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Drivers of territorial servitization: An empirical analysis of manufacturing productivity in local value chains

Silvia Lombardi [a], Erica Santini [b], Claudia Vecciolini [c,*]

[a] Italian National Institute of Statistics, Rome, Italy
[b] Department of Economics and Management, University of Trento, Trento, Italy
[c] King's Business School, King's College London, London, UK

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ABSTRACT

A recent stream of literature has observed the tendency for advanced services, and particularly knowledge-intensive business services (KIBS), to grow near local manufacturing value chains, supporting a trajectory of growth based on territorial servitization (TS). However, it is still unclear what affects the coupling between KIBS and manufacturing. The paper addresses this research gap by analysing how local drivers of TS moderate the effect of KIBS co-location on manufacturing productivity. To test our hypotheses, we use a functional geographic unit characterized by a well-defined local value chain, i.e., Labour Market Areas (LMAs). The empirical examination of 611 Italian LMAs for the period 2014–2018 provides evidence that human capital availability is a key determinant of KIBS' contribution to manufacturing productivity. Importantly, our analysis shows that human capital impacts variously on TS outcomes, depending on the local setting and industry type. On the one hand, high levels of education help unleash the benefits of proximity to KIBS for manufacturers, especially in urban areas typically hosting high concentrations of knowledge-intensive sectors and supporting infrastructures. On the other hand, medium levels of education play a key role in non-urban areas specialized in traditional, low-tech manufacturing sectors. By helping untangle the drivers of positive TS outcomes, our results are informative for scholars and policymakers interested in developing specific policies to promote the renaissance of local manufacturing. The study may also help manufacturing firms gain a deeper understanding of the conditions allowing them to effectively benefit from TS and increase productivity.

1. Introduction

Manufacturers are radically changing their value creation strategies, going from being pure product-centric firms to hybrid product-service providers, a transition that has been called *servitization* (Vandermerwe and Rada, 1988; Baines et al., 2009; Rabetino et al., 2017). While services have long been considered peripheral to the core business of manufacturers, the servitization literature suggests that firms can create superior value by combining service and manufacturing competencies (Xing et al., 2017; Bustinza et al., 2019b).

Building on this discussion, a recent research stream has emphasized that manufacturing firms are often unable to take advantage of these synergies due to the risks associated with servitization, especially when it involves the integration of services developed in-house (Benedettini et al., 2015; Kohtamäki et al., 2020). In line with this view, several studies show that despite some manufacturers have a strong servitization orientation and internal capabilities, they need to rely on external service providers, and particularly knowledge-intensive business services (KIBS), to successfully enter servitization trajectories, thereby reshaping their established value chain (Gebauer et al., 2017).

The growing interdependencies between KIBS and manufacturers have led to the increasing co-location of the two, promoting a trajectory of local growth based on territorial servitization (TS) (Vendrell-Herrero and Wilson, 2017; Lafuente et al., 2017). TS theories widely acknowledge that the implementation of servitization strategies does not depend on the firm's internal capabilities only, but it is strongly related to the main features of the local industrial fabric where both manufacturing and KIBS are located (Lafuente et al., 2019; Gomes et al., 2019).

In this regard, existing literature tends to emphasize the role of the local setting in enabling relationships between KIBS and manufacturing. Particularly, urban systems are usually considered as the most favourable environment for KIBS to localize and establish connections with

* Corresponding author. King's Business School, King's College London, Bush House, 30 Aldwych, London, WC2B 4BG, UK.
E-mail address: claudia.vecciolini@kcl.ac.uk (C. Vecciolini).

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other industries (Simmie and Strambach, 2006; Doloreux et al., 2010), yet overlooking the role of non-urban systems in TS trajectories. Indeed, recent evidence shows that non-urban systems can also enter TS trajectories, by leveraging a rich and consolidated manufacturing base to attract KIBS locally and establish virtuous relationships of value creation between the two for the development of more advanced customer solutions (Horváth and Rabetino, 2019).

What seems to be critical for entering TS trajectories in both urban and non-urban systems, is the availability of embedded specialized knowledge that can be variously recombined with the newer competencies brought in by KIBS, thereby sustaining learning and innovation in the local value chain (Corrocher and Cusmano, 2014; Muller and Zenker, 2001). As widely discussed in regional studies, the specialized knowledge cumulated in the local value chain over time, i.e., forming the local system's *knowledge base*, is a key determinant of the system's ability to explore new opportunities outside its established field of expertise (Bellandi et al., 2018), including the ability to effectively integrate KIBS knowledge into the local value chain.

While urban systems tend to host a variety of knowledge bases creating wider opportunities for knowledge spillovers and innovation (Scott and Storper, 2015; Vaillant et al., 2012), non-urban systems typically accumulate knowledge in one industry of specialization. In this regard, evidence has produced mixed results on the role of high specialization in underpinning TS in non-urban systems. On the one hand, a more specific knowledge base helps gain technical expertise in all stages of the local value chain, attracting specialized KIBS to the area (Gomes et al., 2019; Lafuente et al., 2017). On the other hand, non-urban systems are often found to be at higher risk of remaining locked into a pre-existing and gradually less competitive industrial structure, which makes them unable to create new synergies in the local value chain and take advantage of the co-located KIBS (Bellandi and Santini, 2019; Sforzi and Boix, 2019). Therefore, two open research questions emerge from this discussion: *why are some local value chains able to enter trajectories of TS and transform themselves into hybrid value chains? What are the drivers of TS?*

Our analysis helps bridge a gap in the TS literature regarding the reasons why territories characterized by a well-established local value chain may fall into a suboptimal trajectory of TS. Consistently with this approach, the aim of the paper is to examine the effect of KIBS and manufacturing co-location on the productivity of manufacturing firms under different local structural conditions. Specifically, in the theoretical background, we discuss the role of KIBS in urban and non-urban local settings and propose an in-depth investigation of the importance of knowledge cumulated in specialized industrial areas through collective learning processes to boost TS trajectories. This is empirically tested by considering Labour Market Areas (LMAs) as the main unit of analysis.[1] LMAs are functional geographic units, either urban or non-urban, characterized by different levels of specialization. Our sample of 611 Italian LMAs for the period 2014–2018 provides evidence that KIBS and manufacturing co-location is not a sign of TS per se. Indeed, this work discusses and empirically demonstrates that KIBS contribution to manufacturing productivity varies with the type of local setting and knowledge base, with educational levels acting as a moderating factor. Hence, this study contributes to a better understanding of the TS phenomenon, and particularly of the local conditions enabling manufacturing firms to benefit from TS.

The paper is structured as follows. In Section 2, we explore the theoretical background and develop our hypotheses. Section 3 presents data and methodology, whereas Section 4 provides a discussion of the findings of the empirical analysis. We then conclude with theoretical, managerial and policy implications, and directions for future research in Section 5.

2. Theoretical background and hypotheses

2.1. Territorial servitization: the two-way relationship between knowledge-intensive business services (KIBS) and manufacturing firms

Manufacturing firms have historically shown patterns of spatial agglomeration, creating places of localized industry with constellations of independent manufacturing small and medium-sized enterprises (SMEs) specialized in a well-defined phase of a local, decentralized value chain (Becattini, 1990; Porter, 1998; Piore and Sabel, 1986 [2]). These firms have maintained a high degree of productivity and innovation by taking advantage of spillover effects resulting from a thick web of inter-firm relations along the value chain (Jaffe et al., 1993; Acs et al., 1994; Rodríguez-Pose and Crescenzi, 2008).

More recently, these places of industry have undergone extensive structural transformations reflecting the diffused deindustrialization trend and the shift of employment from manufacturing to services in most advanced economies (Rodrik, 2016). While the decrease of manufacturing employment has been accompanied by the decline of those localized industries that were unable to renew their knowledge base outside the traditional manufacturing specialization (OECD, 2019; Hu and Hassink, 2015), the corresponding expansion of services, and particularly of KIBS, has represented a vehicle for a *manufacturing renaissance* in other places (Lafuente et al., 2017, 2019). This is argued to be achieved through the creation of new complementarities between manufacturing and KIBS, which open up new pathways of value creation (Crozet and Milet, 2017; Lafuente et al., 2019; Gomes et al., 2019).

Starting from this evidence, the territorial servitization (TS) literature has explored the complexification of local value chains by looking at the growing synergies between KIBS and manufacturing in areas characterized by high industrial specialization and a high concentration of SMEs (De Propris and Storai, 2019; Horváth and Rabetino, 2019; Sforzi and Boix, 2019; Gomes et al., 2019). Here, TS results from the hybridization of the established local value chain through the growing incorporation of services into the value creation processes of manufacturing firms (Gomes et al., 2019; De Propris and Storai, 2019). This hybridization defines a trajectory of local development that is no longer driven by the evolution of the main industry only, but rather, it depends on the establishment of synergetic and mutually supportive interactions between KIBS and manufacturing (Bellandi and Santini, 2019), which are expected to lead to a manufacturing renaissance of highly industrialized areas. Indeed, by leveraging geographical proximity as a key driver of face-to-face contacts and knowledge spillovers (Audretsch and Feldman, 2004), these cross-industry relationships enable the exploration of new complementarities (Frenken et al., 2007), and thus promote the renewal of the main industry's knowledge base (Lafuente et al., 2017).

As the discussion above suggests, TS is conducive to a renewed division of labour in the local value chain, with territorial development depending on a virtuous self-reinforcing feedback loop between KIBS and manufacturing (Lafuente et al., 2017). On the one hand, manufacturing firms can access KIBS' knowledge including both scientific and technological information, as well as knowledge absorbed and recombined from interactions of KIBS with other sectors (Drejer and Vinding, 2005). Indeed, KIBS often establish relationships with an heterogenous set of actors (e.g., clients, suppliers, universities and

[1] For more details about this functional geographic unit of analysis see Section 3 of this paper and Eurostat: https://ec.europa.eu/eurostat/cros/content/labour-market-areas_en.

[2] Seminal papers at the end of the last century underlined the increasing role of local manufacturing value chains and geographically localized networks of small firms linked through stable sub-contracting relations. These decentralized organizational structures were recognized as an organizational solution for the crisis of standardized mass manufacturing (Williams et al., 1987; Hirst and Zeitlin, 1991).

research institutes), and by way of this strategic position in the system, they can act as bridges between different types of knowledge (Muller and Zenker, 2001). On the other hand, by increasing the competitive advantage of manufacturing firms (Bustinza et al., 2017), agglomerations of KIBS positively affect the location choices of new manufacturers (Horváth and Rabetino, 2019), which in turn are magnets for new KIBS (Lafuente et al., 2017).

However, manufacturing firms can also face tensions and frictions in adjusting their activities and value chain relations for co-creating value with KIBS and delivering product-service systems, and especially when they maintain high levels of specialization in the creation of material artefacts. There are indeed several contributions showing that service-related knowledge may not always circulate effectively throughout the local value chain, impeding optimal TS outcomes in the local system (Bellandi and Santini, 2019; Sforzi and Boix, 2019).

To understand how KIBS and manufacturing engage in the above-mentioned self-reinforcing loop that contributes to territorial development (Lafuente et al., 2017, 2019), a closer look at local structural conditions is required, as discussed in the next Section. In this regard, while Lafuente et al. (2017) are the first formally testing the self-reinforcing loop connecting the two sectors, this study will follow the approach by Horváth and Rabetino (2019) and Bustinza et al. (2019a), (b) and focus on the direct effect of KIBS' proximity on manufacturing productivity, while also acknowledging that human capital availability plays a central role in this specific TS process.

2.2. Local drivers and manufacturing knowledge bases

Drawing on the literature exploring the expansion of KIBS in geographically bounded areas (Corrocher and Cusmano, 2014; Koch and Stahlecker, 2006), we can identify two different structural conditions contributing to new connections between KIBS and manufacturing within the local value chain: i) the type of local setting where these dynamics take place, i.e., urban and non-urban; ii) the type of knowledge base characterizing the local value chain.

2.2.1. KIBS in urban and non-urban contexts

The literature on KIBS has widely affirmed that the type of local setting influences the location decisions of KIBS and the likelihood for them to establish interactions with other local industries (Koch and Stahlecker, 2006). In this regard, TS scholars have analyzed the role of contextual factors in explaining the connection between KIBS and manufacturers from different perspectives, including the local institutional setting (Wyrwich, 2019), the entrepreneurial ecosystem (Horváth and Rabetino, 2019), and the structure of the local productive know-how (Bellandi and Santini, 2019). In the same vein, as observed by Corrocher and Cusmano (2014, p. 1215), "the variety of regional settings represents a variety of conducive environments for KIBS and their contribution to innovative activities in other sectors". However, recent evidence shows that there is still a fundamental decoupling between KIBS and manufacturing, with the former being mostly concentrated in urban areas and the latter populating non-urban, industrial areas (De Propris and Storai, 2019).

The general belief that large metropolitan areas attract higher concentrations of KIBS (Pinto et al., 2015; Vaillant et al., 2012), depends on the greater opportunities for interaction and knowledge exchange that KIBS can benefit from by being part of rich and densely connected subsystems for knowledge creation and exploitation. These knowledge-generating subsystems include a variety of innovative industries, research and educational infrastructure, and the availability of highly qualified labour (Aslesen and Isaksen, 2007; Pinto et al., 2015), generating plentiful processes of division of labour, pluri-specialization, and experimentation (Jacobs, 1969). Furthermore, in view of their position as hubs of dense local and global networking opportunities (Scott and Storper, 2015), urban areas attract a large demand for knowledge-intensive services (Doloreux and Shearmur, 2012).

Although urban areas are usually deemed as the privileged location for KIBS, recent evidence shows that an increasing demand of knowledge-intensive services arises from firms belonging to spatially clustered industries in non-urban areas (Vendrell-Herrero and Wilson, 2017). This is based on the widely accepted view that KIBS are becoming more and more important to restore the competitiveness of manufacturing firms, as also discussed by the extensive empirical evidence focusing on the contribution of a service-oriented business model to various dimensions of manufacturers' performance, including manufacturing productivity (Vaillant et al., 2021), diversification (Bustinza et al., 2019a), and innovative activity (Ciriaci et al., 2015).

In these areas characterized by a critical mass of manufacturing firms and by dense local networking (Bellandi and Santini, 2019; Sforzi and Boix, 2019), spatial, cognitive and cultural proximity supports processes of knowledge sharing and recombination, contributing to incremental learning and innovation (Boschma, 2005). The presence of a resilient industrial base imbued with highly specialized manufacturing competencies, can also promote new entrepreneurial activity depending on local structural conditions, such as the quality of human capital and the availability of vivacious social networks (Horváth and Rabetino, 2019). Such entrepreneurial drive is an intrinsic characteristic of the TS loop, whereby the KIBS sector opens up opportunities for the creation of new manufacturing firms, which in turn support the expansion of the KIBS sector in the area (Lafuente et al., 2017). Therefore, in highly industrialized non-urban areas, the synergies between KIBS and manufacturing create opportunities for pluri-specialization and division of labour originating from the established local value chain (Bellandi and Santini, 2019).

As the discussion above suggests, the expansion of KIBS combined with a resilient manufacturing sector triggers a TS loop in both urban and non-urban areas. By creating local hybrid value chains in these local settings, TS "facilitates local knowledge diffusion and enhances the local impact of manufacturing activity on regional outcomes" (Lafuente et al., 2019: 314). This is achieved by means of the embedded interactions that manufacturers establish with KIBS to enhance their value creation processes. Indeed, interactions with KIBS enable manufacturers to develop a more complete bundle of solutions for their customers, going from physical product offerings to more complex and advanced product-service systems (Gomes et al., 2019). Furthermore, the local hybrid value chain provides servitization opportunities within the organization, with manufacturing firms acquiring stronger inventive capabilities when they are capable of absorbing R&D knowledge from KIBS (Ciriaci et al., 2015).

Based on these considerations, it is expected that relationships with KIBS can boost the competitiveness of manufacturers by helping them shift towards more value-adding, service-oriented activities (Crozet and Milet, 2017), thereby enhancing the productivity of the local industry (Vaillant et al., 2021).

Hp1. KIBS have a positive effect on manufacturing productivity in both urban and non-urban areas.

2.2.2. The role of knowledge bases for territorial servitization

As conduits of knowledge-intensive inputs for other firms (Muller and Zenker, 2001), KIBS flourish in areas where they can engage with a strong and specialized manufacturing sector. However, the purely quantitative agglomeration of KIBS does not suffice for a manufacturing renaissance of the place, as this primarily depends on the emergence of new complementarities between manufacturing and KIBS, renewing opportunities for value creation (Lafuente et al., 2019; Frenken et al., 2007).

Following this approach, it has been widely demonstrated in the TS literature that highly industrialized places show TS outcomes, when they can leverage a high degree of specialized know-how and networking emerging from the distributed and spatially bounded local value chain (Bellandi and Santini, 2019). Being populated by highly interdependent and complementary activities, these areas of localized industry host collective learning processes that benefit from the geographic proximity of related know-hows, contributing to the development of a specialized knowledge base (Boschma, 2005). This is comprised of all the tacit and codified knowledge inputs that are cumulated over time around the same industrial specialization and that are enmeshed in a thick web of local social relations (Jensen et al., 2007; Isaksen, 2015; Bellandi et al., 2018), making this type of knowledge "sticky" and not easily accessible if not by being there (Markusen, 1996).

As suggested by Patel and Pavitt (1997), the composition of knowledge bases determines what the local system can actually produce and what new search trajectories is capable to achieve. In line with this argument, Ciriaci et al. (2015) underline that it is important to investigate the nature of the local knowledge bases to establish which opportunities KIBS have to connect with other industries, create value, and build local hybrid value chains.

Different taxonomies have been proposed to characterize an industry's knowledge base and investigate opportunities for innovation and lock-in within value chains. For example, Hauknes and Knell (2009) have built on the seminal taxonomy proposed by Pavitt (1984) to emphasize the effect of different technological intensities on the opportunities for interaction and knowledge diffusion between two sectors. Using an input-output framework, the authors obtain that the level of technology intensity affects the production, diffusion and use of knowledge between national sectors, with KIBS activities depending heavily on interactions with high-tech (i.e., science-based) manufacturing industries.

Similar studies at the regional level have produced mixed results on the role of technological intensity as a driver of stronger relationships between KIBS and manufacturing. On the one hand, low-tech manufacturing areas are showing a rapid increase of servitization trajectories in recent years (Gomes et al., 2019; Sforzi and Boix, 2019). This trend is especially associated with traditional manufacturing knowledge bases that have reached a maturity stage in their life cycle, and thus resort to the outsourcing of advanced services, such as IT, R&D and management consulting, to re-build their competitive advantage (Strambach, 2001). In these sectors, interactions with KIBS provide access to more costly and cognitively distant knowledge inputs that help compensate for myopic learning processes, thereby renewing value creation among manufacturers (Elche et al., 2021).

On the other hand, several studies highlighted that firms from medium-to-high-tech manufacturing sectors are especially prone to establishing relations with KIBS (García-Quevedo and Mas-Verdú, 2008; Martinez-Fernandez and Miles, 2011). By leveraging their innovative capabilities acquired through internal R&D departments and participation in collaborative networks (Lafuente et al., 2017), large, vertically integrated medium-to-high-tech manufacturers have the necessary absorptive capacity to recognise the value of KIBS as complementors of internal resources (Cohen and Levinthal, 1990). Hence, the knowledge acquired from KIBS is then recombined with internal knowledge to develop more complex services and deliver sophisticated customer solutions (Doloreux and Shearmur, 2012; Liu et al., 2019). Building on these considerations, we assume that greater technological intensity allows the local value chain to create new interdependencies with the local clustering of KIBS, promoting exploratory learning and the expansion of manufacturers' product-service innovative capabilities (Bustinza et al., 2017; March, 1991).

Hp2. The positive effect of the local agglomeration of KIBS on manufacturing productivity increases with the technological intensity of the manufacturing sector.

Investigating TS across regions, Vaillant et al. (2021) argue that KIBS variously contribute to the transformation of the local industry and thus to the productivity of manufacturers, depending on their knowledge intensity and innovation.

To consider the moderating role of KIBS characteristics, prior studies have used KIBS size as a proxy for the propensity of KIBS firms to innovate (Cabigiosu and Campagnolo, 2019; Hidalgo, and Herrera, 2020). This approach resonates with the extensive literature using firm size as a determinant of innovation (Jung and Kwak, 2018), as larger firms are typically found to benefit from a series of advantages, such as greater financial capability to bear the high fixed costs of innovation, economies of scale, and stronger negotiation power allowing them to access resources and appropriate the returns from innovation (Acs and Audretsch, 2003).

Building on this discussion, evidence shows that KIBS are indeed more prone to developing advanced services which are strongly knowledge based, as they grow in size (Strambach, 2001). Furthermore, they are more widely involved in the co-creation process with clients, suppliers and universities, exposing them to various sources of external knowledge that enhance their degree of innovativeness (Hidalgo and Herrera, 2020). In the co-creation process, KIBS and manufacturing firms take both an active role in the creation of value for customers (Sjödin et al., 2016). To this end, business partners engage in interactive relationships to share information on needs and expectations, and to jointly develop more complex, customer-specific product-service solutions. Collaborative relationships and value co-creation have also recently been found to allow the exchange of more advanced technology, thereby increasing productivity in the long run (Aquilani et al., 2020).

Hp3. KIBS size has a positive impact on manufacturing productivity.

The literature emphasizes that knowledge is the most important factor of production in the value creation process of KIBS (Strambach, 2001). Considering that knowledge is not pure information, but it takes different forms, i.e., explicit and codified *versus* implicit and tacit, how KIBS can effectively convey it to manufacturing firms is not trivial (Bellandi and Santini, 2019). Doloreux and Frigon (2020) demonstrated that the higher the level of qualification of the manufacturing firm's human resources, the greater the capability to understand the value and use the content of knowledge-intensive services. In interactions with KIBS, the main explanatory factor of success is often found to be the availability of human capital with a university degree (Horváth and Berbegal-Mirabent, 2020).

As these considerations suggest, the quality of human capital is key to unlock new trajectories of growth via TS (De Propris and Storai, 2019). The meaning of human capital is quite complex, with Costanza and Daly (1992) defining it as "the stock of education, skills, culture and knowledge stored in human beings themselves" (p. 38, *ibidem*). In the regional studies literature, this has long been associated with proximity to universities, in consideration of their role as centres of knowledge production and innovation (Capello and Faggian, 2005). Therefore, highly educated labour, i.e. with University education, can be expected to contribute to the innovativeness of KIBS (Muller and Doloreux, 2009), while also increasing the capacity of manufacturers to engage with advanced services and absorb more complex knowledge from them (Horváth and Rabetino, 2019).

Based on these considerations, it appears that the availability of diversified and educated human capital positively affects the ability of the local system to establish value-creating relationships between KIBS and manufacturing (Corrocher and Cusmano, 2014), thus contributing to the higher productivity of the local industry.

Hp4. The positive effect of KIBS on manufacturing productivity increases with the share of population having a university degree.

3. Data and method

3.1. Research setting and data sources

The Italian production system is characterized by a strong manufacturing sector that has been affected by a radical reconfiguration over the last three decades. In fact, the last official three Business Census editions reveal a sharp decrease of the number of people employed in manufacturing (Fig. 1). The share of people employed in manufacturing enterprises with at least 3 employees went from 37.6% in 2001 to 29% in 2011 and again down to 26% in 2018. On the other hand, the share of people employed in service activities increased by 13% during the same time, representing 64% of the total employment in 2018.

Based on these figures, we consider Italy as an interesting case for our empirical analysis, given that this country is experiencing a major transition of its economic structure following the decline of manufacturing employment.

In order to investigate the effect of KIBS on manufacturing productivity, we test our hypotheses on the contemporary Italian landscape of Labour Market Areas (LMAs).[3]

An LMA is a form of functional geographic unit that identifies sets of contiguous municipalities with a high degree of self-containment of the commuting inflows and outflows at the municipality level. We use the Italian LMA classification obtained through the 2011 Population Census (Istat, 2014).

In the 2011 Census edition, the Italian territory is partitioned into 611 LMAs that can be classified, according to official statistics, into categories and sub-categories according to LMA's prevailing productive specialization, and urban and non-urban nature (Istat, 2015)[4]:

- Non- Urban Made-In-Italy LMAs (Local systems of textile and clothing industries; Hides and leather industries; Machine manufacturing industries; Wood and furniture industries; Agri-food industries; Jewels, glasses and musical instruments);
- Non-Urban Heavy Manufacturing LMAs (Local systems of transport industries, Metals production and processing, Construction materials industries, Petrochemical and pharmaceutical industries);
- Non-manufacturing LMAs, divided into:
  - Urban LMAs (Local urban systems with high specialization,[5] Multi-specialized local urban systems,[6] Predominantly local urban port systems, Non-specialized local urban systems[7]);
  - Non-urban and Non- Manufacturing LMAs (Tourist local systems, Agricultural vocation);
- Non-Urban and Non-specialized local systems.

To identify KIBS firms, we follow the typical classification adopted by the TS literature. Specifically, we base our classification on the North American Industry Classification System (NAICS) codes utilized by Gomes et al. (2019) .[8]

Our data sources include the Italian Business Registers (BR) for employment data at plant level for the year 2007 and the period 2014–2018. For the econometric model, we use plant level economic accounts for the years 2014–2018, drawing on a new statistical register called 'Territorial Structural Business Statistics' Register (T-SBS). The 'T-SBS' is a statistical register which estimates economic account variables at the level of the firm's establishment. The use of plant-level economic micro-data makes it possible to calculate the most accurate value of employment and value added realized by enterprises at the territorial level. This significantly improves previous analyses, as we can now measure labour nominal productivity.[9] Data on education were obtained from the integration of the micro-data of population census and the Italian Ministry of Education, University and Research (MIUR) for the years 2014–2018. In this regard, we selected the working age of resident population, i.e., 15–64, and we aggregated years of education at LMA level.

3.2. Methodology

In the first step of the analysis, we consider urban and non-urban local systems (i.e. 611 LMAs) to calculate descriptive statistics over the period 2014–2018. Specifically, we compare the different Italian LMAs during the economic recovery period, i.e., post-2014 (Istat, 2022), by looking at the variations of the number of employees and value-added for both KIBS and manufacturing. This provides an initial insight of the structural transformations taking place in urban and non-urban areas.

In the second step of the analysis, we apply a regression model to examine the effect of KIBS on manufacturing productivity based on our hypotheses. We first run our model on the entire population, i.e. 611 LMAs, over five years, i.e. 2014-2018. Then, we consider the two main sub-samples, i.e. Made-In-Italy (189 observations in 2014) and Heavy Manufacturing (85 observations), to account for the role of technological intensity in TS trajectories[10]. We use the Made-In-Italy sub-sample to obtain information on low-tech manufacturing, as opposed to Heavy Manufacturing LMAs being largely represented by medium-to-high-tech specializations. The two sub-groups present key differences in terms of their degree of technological intensity. For example, investment per

[3] As described by Istat (2018), in Italy LMAs are released since 1989 based on the commuting data stemming from the 1981 population census. Similar exercises have been replicated for the 1991 and 2001 census. In December 2014, Istat has released LMAs based on 2011 commuting data and the TTWA method stemming from Coombes and Bond (2008). Istat has been working on such method together with Eurostat and members of the Task Force on Harmonised LMAs.

[4] Istat (2015) presents a classification of LMAs based on their economic vocation using 2011 Business Census employment data. The LMAs have been classified into 17 categories which were detected also in 2001 as stable typologies of LMAs over time. The report also groups the resulting categories into urban and non-urban LMAs. LMAs can also include other less extended sectors besides the main industry of specialization. Consistently with Istat's approach to the construction of the abovementioned categories, the territorial development of the area is nonetheless expected to be largely driven by the main industry of specialization (Bellandi et al., 2018).

[5] According to Istat (2015) this group is composed of the following LMAs: Rome (specialized in Air transport, Programming and broadcasting activities, R&D), Milan (editorial activities, Advertising and market research), Ivrea (telecommunications and software), Trieste (insurance and pension funds, and R&D) and Bologna (R&D).

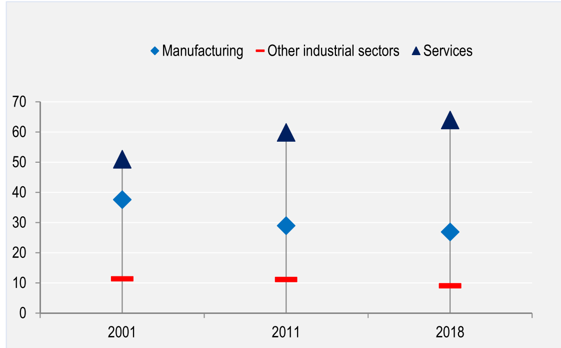
[6] In this group LMAs are simultaneously specialized into both manufacturing and services activities. Examples of these LMAs are Asti, Firenze, Siena, Caserta e Cagliari.

[7] This group of 34 LMAS is featured by 22 administrative centres whose economic relevance in terms of employment is though limited.

[8] Service activities have not the same content in terms of technological knowledge. In this regard, there is a strong attention to take the different classes of services separated. Eurostat metadata supplies a rich description about Knowledge-intensive services (see https://ec.europa.eu/eurostat/cache/metadata/Annexes/htec_esms_an3.pdf). The EC Commission Staff (2009: 17) explicitly defines KIBS for the empirical investigation, Knowledge intensive business services include as Computer and related activities (NACE Rev.1.1 72), Research and development (NACE Rev.1.1 73), Legal, technical and advertising (NACE Rev.1.1 74.1 - 4) which are a part of Knowledge intensive high-tech services and Knowledge intensive market services. According to the European Commission's classification, KIBS encompass a wide range of activities. However, it does not include division NACE 63 'Information service activities' which is crucial to analyze servitization trends. The TS literature applies indeed Wong and He's (2005) classification to determine the economic activities that are classified as services and are relevant to manufacturing companies (Gomes et al., 2019).

[9] The estimate of value added is provided at the territorial level based on the income approach by Eurostat. Under this approach, value added is the summation of three components at establishment level: wages, net operative sales (NOS) and amortisations. This methodology assures that the estimates of value added at the establishment level are consistent with the enterprise level.

[10] Being the different industrial specializations of LMAs time invariant, they cannot be directly applied to the full sample as a control variable. For this reason, we split it in the two main sub-groups and ran separate models for each of them.



Note: other industrial sectors include sections B, D, E, F of NACE codes. Data refer to enterprises with more than 3 persons employed. Source: authors' elaboration on Business Census data, Istat.

Fig. 1. People employed by economic sector. Percentage shares, years 2001, 2011, 2018.

employee and the share of innovative firms in the sector appear to be on average higher in the Heavy Manufacturing group than in the Made-In-Italy one, according to the latest competitivity reports published by Istat. Furthermore, the contribution of large firms to value added is generally above the manufacturing average for Heavy Manufacturing sectors as opposed to Made-In-Italy sectors, suggesting clear organizational differences between the two sub-samples (Istat, 2022).

In our model, we measure the quality of human capital by looking at the average years of education of the working population (15–64 years old) in each LMA. After calculating the average values, we grouped them into three classes of levels of education based on the values of moments of the statistical distribution. We also performed a cluster analysis to minimize variability within groups. Interestingly, intervals are equal to those obtained from the statistical distribution and represent 78% of variance of the YearsOfEducation variable (see Table 3 in the Appendix).[11]

We built a pooled dataset of longitudinal and cross-sectional data. As the nature of cross-sectional and time-series effects is non-random, we apply a fixed-effects model to a balanced panel of LMAs over the years 2014–2018.[12] Specifically, our equation model is:

$$\mathrm{lnManufacturingProd}_{it} = \beta_0 + \beta_1 \mathrm{Years} + \beta_2 \mathrm{lnKIBSsize}_{it} + \beta_3 \mathrm{YearsOfEducation}_{it} + \beta_4\, \mathrm{lnKIBSsize}_{it} * \mathrm{YearsOfEducation}_{it} + \beta_5 \mathrm{RatioKIBSmanuf}_{it} + \beta_6 \mathrm{EmploymentRate}_{\ it} + \gamma_i + \varepsilon_{it} + e_t$$

where $\mathrm{lnManufacturingProd}_{it}$ represents labour nominal productivity in manufacturing (Section C of Eurostat Classification NACE Rev. 2), measured by value added per person employed; Year dummies control for the effect of the economic cycle; $\mathrm{lnKIBSsize}_{it}$ is the average size of KIBS establishments in each LMA; $\mathrm{YearsOfEducation}_{it}$ is the average level of education of the working age population by LMA, expressed in years of education; $\mathrm{RatioKIBSmanuf}_{it}$ is the local clustering of KIBS in the local economic context measured by the percentage ratio of KIBS establishments on manufacturing establishments in each LMA. The terms γ_i, e_t and ε_{it} are respectively the cross-sectional, time series and error variance components. Variables $\mathrm{lnManufacturingProd}_{it}$, and $\mathrm{lnKIBSsize}_{it}$ are expressed in logarithmic scale as heteroscedasticity problems occur with absolute values. Moreover, we use employment rate (EmploymentRate) to control for the time variant economic characteristics of LMAs. Specifically, EmploymentRate is the ratio between 15 and 64 years old employed population and total population of the same age. Main descriptive statistics for each selected variable and Pearson's correlation matrix are presented in Appendix.

The specification for the one-way fixed-effects estimation is $u_{it} = \gamma_i + \varepsilon_{it}$ where the γ_i are non-random parameters to be estimated and the εit are *iid* with zero mean and variance σ_e^2.

Goodness of fit of models is shown by high R squared. Fit diagnostics show quasi-normal distributions of residuals despite the model slightly suffer from heteroscedasticity even after applying log transformations of continuous variables (see Figs. 1, 2 and 3 in Appendix).

4. Analyses and results

4.1. Descriptive statistics

To understand the evolution of KIBS and manufacturing within urban and non-urban LMAs, we first consider employment and value-added variations in the period 2014–2018, using 2014 as the baseline year.

Figures show that KIBS employment across LMAs has performed better than manufacturing in the post-crisis period (Table 1a). During this time, KIBS employment has overall increased by 17% in relation to 2014, while manufacturing has shown a moderate increase of 2.5%, revealing an ongoing restructuring process of the Italian economic system. The main features of this restructuring process describe the evolution of mature economies, where the expansion of the services sector over manufacturing tends to be combined with an overall increase of the demand for advanced competencies in the value creation process of manufacturing firms (Rodrik, 2016). As a result, both services and manufacturing sectors experience an increase of value added, which is also observed in relation to the Italian economy, where value added has grown by 19% for KIBS and by 18% for manufacturing from 2014 (Table 1b).

These trends are relatively homogeneous across LMAs. On the one hand, we can see that KIBS employment has grown significantly across LMAs from 2014, compared to the more sluggish recovery of manufacturing employment. On the other hand, value added has conspicuously increased for both KIBS and manufacturing sectors in the same period, revealing a shift of the Italian economy towards more knowledge-intensive, value-adding activities.

Some manufacturing LMAs have performed exceptional variations of manufacturing value-added between 2014 and 2018, coupled with a remarkable vitality of the KIBS sector. For example, Transport industries LMAs registered an extraordinary increase of manufacturing value-added by 32%. This has been accompanied by a moderate increase of

[11] We performed a Kmeans partition cluster analysis by using Euclidean distance as a similarity measure to create groups and check the extreme values of the interval. The choice of the number of groups, three in our case, is based on the Elbow criterion, with the selected number of groups corresponding to the highest explained variance. See Appendix for statistics on the distribution of the *YearsOfEducation* variable.

[12] A Hausman test rejects the null hypothesis of random effects with 5% interval confidence, therefore we apply a fixed effect model as estimates consistent. The F Test suggests using a fixed effects model as we reject the null hypothesis that the coefficients for all years are jointly equal to zero.

Table 1a
Index number of KIBS and Manufacturing employment by type of LMA (base line year 2014 = 100).

Type of LMA	KIBS				Manufacturing			
	2015	2016	2017	2018	2015	2016	2017	2018
Urban LMAs								
Local urban systems with high specialization	105.3	109.9	113.3	117.9	98.5	100.4	101.3	102.5
Multi-specialized local urban systems	103.0	108.5	113.0	117.1	98.3	99.4	100.4	102.1
Predominantly local urban port systems	102.4	107.0	110.4	112.8	98.3	100.3	100.9	102.0
Non-specialized local urban systems	100.8	103.6	109.0	113.1	98.5	100.7	100.9	102.8
Other non-manufacturing systems								
Tourist local systems	102.2	104.7	109.2	111.7	99.2	100.8	101.8	104.3
Agricultural vocation	102.8	98.4	109.4	112.3	99.5	98.3	101.3	101.6
Manufacturing – Made in Italy systems								
Textile and clothing industries	104.2	109.1	113.0	116.9	99.7	101.3	102.5	103.3
Hides and leather industries	102.2	107.4	113.4	117.8	97.9	98.3	100.3	101.6
Machine manufacturing industries	102.2	104.6	112.3	117.8	98.7	99.1	100.0	101.8
Wood and furniture industries	103.0	106.4	112.7	117.2	98.8	100.7	102.2	104.0
Agro-food industries	104.3	108.6	115.0	118.8	99.5	102.0	103.3	104.2
Jewels, glasses and musical instruments	104.3	111.1	115.0	119.7	100.0	101.0	103.1	105.2
Heavy manufacturing systems								
Local systems of transport industries	104.1	108.6	115.6	119.0	101.2	101.5	101.8	102.1
Metals production and processing	104.2	107.3	115.6	120.4	99.1	99.3	99.8	100.6
Construction materials industries	103.6	105.4	113.9	115.8	99.7	100.8	100.7	101.5
Petrochemical and pharmaceutical industries	103.2	106.6	112.3	117.1	99.2	99.6	100.5	101.5
Non-specialized local systems	103.3	109.4	112.4	113.8	101.0	105.4	106.2	106.8
TOTAL	103.7	108.0	112.8	116.9	99.0	100.3	101.3	102.5

Source: Data have been processed on ASIA - ISTAT archives (2014, 2015, 2016, 2017, 2018).

Table 1b
Index numbers of KIBS and Manufacturing value added by type of LMA (base line year 2014 = 100).

Type of LMA	KIBS				Manufacturing			
	2015	2016	2017	2018	2015	2016	2017	2018
Urban LMAs								
Local urban systems with high specialization	104.9	110.4	113.6	118.9	105.6	112.3	115.5	118.0
Multi-specialized local urban systems	106.0	112.1	115.4	121.7	100.7	105.1	109.9	113.4
Predominantly local urban port systems	102.2	102.3	107.4	110.1	100.7	109.9	115.9	115.5
Non-specialized local urban systems	101.5	100.9	107.3	113.9	103.4	110.0	112.8	118.0
Other non-manufacturing systems								
Tourist local systems	103.7	107.3	114.3	121.3	103.2	106.0	111.8	116.2
Agricultural vocation	104.4	102.6	105.7	112.5	103.3	109.5	105.9	113.1
Manufacturing – Made in Italy systems								
Textile and clothing industries	105.4	109.6	115.4	121.5	102.3	106.4	108.8	112.0
Hides and leather industries	102.1	109.2	114.8	120.1	100.2	100.9	108.1	112.1
Machine manufacturing industries	101.6	106.7	114.2	123.7	102.6	107.6	113.7	117.1
Wood and furniture industries	101.5	105.9	114.4	122.0	106.0	115.0	117.3	123.0
Agro-food industries	105.7	110.6	119.1	128.4	103.8	111.8	112.7	115.7
Jewels, glasses and musical instruments	103.1	111.9	116.1	119.0	104.7	107.6	114.9	121.4
Heavy manufacturing systems								
Local systems of transport industries	104.5	108.4	117.4	119.8	111.2	120.7	129.3	132.3
Metals production and processing	101.9	105.9	114.9	120.8	102.5	108.2	114.9	117.1
Construction materials industries	103.3	103.8	114.1	119.8	107.9	118.1	112.2	116.3
Petrochemical and pharmaceutical industries	101.3	105.4	113.1	117.8	109.8	115.6	119.9	123.5
Non-specialized local systems	104.9	109.0	113.9	116.6	108.6	114.2	113.1	119.7
TOTAL	104.2	108.7	113.7	119.1	104.3	110.3	114.6	117.9

Source: Data have been processed on Territorial-SBS archives (2014, 2015, 2016, 2017, 2018).

manufacturing employment by 2% only, whereas KIBS employment has grown by 19%, corresponding to one of the highest positive variations across LMAs. In Wood and furniture LMAs, manufacturing value-added increased by 23%, with the KIBS sector also being high-performing and registering an increase of value-added by 22% and an increase of employment by 17,2% in 2018.

These results give us some important preliminary information on the two variables affecting the productivity of manufacturing, i.e. value-added and employees. In this regard, data suggests an overall increase of manufacturing productivity from 2014 to 2018, which is driven by a more than proportionate increase of value added over employment in the same recovery period.

4.2. A LMA-based panel data analysis

The panel data analysis over the 2014–2018 time period highlights the role of KIBS in determining manufacturing productivity, while also taking into account other place-specific characteristics (e.g. the type of local setting, the industry of specialization, the quality of human capital). These effects are found to be different according to the sub-groups of specialization that are being examined (Table 2). To interpret the results of the three models (i.e. full sample of LMAs, Made-in-Italy LMAs and Heavy Manufacturing LMAs), we calculated the average effects of the regressors, as required following the introduction of non-linearity (i.

Table 2
Panel data analysis over the period 2014–2018.

Dependent Variable	Manufacturing productivity *(ln)*		
Estimator	Fixed-effects regression		
Variable	Full model	Made in Italy	Heavy manufacturing
KIBS Size *(ln)*	0.0322	−0.0295	0.3594**
	(0.0506)	(0.0479)	(0.1398)
Years of education 2 (15–64 population)	−0.0251	−0.0493*	0.1603
	(0.0315)	(0.0267)	(0.1035)
Years of education 3 (15–64 population)	−0.1450***	−0.0502	0.0421
	(0.0415)	(0.0390)	(0.1198)
KIBS size *(ln)* * Years of education 2	0.0303	0.0812**	−0.2430*
	(0.0519)	(0.0412)	(0.1393)
KIBS size *(ln)* * Years of education 3	0.2216***	0.0960	−0.0559
	(0.0638)	(0.0592)	(0.1492)
Ratio of KIBS over manufacturing	0.0001	−0.0005	0.0020**
	(0.0003)	(0.0004)	(0.0008)
Employment rate	0.0191***	−0.0009	0.0093
	(0.0048)	(0.0041)	(0.0104)
Year dummy (2015)	0.0416***	0.0518***	0.0289
	(0.0089)	(0.0072)	(0.0196)
Year dummy (2016)	0.0533***	0.0831***	0.0573**
	(0.0104)	(0.0089)	(0.0245)
Year dummy (2017)	0.0520***	0.1120***	0.0768**
	(0.0127)	(0.0111)	(0.0326)
Year dummy (2018)	0.0804***	0.1442***	0.0447
	(0.0158)	(0.0146)	(0.0400)
Intercept	9.7156***	10.8814***	9.7995***
	(0.2134)	(0.2029)	(0.5290)
Observations	3044	944	424
R^2	0.109	0.410	0.272

Note: Standard errors in parentheses. The reported significance levels are: ***p < 0.01, **p < 0.05, *p < 0.1. R^2 is the overall statistic.

e. interaction term) in the regression model.[13]

In all our models, year dummies capture the effect of the economic cycle for each post-crisis year since 2014. The significant and growing parameters reflect the positive trend of the Italian economy since the double-deep recession, showing the highest value in the last year of our time period (2018). Therefore, the use of year dummies allows us to interpret the other variables, net of such cycle effect.

In our first model including the full sample of 611 urban and non-urban Italian LMAs, KIBS size does not significantly impact on manufacturing productivity. Furthermore, the average effect of the highest level of education on manufacturing productivity is significant, but overall slightly negative. However, if we look at the relation between KIBS and human capital given by the interaction term, we obtain that a high level of education exerts a positive and significant effect on manufacturing productivity, as the average size of KIBS establishments increases (see Fig. 1 in Appendix). Particularly, only the highest level of average education is significant (that is, LMAs with an average level of years of education between 11.1 and 12.6) and positive if interacted with KIBS size. This result suggests that the highest effect over manufacturing productivity is related to the presence of relatively larger KIBS as well as of human capital with a higher level of education.[14]

Focusing on the differences between urban and non-urban areas in the same model, our findings reveal that the simultaneous presence of larger KIBS and high education level relates primarily to urban highly specialized and multi-specialized LMAs. Specifically, post-regression descriptive statistics reveal that the totality of urban highly specialized LMAs and 69.7% of multi-specialized LMAs present a positive correlation between manufacturing productivity and the co-presence of larger KIBS and higher educated human capital.

This is consistent with the significant and positive effect of employment rate over productivity, reflecting that these results are strongly driven by LMAs with high levels of economic activity and industrial performance. Here, an increase by 1% in employment rate determines an increase by 1.9% in manufacturing productivity.

If we consider the different degrees of technological intensity, the results related to the two sub-groups present an heterogenous effect of KIBS size and education on manufacturing productivity. Specifically, results for the sub-population of Heavy Manufacturing LMAs show that the increase of KIBS size has a significant and negative effect on manufacturing productivity. However, we find that heavy manufacturing firms might still benefit from the local clustering of KIBS in terms of knowledge spillovers, as demonstrated by a positive and significant effect of KIBS over manufacturing ratio. Considering the large size of heavy manufacturing firms and their overall degree of innovativeness (Istat, 2015, 2022), this result may suggest that firms in this category have indeed superior innovative capabilities that allow them to effectively absorb and recombine the knowledge acquired from the local clustering of KIBS to develop advanced services, which in turn further enhance their critical capabilities and highly specialized knowledge (Bustinza et al., 2019b).

The role of education, as well as its interaction with KIBS size, is not significant for the heavy manufacturing sub-group, with the exception of a slightly negative significant effect of medium levels of education.

Lastly, the sub-population of Made-in-Italy LMAs shows yet another behaviour in relation to how manufacturing can benefit from co-location with KIBS. Here, we observe that the beta coefficient of the interaction term between KIBS size and years of education is statistically significant and positive for middle average education levels (that is, between 10.7 and 11.1 years of education). In other terms, average KIBS size positively impacts productivity only with medium levels of education.[15] At the same time, the education level matters, if KIBS size is higher than the median value of 1,91 persons employed. This is particularly true for LMAs specialized in Machine manufacturing industries, wood and furniture, textile and clothing, where LMAs with such level of education and KIBS size account for 57,1%, 38,7% and 25,7% of their respective group of specialization.

Based on the findings above, we can affirm that the ability of manufacturers to benefit from KIBS co-location depends heavily on contextual factors, such as the quality of human capital and the level of technological intensity of the main industry. Importantly, this implies that TS is achieved in various ways depending on the structural differences between places, as further detailed below.

With the exception of heavy manufacturing sectors, the results based on the full sample of LMAs and on the Made-In-Italy sub-sample show that KIBS only exert a significant effect on manufacturing productivity, when they are associated with high and medium levels of education in the area respectively. In this regard, the effect of larger KIBS combined with the highest level of education is particularly concentrated in urban areas, consistently with their typical function as hubs of knowledge-intensive sectors and supporting infrastructures (including, higher education institutions). On the other hand, medium levels of education

[13] If there were no interaction term, each explanatory variable would be interpreted as the unique effect on the dependent variable. Instead, the average effect of interacted variables on dependent variable varies according to their values. Therefore, it must be interpreted at their average values. For instance, the effect of KIBS size on manufacturing must be calculated for different levels of *YearsOfEducation*.

[14] As far as marginal effects are concerned, in the model calculated on the full sample of LMAs, manufacturing productivity increases as KIBS size is in the third quartile of the distribution, that is average KIBS size is between 2.15 and 3.41.

[15] Also in this case, partial derivatives allow to calculate the average effect of size of KIBS on manufacturing productivity at different levels of education. In particular, education level must be higher than 9,6 years (high school degree). Positive results are indeed particularly true for the 90th percentile of the distribution of LMAs by level of education.

help unleash the benefits of proximity to KIBS in non-urban areas specialized in traditional, Made-In-Italy sectors. Such result highlights the strategic role of professional schools, which are industry-specific for Made-In-Italy sectors. Based on these findings, we can say that *Hp1* is only conditionally confirmed, depending on the average levels of education in the area and on the degree of technological intensity of the main industry.

A different dynamic is observed in Heavy Manufacturing LMAs, where TS outcomes seem to be driven by the knowledge spillovers generating from a high agglomeration of KIBS over manufacturing locally, that support and augment the internal capabilities of manufacturers for the development and implementation of advanced services. We can thus infer that while medium levels of education are required in Made-In-Italy LMAs for the development of skills and competencies that help manufacturers engage with knowledge-intensive services, the presence of a local agglomeration of KIBS plays a key role in Heavy Manufacturing LMAs instead. This resonates with prior studies observing that firms from sectors with high technological intensity typically have strong internal capabilities for product-service innovation, allowing them to take advantage of knowledge spillovers and networking opportunities (Bustinza et al., 2017). *Hp2* is thus confirmed.

Interestingly, KIBS size does not produce a positive effect on manufacturing productivity on its own, but only when it is considered in relation to the LMA's average level of education. The combination of KIBS size and education is crucial to enable KIBS′ role as facilitators of knowledge creation, accumulation and dissemination within the system, thereby positively affecting manufacturing productivity. This is particularly important for low-tech, Made-In-Italy specializations, demonstrating how important it is for them to embark on TS trajectories to curb the risk of deindustrialization. These results seem to suggest that *Hp3* is not confirmed in all cases, but only when larger KIBS are combined with education levels that fit the characteristics of the local industry. In fact, as also discussed in the previous paragraphs, high levels of education allow for a positive effect of KIBS on manufacturing productivity in areas characterized by high specialization in knowledge-intensive activities (i. e. urban LMAs). However, medium levels of education can also provide the necessary skills and competencies that manufacturers need to benefit from KIBS, as confirmed by the results of Made-In-Italy LMAs. Therefore, *Hp4* is also partially confirmed, depending on the type of local system and the technological intensity of its main industry.

5. Conclusions

5.1. Implications for research and practice

This paper has analyzed the conditions enabling local value chains to transform and incorporate advanced services into existing manufacturing activities to boost value creation. Following the TS approach, service activities, and especially KIBS, are expected to underpin the transformation of local value chains and promote local growth, when they establish virtuous relationships with other manufacturing firms in the area. This leads to new processes of value co-creation that reposition the local value chain into a trajectory of TS (Rabetino et al., 2017; Mahut et al., 2017).

In this paper, we have discussed the role of the type of local setting, i. e. urban or non-urban, and knowledge base – interpreted here in terms of degree of technological intensity – in enabling the synergetic coupling between manufacturing and KIBS. Our analysis shows that the benefits of proximity to KIBS for manufacturers are particularly visible in specialized urban areas, and more interestingly, in non-urban areas with high industrial specialization. This confirms that TS trajectories are more likely to occur in places characterized by specialized knowledge bases and embedded and complex networks.

Building on these results, our study makes a substantial contribution to the literature, by emphasizing that TS is achieved in different ways depending on contextual factors. Indeed, we obtain that the quality of human capital and especially their level of qualification can variously affect TS outcomes, depending on the type of local setting (urban or non-urban) and the degree of technological intensity of the main industry. Therefore, the analysis shows that human capital plays a key role in nurturing skills and competencies for TS, but only to the extent that it resonates with the level and type of qualification required by the local industry. For example, low-tech, Made-in-Italy industries are found to grasp opportunities for TS with medium average levels of education in the area. In these areas, positive interactions between KIBS and manufacturing may be supported by the combination of various forms of training and skill building strategies at the local level, such as the presence of industry-specific vocational programmes, professional schools and long-life learning opportunities.

The level of education does not exert the same role in Heavy Manufacturing industries, where capabilities are expected to be largely developed internally and provide firms with the necessary absorptive capacity to take advantage of the knowledge spillovers arising from the local clustering of KIBS.

Our findings are informative for scholars and policymakers interested in exploring trajectories of manufacturing renaissance (Lafuente et al., 2019). A key contribution of this study is that TS outcomes largely depend on contextual factors, such as the level of technological intensity of the local value chain, the quality of human capital and the type of local setting. This confirms the importance of considering the specificity of the area through place-based developmental policies (Barca et al., 2012).

Given the spectrum of interdependencies affecting TS as emphasized in this study, a closer coordination of policies at national and sub-national level is recommended to fine-tune interventions with contextual factors affecting TS (Andreoni and Chang, 2019). In this regard, previous studies maintain that when manufacturers and KIBS jointly engage in the co-creation of more complex services, tensions may arise in the local value chain that need to be managed at the local level (Bellandi and Santini, 2019). However, an alignment of multilevel policies might also help to efficiently achieve the industrial transformation of the local value chain, if the place has a strong leadership capable of managing existing (and arising) conflicting interests (Bellandi and Santini, 2020).

As demonstrated by this study, to establish positive synergies and sustain manufacturing productivity, local value chains must go through an adjustment of the capabilities available in the area, which largely relies on the build-up of the local labour market (Doloreux and Shearmur, 2012). Therefore, policymakers are advised to design plans of investment in education, that consider the differences between territories and particularly in relation to their main industry. Following this approach, our analysis has proved the role of medium levels of education, corresponding to technical and vocational schools, in promoting TS in traditional manufacturing areas, such as those specialized in Made-In-Italy sectors. Strengthening collaboration between manufacturers and relevant educational infrastructures in these areas (for example, through the co-creation of training programmes) could help build those fields of expertise that are still relatively underdeveloped, such as science, technology, engineering, and math (STEM) skills.

For Heavy Manufacturing sectors where competencies are largely developed in-house, policymakers are advised to adopt initiatives that aim to sustain the growth of the KIBS sector locally and promote local networking, for example by investing in digital and physical infrastructure (Vaillant et al., 2021). KIBS bring indeed new knowledge into the area promoting exploratory learning that is needed for the development of product-service innovations (Bustinza et al., 2017; March, 1991). In line with this view, our analysis suggests that the productivity of heavy-manufacturing firms responds to high agglomerations of KIBS, for they can leverage their internal capabilities to absorb and recombine the knowledge spillovers arising from there.

6. Limitations and directions for future research

The results of this study should be interpreted considering some caveats in the proposed methodology. The distinction between "Made-In-Italy" and "Heavy Manufacturing" sectors does not always correspond to the classification of low-tech and medium-to-high tech sectors proposed by Eurostat. However, based on this classification, we find that 77.4% of employment in the Made in Italy sub-sample is concentrated in low-tech sectors, whereas 71.6% of employment in the Heavy Manufacturing sub-sample can be considered high-tech (Istat, 2015). Furthermore, we believe this is still a good approximation of the different levels of technological intensity of the two groups in terms of level of investment and innovativeness, as also reported in Section 3.2. In this regard, future work could further explore the organizational structure of the local value chain and its impact on TS.

Building on the results of this study, we encourage future research to further explore TS dynamics by considering the heterogeneity of KIBS and their characteristics. As recently suggested by Vaillant et al. (2021), distinctions such as technology-based knowledge-intensive business service (TKIBS) and professional-based knowledge intensive business services (PKIBS) are expected to affect the synergies with manufacturing knowledge bases. Particularly, the role of T-KIBS deserves further attention, as it might support local manufacturers to enter a second generation of TS, where the value creation process is driven by digital technologies, i.e., digital servitization (Sklyar et al., 2019; Mosch et al., 2021).

Moreover, our analysis has used the education levels of LMAs working age population to capture the effect of human capital on TS outcomes. In this regard, the literature has also recognized that specialized competences can also be acquired through forms of learning other than formal education, and yet they can still contribute to innovation and competitiveness at the local level (Bellandi and Santini, 2019). Future research should focus on the different dimensions of human capital allowing a more comprehensive understanding of its moderating role in supporting or hampering TS.

Data availability

The authors do not have permission to share data.

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Appendix

Table 1
NACE Rev. 2 Codes for KIBS (Section K excluded)

NACE 2007 CODE	NACE 2007 DESCRIPTION
2 .4	Support services to forestry
33 .2	Installation of industrial machinery and equipment
52 .29	Other transportation support activities
58 .11	Book publishing
58 .12	Publishing of directories and mailing lists
58 .13	Publishing of newspapers
58 .14	Publishing of journals and periodicals
58 .19	Other publishing activities
58 .21	Publishing of computer games
58 .29	Other software publishing
59 .2	Sound recording and music publishing activities
60 .1	Radio broadcasting
60 .2	Television programming and broadcasting activities
61 .1	Wired telecommunications activities
61 .2	Wireless telecommunications activities
61 .3	Satellite telecommunications activities
61 .9	Other telecommunications activities
62 .01	Computer programming activities
62 .02	Computer consultancy activities
62 .03	Computer facilities management activities
62 .09	Other information technology and computer service activities
63 .11	Data processing, hosting and related activities
63 .12	Web portals
63 .91	News agency activities
63 .99	Other information service activities n.e.c.
68 .1	Buying and selling of own real estate
68 .2	Renting and operating of own or leased real estate
68 .31	Real estate agencies
68 .32	Management of real estate on a fee or contract basis
69 .1	Legal activities
69 .2	Accounting, bookkeeping and auditing activities; tax consultancy
70 .21	Public relations and communication activities
70 .22	Business and other management consultancy activities
71 .11	Architectural activities
71 .12	Engineering activities and related technical consultancy
71 .2	Technical testing and analysis
72 .11	Research and experimental development on biotechnology
72 .19	Other research and experimental development on natural sciences and engineering
72 .2	Research and experimental development on social sciences and humanities
73 .11	Advertising agencies
73 .12	Media representation
73 .2	Market research and public opinion polling

(*continued on next page*)

Table 1 (*continued*)

NACE 2007 CODE	NACE 2007 DESCRIPTION
74 .1	Specialized design activities
74 .2	Photographic activities
74 .3	Translation and interpretation activities
74 .9	Other professional, scientific and technical activities n.e.c.
75	Veterinary activities
77 .11	Renting and leasing of cars and light motor vehicles
77 .12	Renting and leasing of trucks
77 .21	Renting and leasing of recreational and sports goods
77 .22	Renting of video tapes and disks
77 .29	Renting and leasing of other personal and household goods
77 .31	Renting and leasing of agricultural machinery and equipment
77 .32	Renting and leasing of construction and civil engineering machinery and equipment
77 .33	Renting and leasing of office machinery and equipment (including computers)
77 .34	Renting and leasing of water transport equipment
77 .35	Renting and leasing of air transport equipment
77 .39	Renting and leasing of other machinery, equipment and tangible goods n.e.c.
77 .4	Leasing of intellectual property and similar products, except copyrighted works
78 .1	Activities of employment placement agencies
78 .2	Temporary employment agency activities
78 .3	Other human resources provision
80 .1	Private security activities
80 .2	Security systems service activities
80 .3	Investigation activities
81 .1	Combined facilities support activities
82 .11	Combined office administrative service activities
82 .19	Photocopying, document preparation and other specialized office support activities
82 .3	Organization of conventions and trade shows
82 .91	Activities of collection agencies and credit bureaus
82 .99	Other business support service activities n.e.c.
84 .11	General public administration activities
84 .24	Public order and safety activities
85 .6	Educational support activities
88 .1	Social work activities without accommodation for the elderly and disabled
88 .91	Child day-care activities
88 .99	Other social work activities without accommodation n.e.c.
90 .03	Artistic creation
91 .01	Library and archives activities

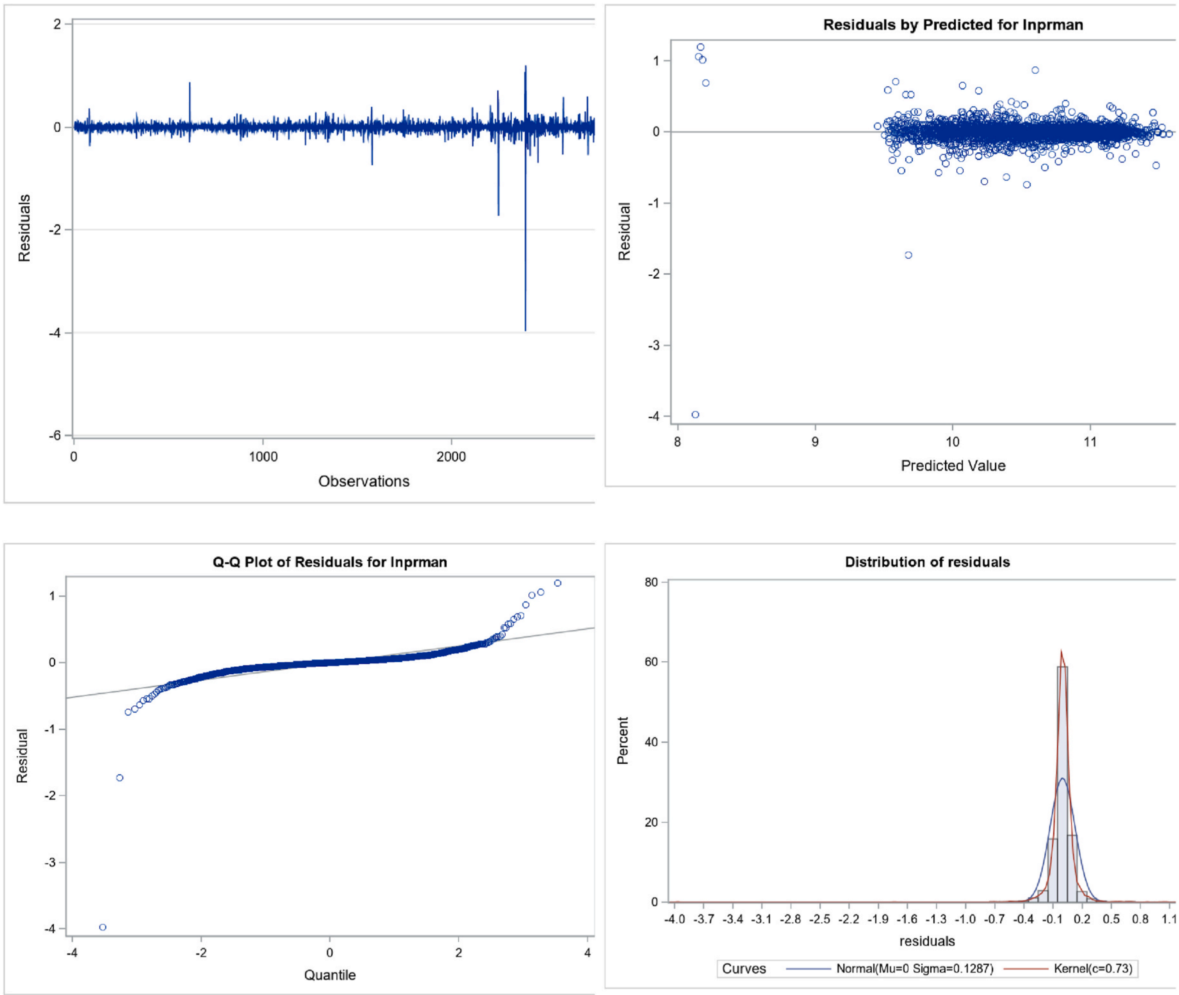

Fig. 1. Fit Diagnostics for the full model

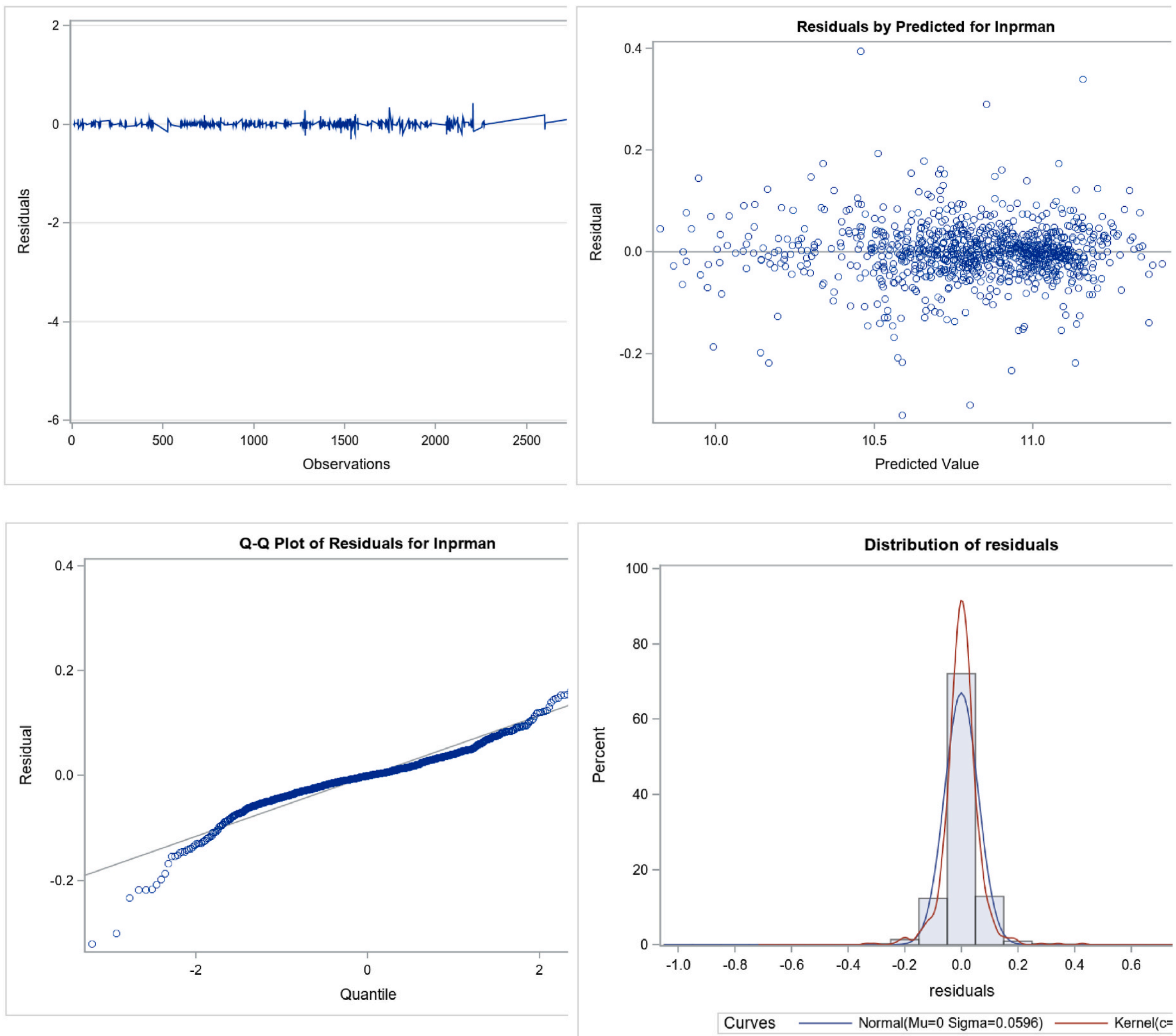

Fig. 2. Fit Diagnostics for the model related to Made-Italy LMAs

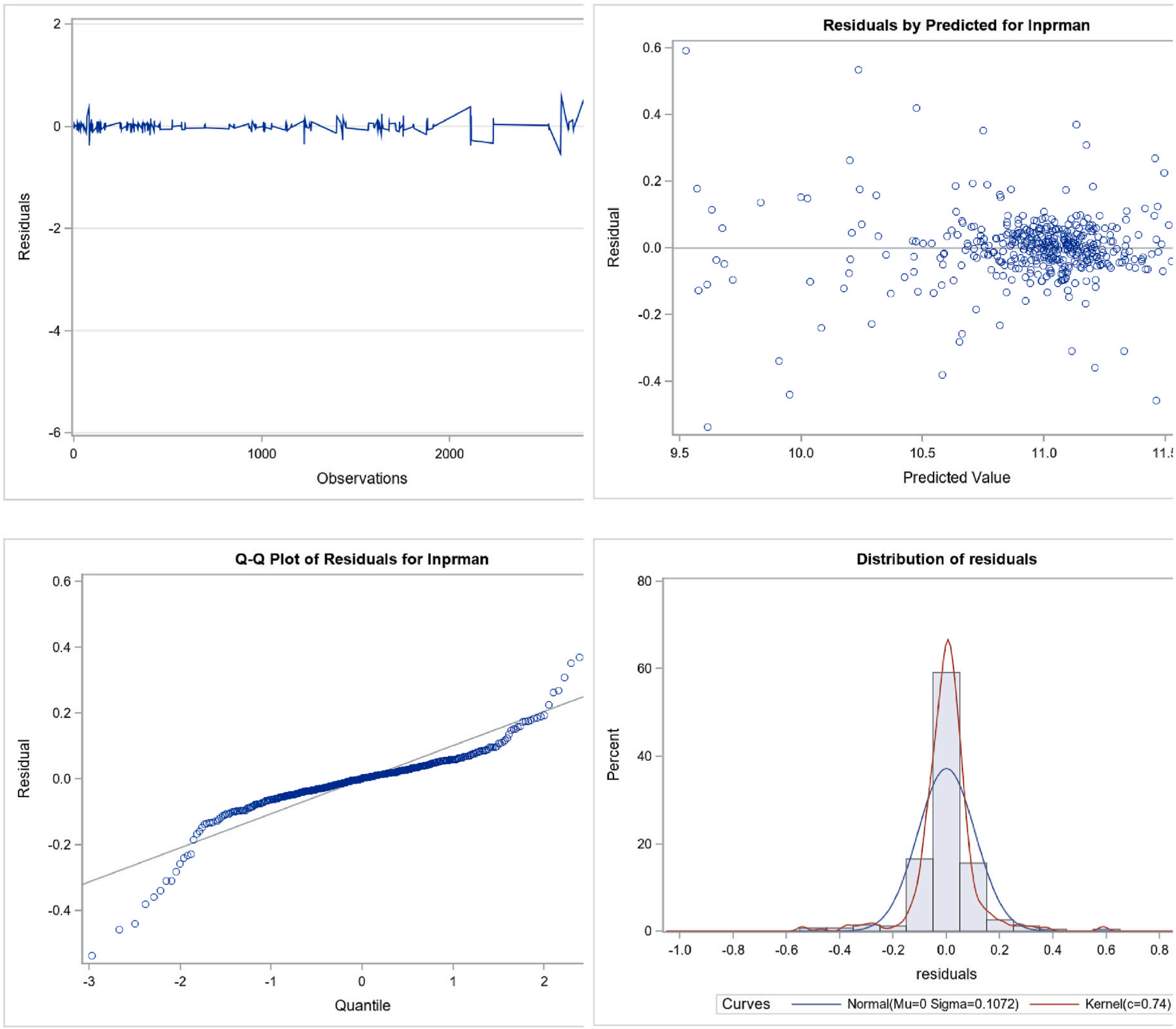

Fig. 3. Fit Diagnostics for the model related to Heavy Manufacturing LMAs

Table 2
Descriptive statistics for the econometric model 2014–2018. Average values for LMA

Variable	Obs	Mean	Std.Dev	Min	Max
Manufacturing Productivity	3054	44,610.5	19,071.3	−50870.8	150,096.2
KIBS size	3054	1.9	0.5	0.9	6.5
Years of education	3046	10.9	0.5	9.3	12.6
Ratio of KIBS over manufacturing	3046	223.6	105.9	45.6	1037
Employment rate	3046	42	8.4	23	62

Table 3
Descriptive statistics for the different classes of education expressed in years of education. Average values for LMA over the period 2014–2018

Years of education (15–64 population)	min	max	Mean
Class 1	9.26	10.67	10.31
Class 2	10.68	11.11	10.89
Class 3	11.11	12.61	11.45
Total	9.26	12.61	10.89

Table 4
Pearson's Correlation matrix

	Manufacturing Productivity (ln)	KIBS size (ln)	Years of education	Ratio of KIBS over manufacturing	Employment rate	Intercept
Manufacturing Productivity (ln)	1.00000	0.57187***	0.30180***	0.14293***	0.65967***	0.58958***
KIBS size (ln)	0.57187***	1.00000	0.24146***	0.21763***	0.44417***	0.99171***
Years of education	0.30180***	0.24146***	1.00000	0.54899***	0.25397***	0.35345***
Ratio of KIBS over manufacturing	0.14293***	0.21763***	0.54899***	1.00000	0.13774***	0.28296***
Employment rate	0.65967***	0.44417***	0.25397***	0.13774***	1.00000	0.45791***
Intercept	0.58958***	0.99171***	0.35345***	0.28296***	0.45791***	1.00000

Note: The reported significance levels are: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

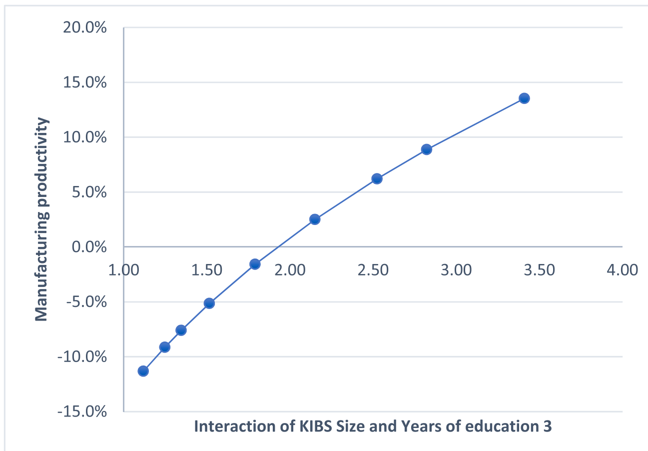

Fig. 4. Effect of years of education (class 3) interacted with KIBS size on manufacturing productivity

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