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Hervás Oliver, J.L.; Estelles Miguel, S.; Mallol-Gasch, G.; Boix-Palomero, J. (2019). A place-based policy for promoting Industry 4.0: the case of the Castellon ceramic tile district. *European Planning Studies*. 27(9):1838-1856.
<https://doi.org/10.1080/09654313.2019.1642855>



The final publication is available at

<https://doi.org/10.1080/09654313.2019.1642855>

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Additional Information

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A place-based policy for promoting Industry 4.0: the case of the Castellon ceramic tile district.

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Abstract: Digitization and its impact on regions and clusters remains overlooked in the literature, and constitute this present paper's goal. How does an industrial district transit collectively to the adoption of new radical changes brought about by Industry 4.0? This study explores the role of collective actors and innovation platforms during the early stages of a pilot policy to stimulate a collective transition of an entire MID (Marshallian Industrial District) into Industry 4.0. We posit that institutional isomorphism and the existent social capital in MIDs is a double-sword phenomenon that can also positively constitute an enabler for fostering change on a collective-basis. Technology transitions, such as Industry 4.0, can be supported and led by collective actors that are central in facilitating the adoption of Industry 4.0 in MIDs, enticing innovative firms to engage in that transition, establishing, legitimizing, and embedding a new set of processes, practices and inter-firm arrangements for digitizing and then promoting imitation: the positive leverage of isomorphism. Thus, MID transition is facilitated through capitalizing on the MID logic of cooperation-competition and isomorphism, by developing and promoting a collective understanding of the new paradigm, building a supportive infrastructure, educating in the new technology and avoiding cognitive inertia.

Key words: Industry 4.0; Marshallian Industrial Districts; clusters; innovation

1.-INTRODUCTION

Following Fitzgerald et al.'s (2014) business-based definition, digital transformation of business is the “use of new digital technologies (social media, mobile, analytics or embedded devices) to enable major business improvements (such as enhancing customer experience, streamlining operations or creating new business models)”. Within the digitization of business, Industry 4.0 encompasses the digitization of manufacturing, constituting the manufacturing-dedicated digitization of business and industries. Industry 4.0 is also known as the *Industrial Internet of Things* and refers to a new paradigm of digital-based manufacturing and industrial inter-firm connected value (e.g., Kagermann et al., 2013). The concept includes different digital enabling technologies, such as *the Internet of Things, Additive Manufacturing, Big Data, Artificial Intelligence, Cloud Computing, Augmented and Virtual Reality, and Block chain*, among others¹.

Despite pioneering efforts on developing conceptualizations and logics of Industry 4.0 in the innovation community (e.g. Müller et al., 2018), innovation policies and their practical application to regions and industrial clusters² remain overlooked in the literature, and constitutes this study's goal. Place-based innovation policies for Industry 4.0 in clusters and regions constitute an emerging research gap. Specifically, we focused on disentangling how a place-based developmental regional industrial strategy is co-created in order to digitize a traditional Marshallian Industrial District (MID). Thus, our research question is as follows: *How does an industrial cluster transit collectively to the adoption of new radical changes brought about by Industry 4.0?*

Due to the recent emergence of the topic Industry 4.0, we present an exploratory study, following an innovation framework from which to theorize on difficulties for clusters to transit when facing radical changes and contextualizing the argumentation on traditional MIDs. For this purpose, first, we position that phenomenon in clusters, our unit of analysis, by drawing on theoretical frameworks of innovation (e.g. Eisengerich et al., 2010; Hervas-Oliver et al., 2018a), isomorphism (DiMaggio and Powell, 1983; Tan et al., 2013) and cognitive inertia (Glasmeier, 1991), arguing that changes from Industry 4.0

¹ See Liao et al., (2017) for an extensive revision of the concept.

² We refer to Marshallian Industrial Districts, those socially-based socio-economic phenomena described in Becattini (1990) and others. Sometimes, however, we use interchangeably the concept of cluster but always referring to MIDs.

present discontinuous innovation incorporating technology-distant and boundary-spanning (to the cluster theme) knowledge, a complicated combination in traditional MIDs, due to the potential lock-in driven by a strong collective identity for legitimization (e.g. Gilbert, 2012; Staber and Sautter, 2011). Beyond its potential propensity toward inertia, however, we posit that institutional isomorphism and the existent social capital in MIDs is a double-sword phenomenon that can also positively constitute an enabler for fostering change on a collective-basis. In other words, the same mechanisms that can promote (negative) inertia, that is to say, too much uniformity and lack of heterogeneity, can also, with the proper policies and collective actions, (positively) foster change and adaptation.

Second, we introduce the potential role of collective actors and experimental place-based policies aimed at promoting change and avoiding cognitive inertia by building on regions' existing capabilities. In this case, we framework the argument assuming that the occurrence of effective policy for collective co-creation is endogenous and inspired by social relations and creative and collective decisions (e.g. Bailey et al., 2018; Feldman and Lowe, 2018).

This study presents and analyzes the early stages of an (ongoing) experimental place-based policy aimed at facilitating a collectively-based transition towards Industry 4.0 in a traditional Marshallian Industrial District (MID). For this purpose, a total of 30 informants directly or indirectly involved in a program were interviewed.

The focal process is an emerging new place-based policy program (CEBRA+, *Ceramic Brain*) designed for Industry 4.0 transition in the Castellon ceramic tile (Spain) MID, covering 2017 and 2018. The setting is chosen because it is currently undergoing a collective process of digitization, being a regional pilot project for Industry 4.0 in traditional low-tech industries and clusters. The ceramic tile industry is a low and medium-low tech setting (ceramic tile production is labeled as low- and medium-low-technology industry, hereinafter LMT) and the Castellon ceramic tile cluster has also been labelled a *Marshallian industrial district* (Hervas-Oliver and Albors-Garrigos, 2009). This characteristic makes the Castellon case different from other types of clusters, making this setting well suited to our purpose. Our research represents an original and pioneering investigation focused on a place-based policy to digitize a traditional MID, a setting where Industry 4.0 represents a radical innovation not yet researched. Thus, findings

could be extended to place-based policies in other peripheral regions and traditional industries and clusters in Europe.

Pursuing this chain of thought, the present study contributes to the cluster literature by dissecting and building insights from an experimental place-based policy based on an endogenous and creative collective action aimed at digitizing a traditional manufacturing MID, contributing to extending our knowledge on effective policies for developing endogenous place-based programs based on collective action and social relations to innovate (e.g. Feldman and Lowe, 2018; Magro and Wilson, 2018). The article also presents contributions to the debates on cognitive inertia and legitimization, building a new perspective on isomorphism that presents its positive *leverage function* in order to facilitate a collective transition to avoid lock-in, building new implications for literature on cluster and regional changes (e.g. Glasmeier, 1991; Gilbert, 2012). Finally, the paper also contributes to the socially-based agglomeration literature (e.g. Piore and Sable, 1984; Becattini, 1990; Hervas-Oliver et al., 2017) by presenting evidence of new policies and mechanisms that reinforce the socio-economic logic that drives innovation in those socio-economic concentrations.

2. LITERATURE REVIEW

2.1-Changes and MID institutional isomorphism: friends or foes?

Institutional isomorphism

Models on technology evolution posit that emergent technologies present an emergence phase where trial and error, experimentation and uncertainty are the norm, up to the creation of a dominant design that is the final technological trajectory imposed over alternative ones (e.g. Anderson and Tushman, 1990). In MIDs, however, the barrier to move from existent lock-in incumbent technologies to new paradigms is, generally, much more difficult, due to the existence of a solid *collective identity* (Staber and Sautter, 2011) and a strong necessity to be *legitimized* in order to access tacit knowledge exchanged in local networks (e.g. Glasmeier, 1991; Langlois and Robertson, 1995; Hervas-Oliver and Albors-Garrigos, 2014), especially because local networks (DiMaggio and Powell, 1983; Deephouse, 1999) diffuse the organizational practices, structures and norms that are

prevalent and *socially* accepted. In MIDs, due to the existent social capital based on trust and repetitive interactions, a collective understanding of collective goods, mental models or, as Staber and Sautter (2011) state a shared understanding of “*Who we are*”, is facilitated. Such a collective identity and understanding drives cluster firms’ isomorphism in order to obtain legitimacy (to access to local networks and tacit knowledge) by deploying similar industrial standards, business practices, culture and norms and thus promoting institutional isomorphism or conforming (in the sense of DiMaggio and Powell, 1983).

According to Hervas-Oliver et al., (2018a), in MIDs existing local networks, however, are the quintessential institutions providing the legitimacy to access tacit knowledge (Scott, 1992:16), being mainly orchestrated by leading firms in MIDs that are said to organize knowledge and networks (e.g. Lorenzoni & Lipparini, 1999), usually avoiding radical innovation in order to maintain their status quo and their central positions in a cluster’s networks (e.g., Allarakhia & Walsh, 2011; Hervas-Oliver and Albors-Garrigos, 2014). Thus, the exchanged tacit knowledge within those networks is supported as long as it maintains leading firms’ centrality. These central actors or anchor tenants feed the networks with knowledge and norms (Lorenzoni and Lipparini,1999) and establish the institutional models and norms in the organization field, provoking, along with other forces, institutional isomorphism. Thus, institutional isomorphism refers to the local environment that constrains and shapes organizations (Hawley, 1968), especially in agglomerations (e.g. Scott, 1995; Deephouse, 1999), increasing similarities among firms and lowering cluster heterogeneity (Pouder and St. John, 1996).

As mentioned above, trust, repetitive inter-firm interactions and other social aspects make SMEs in those networks dependent on the leading knowledge-provider firm or another central actor (a technology transfer office, local university, etc.). Thus, local networks tend to avoid disruptions and thus, in the long term, may promote inertia (Glasmeier, 1991; Pouder and St. John, 1996; Hervas-Oliver et al., 2018), to the extent that in MIDs gradual change is expected but not disruptions, due to the nature of their local networks and institutional conformity context (e.g. Garofoli, 1991; Robertson and Langlois, 1995; Hervas-Oliver, 2016). MIDs, therefore, mainly function and are based on continuous or incremental innovation upon existing local knowledge and, traditionally, have presented a manifested reluctance to change the lock-in incumbent technology (e.g., Glasmeier,

1991; Hervas-Oliver and Albors-Garrigos, 2014; Ostergaard & Park, 2015). In other words, local networks, through the role of anchor tenants, are the circuits where conformity occurs and institutional isomorphism is established and accepted.

Collective identity and the positive leverage function of isomorphism

Beyond this traditional assumption shown above, we posit that a strong identity and institutional isomorphism can also be an asset for facilitating change, as Staber and Sautter (2011) show in the Tuttlingen cluster transition, whereby a manufacturing cluster becomes an international trading cluster.

We argue that, with the right place-based policy, this isomorphism can adopt a positive role, facing changes, acting as a (positive) *change leverage*. In other words, institutional isomorphism in MIDs can be understood as a double-sword phenomenon constituting a positive leverage function enabling change on a collective-basis, beyond its usually assumed negative effect in the form of cognitive inertia. The rationale is based on the idea that a sound place-based policy built upon local context and social relationships can convert the potentially negative into a positive trigger to foster change.

How does it occur? We are not assuming that the strong identity per se is enough. Rather we posit that place-based policies can activate and capitalize on identity in order to influence collective understanding to stimulate change in a certain desired direction. Especially in MIDs, the strong convergence of business practices and the strong shared mental model that stimulates imitation, due to institutional isomorphism, can drive cluster firms towards a negative direction of cognitive inertia, which resists change due to old lock-in mentalities (e.g. Swiss watch-making cluster in Jura, see Glasmeier, 1991). However, that convergence and conformity can also drive cluster firms in a positive direction towards a certain change, leveraging transition and catapulting firms, all together, to the new position envisioned, building a new sub-identity (in this case on Industry 4.0) that fits with the existing one and opens up to change and knowledge heterogeneity creation.

Assuming that Industry 4.0, therefore, presents discontinuous changes from technology-distant and cluster-spanning technology (IT and digital enablers) that go beyond the cluster theme, potential (negative) cognitive inertia may arise. Alternatively, the potential leverage effect of institutional isomorphism may trigger an over-reaction in the opposite

(positive) new direction with a sound, place-based policy that capitalizes on local identity and builds up a new compatible sub-identity that permits change. Who is promoting that positive change? Collective actors and place-based innovation policies.

2.2-Collective actors and place-based innovation policies

How do we solve the potential cognitive inertia of the new digital technologies' acceptance? Collective actors navigate between the interplay of technology and institutions, and even legitimize new industries (e.g. Aldrich and Fiol, 1994). Professional associations and/or public technology transfer offices (TTOs), among others, combine the complex layers of technology, institutions and social aspects (e.g. Van de Ven & Garud, 1993; York et al., 2016) and may constitute collective organizations that support technological transitions such as the emergence of new industries (e.g. Sine and Lee, 2009). In clusters, these collective actors also represent the shared understanding and the collective mindset of clusters, because they shape the norms, rules and other components of the institutional environment in an important way. Collective actors may act as supporting institutions, developing a function of brokerage on clusters, fostering innovation by acting as mediators and facilitators to diffuse knowledge within clusters, connecting the local parts or connecting the cluster to external knowledge³ (e.g. Mesquita, 2007). Also, collective actors can act as technology gatekeepers, introducing new technologies to the local domain (e.g. Bell and Albu, 1999). All in all, these collective actors are agents that can lead and activate place-based policies, as long as the latter are built upon endogenous initiatives that are based on the local context and social relationships.

Collective actors also need to cooperate with policymakers in order to co-create regional advantage, building upon regions' existing advantages, following a place-based regional policy that avoid spatially blinds approaches (Barca et al., 2012; Bailey et al., 2018). Thus, following Bailey et al., (2018) public (policymakers and others such as technology transfer offices or public R&D organizations) and private (organizations, trade associations) actors shape and co-create the regional ecosystem that facilitates entrepreneurial discovery to leverage a region's existing advantage, thereby engendering

³ Adopting the roles of coordinators, interconnectors and gatekeepers. See Belso et al., (2018).

spill-overs. Effective place-based policymaking should enable regional actors to co-create upon existing regional capabilities (products, technologies, etc.), stimulating especially those anchor tenants or regional firms that can activate change.

Offering support to regional firms and organizations, it is also necessary to identify those institutional agents, such as policymakers or trade associations, that are responsible for institutional change, creating or adapting institutions in regions by favoring the mobilization of resources and the design of place-based policies (Alvedalen and Boschma, 2017; Foray, 2016) that facilitate dynamic interactions between different actors and construct successful entrepreneurial regions by strengthening the regional context with proper initiatives (e.g., Mason and Brown, 2014; Stam, 2015). Under this approach, following Bailey et al., (2018), policymakers can act as public entrepreneurs by co-designing with other regional stakeholders and implementing strategies for sustainable capture of co-created value. In fact, this place-based and institutional-changing orientation may prevent policy isomorphism, where policymakers mimic each other without considering a region's existing advantages and capabilities.

Following this chain of thought, place-based policies (e.g. Barca, 2009), refer to mechanisms built upon associative structures of governance that are bottom-up, decentralized, open, consultative, facilitating coupling and coordination of actors, and including private and public stakeholders that share a collective understanding of a territory's strategic needs and priorities. Effective policies are bottom-up, endogenous and the result of negotiations, adaptations and incremental changes in response to changing conditions, which are constructed upon creative actions and collective decisions that take into account local social conditions and the interactions of actors in the policy. These policies encourage, as Magro and Wilson (2018) state, different stakeholders to bring ideas, new solutions and debate to frame and reframe the problem, finding new ways of doing things based on the complementarities generated in the insights from bottom-up, collaboration policy design. The involvement of all the different stakeholders and their participation in the decision-making process, also permits implication and engagement in the solution process, reinforcing collaboration and strengthening the different yet related views and perspectives to solve problems and learn. All in all, place-based policies need to consider institutional change that facilitates collective action aimed at transforming regions through building upon their existing capabilities.

To sum up, we posit that technology transitions in MIDs, such as that originated by Industry 4.0, can be supported and led by public and private actors aimed at inducing institutional change that facilitates collective action and builds upon existing regional capabilities, reinforcing the regional ecosystem. Public and private co-creation of place-based developmental regional industrial strategies facilitate new entrepreneurial discoveries for constructing regional advantage. Policymakers are key actors that, along with other public and private ones, can influence existing institutions in order to facilitate change and avoid cognitive inertia.

3.-The case study: understanding a place-based industrial strategy for digitizing a Marshallian Industrial District.

3.1-Methods

To answer the research question, we carried out an inductive case study of the design, development and application of a place-based industrial strategy (CEBRA+, *Ceramic Brain*) composed of public and private actors around the development of a digital manufacturing platform for demonstration, aimed at facilitating transition to Industry 4.0 in the Castellon ceramic tile district, as explained below. We analyzed it during the period 2017-2018. We performed an analysis of reports and press releases on the platform, attended the diffusion seminars and also interviewed 30 informants from the private (12) (ASCER and Colorker) and public (5) (IVACE and ITC) actors that co-designed the digital platform fostering transition into digital manufacturing in the Castellon MID. Informants also included IT digitally-dedicated firms supporting the transition (6) and cluster firms (7). See below for more details. See Table 1.

Table 1. Informants from interviews

	Colorker	ASCER	IVACE	ITC	IT companies supporting	Cluster companies	Total informants
Engineers and top executives	5			1			
Officials and representatives			2				
Researchers and scientists	2			2			
Representatives		5					
IT and engineers					6		
CEOs*						7	
Total	7	5	2	3	6	7	30

Source: own; *not involved, but cluster firms participating in interviews as users or interested on the manufacturing platform in the second stage of diffusion.

3.2-A quick presentation of the MID: Castellon ceramic tile district.

The Castellon (Valencia Region, Spain) ceramic tile cluster is a typical MID, a leading manufacturer of ceramic tiles in Europe and representing more than 95% of the production of ceramic tiles in Spain. It is well-endowed with world-class public R&D organisations (Institute of Ceramic Technology, ITC), educational centres such as the local university (Universitat Jaume I), and private institutions such as trade associations (ASCER), all of which are focused on ceramic tiles, supporting the local cluster.⁴ The Castellon frit and glaze (chemistry for tile coverings) industry is the most powerful auxiliary industry in the Castellon cluster and is the absolute world leader⁵ in the frit and glaze activity for tiles, having extensive operations in other clusters worldwide. A crucial part of the “innovation engine”, and the true strength of the Castellon cluster, is its *systemic behaviour*, exemplified by the inter-organisational interaction of the ITC, within the Jaume I Universitat, the frit and glaze (chemistry) subsector and the ceramic tile producers. This mechanism of innovation dissemination is very difficult to replicate elsewhere (Meyer-Stamer et al., 2004). See more facts about the cluster in Table 2.

Table 2 Overview of Castellon tile district

⁴ The agglomeration index for Castellon is reported to be around 4.5 (450%) (See Hervas-Oliver et al., 2018a). See more at Gabaldon-Estevan et al., (2018).

⁵ In 2014, 26 Castellon frit firms exported around 66% of their total production valued at 1.2 billion Euros, and employed around 3,400 workers (Anffecc, 2014). Five of them account for 75% of those exports, the leading group. See www.anffecc.es (<http://www.anffecc.com/es/cifras-del-sector>).

Variables	Castellon (Spain, Valencia Region)
Firms and employees	Around 120 tile firms in 2018 (200 in total, counting auxiliary industry) 20,000 employees in 2018 Production of 560 million of square meters in 2018 (no.1 in Europe) Traditionally SMEs firms (co-existing with multinationals, both foreign and indigenous)
Export intensity and markets	80% of exports in 2017 (70% in 2018, as national market has rebounded) First European producer and second most export-led cluster in relative terms as % of production Main markets are Europe, Asia and USA (France, USA, UK or Israel, among the top). Around 50% to Europe, 24% Asia and 14% USA
Local institutions	Very comprehensive array of supporting local institutions: world-class public R&D centre (ITC), local university focused on engineering for ceramics (UJI), powerful trade associations (ASCER), etc. ITC is the leading ceramic R&D centre in the world. QUALICER world-class congress on manufacturing/chemistry for ceramics

Source: own elaboration, based on Ascer and Assopiastrelle, from Hervas-Oliver et al., 2017.

3.3-A place-based program for Industry 4.0

The undertaking of the focal policy is the result of the *Digital Agenda i4.0* launched in the Valencia Region in 2017, suggesting the necessity to facilitate digitization, especially in clusters. The *Valencian Business and Competitiveness Regional Agency (IVACE)* decided to test that potential change on one of the most advanced LMT industries, the Castellon ceramic tile district, initiating the IMDEEA/2017/59 – CEBRA+ (*Ceramic Brain*) program to test a place-based industrial strategy towards digitization⁶. IVACE used FEDER funding to support the program and promote the formation of an *ad-hoc* task force involving private and public actors from the cluster itself, developing a bottom-up approach to deliver a bespoke program on that particular setting, co-creating with other public and private actors and building upon the cluster's existing capabilities.

The aim of CEBRA+ was to develop a new technology dominant design in order to collectively promote digitization in that industrial district. Overall, we distinguish three type of actors involved in the place-based initiative: (i) the collective actors (ASCER, the regional trade association and ITC, a public research organization that provides R&D to the cluster), that cooperate with IVACE in order to change technology and institutions,

⁶ <http://www.colorker.com/eng/new/colorker-pioneering-industry-40>

(ii) the firms of the emergent digital design (e.g. IT digitally-dedicated firms) that support transition to digital manufacturing and, (iii) the cluster firms that potentially can access that knowledge once developed. For that purpose, the ITC designed and set up a manufacturing demonstration platform, committed to developing, testing and eventually diffusing digital manufacturing technology for ceramic tile, enrolling an anchor tenant and one of the most innovative companies from the district (Colorker SA). This program, and the digital platform, in its *first stage* it is aimed at producing a tentative dominant design introducing digital technologies. In its *second stage*, it has to diffuse the technological architecture to digitize production of ceramic tiles.

The agreement of the CEBRA+ program consisted of fully developing the digitization of manufacturing tiles at Colorker, as a real testbed, financially supported by IVACE (policymaker), in exchange for opening up the platform and performing demonstrations to local firms in the cluster, to its local competitors (supervised by the ITC). ASCER, the private ceramic tile trade association, was the liaison between ITC and Colorker, and facilitated the creation of forums and meetings in order to diffuse the initiative. The leading innovation firm (Colorker) acts as developer and “demonstrator” (competitors are welcome to have a look!) in order to show digitization advances to the rest of the industrial cluster. The technology program has also been described by the world-class authoritative ceramic magazine (*Ceramic World Review*) as the first ceramic revolution in Industry 4.0⁷. Once the program is introduced, we decipher the role and actions of the different actors involved in it.

3.3.1- The role of collective actors: leadership, cooperation and place-based co-design

Firms interviewed agreed that collective actors (public ITC and the private ASCER) made possible the initiation of the (place-based policy) manufacturing platform for digital production of tiles. According to informants, the leadership of the collective actors has been key to the design of the new initiative. Also, the design of the initiative, transferring local business needs to policymakers (IVACE) was crucial for launching a real place-based policy, transforming a general initiative (digitizing) into a ceramic-specific demand

⁷ Ceramic World Review 128/2018, pp. 12-126

and tailoring it to the ceramic tile district's requirements. Quotes from interviews reflect that:

"The involvement of ASCER and the ITC has given legitimacy to the digital program (a Colorker engineer).

"ASCER, was very active in promoting the change, arranging events and seminars on the topic....."
(Company C).

"Yes, ASCER is preaching how important the change to digital is continuously....." (Company D).

"I think the ITC is the key actor, capable of designing the plan for showing us how to turn manufacturing into digital, who else can do that?" (Company E)

"Without the involvement and leadership of ITC and ASCER, only the leading firms would look at digital manufacturing of tiles, they are the organizations that know better what we need and how to get it done, policymakers only know the theory, not our real business....." (Company F).

"It is clear that the ITC is playing a major role in leading the (CEBRA) project.....thanks to them the involvement of the Regional Government has been timely and generous.....we are acting as a block in that matter.....and this cluster looks like being the one leading the change in the Valencian Region, supposedly behind the automotive cluster...." (a Colorker engineer).

IVACE (policymaker) agrees with the fact that the Ceramic district was a good testbed for the digitization of manufacturing in the Region, emphasizing the endogenous and bottom-up character of the policy initiative that was based on consensus by negotiating with the ceramic tile collective actors (ITC and ASCER). IVACE also did recognize that for digitizing it is necessary to contextualize on place. All the collective actors agreed on the necessity to build consensus with policymakers:

As officials at IVACE stated during the interviews:

"Industry 4.0 is a nascent complex issue, as the richness of industries (from footwear to ceramic tiles, automobiles or chemistry) need to be taken into account, and all of which demand specific and made-to-order digitization policies. The different degrees of concentration, historical roots and current positions, all demand new trial-and-error policies and instruments from which to learn from. We are learning from automobiles, and then passing that knowledge on to ceramic tiles, waiting to see how new steps (footwear, plastics or furniture) can be approached. A bottom-up process and flat structure, where local actors

participate and make suggestions, facilitates governance and ongoing evaluation..... All this is totally exploratory, let's see what happens....” (IVACE representative).

“...the attraction of this digital program is based on the fact that it is totally endogenous and bottom-up, based on trial and error and the empowerment of the cluster actors. We sought a consensus-based approach” (IVACE representative).

“Yes, since the beginning IVACE asked us what to do to digitize ceramics.....we (ITC) suggested the demonstration manufacturing platform, as a way to show the new digital technology and testing it in a real environment.....also, it was important that we wanted to diffuse it for local companies' imitation....yes, they need to see the future....” (CEO of ITC).

“The policy has been designed by cluster actors, we (ASCER), ITC, and the IVACE agreed with the idea of the demonstration platform, we (ASCER) realized how important it could be,.....and we contribute as much as possible, suggesting different local firms for testing the new technology.....; we continuously promote events and seminars for that purpose...”. (ASCER representative).

Therefore, the role of collective actors from the district, along with policymakers, was crucial to cooperate and co-create regional advantage, seeking consensus and co-creating with policymakers the place-based development regional strategy for capturing co-created value from digitizing manufacturing in the district. Collective actors' leadership and endogenous bottom-up cooperation and co-creation with policymakers turned out to be key ingredients of the place-based initiative for building on specific existing regional advantage. This cooperative initiative between public and private actors, all together, promotes and reinforces a new digital logic for the cluster, fostering cooperation and competition for Industry 4.0 introduction in the district, and trying to avoid cognitive inertia by attempting to overcome the strong character of MID functioning that is primarily rooted in non-radical changes and prone to suffer lock-in (e.g. Glasmeier, 1991; Hervas-Oliver et al., 2018b), signaling the necessity to search beyond cluster themes (incumbent lock-in technologies and paradigms).

3.3.2-Social capital and diffusion

The CEBRA+ program not only seeks digital manufacturing development, but also diffusion among firms in the MID and, eventually, adoption of the new technology. The digital initiative launched by IVACE, led by ITC and supported and facilitated by

ASCER, a trade association formed by local ceramic tile-dedicated firms that simultaneously cooperate and compete, represents an endogenous initiative built upon collective action and social relations, to the extent that the eventual goal is to diffuse the new technology locally, attempting to avoid inertia in the district. The social relations and the cooperative basis of the industrial district are seen in the interviews as a main cornerstone underpinning and facilitating the initiative. The quotes point out this social component as follows:

“The cooperation we see in this cluster, far beyond just subcontracting or arranging their own fair trade, make the perfect context in order to test the demonstration platform for 4.0....., I do not think that the same pilot project can be replicated in other industries with that collective sense of cooperation....” (ASCER representative).

“For the important things, the cluster acts as a block....we (ITC) have seen this before in energy, regulation and other issues....it is the social basis existent in the cluster....all of them have good relationships and trust is an important asset of this local spot...” (ITC representative)

“We share at ASCER the idea that the new digital tide is paramount....; ASCER decided that Colorker could develop the platform...they can do that job...no matter whether we all also compete among each other, this is a very important issue and we all understand the importance of cooperation for developing advantage.....” (Company A).

The digital demonstration platform case was presented in QUALICER, the world-class leading congress on manufacturing and chemistry for ceramics, in February of 2018, with 456 international attendants from the industry. Other local seminars in the cluster organized by ASCER were also held throughout 2018, counting all together for more than 300 attendants from the industry.

Up to May 2019, the firm has performed up to 20 technical demonstrations. As quoted from the interviews:

“The demonstrations are informal, there is no contract or signature. ITC supervises them at Colorker and facilitates the visit. It is part of the agreement for developing the infrastructure there at Colorker” (ITC representative).

“Definitively, this district’s social relations facilitate cooperation for different matters, and the digital program is one of them.....all firms will gain with the CEBRA program, no matter which company develops it....it is really a common good” (Company D)

“In this industry companies share a collective vision and for the really important things they do cooperate, as in this case. The attraction is that the CEBRA program is paid by IVACE, yes, and developed at Colorker.....but all firms can see how it works...it is like an open-door program where all can see what’s going on...this is due to the social relations existent in the district... the capability to develop a shared goal.....” (ASCER)

As mentioned above, cooperation (along with competition) is a very important characteristic of the Castellon MID. From the interviews we noticed that existing social relations, strong collective identity and a shared vision, all together, facilitated the shared understanding of all stakeholders (the collective actors, firms and policymakers). All in all, the existing consensus-basis and social relations enabled the co-design and co-development of digital collective action. As pointed out in the literature, the social capital existing in the district (e.g. Hervas-Oliver et al., 2017) has traditionally facilitated cooperation between collective actors, but also among district firms themselves, enabling collective action that supports collective-oriented programs, such as the CEBRA+ one.

3.3.3-Promoting awareness: building a new sub-identity

Beyond those events (seminars, congresses, the digital platform, etc.), the cluster has been exposed to all the most important details about how to undertake the new digital process. The most important thing is that the policy (CEBRA+) is legitimizing change, building a new sub-identity (digital manufacturing) which is compatible with the existing collective identity. As observed in the interviews, companies agreed that the industry representatives are enabling change and promoting awareness of the necessity to go gradually digital:

“Yes, due to the CEBRA we agree that digitization is a must.....we are also starting our own digital project based on CEBRA,we are not interested in showing our changes yet” (Company A).

“Definitively, we are enabling our production process to be digital, taking mostly the ideas from the CEBRA program...but developing in ways specifically tailored to our manufacturing capabilities and technical conditions. The most important thing is that we can visualize how to do that....in a really practical way.....” (Firm B)

“.....I agree with you that the program (CEBRA) has undoubtedly contributed to disseminating the digital knowledge we need.....has also sent a message to our technology suppliers that do not want to be left behind.....yes, it is a way to say: you need to change, as soon as possible”. (Company E)

“The new digital possibilities for production constitute a hot topic; according to the industry representatives it is a must for all of us...and CEBRA is our benchmarking.....” (Company D)

“We need to go digital in manufacturing, this is the new mantra from the industry.....at any public meeting you attend, this is what you hear about.....it is time to plan for the new digital era as a new project in our innovation plans...CEBRA is our starting point...” (Company G)

One of the most important collective actors, the ITC, comments that developing the new technology with locally-embedded and indigenous technology gatekeepers, instead of waiting for the foreign multinationals’ solutions, is better as a way of encouraging other local firms to do so, and thus activating change through imitation.

As engineers involved in the process from the ITC point out:

“We are creating awareness, showing to the local industrial base that the digital change is possible....and showing how it can be accomplished. For this reason, we are working with a very local firm, which is a way to say: all of you can do it”. (Engineer from ITC)

“....yes, we want local companies to imitate the leading ones. We expect a reaction and an imitation by the rest of the cluster, starting with the most advanced firms...; Why not going all together?” (Director of ITC)

All in all, the joint efforts by the collective actors (ASCER, ITC) are aimed at encouraging change and promoting awareness about the necessity to plan for the new digital imperative. All the activities devoted to that end are building a new logic of direction that is compatible and complementary to the existing collective identity in the MID. Beyond just promoting awareness, the CEBRA+ initiative is a reference point that enables companies to learn and plan the change. Specifically, using a local firm to develop the technology is also a way to make local companies think that they can also do it.

3.3.4-Summary of findings

The initiative is very well-known in the cluster, as it has permeated among firms and local business associations. As pointed out by the ITC, up to May of 2019, Colorker has received 20 organizations for visiting the pilot platform, including 10 direct local competitors interested in the new technology. From September 2019 on, the ITC will

open a *virtual simulator* of Industry 4.0 applied to ceramic tile production, based on the learning process with Colorker, a device for diffusing major functionalities of the new technology, contributing to disseminate the new digital enablers among the cluster. ITC is also preparing seminars and training courses for diffusing the technology in the next years.

Summarizing, findings suggest that collective actors' leadership and endogenous bottom-up cooperation and co-creation with policymakers turned out to be key ingredients of the place-based initiative for building on specific existing regional advantage. Findings also reveal that existing social relations, strong collective identity and a shared vision have facilitated the shared understanding of all stakeholders involved in the program: social relationships enabled the co-design and co-development of the place-based policy in the district. In table 1 we show a summary of the evidence gathered during interviews. See Table 1.

Table 1. Summary of main points during interviews

Issues	Evidence
The role of collective actors	<ul style="list-style-type: none"> • <i>“The involvement of ASCER and the ITC has given legitimacy to the digital program” (Colorker)</i> • <i>“ASCER, was very active in promoting the change, arranging events and seminars on the topic” (Company C)</i> • <i>“Yes, ASCER is preaching how important the change to digital iscontinuously” (Company D)</i> • <i>“It is clear that the ITC is playing a major role in leading the (CEBRA) project.....thanks to them the involvement of the Regional Government has been timely and generous” (Colorker)</i> • <i>“Without the involvement and leadership of ITC and ASCER, only the leading firms would look at digital manufacturing” (Company F)</i> • <i>“I think the ITC is the key actor, capable of designing the plan for showing us how to turn manufacturing into digital;.....who else can do that?” (Company E)</i>
Endogenous and bottom-up collective creative policy	<ul style="list-style-type: none"> • <i>“A bottom-up process and flat structure where local actors participate and make suggestions facilitates governance and ongoing evaluation..... All this is totally exploratory” (IVACE)</i> • <i>“The attraction of this digital program is based on the fact that it is totally endogenous and bottom-up....based on trial and error and the empowerment of the cluster actors....we sought a consensus-based approach” (IVACE)</i> • <i>The policy has been designed by cluster actors, we (ASCER), ITC, and the IVACE agreed with the idea of the demonstration platform.....(ASCER)</i>
Cooperation in the MID	<ul style="list-style-type: none"> • <i>“The cooperation we see in this cluster, far beyond just subcontracting or arranging their own fair trade, make the perfect context in order to test the demonstration platform for 4.0” (ASCER)</i> • <i>“For the important things, the cluster acts as a block....” (ITC)</i> • <i>“, this is a very important issue and we all understand the importance of cooperation for developing advantage.” (Company A).</i>

	<ul style="list-style-type: none"> • “.....all firms will gain with the CEBRA program, no matter which company develops it....it is really a common good.” (Company D) • “In this industry companies share a collective vision and for the really important things they do cooperate, ...this is due to the social relations existent in the district... the capability to develop a shared goal.” (ASCER)
Promoting awareness and change on the cluster	<ul style="list-style-type: none"> • “...also, it was important that we wanted to diffuse it for local companies’ imitation....yes, they need to see the future....” (ITC) • “...we continuously promote events and seminars for that purpose...” (an ASCER representative). • “Yes, due to the CEBRA we agree that digitization is a must.....” (Company A) • “... taking mostly the ideas from the CEBRA program...but developing in ways specifically tailored to our manufacturing capabilities and technical conditions. The most important thing is that we can visualize how to do that....in a really practical way.....” (Company B) • “.....I agree with you that the program (CEBRA) is a way to say: you need to change, as soon as possible” (Company E) • “We are creating awareness, showing to the local industrial base that digital change is possible....and showing how it can be accomplished.... is a way to say: all of you can do it”. (ITC) • “....yes, we want local companies to imitate the leading ones. We expect a reaction and an imitation by the rest of the cluster, starting with the most advanced firms....Why not going all together?” (ITC) • “We are just showing tools and extending the general idea of how to do it” (ITC) • “The new digital possibilities for production constitute a hot topic; according to the industry representatives it is a must for all of us...and CEBRA is our benchmarking.....” (Company D) • “We need to go digital in manufacturing, this is the new mantra from the industry.....at any public meeting you attend, this is what you hear about.....it is time to plan for the new digital era as a new project in our innovation plans...CEBRA is our starting point..” (Company G)

Source: own, based on the summary of interviews. Notice that interviews with IT companies are not used because they basically point out the technical developments.

4.-Discussion

Place-based endogenous policy, orchestrated through collective actors co-creating with policymakers has been effective, enabling thus a bottom-up collective understanding and shared vision of the future of the district. In this context, public and private actors’ co-

design of industrial strategies to shape the local institutional context has facilitated the introduction of a new sub-identity, compatible with the existing one, legitimizing and institutionalizing new (digital) knowledge and processes to facilitate transition into Industry 4.0. As observed in the results, collective actors can remove barriers to change, coordinate efforts and act as brokers of institutional and technological processes, proposing solutions, aligning stakeholders' share vision, developing a collective understanding of the new technology and facilitating the development of an institutional framework that stimulates change. As shown, CEBRA+ place-based policy, led by collective actors co-creating with policymakers, resulting from a bottom-up approach and facilitated by an endogenous collective reflection, has made possible to remove institutional barriers, foster change and develop a collective understanding and real involvement in the necessity to change.

The cooperation and involvement of policymakers for place-based policy, however, is necessary in order to accomplish goals. As observed in this study, IVACE not only financed the initiative but also adopted a bottom-up and collaboration-based policy aimed at building upon existing capabilities, cooperating with the public (ITC) and private (ASCER) collective actors in order to co-create a context-specific industrial strategy to improve regional capabilities. It is also worth to mention that the present innovation policy is set within a socio-economical context, the MID, that facilitates governance, evaluation and learning. As Magro and Wilson (2018) point out, all the different stakeholders participate, interact and exchange ideas, allowing the formation of complementarities generated in the insights from bottom-up and collaborative policy co-design. This participation and involvement allows knowledge and solutions to circulate in multiple ways to solve the problem, contextualizing issues and focusing on the specific local context. Enabling an endogenous bottom-up mobilization of resources, policymakers need to facilitate cooperation and dialogue between regional stakeholders that can re-shape or adapt existing institutions for strengthening the regional advantages by implementing contextualized initiatives. Thus, policymakers need to co-design and participate in the conversation to build upon existing capabilities with collective actors and other stakeholders, as the literature indicates (e.g. Bailey et al., 2018; Alvedalen and Boschma, 2017; Mason and Brown, 2014).

Understanding MID with place-based policies

The cooperation and competition logic and the intense social capital traditionally found in MIDs (e.g. Becattini, 1990) and specifically in the Castellon MID (see Hervas-Oliver et al., 2018a; 2017) have both played a major role, enabling the development of a shared understanding and a collective identity that facilitates the cooperative co-design among collective actors, firms and policymakers.

Similarly, the institutional isomorphism (mimetic behavior of local firms) observed in MIDs (e.g. Glasmeier, 1991) can represent an advantage by using it for catapulting all the stakeholders together towards change. For this to occur, the construction of a new (digital) sub-identity, compatible with the existing one, is necessary enabling capitalization on the positive leverage function of isomorphism: all together doing the same but changing! Thus, collective actors (ASCER and ITC) have influenced change for the cluster acceptance of the new technology, promoting the change of existing institutions for adopting digital technologies that go beyond the lock-in existent technologies and paradigms in the district, attempting to avoid the traditional assumption that industrial districts are rooted in non-radical change acceptance. Specially the ITC has played a major role as a leading technology gatekeeper, leading the formulation of the technology policy.

5.-Conclusions

Specifically, we focused on disentangling how a place-based developmental regional industrial strategy is co-created in order to digitize a traditional Marshallian Industrial District (MID), responding to the following research question: *How does an industrial cluster transit collectively to the adoption of new radical changes brought about by Industry 4.0?* This study has explored the first stages of an experimental place-based policy to foster transition into digital manufacturing or Industry 4.0 in the traditional industrial district of Castellon, pursuing a gradual collective adaptation of a MID to Industry 4.0. Specifically, a place-based industrial strategy for digitizing manufacturing is analyzed (CEBRA+), dissecting the role of the collective actors and policymakers involved.

First, the study contributes by deciphering the role of policymakers and collective actors for place-based policy to be effective, contributing to the place-based policy conversation (Bailey et al., 2018; Magro and Wilson, 2018; Feldman and Lowe, 2018). In this chain of thought, this study has shown how technology transitions in traditional MIDs, such as Industry 4.0, can be supported and led by public and private cooperation aimed at inducing institutional change that facilitates collective action, building upon existing regional capabilities and thus reinforcing the regional ecosystem. This study, therefore, contributes to the general debates on place-based industrial policies and the special role of policymakers therein (Magro and Wilson, 2018; Bailey et al., 2018; Alvedalen and Boschma, 2017; Stam, 2015; Foray, 2016; Mason and Brown, 2014). In this chain of thought, the role of collective actors facilitating place-based policies needs to be highlighted, as they are the actors that can remove barriers to change, coordinate efforts and act as brokers of institutional and technological processes, aligning stakeholders, developing a collective understanding of the new technology and facilitating the development of an institutional framework that stimulates change, even reshaping existing institutions, in line with existing literature (e.g. Sine and Lee, 2009).

Second, this study also contributes to explaining how a traditional MID transits towards Industry 4.0, presenting new insights on institutional isomorphism that point out its positive leverage function in order to facilitate a collective transition, through capitalizing on local cooperative-oriented social relationships and institutional isomorphism in order to build a new (digital) sub-identity compatible with the existing one.

Overall, this study has shown (i) a case of a place-based developmental regional industrial strategy for digitizing a cluster, building on its existent capabilities, (ii) the role of collective actors co-creating with policymakers for that purpose, and (iii) how the social-based and cooperative orientation of MIDs enable endogenous bottom-up co-creation that enable a place-based policy to be effective. Last but not least, the study's insights also contribute to the socially-based agglomeration or Marshallian literature (e.g. Piore and Sable, 1984; Becattini, 1990; Saxenian, 1994; Belussi and Sedita, 2009; Hervas-Oliver et al., 2017) by presenting tools in order to facilitate change upon cooperation and competition endowment, underpinned by a high local component of social capital, one of the cornerstones of the MID concept. For future studies, this framework needs to be applied to different clusters and industrial districts.

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