. The underlying mechanism consists of self-enhancing, path-dependent cumulative processes that lead to the accumulation of regional capabilities in complex regions, which leverage the existing proximity across economic assets. Indeed, regions that host complex activities are often characterised by a strong scientific and educational infrastructure (Crescenzi et al., 2014) and a significant stock of technological and scientific knowledge (Boschma and Iammarino 2009; Rodrik, 2018). This may imply that GVC linkages are relatively less relevant for such regions, since they can rely on their strong set of local capabilities. In contrast, low-income regions have a weaker set of capabilities and/or might lack appropriate human and technological infrastructures, so they more easily get trapped in a ‘low complexity’ trajectory. External knowledge captured through GVC participation can then provide a way out and prepare regions for a leap forward.

Finally, the relevance of GVC participation can be reinforced by being combined with the existing capabilities low-income regions already have. This leads to the following hypothesis.

**H3:** GVC participation has a positive effect on economic complexity in low-income regions with higher levels of relatedness density

Like organisations more easily process external knowledge for high level of absorptive capacity (Cohen and Levinthal 1990), similarly regions, which can be seen as a collection of organisations, reduces their costs of absorbing and using external knowledge (as provided by GVC) for higher levels of relatedness density. Relatedness density can boost not only the spill-over mechanisms within economies, but also the process of knowledge accumulation through GVCs. Therefore, among low-income regions, we expect that those with higher (average) relatedness density are in a better position to take advantage of GVC participation, which in turn can enhance the economic complexity of places.

### **3 Data and variables**

To test our hypotheses, we rely on two different databases. First, to compute the regional participation in GVCs we use the EUREGIO interregional input-output tables (Thissen et al., 2018). EUREGIO contains data on input-output relationships for 249 NUTS-2 regions from 24 European countries, 16 non-EU countries, a rest of the world, and 14 industries, between the years 2000-2010. Thus, EUREGIO allows to compute the engagement of EU NUTS-2 regions in GVCs for such period. Second, to compute measures of economic complexity and relatedness density we use employment data from Eurostat's Structural Business Statistics (SBS). SBS contains information on the number of workers in each regional industry between 1995-2020. However, the use of SBS data has an important drawback: while between 1995-2007 the industrial classification of sectors is NACE Rev. 1.1, from 2008 onwards it is NACE Rev. 2. There is not a completely direct match between both classifications since SBS provide information only at two digit codes. Thus, when computing the economic complexity and relatedness density metrics NACE Rev.1.1 is used for the period 2000-2007 and NACE Rev. 2 for the period 2008-2012. Since our analysis is performed at the regional level (no sectoral dimension is included, as it will be explained in the next subsections), this shouldn't be a major concern. We will capture the overall complexity of regions regardless of the specific industrial classification used in each time period. Finally, control variables are also drawn from Eurostat. We explain the methods and variables used in the empirical analysis in what follows.

#### **3.1 Global value chain participation**

The concept of global value chains revolves around the process of fragmentation of economic activities across territories, as geographically clustered firms contribute to the production of final goods and services, trading in parts and components with companies localized all over the world. Firms and territories are therefore integrated into these trade-flows as much as they contribute to the value of final products. Earlier empirical works, based on sectoral exports (from world input-output tables), showed that the growing fragmentation of production was accompanied by a growing trend towards the vertical specialization of countries (Hummels et al., 1998). Yet, since the works of Koopman et al. (2010; 2014), who showed that exports-based measures embodied computational-bias in their key assumptions, the literature started adopting an export's decomposition methods to assess how domestic value is added to international trade, so avoiding double-counting. In this vein, and relying on this principle, Borin and Mancini (2023) propose a measure of integration in Global Value Chains, starting

from a consolidated literature (Koopman et al., 2014) providing a new, and more accurate, method to trace the domestic value-added in trade flows. Another recent methodological contribution is given by Coniglio et al. (2021), who employ GVC participation indexes using input-output tables to investigate country patterns of specializations<sup>2</sup>. We build on this reasoning and expand it to the regional scale in our empirical analysis. Indeed, a key challenge is to compute the regional and sectoral GVC participation's indexes for EU regions, as data on EU regional trade is scant. Also, GVC participation indexes falls under the so-called “macro” approaches to measuring countries’ participation in the global division of production (Antràs and Chor, 2022: 301). While such indexes capture several dimensions of the global fragmentation of production activities, they also overlook relevant actors, dynamics and institutional features (e.g. the role of lead firms, offshoring strategies, GVCs governance structures, power asymmetries). All these aspects are usually analysed by using the “micro” and “relational” approaches (Gereffi et al. 2005) with firm level data (Antràs and Chor, 2022: 319). Following the macro approaches, we rely on the recently released EUREGIO interregional input-output tables (Thissen et al., 2018) which include information about input-output linkages for EU NUTS-2 regions between 2000-2010.

To compute our GVC indicator, we follow the existing literature (Hummels et al. 2001; Koopman et al., 2014; Kowalski et al., 2015; Borin and Mancini, 2017, 2019) and calculate the GVC participation index as the ratio of the backward and forward components on gross exports, for each region  $r$  and year  $t$ , as follows. Notice that the backward component represents the foreign value-added content of exports, while the forward component stands for the domestic value-added sent to third economies to produce their own exports.

$$GVC\ participation_{r,t} = \frac{FVA_{r,t}}{E_{r,t}} + \frac{DVA_{r,t}}{E_{r,t}} \quad (1)$$

The GVC participation index is computed as the sum of two components: backward and forward participation. Precisely,  $FVA$  is for the foreign content of the region's gross exports,  $DVA$  is the domestic value added contained in third region's gross exports, and  $E$  is the region's total gross exports. Thus, using the EUREGIO interregional input-output tables, GVC participation indexes are obtained for each region and year, and then averaged for 7 non-

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<sup>2</sup> For a detailed review of measures of integration in global value chains see Antràs, 2020.

overlapping time windows: 2000-2001, 2002-2003, 2004-2005, 2006-2007, 2008-2009, and 2010.

Furthermore, indexes of GVC participation at the region-sector level are computed by measuring the ratio of the sectoral backward and forward component on sectoral exports. We compute the participation indexes for the 14 industries included in EUREGIO and then, focusing on the manufacturing industries, average them across regions and time windows to just capture GVC participation in such manufacturing industries<sup>3</sup>. These indicators will be lately used in the empirical analysis as a robustness check, since manufacturing sectors are more likely to take a GVC kind of industrial organisation, thus capturing more intensively GVC engagement.

There is remarkable heterogeneity in GVCs participation across EU regions. Broadly speaking, GVC integration is high in the Czech Republic, Hungary, Slovakia, Belgium, Finland, the Netherlands, Italy and large parts of Spain, while Greece, the Baltic states, France, Germany, and Poland, show lower levels of GVC engagement. In particular, two patterns emerge: first, small countries tend to be involved more in GVCs, as compared to large ones. This is in line with the evidence suggesting that small open economies rely extensively on external channels (Antràs and Chor, 2022; Borin and Mancini, 2017); second, some peripheral European regions are relatively more integrated into GVCs (e.g. Eastern and Southern European regions). This is in line with some recent country-sector studies showing the integration of these countries in extensive value chains (among others see Bacchiocchi, et al. 2014; Grodzicki and Skrzypek, 2020).

### 3.2 Relatedness density

To capture the role of regional capabilities, we compute a relatedness density measure which requires two steps (Hidalgo et al. 2007; Boschma et al., 2015; Balland et al. 2019). First, we compute the degree of relatedness ( $\phi$ ) between industries using sectoral employment data. The degree of relatedness between two industries ( $s_i, s_j$ ) is obtained as the minimum value of the pairwise conditional probability of a region being specialised ( $RCA = 1$ ) in an industry given that it is also specialised in another one in period  $t$ . We consider 6 different non-overlapping

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<sup>3</sup> Therefore, the following industries are excluded when computing the GVC participation index: agriculture; mining, quarrying and energy supply; distribution; hotels and restaurants; transport, storage and communication; financial intermediation; real estate, renting and business activities; non-market service. However, while we do this as a robustness check, we acknowledge that trade in services is also important, that's why we consider all industries as our prefer indicator (Baldwin et al., 2024).

time windows (2000-2001, 2002-2003, 2004-2005, 2006-2007, 2008-2009, 2010) to avoid spurious changes in the revealed comparative advantages (*RCAs*).

$$\phi_{s_i, s_j, t} = \min \left\{ P \left( RCA_{s_i, t} = 1 \mid RCA_{s_j, t} = 1 \right), P \left( RCA_{s_j, t} = 1 \mid RCA_{s_i, t} = 1 \right) \right\} \quad (2)$$

Notice that the *RCA* is a specialisation index computed based on the sectoral employment in each region and time period (Balassa, 1965). It takes the following mathematical form.

$$RCA_{r, s, t} = \frac{Emp_{r, s, t} / \sum_s Emp_{r, s, t}}{\sum_r Emp_{r, s, t} / \sum_r \sum_s Emp_{r, s, t}} \quad (3)$$

Second, considering parameter  $x_{r, s, t}$  equal 1 when the *RCA* of industry  $s$  in region  $r$  at time  $t$  is 1, and 0 otherwise, the relatedness density for each region  $r$  and a particular industry  $s_i$  at time  $t$  is obtained by adding all the relatedness values of the other industries that are related to  $s_i$ , and in which region  $r$  has an *RCA* equal to 1:

$$Relatedness\ density_{r, s_i, t} = \frac{\sum_s x_{r, s, t} \phi_{s, s_i, t}}{\sum_s \phi_{s, s_i, t}} \quad (4)$$

The relatedness density is computed for each region included in the sample with respect to each industry for the above-mentioned 6 time windows. It is important to underline that, although the relatedness density is industry-specific, in our empirical analysis we average it at the regional level, due to the lack of a proper sectoral disaggregation in the GVC variables. However, in doing so we are not altering the original definitions of economic complexity and relatedness, or their “iterative” mechanisms (recent work using similar approaches include Hausmann, Pietrobelli & Santos, 2021, and Davies & Maré, 2021)<sup>4</sup>.

### 3.3 Regional complexity

As discussed above, to measure the sophistication or complexity of regional economies, we rely on economic complexity metrics. Specifically, we use the Economic Complexity Index (*ECI*), using the method of reflections, as an indicator capturing both the ubiquity of industries and the diversity of regions (Hidalgo and Hausmann, 2009). In particular, Hidalgo and Hausmann (2009) show how this index embodies the complexity of economic output, by measuring the sophistication of export products. Balland and Rigby (2017) and Balland et al.

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<sup>4</sup> Appendix I includes a map showing regions’ average relatedness density for the period 2000-2012.

(2019) adapt this measure to assess the level of complexity of technologies, by using patent data. However, in this analysis we use employment data from Eurostat's SBS to capture the different industrial structures across regions<sup>5</sup>.

Then, using average employment matrices of dimensions  $R \times S$  (where  $R$  is the number of regions at NUTS-2 level and  $S$  the number of industries) for each considered non-overlapping time window, the economic complexity of both regions ( $ECI$ ) and industries ( $PCI$ ) is obtained as follows.

$$ECI = K_{r,n} = \frac{1}{K_{r,0}} \sum_s M_{r,s} K_{s,n-1} \quad (5)$$

$$PCI = K_{s,n} = \frac{1}{K_{s,0}} \sum_r M_{r,s} K_{r,n-1} \quad (6)$$

As previously anticipated, both the  $ECI$  and the  $PCI$  will depend on how diverse regions are in terms of industrial specialisation (diversity) and how industries are distributed across territories (ubiquity).

$$Diversity = K_{r,0} = \sum_s M_{r,s} \quad (7)$$

$$Ubiquity = K_{s,0} = \sum_r M_{r,s} \quad (8)$$

Therefore, the  $ECI$  captures the economic complexity of each regional economy for each time window. However, one drawback of the  $ECI$  is that it cannot be directly compared across periods (Hausmann et al. 2014; Stojkoski et al. 2023). Then, following a similar approach than Balland and Rigby (2017), the values of the  $ECI$  are transformed into a scale from 0-100, where 0 is the lowest economic complexity and 100 the highest, for each time period. Thus, changes in this economic complexity ranking capture how regional economies evolve in sophistication and complexity with respect to others.

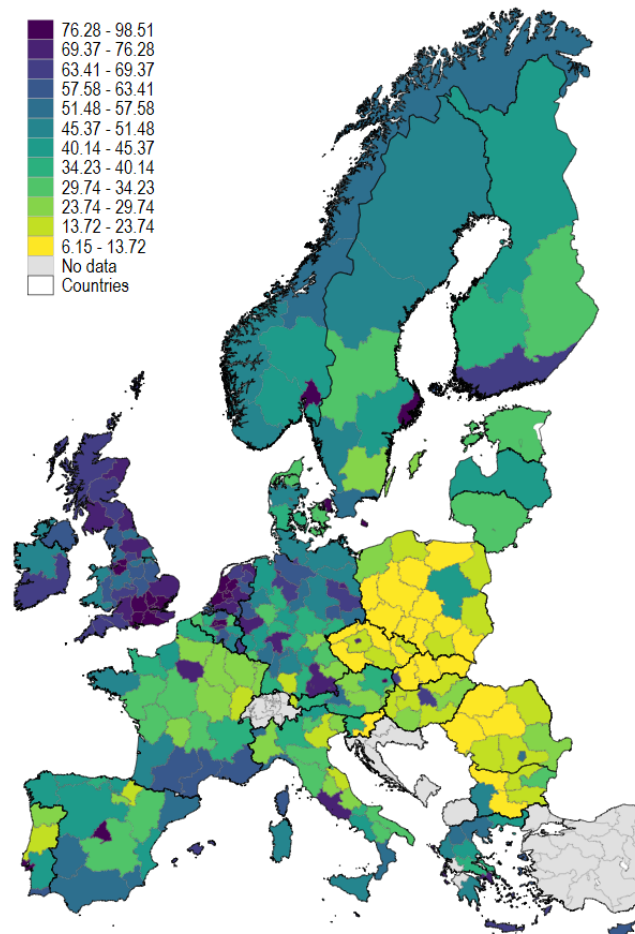
Figure 1 shows the spatial patterns of economic complexity in EU regions. As expected, capital regions such as Rome, Amsterdam, Paris, Brussels, Madrid, and Inner London tend to show

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<sup>5</sup> In line with other studies, we make the implicit assumption of homogenous rates in sectoral productivity across EU regions, for both the calculation of economic complexity and relatedness density indicators.

high levels of economic complexity. Many regions in countries like the Netherlands and the UK, and some regions in Germany and Spain also score high. Eastern European countries score low, as well as some regions in Italy<sup>6</sup>.

**Figure 1** Average economic complexity (*ECI*) in EU regions between 2000-2012



**Source:** Authors' own elaboration.

### 3.4 Descriptive statistics

The descriptive statistics of all variables used in the empirical analysis are summarized in Table 1. It is worth highlighting that a few EU regions cannot be included in the analysis: this is the case for example for regions in Bulgaria, Romania, and the UK, for which there is no regional data either in EUREGIO and/or Eurostat.

<sup>6</sup> These results meet our expectations and are similar to other geographical representations of this index (Lapatinas et al., 2022). In particular, capital cities appear to be the most complex ones, and peripheral territories have relatively lower levels of economic complexity.

**Table 1** Descriptive statistics

|                     | <b>N</b> | <b>Mean</b> | <b>Std. Dev.</b> | <b>Min</b> | <b>Max</b> |
|---------------------|----------|-------------|------------------|------------|------------|
| ECI                 | 1,848    | 46.555      | 23.379           | 0          | 100        |
| Relatedness density | 1,848    | 37.56       | 7.652            | 1.902      | 64.032     |
| GVC participation   | 1,254    | 0.638       | .089             | 0.32       | 0.85       |
| GDP pc              | 1,254    | 23,172.476  | 9035.445         | 6,533.932  | 68,308.664 |
| Population density  | 1,179    | 304.559     | 670.558          | 3.3        | 6,957.2    |
| Patents             | 1,254    | 458.574     | 838.478          | 0          | 6,393.19   |
| Education           | 1,725    | 22.823      | 9.034            | 3.95       | 63.975     |
| Industrial share    | 1,599    | 0.223       | 0.116            | 0          | 0.967      |

As previously explained, the *ECI* is transformed into a ranking from 0-100 by each period to allow for time comparisons. Furthermore, the relatedness density captures the percentage of related industries in which regions are already specialised. The higher the relatedness density, the higher the presence of related capabilities in a region. GVC participation captures the engagement of regions in global value chains, as explained in Section 3.1. Control variables include GDP per capita, population density, measured as population by square kilometre, patents, which refers to the number of patents applications by region, education, which is the share of population with tertiary education by region, and industrial share, measured by the share of gross value added produced by manufacturing sectors within regions, from 0 to 1.

### 3.5 Empirical strategy

To analyse the impact of GVC participation and relatedness density on the economic complexity of NUTS-2 regions in Europe between 2000-2012, we estimate OLS models with region and time fixed effects. First, to test Hypothesis 1, we estimate the effects of GVC participation (*GVC*) and relatedness density (*REL*) on the economic complexity (*ECI*) of regions. This model takes the following form.

$$ECI_{r,t} = \alpha + \beta_1 GVC_{r,t-1} + \beta_2 REL_{r,t-1} + \theta \gamma_{r,t-1} + \mu_r + \varphi_t + \varepsilon_{r,t} \quad (9)$$

Furthermore, the model includes a vector of control variables at the regional level ( $\gamma_{r,t-1}$ ). In particular, GDP per capita is included to account for regions' level of economic development, population density to account for agglomeration externalities, patents applications to capture regions' knowledge base, regional levels of education, proxied by the percentage of population with tertiary education, to control for human capital, and the share of gross value added produced by manufacturing sectors, to control for regions' industrial structures. Also,  $\mu_r$ ,  $\varphi_t$ ,  $\varepsilon_{r,t}$  stand for region and time fixed effects, and the regression residual, respectively. Notice that

all independent variables are mean centred and lagged by one period. Also, control variables are in logarithmic form to alleviate excessed kurtosis. To account for the presence of heteroskedasticity, standard errors are clustered at the regional level.

To test Hypotheses 2, we split the sample into two sub-samples according to differences in regional income. Thus, the sample is divided for the top and bottom of regions above and below the median GDP per capita. Then, we also include the interaction term between GVC participation and the relatedness density, which provides evidence to test Hypothesis 3. This model takes the following form.

$$ECI_{r,t} = \alpha + \beta_1 GVC_{r,t-1} + \beta_2 REL_{r,t-1} + \beta_3 GVC_{r,t-1} * REL_{r,t-1} + \theta \gamma_{r,t-1} + \mu_r + \varphi_t + \varepsilon_{r,t} \quad (10)$$

Finally, we check the robustness of our results repeating this analysis for the lower and upper quartiles of regions depending on their GDP per capita. We also repeat the same analyses constructing our indicator of GVC participation only using manufacturing industries, since they are more likely to be characterized by an industrial organization like GVCs.

## 4 Results

Table 2 presents the main results. Models 1 and 2 show the results for the whole sample. Both the relatedness density and the GVC participation are positively associated with the economic complexity of regions. This leads to validating hypothesis 1. However, as expected, some heterogeneities are in place when differentiating regions by their level of economic development: low-income regions vs high-income regions. Such differences are presented across models 3-6: models 3 and 4 just include low-income regions (those below the median GDP pc), and models 5 and 6 for high-income regions (those above the median GDP pc).

In the first place, the relatedness density is always positively associated with the economic complexity of regions, independently of their level of economic development (models 3-6). In particular, using coefficients from models 3 and 5, 1 standard deviation increase in the relatedness density leads to 1.3 and 2.1 points increase in the complexity ranking for low-income and high-income regions, respectively. Second, although overall we observe a positive and significant effect of GVC participation on economic complexity (models 1 and 2), we then observe that this effect is driven by low-income regions rather than high-income regions. Particularly, we find that 1 SD increase in the GVC participation of low-income regions

translated into 7.1 points increase in the economic complexity ranking. This leads to supporting hypothesis 2. Indeed, low-income regions seem to benefit more than high-income regions from GVC participation. Moreover, we find no significant effect for the interaction between relatedness density and GVCs across all models (2, 4, and 6). Particularly, looking at model 4, we can then reject hypothesis 3. We do not find that low-income regions with higher relatedness density benefit more from GVC participation than low-income regions with lower relatedness density. This however can be due to the fact that the empirical analyses are performed at the regional level and not at the sectoral level. The industrial classification of EUREGIO deter us to explore particular aspects at the sectoral level that could be crucial to understand the interplay between local capabilities and GVC participation. In any case, although the interactions are not significant (models 2, 4 and 6) we observe different signs for low-income (positive) and high-income (negative) regions.

**Table 2** Results for full sample and sub-samples of low- and high-income regions

| Fixed-effects OLS – Dependent variable: ECI |                        |                        |                       |                       |                        |                        |
|---------------------------------------------|------------------------|------------------------|-----------------------|-----------------------|------------------------|------------------------|
|                                             | (1)<br>Whole<br>Sample | (2)<br>Whole<br>Sample | (3)<br>Low-<br>Income | (4)<br>Low-<br>Income | (5)<br>High-<br>Income | (6)<br>High-<br>Income |
| Rel. den. (RD)                              | 0.309***<br>(0.0504)   | 0.305***<br>(0.0501)   | 0.193**<br>(0.0897)   | 0.206**<br>(0.0897)   | 0.274***<br>(0.0687)   | 0.274***<br>(0.0691)   |
| GVC part. (log)                             | 20.99***<br>(6.363)    | 19.42***<br>(6.312)    | 41.92***<br>(15.80)   | 47.28***<br>(16.13)   | 6.817<br>(9.888)       | 6.837<br>(9.882)       |
| RD * GVC                                    |                        | -0.223<br>(0.260)      |                       | 0.554<br>(0.501)      |                        | -0.0215<br>(0.401)     |
| GDP pc (log)                                | -2.862<br>(7.775)      | -3.768<br>(8.016)      | -1.046<br>(9.530)     | 1.101<br>(9.889)      | 3.751<br>(13.48)       | 3.691<br>(13.53)       |
| Pop. den. (log)                             | 22.66<br>(17.32)       | 21.32<br>(17.19)       | 9.652<br>(18.76)      | 13.18<br>(19.36)      | 12.23<br>(30.20)       | 12.21<br>(30.25)       |
| Patents (log)                               | -1.865*<br>(0.970)     | -1.796*<br>(0.972)     | -0.268<br>(0.935)     | -0.298<br>(0.915)     | -7.707***<br>(2.302)   | -7.687***<br>(2.360)   |
| Educ. (log)                                 | 5.775**<br>(2.895)     | 5.906**<br>(2.868)     | 8.621**<br>(4.287)    | 8.513*<br>(4.333)     | 3.651<br>(3.934)       | 3.671<br>(3.977)       |
| Ind. share (log)                            | 1.648<br>(5.344)       | 1.825<br>(5.412)       | 4.467<br>(10.48)      | 3.668<br>(10.74)      | -4.006<br>(6.531)      | -3.993<br>(6.580)      |
| Constant                                    | 54.54***<br>(1.476)    | 54.37***<br>(1.524)    | 53.75***<br>(9.639)   | 56.39***<br>(10.21)   | 59.53***<br>(6.525)    | 59.53***<br>(6.541)    |
| Observations                                | 1,007                  | 1,007                  | 365                   | 365                   | 642                    | 642                    |

|                         |       |       |       |       |       |       |
|-------------------------|-------|-------|-------|-------|-------|-------|
| Adjusted R <sup>2</sup> | 0.412 | 0.412 | 0.561 | 0.563 | 0.275 | 0.274 |
| Region FEs              | YES   | YES   | YES   | YES   | YES   | YES   |
| Time FEs                | YES   | YES   | YES   | YES   | YES   | YES   |

**Notes.** All independent variables are mean centred and lagged by one period. Heteroskedasticity-robust standard errors (clustered at the regional level) are shown in parentheses. Coefficients are statistically significant at the \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$  level.

Finally, as a robustness test, we analyse only manufacturing industries, as they are more likely to adopt a GVC-like form of industrial organization (Table 3). Results remain the same. Across all models the relatedness density has a positive effect on the economic complexity of regions (models 1-6). Likewise, the coefficient of GVCs participation is significant in both the whole sample (models 1 and 2), and for the low-income regions (models 3-4). GVC participation is not significant for high-income regions (models 5 and 6). Again, no significant effect is found for the interaction between local capabilities (relatedness density) and GVC participation (models 2, 4, and 6).<sup>7</sup>

**Table 3** Results for full sample and sub-samples of low- and high-income regions using GVC participation in manufacturing industries

| Fixed-effects OLS – Dependent variable: ECI |                        |                        |                       |                       |                        |                        |
|---------------------------------------------|------------------------|------------------------|-----------------------|-----------------------|------------------------|------------------------|
|                                             | (1)<br>Whole<br>Sample | (2)<br>Whole<br>Sample | (3)<br>Low-<br>Income | (4)<br>Low-<br>Income | (5)<br>High-<br>Income | (6)<br>High-<br>Income |
| Rel. den. (RD)                              | 0.301***<br>(0.0498)   | 0.296***<br>(0.0497)   | 0.207**<br>(0.0877)   | 0.211**<br>(0.0858)   | 0.273***<br>(0.0675)   | 0.269***<br>(0.0694)   |
| GVC part. (log)                             | 26.99***<br>(7.222)    | 24.77***<br>(7.263)    | 43.14***<br>(16.28)   | 44.55***<br>(16.41)   | 10.87<br>(10.79)       | 9.550<br>(11.26)       |
| RD * GVC                                    |                        | -0.299<br>(0.302)      |                       | 0.251<br>(0.593)      |                        | -0.319<br>(0.424)      |
| GDP pc (log)                                | -3.227<br>(7.827)      | -4.454<br>(8.169)      | -2.145<br>(9.287)     | -1.294<br>(9.777)     | 3.382<br>(13.80)       | 2.582<br>(14.06)       |
| Pop. den. (log)                             | 20.78<br>(16.49)       | 19.16<br>(16.31)       | 0.886<br>(18.69)      | 2.383<br>(18.99)      | 12.52<br>(29.72)       | 11.90<br>(29.71)       |
| Patents (log)                               | -1.807*<br>(0.984)     | -1.756*<br>(0.991)     | -0.212<br>(0.935)     | -0.218<br>(0.928)     | -<br>(2.326)           | -7.543***<br>(2.393)   |
| Educ. (log)                                 | 6.302**                | 6.321**                | 9.545**               | 9.638**               | 7.685***<br>3.896      | 3.959                  |

<sup>7</sup> We carry out an additional check to ensure the robustness of our findings. In appendix III results are shown when limiting the sample to the 25% of the least and most developed regions, in terms of GDP per capita. Besides the important loss of observations, results remain the same.

|                         |          |          |          |          |          |          |
|-------------------------|----------|----------|----------|----------|----------|----------|
|                         | (2.886)  | (2.869)  | (4.327)  | (4.438)  | (3.839)  | (3.837)  |
| Ind. share (log)        | 2.036    | 1.854    | 6.751    | 6.760    | -3.989   | -4.009   |
|                         | (5.332)  | (5.363)  | (10.44)  | (10.47)  | (6.668)  | (6.723)  |
| Constant                | 54.66*** | 54.38*** | 50.03*** | 51.18*** | 59.53*** | 59.59*** |
|                         | (1.476)  | (1.565)  | (9.277)  | (9.972)  | (6.385)  | (6.377)  |
| Observations            | 1,007    | 1,007    | 365      | 365      | 642      | 642      |
| Adjusted R <sup>2</sup> | 0.422    | 0.423    | 0.575    | 0.576    | 0.289    | 0.290    |
| Region FEs              | YES      | YES      | YES      | YES      | YES      | YES      |
| Time FEs                | YES      | YES      | YES      | YES      | YES      | YES      |

**Notes.** All independent variables are mean centred and lagged by one period. Heteroskedasticity-robust standard errors (clustered at the regional level) are shown in parentheses. Coefficients are statistically significant at the \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$  level.

## 5 Conclusions

The aim of the paper is to assess the effects of GVC participation and relatedness density on the economic complexity of regions in Europe, and whether these effects differ across regions. We find that not all regions benefit from GVCs in the same manner: the results are very different for low-income and high-income regions. Low-income regions benefit from both local capabilities and GVC participation. In contrast, high-income regions rely more on their existing local capabilities rather than on GVC participation.

This paper contributes to different streams of literature. It shows how fruitful it can be to make connections between the GVC and the Economic Complexity strands of literature, which only few papers have done so far. This study also shows how levels of economic complexity may be affected by external linkages such as GVCs. The paper also contributes to the Evolutionary Economic Geography, taking on board GVCs as an object of study (Boschma 2022). The study argues that the impact of GVC participation on regional development cannot be analysed in isolation, leaving out the role of regional capabilities (Boschma 2017). This is in line with Kano et al. (2020) – and with the earlier contributions of Pietrobelli and Rabellotti (2007) – who highlighted that the GVC literature should investigate more thoroughly the interplay between local capabilities and inter-regional linkages.

It goes without saying that this work has limitations that need to be taken up in future research. First, we looked at the heterogeneity of regions in terms of low and high-income only, but there could also be other sources of heterogeneity, such as for example institutions and innovation systems (Pietrobelli and Rabellotti, 2011; Yeung 2021), and this could influence the effect of GVC participation on regional complexity. Second, we did not investigate

whether low-income regions are indeed trapped in a low-complexity economy, and how and to what extent GVC participation, and other factors, could contribute to escaping such a trap. Third, a key finding of our work is that in low-income regions, GVC participation and local capabilities foster the process of growing complexity through different channels. We have to develop a deeper understanding of which local capabilities are needed, and through which concrete mechanisms an increase in economic complexity works out, as in our data, we had to average out both complexity and relatedness density indicators. Fourth, the paper opens up questions on what policies are needed to make GVC participation more beneficial in regions, especially regarding their different levels of economic development (Pietrobelli et al, 2021), on how to tackle economic unevenness in Europe (Boschma 2024), and on how GVC participation could contribute to enhance convergence in Europe, in line with the objectives of Cohesion policies (Comotti et al. 2020).

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## References

- Almazán-Gómez, M.A., C. Llano, J. Pérez and G. Mandras (2023) The European regions in the global value chains: New results with new data, *Papers in Regional Science* 102 (6), 1097-1126.
- Álvarez-Cuadrado, F., Casado, J. M., & Labeaga, J. M. (2016). Envy and habits: panel data estimates of interdependent preferences. *Oxford Bulletin of Economics and Statistics*, 78(4), 443-469.
- Antràs, P. (2020). Conceptual aspects of global value chains. *The World Bank Economic Review*, 34(3), 551-574.
- Antràs, P., & Chor, D. (2022). Global value chains. *Handbook of international economics*, 5, 297-376.
- Ascani, A., Bettarelli, L., Resmini, L., & Balland, P. A. (2020). Global networks, local specialisation and regional patterns of innovation. *Research Policy*, 49(8), 104031.
- Ascani, A. & Prenzel, P. (2022). Economic complexity and the global asset-seeking strategies of Chinese multinationals. *Industry and Innovation*, pp.1-29.
- Bacchiocchi, E., Florio, M., & Giunta, A. (2014). Internationalization and industrial districts: evidence from the Italian automotive supply chain. *International Review of Applied Economics*, 28(1), 1-21.
- Balassa, B. (1965). Trade liberalisation and “revealed” comparative advantage. *The Manchester School*, 33(2), 99-123.
- Baldwin, R., Freeman, R., & Theodorakopoulos, A. (2024). Deconstructing deglobalization: The future of trade is in intermediate services. *Asian Economic Policy Review*, 19(1), 18-37.
- Balland, P. A. (2016). Relatedness and the geography of innovation. In *Handbook on the geographies of innovation*. Edward Elgar Publishing.
- Balland, P. A., & Rigby, D. (2017). The geography of complex knowledge. *Economic Geography*, 93(1), 1-23.
- 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.
- Balland, P.A., Jara-Figueroa, C., Petralia, S.G., Steijn, M.P.A., Rigby, D.L. & Hidalgo, C.A., (2020). Complex economic activities concentrate in large cities. *Nature Human Behaviour* 4, 248–254.
- Balland, P. & Boschma, R. (2021). Complementary inter-regional linkages and Smart Specialisation. An empirical study on European regions, *Regional Studies* 55 (6), 1059-1070.
- Balland, P. A., Broekel, T., Diodato, D., Giuliani, E., Hausmann, R., O'Clery, N., & Rigby, D. (2022). The new paradigm of economic complexity. *Research Policy*, 51(3), 104450.
- Barbero, J., Mandras, G., Rodríguez-Crespo, E., & Rodríguez-Pose, A. (2021). Quality of government and regional trade: evidence from European Union regions. *Regional Studies*, 55(7), 1240-1251.
- Blažek, J. (2016) Towards a typology of repositioning strategies of GVC/GPN suppliers: the case of functional upgrading and downgrading. *Journal of Economic Geography* 16 (4), 849–869.

- Bloom, N., Schankerman, M., & Van Reenen, J. (2013). Identifying technology spillovers and product market rivalry. *Econometrica*, 81(4), 1347-1393.
- Borin, A., & Mancini, M. (2017). Follow the value added: Tracking bilateral relations in global value chains.
- Borin, A., & Mancini, M. (2019). Measuring what matters in global value chains and value-added trade. *The World Bank*.
- Borin, A., & Mancini, M. (2023). Measuring what matters in value-added trade. *Economic Systems Research*, 1-28.
- Boschma, R. (2017). Relatedness as driver of regional diversification: A research agenda. *Regional Studies*, 51(3), 351-364.
- Boschma, R. (2022) Global value chains from an evolutionary economic geography perspective: a research agenda, *Area Development and Policy* 7 (2), 123-146
- Boschma, R. (2024). An evolutionary approach to regional studies on global value chains. *Regional Studies*, 1-9.
- Boschma, R. A. & Frenken, K. (2006). Why is economic geography not an evolutionary science? Towards an evolutionary economic geography. *Journal of Economic Geography* 6 (3), 273–302.
- Boschma, R., & Iammarino, S. (2009). Related variety, trade linkages, and regional growth in Italy. *Economic Geography*, 85(3), 289-311.
- Boschma, R., Balland, P. A., & Kogler, D. F. (2015). Relatedness and technological change in cities: the rise and fall of technological knowledge in US metropolitan areas from 1981 to 2010. *Industrial and Corporate Change*, 24(1), 223-250.
- Boulding, W., & Staelin, R. (1990). Environment, market share, and market power. *Management Science*, 36(10), 1160-1177.
- Breschi, S., Lissoni, F., & Malerba, F. (2003). Knowledge-relatedness in firm technological diversification. *Research Policy*, 32(1), 69-87.
- Cainelli, G., Ganau, R., & Giunta, A. (2018). Spatial agglomeration, global value chains, and productivity. Micro-evidence from Italy and Spain. *Economics Letters*, 169, 43-46.
- Capello, R., Dellisanti, R., & Perucca, G. (2024). At the territorial roots of global processes: Heterogeneous modes of regional involvement in Global Value Chains. *Environment and Planning A: Economy and Space* 56 (3), 833-848.
- Capello, R., & Dellisanti, R. (2024). Smile-and-go. Regional performance through global value chains in Europe. *Papers in Regional Science* 103 (2), 100018.
- Castellani, D., Marin, G., Montresor, S., & Zanfei, A. (2022). Greenfield foreign direct investments and regional environmental technologies. *Research Policy*, 51(1), 104405.
- Cheng, K., S. Rehman, D. Seneviratne and S. Zhang (2015) Reaping the Benefits from Global Value Chains, *IMF Working Paper*, WP15/204.
- Choksy, U. S., Sinkovics, N., & Sinkovics, R. R. (2017). Exploring the relationship between upgrading and capturing profits from GVC participation for disadvantaged suppliers in developing countries. *Canadian Journal of Administrative Sciences/Revue Canadienne des Sciences de l'Administration*, 34(4), 356-386.
- Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, 35(1), 128-152.

- Colozza, F., & Pietrobelli, C. (2023). The Relationship Between Global Value Chains, Green Technologies, and Air Pollution: Initial Evidence for EU Regions. In *Inequality, Geography and Global Value Chains* (pp. 213-230). Cham: Springer International Publishing.
- Comotti, S., R. Crescenzi and S. Iammarino (2020) Foreign direct investment, global value chains and regional economic development in Europe. *Final Report*, Luxembourg: Publications Office of the European Union.
- Coniglio, N. D., Vurchio, D., Cantore, N., & Clara, M. (2021). On the evolution of comparative advantage: path-dependent versus path-defying changes. *Journal of International Economics*, 133, 103522.
- Cortinovis, N., Crescenzi, R., & Van Oort, F. (2020). Multinational enterprises, industrial relatedness and employment in European regions. *Journal of Economic Geography*, 20(5), 1165-1205.
- Crescenzi, R., Pietrobelli, C., & Rabelotti, R. (2014). Innovation drivers, value chains and the geography of multinational corporations in Europe. *Journal of Economic Geography*, 14(6), 1053-1086.
- Davies, B. & Maré, D. C. (2021). Relatedness, complexity and local growth. *Regional Studies*, 55 (3), 479-494.
- De Marchi, V., Giuliani, E., & Rabelotti, R. (2018) Do global value chains offer developing countries learning and innovation opportunities? *The European Journal of Development Research*, 30, 389-407.
- De Propriis, L. (2024). Globalisation must work for as many regions as possible. *Regional Studies*, 1-4.
- Deng, Z., Ma, X., & Zhu, Z. (2022). Transactional dependence and technological upgrading in global value chains. *Journal of Management Studies*, 59(2), 390-416.
- Dissart, J. C. (2003). Regional economic diversity and regional economic stability: research results and agenda. *International Regional Science Review*, 26(4), 423-446.
- Elekes, Z., Boschma, R., & Lengyel, B. (2019). Foreign-owned firms as agents of structural change in regions. *Regional Studies*, 53(11), 1603-1613.
- Engel, J., & Taglioni, D. (2017). The middle-income trap and upgrading along global value chains. *Global Value Chain Report*, 119-139.
- Fagerberg, J., Lundvall, B. Å., & Srholec, M. (2018). Global value chains, national innovation systems and economic development. *The European Journal of Development Research*, 30(3), 533-556.
- Feldman, M., Guy, F., & Iammarino, S. (2021). Regional income disparities, monopoly and finance, *Cambridge Journal of Regions, Economy and Society* 14 (1), 25–49.
- Fischer, B., Meissner, D., Boschma, R., & Vonortas, N. (2024). Global value chains and regional systems of innovation: Towards a critical juncture?. *Technological Forecasting and Social Change*, 123245.
- Frenken, K, van Oort, FG & Verburg, T (2007). Related variety, unrelated variety and regional economic growth, *Regional Studies* 41 (5), 685–697.
- Gehl Sampath, P., & Vallejo, B. (2018). Trade, global value chains and upgrading: what, when and how?. *The European Journal of Development Research*, 30(3), 481-504.

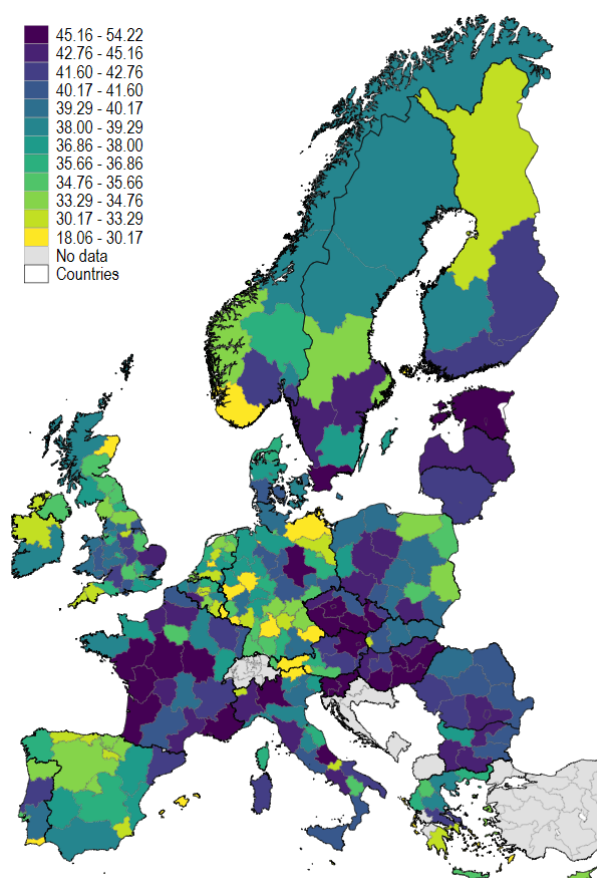
- Gereffi, G. (1999) International trade and industrial upgrading in the apparel commodity chain. *Journal of International Economics* 48, 37–70.
- Gereffi, G. (2019). Economic upgrading in global value chains. In S.Ponte, G.Gereffi and G.Raj-Reichert (Eds.) *Handbook on global value chains*. Edward Elgar Publishing, pp.240-54.
- Gereffi, G., Humphrey, J., & Sturgeon, T. (2005). The governance of global value chains. *Review of International Political Economy*, 12(1), 78-104.
- Gereffi, G., & Rossi, A., Barrientos, S., (2011). Economic and social upgrading in global production networks: A new paradigm for a changing world. *International Labour Review*, 150(3-4), 319-340.
- Gereffi, G., & Fernandez-Stark, K. (2011). Global value chain analysis: a primer. *Center on Globalization, Governance & Competitiveness* (CGGC), Duke University, North Carolina, USA.
- Gereffi, G., & Fernandez-Stark, K. (2016). *Global value chain analysis: a primer*. Duke University Global Value Chains Center, Durham NC, USA.
- Giuliani, E., C. Pietrobelli & R. Rabellotti (2005). Upgrading in global value chains: Lessons from Latin American clusters. *World Development* 33 (4), 549–573.
- Griliches, Z. (1979). Issues in assessing the contribution of research and development to productivity growth. *The Bell Journal of Economics*, 92-116.
- Grodzicki, M. J., & Skrzypek, J. (2020). Cost-competitiveness and structural change in value chains—vertically-integrated analysis of the European automotive sector. *Structural Change and Economic Dynamics*, 55, 276-287.
- Guerrieri, P., Iammarino, S. & Pietrobelli, C. (eds.) (2001), *The global challenge to industrial districts. Small and medium-sized enterprises in Italy and Taiwan*, Cheltenham : Edward Elgar.
- Hausmann, R., & Klinger, B. (2007). The structure of the product space and the evolution of comparative advantage. *CID Working Paper Series*.
- Hausmann, R., Hidalgo, C. A., Bustos, S., Coscia, M., & Simoes, A. (2014). *The atlas of economic complexity: Mapping paths to prosperity*. Cambridge MA: MIT Press.
- Hausmann, R., Pietrobelli, C., & Santos, M. A. (2021). Place-specific determinants of income gaps: New sub-national evidence from Mexico. *Journal of Business Research*, 131, 782-792.
- Hayek, F. (1945). The use of Knowledge in Society. *American Economic Review*, 35(1), 519-530.
- Hidalgo, C. A., Klinger, B., Barabási, A. L., & Hausmann, R. (2007). The product space conditions the development of nations. *Science*, 317(5837), 482-487.
- Hidalgo, C. A., & Hausmann, R. (2009). The building blocks of economic complexity. *Proceedings of the national academy of sciences*, 106(26), 10570-10575.
- Hidalgo, C., Balland, P.A., Boschma, R., Delgado, M., Feldman, M., Frenken, K., Glaeser, E., He, C., Kogler, D., Morrison, A., Neffke, F., Rigby, D., Stern, S., Zheng, S., and Zhu, S. (2018) The principle of relatedness, *Springer Proceedings in Complexity*, 451-457.
- Hummels, D. L., Rapoport, D., & Yi, K. M. (1998). Vertical specialization and the changing nature of world trade. *Economic Policy Review*, 4(2).
- Hummels, D., Ishii, J., & Yi, K. M. (2001). The nature and growth of vertical specialization in world trade. *Journal of International Economics*, 54(1), 75-96.

- Humphrey, J., & Schmitz, H. (2002). How does insertion in global value chains affect upgrading in industrial clusters? . *Regional Studies*, 36(9), 1017-1027.
- Humphrey, J., & Memedovic, O. (2006). Global value chains in the agrifood sector.
- Isaksson, O. H., Simeth, M., & Seifert, R. W. (2016). Knowledge spillovers in the supply chain: Evidence from the high tech sectors. *Research Policy*, 45(3), 699-706.
- 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.
- Jona-Lasinio, C., Manzocchi, S., & Meliciani, V. (2019). Knowledge based capital and value creation in global supply chains. *Technological Forecasting and Social Change*, 148, 119709.
- Jurowetzki, R., Lema, R., & Lundvall, B. Å. (2018). Combining innovation systems and global value chains for development: Towards a research agenda. *The European Journal of Development Research*, 30(3), 364-388.
- Kano, L., Tsang, E. W. K. & Yeung, H. W. (2020). Global value chains: A review of the multi-disciplinary literature. *Journal of International Business Studies* 51 (4), 577–622.
- Kergroach, S., (2019). National innovation policies for technology upgrading through GVCs: A cross-country comparison. *Technological Forecasting and Social Change*, 145, pp.258-272.
- Kogler, D.F., A. Whittle, K. Kim and B. Lengyel (2023) Understanding regional branching: Knowledge diversification via inventor and firm collaboration networks, *Economic Geography* 99 (5), 471-498.
- Koopman, R., Powers, W., Wang, Z., & Wei, S. J. (2010). Give credit where credit is due: Tracing value added in global production chains (No. w16426). *National Bureau of Economic Research*.
- Koopman, R., Wang, Z., & Wei, S. J. (2014). Tracing value-added and double counting in gross exports. *American Economic Review*, 104(2), 459-94.
- Kordalska, A., & Olczyk, M. (2023). Upgrading low value-added activities in global value chains: a functional specialisation approach. *Economic Systems Research*, 35(2), 265-291.
- Koval, V., Duginets, G., Plekhanova, O., Antonov, A., & Petrova, M. (2019). On the supranational and national level of global value chain management. *Entrepreneurship and Sustainability issues*, 6(4), 1922.
- Kowalski, P., Gonzalez, J. L., Ragoussis, A., & Ugarte, C. (2015). Participation of developing countries in global value chains: Implications for trade and trade-related policies. *OECD*.
- Lapatinas, A., Litina, A., & Poullos, K. (2022). Economic complexity of cities and its role for resilience. *Plos One*, 17(8), e0269797.
- Lee, K., Szapiro, M., & Mao, Z. (2018). From global value chains (GVC) to innovation systems for local value chains and knowledge creation. *The European Journal of Development Research*, 30(3), 424-441.
- Lema, R., Rabellotti, R., & Sampath, P. G. (2018). Innovation trajectories in developing countries: Co-evolution of Global Value Chains and innovation systems. *The European Journal of Development Research*, 30(3), 345-363.
- Lema, R., Pietrobelli, C., & Rabellotti, R. (2019). Innovation in global value chains. In *Handbook on global value chains*. Edward Elgar Publishing.

- Lo Turco, A., & Maggioni, D. (2019). Local discoveries and technological relatedness: the role of MNEs, imports and domestic capabilities. *Journal of Economic Geography*, 19(5), 1077-1098.
- Los, B., & Verspagen, B. (2002). An introduction to the analysis of systems of innovation: scientific and technological interdependencies. *Economic Systems Research*, 14(4), 315-322.
- MacKinnon, D. (2012). Beyond strategic coupling: reassessing the firm-region nexus in Global Production Networks. *Journal of Economic Geography* 12, 227–245.
- Martin, R. & P. Sunley (2006). Path dependence and regional economic evolution, *Journal of Economic Geography* 6, 395– 437.
- Mewes, L. & Broekel, T. (2020) Technological complexity and economic growth of regions. *Research Policy*, DOI: 10.1016/j.respol.2020.104156
- Migueluez, E., Morrison, A. (2023) Migrant inventors as agents of technological change. *Journal of Technology Transfer* 48, 669–692.
- Montalbano, P., & Nenci, S. (2022). Does global value chain participation and positioning in the agriculture and food sectors affect economic performance? A global assessment. *Food Policy*, 108, 102235.
- Morrison, A., Pietrobelli, C., & Rabellotti, R. (2008). Global value chains and technological capabilities: a framework to study learning and innovation in developing countries. *Oxford Development Studies*, 36(1), 39-58.
- Morrison, A., Rabellotti, R., & Zirulia, L. (2013). When do global pipelines enhance the diffusion of knowledge in clusters?. *Economic Geography*, 89(1), 77-96..
- Neffke, F., Hartog, M., Boschma, R. and Henning, M. (2018) Agents of structural change. The role of firms and entrepreneurs in regional diversification. *Economic Geography* 94 (1), 23–48.
- Neffke, F., Henning, M., & Boschma, R. (2011). How do regions diversify over time? Industry relatedness and the development of new growth paths in regions. *Economic Geography*, 87(3), 237-265.
- OECD (2018), *Productivity and Jobs in a Globalised World: (How) Can All Regions Benefit?*, OECD Regional Development Studies, OECD Publishing, Paris.
- Pahl, S., & Timmer, M. P. (2020). Do global value chains enhance economic upgrading? A long view. *The Journal of Development Studies*, 56(9), 1683-1705.
- Pietrobelli, C. (2022). Cross-border Innovation and Global Value Chains: The Role of Public Policies. In D. Castellani, A. Perri, V. G. Scalera, and A. Zanfei, (Eds.) *Cross-Border Innovation in a Changing World*. Oxford: Oxford University Press. <https://doi.org/10.1093/oso/9780198870067.003.0009>
- Pietrobelli, C. & Rabellotti R. (2007). *Upgrading to Compete. Clusters and Value Chains in Latin America*. Cambridge, MA: Harvard University Press.
- Pietrobelli, C., & Rabellotti, R. (2011). Global value chains meet innovation systems: are there learning opportunities for developing countries?. *World Development*, 39(7), 1261-1269.
- Pietrobelli C., Rabellotti R. and Van Assche A., (2021) Making sense of global value chain-oriented policies: The trifecta of tasks, linkages, and firms, *Journal of International Business Policy*, 4, 327-46.

- Pinheiro, F.L., P.A. Balland, R. Boschma & D. Hartmann (2022) The dark side of the geography of innovation: Relatedness, complexity, and regional inequality in Europe, *Regional Studies*, DOI: 10.1080/00343404.2022.2106362.
- Pintar, N. and T. Scherngell (2020) The complex nature of regional knowledge production: Evidence on European regions, *Research Policy*, doi.org/10.1016/j.respol.2020.104170.
- Rigby, D.L., C. Roesler, D. Kogler, R. Boschma & P.A. Balland (2022). Do EU regions benefit from Smart Specialisation principles?, *Regional Studies* 56 (12), 2058-2073.
- Rodríguez-Pose, A. (2021) Costs, incentives, and institutions in bridging evolutionary economic geography and global production networks, *Regional Studies* 55 (6), 1011-1014.
- Rodrik, D. (2018). New technologies, global value chains, and developing economies (No. w25164). *National Bureau of Economic Research*.
- Scharff, J., & Schreiber, S. (2012). Evidence on the effects of inflation on price dispersion under indexation. *Empirical Economics*, 43, 291-311.
- Stock, J. H., & Yogo, M. (2002). Testing for weak instruments in linear IV regression.
- Stojkoski, V., Koch, P., & Hidalgo, C. A. (2023). Multidimensional economic complexity and inclusive green growth. *Communications Earth & Environment*, 4(1), 130.
- Tajoli, L. and G. Felice (2018) Global value chains participation and knowledge spillovers in developed and developing countries: An empirical investigation, *The European Journal of Development Research* 30 (3), 9, 505-532.
- Thissen, M., Lankhuizen, M., van Oort, F., Los, B., & Diodato, D. (2018). EUREGIO: The construction of a global IO DATABASE with regional detail for Europe for 2000–2010.
- Trippl, M., Grillitsch, M. and A. Isaksen (2018) Exogenous sources of regional industrial change: Attraction and absorption of nonlocal knowledge for new path development. *Progress in Human Geography* 42 (2), 687–705.
- Uhlbach, W.H., P.A. Balland and T. Scherngell (2022) Public R&D funding and new regional specialisations: The contingent role of technological relatedness, *Industry and Innovation* 29 (4), 511-532.
- Van Dam, A., & Frenken, K. (2022). Variety, complexity and economic development. *Research Policy*, 51(8), 103949.
- Werner, M., & Bair, J. (2019). Global value chains and uneven development: a disarticulations perspective. In *Handbook on global value chains*. Edward Elgar Publishing.
- Yeung, H.W. (2021) Regional worlds: from related variety in regional diversification to strategic coupling in global production networks, *Regional Studies* 55 (6), 998-1010.
- Yeung, H.W. (2024) From regional to global and back again? A future agenda for regional evolution and (de)globalized production networks in regional studies, *Regional Studies*, forthcoming.

## Appendix I Average relatedness density in EU regions between 2000-2012



**Appendix II** Correlation table

|                  | (1)    | (2)    | (3)    | (4)    | (5)    | (6)   | (7)    | (8)   |
|------------------|--------|--------|--------|--------|--------|-------|--------|-------|
| (1) ECI          | 1.000  |        |        |        |        |       |        |       |
| (2) Rel. density | -0.164 | 1.000  |        |        |        |       |        |       |
| (3) GVC part.    | -0.181 | 0.091  | 1.000  |        |        |       |        |       |
| (4) GDP pc       | 0.495  | -0.191 | 0.074  | 1.000  |        |       |        |       |
| (5) Pop. density | 0.336  | -0.122 | -0.031 | 0.436  | 1.000  |       |        |       |
| (6) Patents      | 0.206  | -0.037 | -0.012 | 0.391  | 0.107  | 1.000 |        |       |
| (7) Education    | 0.448  | -0.188 | 0.020  | 0.442  | 0.161  | 0.179 | 1.000  |       |
| (8) Ind. share   | -0.544 | 0.246  | 0.295  | -0.175 | -0.221 | 0.091 | -0.191 | 1.000 |

### Appendix III Results for the lower and upper quartiles of regions in GDP per capita

| Fixed-effects OLS – Dependent variable: ECI |                                               |                                               |                                                |                                                |
|---------------------------------------------|-----------------------------------------------|-----------------------------------------------|------------------------------------------------|------------------------------------------------|
|                                             | (1)<br>1 <sup>st</sup> Quartile<br>Low-Income | (2)<br>1 <sup>st</sup> Quartile<br>Low-Income | (3)<br>4 <sup>th</sup> Quartile<br>High-Income | (4)<br>4 <sup>th</sup> Quartile<br>High-Income |
| Rel. den. (RD)                              | 0.376*<br>(0.204)                             | 0.403**<br>(0.190)                            | 0.249***<br>(0.0834)                           | 0.254***<br>(0.0835)                           |
| GVC part. (log)                             | 35.61*<br>(19.33)                             | 44.01*<br>(22.08)                             | 25.14<br>(16.74)                               | 31.23<br>(20.10)                               |
| RD * GVC                                    |                                               | 0.851<br>(1.086)                              |                                                | -0.501<br>(0.507)                              |
| GDP pc (log)                                | -6.982<br>(13.79)                             | -4.711<br>(14.70)                             | -10.99<br>(16.42)                              | -10.17<br>(16.60)                              |
| Pop. den. (log)                             | 61.35<br>(57.27)                              | 67.47<br>(58.50)                              | 59.52<br>(47.69)                               | 65.14<br>(47.27)                               |
| Patents (log)                               | -0.300<br>(1.136)                             | -0.333<br>(1.098)                             | -6.530**<br>(2.796)                            | -6.149**<br>(2.757)                            |
| Educ. (log)                                 | 6.024<br>(7.532)                              | 6.444<br>(7.853)                              | 5.478<br>(5.523)                               | 6.437<br>(5.838)                               |
| Ind. share (log)                            | 11.76<br>(18.59)                              | 11.91<br>(18.76)                              | 2.071<br>(6.214)                               | 3.040<br>(6.545)                               |
| Constant                                    | 58.24**<br>(25.30)                            | 62.60**<br>(27.83)                            | 37.94**<br>(18.72)                             | 35.70*<br>(18.42)                              |
| Observations                                | 168                                           | 168                                           | 421                                            | 421                                            |
| Adjusted R <sup>2</sup>                     | 0.495                                         | 0.496                                         | 0.190                                          | 0.190                                          |
| Region FEs                                  | YES                                           | YES                                           | YES                                            | YES                                            |
| Time FEs                                    | YES                                           | YES                                           | YES                                            | YES                                            |

**Notes.** All independent variables are mean centred and lagged by one period. Heteroskedasticity-robust standard errors (clustered at the regional level) are shown in parentheses. Coefficients are statistically significant at the \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$  level.

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