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LOCAL INDUSTRIAL AGGLOMERATIONS VIS-À-VIS GLOBAL COMPETITIVE NETWORKS: MARSHALLIAN NOTIONS OF CLUSTERS, INNOVATION AND TERRITORIAL DEVELOPMENT

AGLOMERACIONES INDUSTRIALES LOCALES VIS-À-VIS REDES COMPETITIVAS GLOBALES: NOCIONES MARSHALLIANAS DE ZONAS ECONÓMICAS, INNOVACIÓN Y DESARROLLO TERRITORIAL

AGLOMERAÇÕES INDUSTRIAIS LOCAIS VIS-À-VIS REDES COMPETITIVAS GLOBAIS: NOÇÕES MARSHALLIANAS DE ÁREAS ECONÔMICAS, INOVAÇÃO E DESENVOLVIMENTO TERRITORIAL

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Abstract

Innovation is one of the key contributions that clusters can make in driving regional and territorial development. This exhaustive post-Marshallian literary review compares and contrasts the notion of innovation and explains its evolution within the context of recent theoretical approaches explaining modern industrial agglomerations and territorial development.

Beginning in early 1990s and ending with the most recent intellectual contributions, this study analyzes innovation, particularly in relation to how it is employed in the cluster and how it could contribute to the development and competitiveness of clusters, territories and nations. Porter's diamond model and its extended versions, which focus on demand and other market and factor determinants, are regarded as the intellectual catalysts for the notion of innovation in relation to clusters and territories. However, the study notes that the ambiguity and flexibility of these models led French post-Porterian writers to consider

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the role played by spatiality and relationality through networks, sectors and industries in sparking innovation as well as knowledge creation and diffusion. Additionally, political economy theoretical approaches, such as the helix innovation models and the Marxist-inspired semiotic analysis, have also stimulated the use of innovation as a factor of change, which spills over the influenced territories and nations.

As innovation is incorporated into each of the models examined, its contribution becomes increasingly evident. The common denominator among all post-Marshallian theories is the crucial and shifting role that innovation plays as a catalyst for competitiveness and development at the cluster, territorial, national and, global levels.

Keywords: Industrial areas; technological change; political economy

Resumen

Innovación es una contribución importante que las áreas industriales (clusters) hacen en relación al desarrollo territorial. Esta revisión literaria post-Marshalliana analiza la noción de innovación, y explica su evolución en el contexto de las teorías recientes, que abordan los clusters, y el desarrollo territorial.

Desde 1990, y hasta las contribuciones teóricas más recientes, éste estudio analiza la innovación, particularmente en relación a los clusters, y cómo pueden contribuir al desarrollo y la competitividad de las de los territorios y los países. El modelo de Diamante de Porter y sus extensiones teóricas, enfocadas en demanda y determinantes de factores y de mercado, son catalizadores intelectuales de la noción de innovación en relación al desarrollo territorial. Sin embargo, éste estudio denota que su ambigüedad y su flexibilidad ha hecho que escritores franceses post-Porterianos consideren que espacialidad y relacionalidad a través de redes, sectores e industrias, son esenciales para generar innovación y la creación de conocimiento, y su respectiva difusión. Además, los enfoques de Economía Política, tales como los modelos de innovación de las hélices y el análisis semiótico inspirado en Marxismo, han estimulado el uso de innovación como un factor de cambio, el cual influencia los territorios y las naciones.

Conforme la innovación se incorporar en los modelos estudiados, su contribución se hace cada vez más evidente. El común denominador

entre todas las teorías post-Marshallianas es el papel cambiante y crucial que innovación juega como catalizador de competitividad y desarrollo en las zonas francas, y a nivel territorial, nacional y global.

Palabras claves: Áreas industriales; cambio tecnológico; economía política

Resumo

A inovação é uma das principais contribuições que os clusters podem fazer para impulsionar o desenvolvimento regional e territorial. Esta revisão literária pós-marshalliana exaustiva compara e contrasta a noção de inovação e explica sua evolução no contexto de abordagens teóricas recentes que explicam as aglomerações industriais modernas e o desenvolvimento territorial.

Desde 1990, e até as contribuições teóricas mais recentes, este estudo analisa a inovação, principalmente em relação aos clusters, e como eles podem contribuir para o desenvolvimento e a competitividade daqueles em territórios e países. O modelo Diamond de Porter e suas extensões teóricas, focadas na demanda e determinantes de fatores e mercado, são catalisadores intelectuais da noção de inovação em relação ao desenvolvimento territorial. No entanto, este estudo denota que sua ambiguidade e flexibilidade levaram escritores franceses pós-Porterianos a considerar que espacialidade e relacionalidade através de redes, setores e indústrias são essenciais para gerar inovação e criação de conhecimento, e sua respectiva disseminação. Além disso, abordagens de economia política, como os modelos de inovação de hélices e a análise semiótica inspirada no marxismo, estimularam o uso da inovação como um fator de mudança, que influencia territórios e nações.

À medida que a inovação é incorporada aos modelos estudados, sua contribuição se torna cada vez mais evidente. O denominador comum entre todas as teorias pós-marshallianas é o papel crucial e mutante que a inovação desempenha como catalisador da competitividade e do desenvolvimento nas zonas francas e nos níveis territorial, nacional e global.

Palavras-chaves: Áreas industriais; mudança tecnológica; economia política

Introduction

In 1879, Alfred Marshall published *The Pure Theory of Foreign Trade, the Pure Theory of Domestic Values,* a prominent paper in which he uses the United States metal industry as an example to argue that "the advantages of production on a large scale can, in general, be as well attained by the aggregation of a large number of small masters into one district as by the erection of a few large works" (Marshall, p. 8). The "district" has unique features that enables it to obtain economies, such as firm agglomerations (hereinafter referred to as clusters) of a small, medium and large size.

These clusters are characterized by geographical proximity, a localized workforce, the development of "subsidiary industries" (Marshall, p. 8) specializing in the acquisition of intermediate goods and raw materials, an information flow of "technical skills" (Marshall, p. 8), and the "intercommunication of new ideas" (Marshall, p. 9).

As the concept of innovation has evolved, so has the Marshallian industrial district (ID), a concept coined by Becattini (1986). Since the 1990s, relevant literature has emphasized the contribution of specific actors, such as Michael Porter (1990, 2000). He developed the diamond model, which focuses on the sources of localized competitive advantage in nations and territories. This model is contested by other intellectual contributions such as Cho (1994), who introduced into the equation locally present multinational companies and the government. Moon, Rugman and Verbenke (1995) promoted the idea of the human factors' role at the local and international level. Cho, Moon and Kim (2006) included heterogenous attributes, covering the four dimensions of national competitiveness: physical and human factors in both domestic and international markets. Despite these new models based on demand and supply factors, there was no clarity as to what role innovation[2] plays in them (Innovation is considered as 'unceasing novelty and change' in this article, as also understood by J.A. Schumpeter (1928).

Alternatively, modern cluster literature has emphasized the influence of the relationality of specific actors in the spatial geography in times of the knowledge economy (Rullani, 2003; Yeung, 2005; Grandeclément, 2016; Depret and Hamdouch, 2009). More recently, other authors (Etzkowitz, 2008; Carayannis and Campbell, 2012; Carayannis and Grigoroudis, 2016) have highlighted the Political Economy perspectives of innovation, namely the helix model comprising of government-industry-university-civil society-environment spirals, as well as the Cultural Political Economy (CPE) (Jessop, 2006; Jessop, 2005) perspective based on semiotic analysis.

[2] Innovation is a concept that has been around since the 13th century. The Renaissance propelled novelty to be present everywhere. Schumpeter (1928) in the 1930's and 1940's considered that capitalism caused creative destruction (as a consequence of unceasing novelty and change, or innovation).

In view of the foregoing, the following research question is proposed:

How has innovation influenced the various theoretical approaches used to explain the modern ID, and what spillover effects has it had on territorial development?

To respond to this question, the following research objectives are established: 1) to conduct a literary review of the most important Post-Marshallian theoretical approaches to the modern ID and its territorial influence since 1990; and 2) to conduct a comparative analysis of the role that innovation has played in the various theoretical approaches to the modern ID, and how it could prompt territorial development.

This essay argues that innovation is a notion that evolves depending upon the theoretical perspective used to analyze it. It also contends that innovation is a key factor in the development of the modern cluster's competitiveness and in the territorial development of host territories and nations. Firstly, this essay examines in detail Porter's cluster approaches and extended models. Secondly, Post-Porterian French theoretical approaches are inquired into. Finally, Political Economy cluster approaches are investigated, such as the helix models and the semiotic analysis. The Table 1 synthetizes the most important theoretical approaches analyzed in this study.

Table 1
Theoretical approaches on cluster, innovation and competitiveness.

	Porter's cluster approaches and extended models	**Post-Marshallian and Post-Porterian French approaches**	**Political economy approaches: Helix models**	**Political economy approaches: Cultural Political Economy and Semiotic Analysis**
Main Conceptual input	A cluster is "a geographical proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities" (Porter, 2008, p. 215).	Spatiality and Relationality	The intertwining of roles and relationships between actors (represented as helices) leads to new 'social arrangements'.	Critical approach of economic imaginaries (social objects and subjects) as they are influenced by societal productive forces and the relations of production.
Role of innovation	The capacity to innovate will be confined only by the physical factors of national or territorial competitiveness.	Innovation networks, dynamic and interactive concept	Innovation leads to the transformation of roles and relationships among the emerging actors and enhances these actors' capacity to change.	Innovation, viewed as economic objects and subjects, is the result of the economic imaginaries that happen with the open systems of local and global clusters.

	Porter's cluster approaches and extended models	Post-Marshallian and Post-Porterian French approaches	Political economy approaches: Helix models	Political economy approaches: Cultural Political Economy and Semiotic Analysis
Effect on competitiveness of host territories	Porter (2008) primarily focuses on the importance of the domestic context and its physical factors to explain a nation's competitiveness. The extended GDD model and the NF model expand the scope of analysis by including the international context and human factors, respectively.	Influence of spatiality and relationality on spatial geographies can contribute to the development of host territories.	The interaction, communication and relationships of the sectorial helices can lead to cluster and territorial competitiveness.	As these economic imaginaries are "discursively constituted and materially reproduced at different sites, on different scales, and with different spatial and temporal horizons" (Jessop, 2005, p.5), the host territories can benefit from more competitiveness, and development.
Main exponents	Porter (1990,2000, 2008), Cho and Mun (2002), Moon, Rugman and Verbeke(1995), Cho (1994).	Grandclement (2016), Depret and Hamdouch (2009), Torre (2006), Leducq and Lusso (2011).	Etzkowitz (2010), Dzisah and Etzkowtz (2011), Carayannis and Alexander (2009), Carayannis and Campbell (2009, 2012), Carayannis, Barth and Campbell (2012), Carayannis and Grigoroudis (2016).	Jessop (2006, 2005)

Source: Compiled from a variety of sources (as specified inside the chart).

Methods

Grounded theory (Glaser & Strauss, 1967) is used in this study as a means of constructing the proposed theory, as it emerges from the iterative research process of data collection (revision of reputable Post-Marshallian writers), coding of potential categories, and data abstraction. This process of qualitative data analysis was facilitated using Atlas.ti software. After iterating this process several times, the following categories were selected: innovation as a change factor and cluster and territorial development. Non-relevant categories were rejected every time the process was run if it did not fit well with the theory construction.

This methodology involved a literary review of relevant Post-Marshallian writers since the 1990's, in order to identify how they each perceive innovation in terms of clusters and territorial development. A comparative qualitative analysis of the various theories was also conducted, in order to compare and contrast them in relation to the selected categories.

Post-Marshallian approaches to innovation, clusters and territorial development: Porter's cluster approaches and extended models

Post Marshallian approaches to territorial development note that innovation remains centered on "economic processes of localization and its supporting mechanisms" (Lagendijk and Boekema, 2008, p. 12). However, the role played by innovation in the development of the modern ID and its spatial geographies has become increasingly complex, focusing more on the institutional framework for their economic activities. Some of these new approaches are based on new demand-side perspectives that are geared towards understanding the manner in which the strategic competitiveness of territories is determined.

Porter's (1990) diamond model represents a very flexible competitiveness framework for nations, based not only on supply-side variables (other factor and market variables), but also on demand-side variables, which have been integrated into a single model.

The diamond model stands out for its national approach to competitiveness, given that it limits the capacity to innovate to the national or territorial scope described in Porter's analysis. According to the diamond model, clusters, as visualized by Porter (2008), play a very noteworthy role in national or territorial competitiveness; defining them as "a geographical proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities" (Porter, p. 215). The geographical "proximate" group of companies is delimited by how far the cluster can extend its influence. If that is the case, the capacity to innovate will be confined only by the physical factors of national or territorial competitiveness (factors related to production, home-market demand for the industry's product or service, the suppliers' industries and other related industries with international potential, as well as firm strategy, structure and rivalry within the framework of Porter's diamond model and, more specifically, his definition of national competitiveness and cluster.

In juxtaposing Porter's diamond model with various perspectives, author Michael Taylor (2010, p. 276) argues that there is an "over-elaboration," "omission," and "weak empiricism" (p. 276) with respect to the concept of geographical proximity and localization that underlies the idea of clustering. Similarly, James Simmie (2004) states that "limited and local connections" (p. 1101) are called into question by the new perspective of "extended linkages in the context of a globalized international economy" (p. 1101). These arguments become increasingly counterbalanced as more extended iterations of the diamond model are developed.

Two key factors that are not considered by Porter's diamond model are the importance of "the effects of multinational activities" (Cho, Tong-song, Mun, Hwi-ch'ang, 2002, p. 81) and the government's role in regulating local and international interactions. Moon, Rugman and Verbeke (1995) developed a **Generalized Double Diamond (GDD)** model according to which adding

sustainable value added is possible within the framework of an expanded version of Porter's original diamond model, as a result of the presence of locally-owned and foreign-owned firms spread across many countries. Consequently, the scope of action of the original diamond is doubled.

Consequently, because this expanded **GDD** amplifies the scope of determinants of national and territorial competitiveness, the opportunities to innovate become more numerous due to a greater emphasis on multinational companies and governments.

Each of the physical factors described by Porter's diamond model has unlimited potential under the **GDD** model. With respect to production factors, locally-owned and internationally-owned companies in clusters are now able to access not only the local factor markets but also those of an international and even global nature, in order to obtain and implement state-of-the-techniques as part of their production processes. The possibility to meet both the local and international demand drives the creation of innovative products and services, not only at the cluster level, but also within and beyond the territorial and national levels. This also facilitates international and global expansion of the spatial geography. Similarly, a firm's strategy, structure and competitiveness will no longer be limited by the local market, but rather by the international market. According to Markusen (1996), "the most important agglomeration economies are dynamic rather than static efficiencies and revolve around the rate of learning and the capacity for innovation. Cumulative causation takes place as firms based elsewhere 'gravitate to favorable cluster locations' in their locations" (Porter, 1996, cited Markusen, 1996, p. 198).

As an alternative extension the **GDD** model, Cho (1994) proposes the **Nine Factor (NF) model**, according to which human factors mobilize and manage physical factors as "endowed resources, domestic demand, related and supported industries, and other business environments" (Cho, Tong-song, Mun, Hwi-ch'ang, 2002, p. 91). When it comes to innovation, human rather than physical factors are crucial to achieving competitive industries and the related infrastructure to expedite the economic growth of the territories and national competitiveness schemes involved. Each of the human factor groups included in Porter's original diamond (politicians and bureaucrats, workers, professional managers and engineers, as well as entrepreneurs) are determinants for choosing innovation as a competitiveness factor in a territory or a nation.

While Porter's diamond model primarily focuses on the importance of the domestic context and its physical factors to explain a nation's competitiveness, the extended **GDD** model and the **NF** model expand the scope of analysis by including the international context and human factors, respectively. However, it is crucial to consider international human factors as well. In this regard, the **Dual Double (DD)** diamond model represents a very interesting option.

As noted by Cho (1994), the extended **DD** diamond model "provides a comprehensive analysis of the competitiveness of countries with heterogeneous attributes, encompassing the four dimensions of national competitiveness: physical and human factors in domestic and international markets" (p. 107). How does innovation fit into the model, particularly within the local (localized cluster) and international contexts? According to Porter (1998), "clusters align better with the nature of competition and the sources of competitive advantage. Clusters, broader than industries, capture important linkages, complementarities, and spillovers of technology, skills, information, marketing, and customer needs that cut across firms and industries" (p. 221). From his point of view, innovation systems could be propelled under the DD diamond model as a result of the interactions of the four dimensions abovementioned.

Porter's diamond model and its extended versions, which include the aforementioned GDD, NF, and DD models, represent seminal works for understanding the manner in which clusters and territories function. Nonetheless, Porter's model and its extended versions have been criticized due to the fact that the role of innovation in the achievement of territorial competitiveness remains ambiguous.

From a critical standpoint, it is considered that Porter's notions on clusters' and territories' competitiveness rely heavily on the dimensions of international and local factors. However, there is no clear theoretical linkage between Porter's argument and the notion of innovation. Is a country's competitiveness the result of innovation?

For this reason, in the next section, it is worth examining noteworthy Post-Porterian and Post Marshallian French writers who have proposed analyzing how spatiality and relationality can contribute to cluster competitiveness and territorial development.

Post-Marshallian and Post-Porterian French approaches to innovation, clusters and territorial development

Grandclément (2016), and Depret and Hamdouch (2009) developed an alternative, more elaborate perspective to explain innovation using a spatial and relational approach, as well as to foster a clearer understanding of how clusters benefit from innovation networks in the knowledge economy era. According to Depret and Hamdouch (2009), "Nowadays, innovation adopts other organization forms compared to the competitive and geocentric clusters traditionally put forward, and the other forms are simultaneously more complex, more open (spatially and at the relational level), more evolutionary (with respect to time and space) and deeply embedded (at the organizational level) in each other" (p. 24).

Grandclément (2016) describes innovation as a very dynamic and interactive concept. He (2016) states that "the analysis of actors and their relational networks has concentrated on the collective

and interactive nature of innovation, shining a spotlight on the social embeddedness of economic dynamics and innovation processes" (p. 472).

The contribution made by Grandclément (2016) stands out not only for reviving the concept and application of relational networks in territorial development (which was originally described by Becattini in 1992), but also for proposing that knowledge and innovation processes are at the heart of relational networks, sustained by the social interactions, standards and rules of different actors. Consequently, relationality and its influence on the spatial geographies of clusters can contribute to the development of the corresponding territories.

Alongside Grandclément (2016), and Depret and Hamdouch (2009), the focus of French post Marshallian writers on innovation as a key element for the development of territories via clusters is also contrasted by Torre (2006), who considers that clusters develop innovative settings and environments thanks to knowledge transmission. How is this knowledge transmitted, and how does it contribute to territorial development? Torre (2006) proposes "the reinterpretation of clusters in terms of proximity, by showing how using two types of proximity (geographical and organized) allows for characterizing the performance of clusters as knowledge transmission tools" (p. 3).

As opposed to Grandclément (2016), Torre (2006) endorses the traditional Marshallian idea that geographical proximity is necessary in order to stimulate knowledge and enable it to circulate. He also insists that organized proximity is key to achieving innovative competitive settings that can produce positive externalities in the localized territory. Grandclément (2016), on the other hand, focuses on the ways in which relationality and social relations can foster an innovative environment; his approach is broader in terms of its analysis of spatial geography as a factor for territorial and cluster development. Torre (2006) does not include this spatial approach in his argument. He states that "the primary foundation for the rebirth of this polarization is an understanding of innovation processes, which would be founded on knowledge transfer and exchange, primarily through face-to-face interactions" (Torre, 2006, p. 7).

Torre's (2006) arguments represent a return to the naturalist approach that seeks to understand clusters and the manner in which innovation develops and is transmitted within them, more exclusively in localized territories. Torre asserts that proximity is also enhanced by the social relations between the main actors, particularly through face-to-face knowledge exchanges in the present knowledge economy era. As previously noted, Torre's argument disregards the spatial geography that is analyzed by Grandclément (2016) showing that Torre focuses more heavily on the manner in which the territory develops its competitiveness.

Given the fact that networks are generally considered to be open systems as well as spatial learning regions, and that interactions within networks are heavily dependent on knowledge

spread both spatially and globally, this study favors the argument developed by Grandclément (2016). Knowledge is constructed in innovative environments characterized by dynamic economic processes and collective decision-making, which are not only localized at the cluster level, as described by the Marshallian IDs, but are also spread out spatially and relationally (Becattini, 1992; Giuliani, 2007).

French authors Leducq and Lusso (2011) have also made relevant contributions on this topic. They argue that relationality fosters collective learning and cooperation in the corresponding networks, which, in turn, facilitates innovation at the firm and territorial levels. "Cooperation and collective learning at the heart of regional networks allows for fostering the innovation and competitiveness of firms and regions" (Leducq and Lusso, 2011, p. 3). Like Grandclément, Leducq and Lusso underscore the importance of relationality in constructing innovative environments and developing the cluster and territory. Leducq and Lusso (2011) also agree with Grandclément on the need for clusters to be open systems to the outside world, which also fits in quite well with the needs of relational networks. In order to have an impact on relevant territories, knowledge should be able to flow openly within and outside of the cluster. Leducq and Lusso (2011) describe clusters as being "open to the outside – meaning the market and the technological environment – that integrates and has a mastery of know-how, rules, regulations, values and relational capital" (Leducq and Lusso, 2011, p. 6).

These Post-Marshallian and Post-Porterian French approaches towards spatiality and relationality represent a key factor in propelling innovation as a catalyst for enhancing competitiveness in the modern IDs and their host territories.

Following a critical perspective, this study considers that French Post-Porterian spatiality and relationality are essential in achieving innovation in the clusters and spillover effects in the host territories. Nonetheless, it also favors the position that face-to-face communication is necessary in today's cluster.

It is also noteworthy to focus on political economy approaches, which can prove useful in incorporating states, universities, industry, civil society and the environment, in order to understand their fundamental roles in cluster and territorial development. Such approaches are taken into consideration in the following section.

Political Economy approaches to innovation, clusters and territorial development: the helix models

Henry Etzkowitz (2010) developed an innovation model suitable for the knowledge-based society, which takes into account "the transformation of roles and relationships among the emerging primary institutional triad of university-industry-government" (p. 1). This model notes that the

various actors engage in close interactions while still maintaining their "independent identity" (Etzkowitz, 2010, p. 1). At the same time, however, each actor is capable of adopting the abilities of other actors.

As scientific knowledge gains an increasingly relevant role in the development of today's societies, so does innovation, which involves, not only the creation of new technology in the business world, but also the development of new "social arrangements" within industries, the government and universities. The intertwining of the three spirals of this helix, and the cooperation that takes place among these actors with the aim of "enhancing each other's performance of their traditional roles" (Etzkowitz, 2010, p. 3), gives way to innovation.

It is worth noting that the role of each actor, whether industry, university or government, will vary depending on whether the corresponding society is of a laissez-faire or statist nature. Under a laissez-faire regime, the main driving force is the industry, with support from the two other spirals. For the industry, innovation "(through differentiation) can result not only in growth but also in development of the capacity to learn, adapt, and be prepared for the unexpected" (Huggins and Izushi, 2011, p. 195).

As the knowledge-based society shapes innovation and its related conceptualizations, it becomes all the more important to consider how the other two spirals of the helix engage in a dynamic, intertwining relationship with the propelling force of the industry. As previously stated, in a laissez-faire society, both the university and the government are "ancillary supporting structures" (Etzkowitz, 2010, p. 4) in this scheme. Although the industry is the driving force of the triple helix, it can benefit greatly from interactions and communication with the government, and especially with the university.

Under a statist regime, the government serves as the propelling force of the triple helix. Based on public policy-making, funding and even serving as a sort of "public venture capitalist" (Etzkowitz, 2010, p. 2), the government can become a catalyst for innovation and new technology in cooperation with academia and the industry. When a government is interested in promoting innovation and technological change in society, it can promote different schemes, such as the development of public-private venture capital initiatives, as well as government-funded research labs and new firm incubators.

Of the relevant actors of triple helix, the university has a competitive advantage in a knowledge-based society. "As academic scientists take account of the economic value of research findings, the university moves into a more central institutional position in society as an equal partner with industry and government, in effort to promote technological innovation" (Dzisah and Etzkowitz, 2011, p. 3). Furthermore, as the university becomes more interested in entrepreneurial activities, knowledge begins to be "capitalized" (Dzisah and Etzkowitz, 2011, p. 18) on by the partnerships

between universities and corporations, reflecting an "advancement of knowledge and the sale of intellectual property with the service mission of the university" (Dzisah and Etzkowitz, 2011, p. 18).

As the three spirals intertwine and communicate, the conventional roles of the government, the industry and the university are transformed. The interactions between the spirals of the triple helix allow for shaping the "dynamics of innovation at the multi-national, national and regional levels" (Dzisah and Etzkowitz, 2011, p. 28). The intensification of synergies between these relevant actors also has an influence on scientific research, technological change, and the manner in which research is utilized.

The cluster framework and the manner in which innovation and technological change are influenced by the interactions and synergies of the triple helix can determine the effect of these new developments on territorial development. However, the triple helix model lacks the involvement of actors that could "provide feedback…. resulting in socially accountable policies and practices" (Carayannis and Campbell, 2012, p. 1). Innovation and knowledge generated within the triple helix model does not necessarily take into account society's needs.

Carayannis and Campbell (2009) considered that the purpose of the quadruple model is to reduce the gaps between innovation and civil society; consequently, it incorporates a new spiral whereby civil society and the media are considered new relevant actors. How is this new quadruple model different from the triple helix model? The answer lies in the concept known as Mode 3, which "shows the complexity of knowledge that needs many actors from government, academia, industry, and civil society to be generated and diffused" (Carayannis and Campbell, 2009, p. 3). This takes place through "higher-order learning (e.g. learning, learning to learn, learning to learn how to learn) in a multi-lateral, multi-nodal, multi-modal and multi-layered manner" (Carayannis and Campbell, 2009, p. 3). These interactions, synergies and communications lead to processes of "co-opetition (competition-cooperation), co-specialization and co-evolution resource generation, allocation and appropriation processes (3C's) that cause the formation of modalities, such as innovation networks and knowledge clusters" (Carayannis and Campbell, 2009, p. 3).

The quadruple helix encompasses government, industry, university, and civil society actors, which, by means of a "democratic approach to innovation" (Carayannis and Campbell, 2012, p. 1), become exposed to "feedback from key stakeholders, resulting in socially accountable policies and practices" (Carayannis and Campbell, 2012, p. 1). Carayannis and Campbell (2012) emphasize the importance of science and technology in propelling "entrepreneurship-enabled innovation" within the context of the quadruple model and in the helix models overall, noting that they are the "main source of competitive and sustainable advantage for nations and regions alike" (p. 2).

The term “Glo-calizing” (globalizing and localizing), coined by Carayannis and Alexander (2006), illustrates the increasing dynamics and complexity of globalization, which are re-defining the “systems, networks and sectors of innovation” at local and global levels, which, in turn, influences knowledge creation, diffusion and control in today’s knowledge society. Within this context, civil society and the media make a very important contribution. Democratization (knowledge democracy) of knowledge creation and diffusion, as well as its entrepreneurial-driven processes in the quadruple helix model, are creating private and public by-products which reflect this increased level of complexity. Nonetheless, it is very difficult to argue in favor of sustainable competitive-advantage nations, regions and territories if the perspective of natural environments is not incorporated into the perspective of the helix model.

The quintuple helix innovation model emerged from Carayannis, Barth and Campbell (2012) in which the “natural environments of society" (p. 2) and global warming are considered to be indispensable helix spirals or perspectives. Innovation systems, networks and sectors are essentially confronted with societal and economical needs to be “ecologically sensitive” (p. 1). Integrating the concepts of global warming and environment into the helix innovation model represents an opportunity to innovate; these concepts are also essential for territorial and regional development, as well as for cluster agglomerations at the local and even global level. This environmental helix perspective can become a propeller of development in territories and even nations, given that it takes advantage of the “knowledge, know-how, and the natural environment together into one ‘interdisciplinary’ and ‘transdisciplinary’ framework” (Carayannis, Barth and Campbell, 2012, p. 2).

The quintuple helix innovation model considers “the natural environment as a new subsystem for knowledge and innovation models, so that ‘nature’ becomes established as a central and equivalent component of and for knowledge production and innovation” (Carayannis, Barth and Campbell, 2012, p. 5). As such, it represents an opportunity to enhance the creation, use and dissemination of entrepreneurial-enabled innovation and knowledge, such as “new green technologies” (Carayannis, Barth and Campbell, 2012, p. 5).

The natural environment of the society and economy, when taken into account as the new perspective of the quintuple helix model, are capable of triggering ecologically inspired innovation and knowledge, founded on eco-friendly technological change. Both locally and globally, clusters provide a natural context in which eco-innovative ideas can be developed, given that they facilitate networking, connectivity and communication among diverse actors within and beyond the innovative milieu. This, in turn, facilitates the creation, dissemination and emergence of new products, services, and even firms and industries. As clusters become more committed to investing in the implementation of eco-entrepreneurship and sustainability, all spirals of the quintuple helix can be further motivated to create new innovations and knowledge, which

generates positive synergies, not only in local and global clusters, but also in the development of territories involved.

Using a critical political economy frame of reference, this study believes that the Helix models provide a broad holistic framework for understanding how innovation can influence cluster and territorial development; their various spirals represent key elements for achieving competitiveness and sustainability. Nonetheless, it is important to consider that the more spirals that are added to the helix model, the more difficult and complex the study of innovation in the cluster and territories become. It is better to focus on only a few actors to achieve better understanding of how innovation could propel cluster and territories' competitiveness.

Despite the coverage made so far of the different Post-Marshallian theories so far, this study has failed to address the alternative contribution of the Marxist materialist approach. Such critical notion is analyzed in the following section.

Political economy approaches to innovation, clusters and territorial development: CPE and semiotic análisis

Bob Jessop (2006, 2005) is regarded as the main exponent of the CPE concept from a Marxist-inspired perspective, which originated as a means for interpreting the rise of the knowledge-based economies as a "provisional, partial and unstable semiotic-material solution to the crisis of Atlantic Fordism" (Jessop, 2006, p. 4).

From an ontological perspective, CPE notes that "technical and economic objects are always socially constructed, historically specific, more or less socially embedded and dis-embedded…. more or less embodied….and in need of continuing social 'repair' work for their reproduction" (Jessop, 2005, p. 3). From Jessop's point of view, the "production, reproduction and consumption" (Jessop, 2005, p. 3) of social objects and subjects (whether of an economic nature or not), are influenced by discourse and discursive practices. From an epistemological perspective, CPE represents "a critical approach to the categories and methods of political economy and to the inevitable contextuality and historicity of the latter's claims to knowledge" (Jessop, 2005, p. 5).

CPE presents a very interesting theoretical approach for understanding the role that clusters play in territorial development. Additionally, the materialist Marxist perspectives implicit in Jessop's CPE provide a means for understanding the manner in which societal productive forces and the relations of production are influenced by the role that innovation plays in today's knowledge-based society. From a CPE perspective, discourse and discursive practices are the main catalysts for economic objects and subjects. Additionally, clusters develop geographic spatiality that leads to innovation networks, sectors and even industries (which, in turn, generate economic value

added for objects and subjects). Consequently, CPE provides an appropriate theoretical approach for analyzing innovation and knowledge as productive forces of society and their influence on production relations. This analysis can be conducted at a microeconomic level (cluster and geographic spatiality), and then be further expanded to the territory, which is influenced by the industrial agglomeration or cluster.

Considering a semiotic analysis critical perspective, Jessop (2006, 2005) argues that CPE interprets the economy "as the sum of all substantive economic activities and the 'economy' (or, better, economies in the plural) as an imaginatively narrated, more or less coherent subset of these activities" (Jessop, 2005, p.5). This idea takes into account the material conditions of the object or subject under study, and, thus "the operation of the economic imaginary presupposes a substratum of substantive economic relations as its elements" (Jessop, 2005, p.5). Similarly, it is assumed that "where the imaginary is successfully operationalized and institutionalized, it transforms and naturalizes these elements into moments of a specific economy" (Jessop, 2005, p.5).

From a critical perspective, innovation and knowledge, viewed as economic objects and subjects, can be understood from a semiotic analysis perspective as the result of the economic imaginaries that happen within the open systems of local and global clusters. Under a Marxist-inspired CPE, innovation is the materialist result of the workings of the operationalized and functional imaginaries that are constantly transformed by the geographic spatial dynamism of the local and global clusters.

Both the Political Economy approaches of the Helix models and the CPE semiotic analysis are refreshing and alternative notions in understanding how the interaction and synergies between institutional and economic actors can propel innovation as an agent of change and competitiveness, and its potential impact in the development of the host territories.

Conclusions

The present study reviewed, analyzed, and compared different Post-Marshallian theories of clustering, particularly with regards to how they each address innovation. It also evaluated the manner in which territories have been influenced by industrial agglomerations and their externalities. The study shed light on important evidence that supports the notion that innovation is an essential catalyst and determinant for the competitiveness of the modern cluster, and that it can contribute to the territorial development of both regions and nations.

Even though Porter utilized a broad and flexible framework in order to study how demand and other factors and market conditions can determine how the cluster works and how it influences

the involved territories, regions and nations, these models do not specify how innovation is created and stimulated within and outside of the traditional Marshallian cluster.

In contrast, other approaches have explicitly considered innovation as a key factor in cluster and territorial development. Firstly, the contributions made by several French Post-Porterian Marshallian writers were examined, who agree that innovation is greatly influenced by the degree of spatiality and relationality developed in each of the geographical proximities, and in the cluster as well. Secondly, two Political Economy theories were researched: the helix models (triple to quintuple) and the CPE from a semiotic standpoint. The cluster framework, the extent to which innovation and technological change are influenced by the interactions and synergies of the helixes, as proposed by Etzkowitz and Carayannis, can determine how these new advancements influence territorial development. Besides this, the Marxist-inspired CPE theory is highlighted, whose semiotic analysis of the role of innovation, involving economic objects and subjects, presents an economic imaginary that can be operationalized and instituted at the cluster level.

From a critical thinking perspective, this study concludes that the French Post-Porterian approach, along with the Political Economy perspectives, represent a pragmatic and adaptable theoretical notion which takes innovation as a factor of change for cluster and territorial development. Spatial geographies built around relational networks of clusters, communicating and intertwining among their relevant actors, with other ones in other sectors or industries, represent the capstone upon which cluster and territorial development takes place.

As the different Post-Marshallian theories of clustering have been revised and analyzed in regards to how innovation has been tackled in each of them, and as territories have been influenced by industrial agglomerations and their externalities, this study sheds light on important clues as to how innovation is an essential catalyst in the determination of the modern cluster's competitiveness, and how they can contribute with territorial development of the regions and nations in which they are located.

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