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EVOLUTIONARY ECONOMIC GEOGRAPHY: A FRAMEWORK FOR ANALYZING THE DYNAMICS OF FIRM INNOVATION

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Abstract: The contemporary economic environment recognizes technological change as a phenomenon that results from the relations among actors and from the arrangement of firms and institutions within a territory, conferring on it an active, rather than passive, role. Innovative industrial agglomerations emerge from the ongoing exchange of knowledge, tightly linked to collaborative networks and to local institutional contexts. The evolutionary approach to economic geography emphasizes that the experiences and accumulated competencies shape the present and the future of space, driving competitive transformations. The objective of this study is to discuss theoretically the distinct approaches of Economic Geography and to present Evolutionary Economic Geography (EEG) as an alternative to the classical models in the regional literature. To this end, a historical-analytical bibliographic research was conducted, based on the identification, systematic reading, and critical interpretation of contemporary articles and books, in order to recover the conceptual and theoretical evolution of the field. EEG stands out as a theoretical framework that allows analyzing how territorial practices, collective learning, and institutional interactions shape the evolutionary trajectory of economies, stimulating innovation and technological adaptation. It is concluded that this perspective offers a solid basis for understanding regional economic and technological changes, as well as assisting in the interpretation of competitive transformations in specific environments.

Keywords: Evolutionary Economic Geography; Proximity Dynamics; Firm Innovation; Knowledge Flows.

GEOGRAFIA ECONÔMICA EVOLUCIONÁRIA: UMA ESTRUTURA PARA ANALISAR AS DINÂMICA INOVATIVA DA FIRMA

Resumo: O ambiente econômico contemporâneo reconhece a mudança técnica como um fenômeno que resulta das relações entre atores e do arranjo de firmas e instituições no território, conferindo-lhe um papel ativo, e não passivo. As aglomerações industriais inovadoras emergem da troca contínua de conhecimento, fortemente vinculadas às redes colaborativas e aos contextos institucionais locais. A abordagem evolucionista da geografia econômica enfatiza que as experiências e competências acumuladas moldam o presente e o futuro do espaço, impulsionando transformações competitivas. O objetivo deste estudo é discutir teoricamente as distintas abordagens da Geografia Econômica e apresentar a Geografia Econômica Evolucionária (GEE) como alternativa aos modelos clássicos da literatura regional. Para isso, realizou-se uma pesquisa bibliográfica de caráter histórico-analítico, baseada na identificação, leitura sistemática e interpretação crítica de artigos e livros contemporâneos, a fim de resgatar a evolução conceitual e teórica do campo. A GEE destaca-se como uma estrutura teórica que

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permite analisar como práticas territoriais, aprendizado coletivo e interações institucionais moldam a trajetória evolutiva das economias, estimulando a inovação e a adaptação tecnológica. Conclui-se que essa perspectiva oferece uma base sólida para compreender as mudanças econômicas e tecnológicas regionais, além de auxiliar na interpretação das transformações competitivas em ambientes específicos.

Palavras-chave: Geografia Econômica Evolucionária; Dinâmicas de Proximidade; Inovação da Firma; Fluxos de Conhecimento.

1 INTRODUCTION

The literature supports the notion that innovation is not a linear or easily understood phenomenon (Cassiolato; Lastres, 2005; Lundvall, 1992). In fact, innovation has assumed a central role in dynamic competitiveness, which diverges significantly from traditional, static competitive advantages. These static advantages often rely on the exhaustive exploitation of human and natural resources or on the manipulation of exchange rates for artificial international insertion. To cultivate systemic competitiveness, it is essential to prioritize dynamic competitive advantages that arise from the introduction, development, and application of technological, organizational, and managerial innovations in everyday economic activities.

In this context, territory assumes a crucial role, reflecting new perspectives within local development theories and policies. These approaches view territory as a facilitator of social transformation, linked to the entrepreneurial and productive potential inherent in the area, however, innovation and technological production cannot be confined solely to the local scale. Even when rooted in specific territories, these processes are embedded in global chains and networks that transcend geographical boundaries. Local initiatives, once connected to broader social or technological networks, often expand beyond their origin and contribute to global flows of knowledge and production.

Innovation emerges from a cumulative and virtuous learning process, which establishes a connection between industrial agglomeration and technological modernization. This relationship is contingent upon local cooperation networks, public policies, and cultural, institutional, and historical characteristics that together define a territory's potential. Consequently, successful regional development can foster endogenous interactions and create a landscape conducive to long-term competitive conditions (Brinco, 2010).

The neo-Schumpeterian, or evolutionary, perspective posits that transformations are typically contingent upon firms, their learning processes, and their relationships. Firms do not innovate solely through internal resources; they also rely on external sources and a supportive ecosystem that enhances the innovation process (Araújo, 2013; Gonçalves; Fajardo, 2011; Ruffoni, 2015). Howells (2002) emphasizes that geography plays a pivotal role in knowledge activities. Knowledge is shaped by cognitive, social, and cultural developments, as well as by economic circumstances influenced by geographical location. It is, however, profoundly collective in nature. The development of collective knowledge, or local knowledge stocks, is determined by human interactions that are shaped by the environment and affected by geographical distances. This recognition of geography's importance in deepening our understanding of innovation dynamics has led to its increasing prominence within economics.

From a theoretical standpoint, certain foundational works have significantly influenced economic geography and regional economics. Notable contributions include those of Johann Heinrich von Thünen (1826), Alfred Weber (1909), Walter Christaller (1933), August Lösch (1940), and Walter Isard (1956), who conceptualized space as an obstacle to transportation and a factor of production. Between the 1850s and the 1920s, economic effects related to space were primarily attributed to the external economies identified by Alfred Marshall (1890). Spatial economics further developed in Germany and the Scandinavian countries through the work of Claude Ponsard (1958). Additionally, scholars such as François Perroux (1955), Gunnar Myrdal (1957), and Albert Hirschman (1958) emphasized agglomeration factors.

Starting in the 1980s, a new economic geography emerged, more attuned to the roles of innovation and technical progress. To gain recognition, these findings required formalization, leading economists such as Paul Krugman, Masahisa Fujita, and Anthony Venables to analyze geographical space, economic development, increasing returns, and both internal and external trade.

In 2005, Evolutionary Economic Geography (EEG) was established, building on neo-Schumpeterian ideas (Boschma, 2005; Boschma; Frenken, 2010). This perspective argues that regional development is often uneven and can be understood through the relationships between individuals and their surroundings. Moreover, geographical proximity among agents becomes a prerequisite for facilitating interactions and knowledge exchange, impacting the flow of knowledge between actors.

Given this context, this article aims to present Evolutionary Economic Geography (EEG) as an alternative to classical models in regional literature and to examine its contributions to the analysis of technical change. To this end, the paper is organized into four sections, including this introduction. Section 2 discusses EEG, its core concepts, and the main intellectual divergences from other currents in geography, notably New Economic Geography and Institutional Economic Geography. Section 3 examines proximity dynamics and their role in social relations and innovation processes. Section 4 offers a discussion and evaluation of the topics addressed.

2 EVOLUTIONARY ECONOMIC GEOGRAPHY

The evolutionary point of view within geographical economics seeks to nurture its concepts with the belief that the skills and experiences acquired over time by individuals and entities in particular regions are capable of determining the present landscapes, as well as influencing the region's future trajectory. Essentially, the idea of this current is embedded in the socio-economic realities that drive the continuous search for novelty and competitive advantage. Technological change arises endogenously, through mechanisms of transformation and adaptation that shape the evolution of the economy in space. The consequence is that the economic landscape is in constant upheaval, driven and shaped by processes of competition that create work and routines within some sectors and regions and, at the same time, encourage experimentation and discovery in others, resulting in an uneven geography of knowledge production and innovation. Thus, technological change

also has a decidedly geographical dimension that affects economic growth and regional prosperity.

The geographic evolutionary current is interested in the production and destruction of novelties in space and the link between innovation and regional growth (Boschma; Martin, 2010). For Evolutionary Economic Geography (EEG), the creation of technological knowledge is a movement and recombination between agents and institutions that centrally define evolution in regional economic space. EEG seeks to focus on the relationships between agents and institutions rather than relying on the region as the sole unit of analysis. In addition, certain analyses consider firms or public activities as the locus of development and economic change. For EEG, economic evolution is understood as the result of the direction of innovation that is organized by routines and the selective transmission between agents and institutions.

While economic geographers have explored the economy generated in agglomerations and the production and dissemination of knowledge that occurs in some places rather than others, little is still known about the emergence of these agglomerations, how they change over time, and which firms or economic agents are most likely to capture different returns to co-location. In short, the EEG research agenda aims to unravel the spatial evolution of companies, industries, networks, cities and regions, as well as elementary processes such as the entry, growth, decline and exit of companies and their locational behavior (Kogler, 2015).

In order to open the black box and find the forces of diversified regional development at various scales (micro - meso - macro level), GEE is centered on three research efforts: first, the concept of Generalized Darwinism, especially the concepts of search, selection, variety and retention (Nelson, 1995); second, Complexity Theory, closely linked to stochastic behavior, whose essential focus is the research of non-linear dynamic systems attributing non-teleological properties, understanding that micro-components interact constantly and influence decisions in different dimensions and ranges, forming a complex system that transforms the structure and behavior of the region (Martin; Sunley, 2010). The third research effort is the geographical influence on knowledge interactions (knowledge spillovers) in which context plays a decisive role in the diffusion of knowledge through relationships between individuals (Howells, 2002).

Based on these fundamentals, the logic is that the exchange of knowledge flows more effectively between similar, i.e. related, parts of the system. Thus, if knowledge exchange is indeed limited by some kind of proximity (cognitive, social, geographical, institutional or organizational), the expectation is that the existing set of technology composition, together with the stock of knowledge in a given time and place, will shape the future trajectory of the region. However, this does not mean that the effects will remain confined to this scale.

While this logic of path dependency suggests that there are significant limitations on the extent to which a system can become trapped due to technological lock-in (at least in the

short term), it also indicates that there are potential opportunities for related knowledge[2], or mastery of a new technology that is not part of the region's present stock of knowledge (Kogler, 2015).

2.1 Evolutionary Economic Geography: Objective and Scope

Methodologically, Evolutionary Economic Geography diverges from the institutional perspective that avoids formal models and tests; at the same time, it incorporates evaluative tools from institutional studies for regional analyses, in contrast to the neoclassical school. It distances itself from the optimizing agent, the equilibrium attractor, and the focus on neutral space and transport costs. It emphasizes path dependence and multiple/recursive equilibria. An agent's satisfaction derives from structural and individual combinations associated with patterns and locational orientations.

To demarcate its intellectual framework, EEG views firms not as victims of history but of routines that can be altered through decisions, within the structure–agency interaction that shapes the evolution of real space[3]. What matters to EEG are the cycles of birth, growth, and death of firms and sectors, as well as innovation and the co-evolution among firms, industries, and institutions. Replicating routines across distinct geographic contexts tends to support growth; as competitive differentials, routines become sophisticated strategies replicated across territories to expand firms' actions.

EEG centers on two units of analysis: the spatial evolution of sectors and relationship networks. In evolutionary models, the entry/exit of agents and the dynamic formation of ties can be estimated through social network analysis (Giuliani, 2010), identifying hierarchies, singular topologies, and the spatial evolution of relations within non-deterministic and stochastic processes.

Networks are vehicles for the creation and diffusion of knowledge; spillovers largely stem from networks and labor mobility (Boschma; Frenken, 2010; Araújo, 2013), especially in regions characterized by geographic proximity among firms.

Another unit of analysis is the spatial concentration among firms. Agglomeration can foster development or lead to sectoral decline along at least three dimensions: the geographic concentration of industrial activities (which can generate agglomeration economies and start-ups), the geographic concentration of firms (which raises competitiveness by forcing entry and exit and enhancing routine performance), and the spatial concentration of agents (driven by proximity among firms, which affects collective action, as opportunistic behaviors are more likely among close agents) (Boschma; Frenken, 2010).

2 The term related knowledge appears in the GEE literature as a key element in the diversification and development of new knowledge paths. This occurs through the recombination of existing resources and new technologies developed in different industries. Further studies on this perspective can be found in Beaudry and Schiffauerova (2009) and Boschma (2015).

3 Real spaces refer to the actual, physical locations where economic activities, production, and innovation occur. These are the tangible geographic areas where interactions among firms, institutions, and individuals take place, shaping the spatial dynamics of knowledge creation and economic development.

Proximity is central to EEG, as it explains performance and the formation of network structures (Tower; Rallet, 2005). Empirical evidence indicates proximity as a key driver of network evolution (Broekel, 2015) and as a prerequisite for connections and knowledge flows. These issues help elucidate why some actors are better connected than others, how interactions affect performance, and how networks evolve over an industry's life cycle.

Relationships among firms, particularly those involving knowledge and innovation, are systematically biased rather than random: differences in routines, resources, and strategies make some firms more connected. Understanding these interactions explains the formation and evolution of ties, regional diversification, and the institutional role. Distinct forms of proximity (technological, social, institutional, organizational, and geographical) shape these processes.

The field's main contribution lies in revealing how knowledge circulates selectively across space and networks: it is not "in the air," but unevenly distributed within clusters (Marshall, 1920); collaboration is selective due to routines and absorptive capacity (Cohen; Levinthal, 1990); proximity fosters connections but does not guarantee performance (Boschma, 2005); and cluster networks may become increasingly inward-looking, reducing openness to external learning (Martin; Sunley, 2010).

External relations are vital to sustaining competitiveness, but they require complementary forms of proximity to enable effective knowledge transmission (Giuliani, 2010). Even in contexts with strong geographic and institutional proximity, performance is heterogeneous due to internal capabilities and positions within networks (Broekel, 2015). These insights reinforce that the spatial dynamics of knowledge are inherently uneven, shaped by selective interactions and differentiated learning capacities among agents.

2.2 Unveiling New Dimensions: Evolutionary Economic Geography in Context of Established Frameworks

GEE is positioned as a substrate for two important theoretical strands within the field of economics: New Economic Geography (NGE) and Institutional Economic Geography (IEG). The former lends the deductive methodology incorporated in formal models to GEE, even if it is treated differently. However, GEE considers the spatial evolution of sectors and the relationships between individuals to be a co-evolutionary dynamic, considering space in regions with multiple interactions. The second strand brings in the inductive characteristic (appreciative theory), in addition to the concepts of routine, limited rationality, search for imbalance, historical influence (path dependence), understanding that technology advances differently between regions over time, as a reflection of the coevolution of agents and institutions.

The NGE[4] reignited the debate among geographers linked to economics when it opened up a new research agenda combining contributions from regional science, location theory and elements derived from the central concept of traditional microeconomics. NGE, based on Krugman, Venables and Fujita, can be considered a recent extension of neoclassical thinking to explain agglomeration, specialization and trade between agents or nations based on the basic assumption of rational decisions and the concept of optimality[5] (Boschma; Frenken, 2006).

Assuming increasing returns to scale and imperfect competition at the firm level, NGE considers models in which the level of transportation or the transaction costs of goods are the parameters (Braknman; Garretsen, 2003). This current works with formal models and a deductive essence, assuming utility maximization and absolute rationality, and uses the logic of equilibrium attraction to generate conclusions and propositions. In addition, the assumptions do not accept the existence of differences between regions, but only differences between the price factor and institutional arrangements. The model starts its analysis from the position of a neutral space with the aim of explaining how agglomeration can occur from this situation, demonstrating how spatial inequalities can emerge from a blank landscape in a uniform world (Boschma; Frenken, 2006).

Even though it has structural theoretical differences, NGE has elements that are inserted into the GEE framework to help understand the dynamic mechanism of the creation and unequal transformation of regions. This approach is centered on the methodology of the models, including the possibility of technological lock-in and the irreversibility of the processes (Boschma; Frenken, 2006). On the other hand, NGE (like GEE) assumes in its models the possibility of multiple equilibrium, in which the trajectory of the processes indicates one of the possible equilibria, and the irreversibility of actions can lead the system to lock-in and sub-optimal results (Boschma; Lambooy, 1999).

Another common characteristic shared by the two schools of thought is the explanatory power of their models. In New Economic Geography, agglomerations occur when consumers and firms anticipate the advantages of clustering, primarily due to reduced transportation costs and the maximization of profits.

A similar concern is addressed by Evolutionary Economic Geography, which explains how these spatial structures emerge and evolve over time, emphasizing path dependence, innovation processes, and localized learning. EEG investigates where such dynamics occur (usually in regions with dense knowledge networks, universities, and innovative firms) and why some regions succeed in renewing their technological base while others become locked into obsolete trajectories. By integrating historical, institutional, and cognitive dimensions,

4 The debate on the label New Economic Geography has not yet been overcome, despite the fact that it has gained more consensus in the last decade. Some researchers prefer the term Geographical Economics, defending the need to insert more geography into the economic mainstream. Fujita and Thisse (2002) suggest a more in-depth discussion of this perspective.

5 In New Economic Geography, optimality refers to whether the spatial distribution of economic activity (emerging from agglomeration and dispersion forces) is socially efficient, maximizing overall welfare, rather than merely reflecting a market equilibrium.

EEG provides a richer understanding of why regional development follows uneven and irreversible paths, shaped by cumulative processes of knowledge creation, adaptation, and diffusion.

Beginning with the establishment of a firm, and recognizing that this firm possesses a probability of spawning new firms, the outcome of this locational dynamic can be modeled as a stochastic process. This process indicates that past actions exert influence on present and future activities. The stochastic model is also applicable to the spatial evolution of connections among local agents at the micro level, where new connections may emerge. These links can manifest at any time and place, being dependent on geographic space and preferential connections (Barabási, 2002). This same logic is reflected in the industry life cycle model (Klepper, 2002), which demonstrates that early entrants into a market have a higher probability of survival compared to later entrants, attributable to the time required for the development of routines and the maturation of their relationships.

Despite the similarities between the schools of thought, it is essential to clarify their fundamental divergences. First, unlike New Economic Geography which explains the emergence of unequal regional distributions through models based on the concepts of maximization and homogeneous agents, Evolutionary Economic Geography relies on a framework that includes bounded rationality (Simon, 1955), routines, and heterogeneity among agents (Nelson, 1995). While NEG adopts monopolistic competition as its analytical framework, EEG focuses on the processes of market entry, exit, and innovation, which co-evolve endogenously with market dynamics[6] (Boschma; Frenken, 2006).

The second divergence worth highlighting concerns the level of economic aggregation. New Economic Geography (NEG) addresses spatial economics at the macro level, focusing on the location decisions of agents (firms and consumers). At the micro level, it relies on a market structure that has been previously established by microeconomic theory. As a result, NEG is unable to explain where industrial location and specialization occur or why they happen in certain places rather than others. In contrast, Evolutionary Economic Geography (EEG) aims to understand the spatial evolution of industries at the meso level. Thus, the spatial evolution of the economic system at the macro level is examined within a framework of structural change, where territorial units are analyzed in terms of the rise and fall of sectors and infrastructure networks, whether at the level of countries, regions, or cities (Boschma; Frenken, 2006).

The third divergence pertains to the fact that the models of New Economic Geography (NEG) interpret and reflect the formation and agglomeration of economic activity using a static equilibrium analysis. Changes in equilibrium are driven by exogenous parameters, such as a decrease in transportation costs or a reduction in trade barriers. In contrast, the model proposed by Evolutionary Economic Geography (EEG) is centered on economic dynamics, illustrating the temporarily determined direction of convergence that is driven endogenously by a firm's innovative behavior. In other words, this implies that the growth

6 In this regard, some authors argue that New Economic Geography (NEG) has weak foundations when considered in the context of modern industrial organization theories. For a more in-depth exploration of this perspective, Neary (2001) is recommended.

and decline of firms, sectors, and territories are explicitly modeled over time, taking into account the hidden stochastic nature that reflects innovation (Boschma; Frenken, 2006).

A final difference concerns the underlying theory of agglomeration economies. New Economic Geography bases its explanation on increasing returns to scale (internal to the firm). In contrast, Evolutionary Economic Geography focuses on agglomerations resulting from knowledge spillovers. From an evolutionary perspective, knowledge spillovers contribute to the self-reinforcing nature of agglomeration economies, whereby firms located in a region generate and attract new firms to the same area through knowledge creation. At the same time, knowledge spillovers may be responsible for the diffusion and trajectory of technology generated in a particular region, driven by the proximity of established firms within local clusters[7].

In summary, EEG posits that the construction of the geographical landscape arises from the dynamic interaction of agents over time. The key characteristic is the co-evolution of actors (micro, macro, and meso), which occurs in a stochastic and non-deterministic manner. To understand evolution, this framework draws on mathematical modeling concepts and dismisses the principle of absolute rationality and static equilibria.

2.3 Evolutionary Economic Geography in Context of Institutional Economic Geography (IGE)

Currently, there is an increasing consensus regarding the importance of institutions in the economic field. The argument behind this assertion is the difficulty of capturing the broad process of development without considering the role and performance of institutions. The same applies to the field of economic geography. During the 1950s, the discipline was strongly influenced by models of German tradition, particularly the ideas of Lösch. By the 1970s and into the mid-1980s, there was a Marxist and historical materialist bias. From the 1980s onward, geographers adopted methods influenced by the so-called institutional turn, which emphasizes the need to incorporate political, social, and cultural factors into geographic analysis. This new phase is regarded by some researchers as a turning point in the discipline, taking into account economic activity that is socially and institutionally embedded within the context of the economy and regional formation (Amin; Thrift, 2000).

The first aspect that merits attention is that not all researchers within the field of IEG can be classified as evolutionary. This is particularly true for studies assessing the impact of institutional adjustments on economic performance, which tend to overlook the dynamic aspect, central to evolutionary theories. The secund conflict pertains to the

7 This point is particularly important as it highlights an epistemological divergence between New Economic Geography (NEG) and Evolutionary Economic Geography (EEG). According to Krugman, it is not possible to measure knowledge spillovers, or at least not at the level of abstraction required. Currently, there is a substantial body of literature addressing the concept of knowledge spillovers. This discussion began with economist Alfred Marshall (1920), who examined the experiences of industrial districts in England during the 19th century (the Marshallian Trindade), and was revived by Adam Jaffe's (1993) study, which developed a methodology to measure the existence and significance of knowledge flows for the economy. For further exploration of this perspective, Araújo (2013) and Autant-Bernard (2002) are recommended.

analytical tools employed. Evolutionary Economic Geography utilizes formal modeling to derive hypotheses and evidence, whereas Institutional Economic Geography dismisses the use of mathematical models a priori. In regional studies, Institutional Economic Geography prefers qualitative analyses, avoiding the reductionism of models and opting for in-depth case studies that address the multifaceted nature of regional development. This stance has led to criticisms regarding a lack of rigor, insufficient empirical evidence for hypotheses, and poorly defined concepts. Nevertheless, the institutional contributions of economic geography hold some theoretical importance by proposing new explanations and mechanisms for regional development (Davids; Frenken, 2015).

The third point highlighted is the treatment of context. The evolutionary approach begins its analyses with organizational routines at the firm level, while the perspectives of IEG consider institutions within specific territorial contexts. Both recognize the importance of the environment in decision-making, thereby eliminating the neoclassical paradigm of utility maximization. However, routines are specific to each firm (microcontext), arising from past experiences, whereas institutions are specific to particular communities and territories, stemming from a macrocontext. Consequently, the institutional context can exert considerable influence on firm routines; conversely, firm routines may share many characteristics of an institutional system but will tend to differ from one system to another (Davids; Frenken, 2015).

Understanding the adaptability of routines necessitates an analysis of institutions as a determining agent of context. Thus, according to the evolutionary perspective, institutions can shape economic behavior to the extent that routines do not conflict with institutional frameworks. These routines, on the other hand, are heterogeneous. Each firm develops its routine within a specific institutional environment. Therefore, it can be concluded that considering only the territory as a unit of analysis is problematic, as it must be assumed that routines are homogeneous within a given location. As Boschma (2006, p. 288) states:

> […] territories can only be called relevant and meaningful units when the idea of routines and competences can be transferred from the organizational level to the regional level. In that respect, the region has become an entity on its own, providing intangible and non-tradable asset based on a unique knowledge and institutional base, which is not accessible for non-local firms. Only in those (quite exceptional) circumstances, one needs to understand the success and failure of firms through their local context […].

In summary, Evolutionary Economic Geography is primarily interested in understanding whether (and how) geography matters in the economic landscape, rather than theoretically assuming its relevance in all cases. The evolutionary geographical approach posits that neither the theories of real places proposed by the institutional perspective nor the traditional determinants (price factors) put forth by New Economic Geography adequately explain regional differences and their development over time. Evolutionary Economic Geography seeks to understand the reasons behind the varying growth rates and models in

regions that share similar institutional frameworks and endogenous factors[8]. Thus, it is the combination of endogenous factors and institutions that can provide a dynamic analysis at the sector level and in the relationships where patterns of dependence and the self-reinforcing behavior of local actors form the core of the explanation. Consequently, EEG suggests that real places and their changes over time emerge from the actions of economic agents rather than being determined by the characteristics of places themselves.

Finally, for EEG, a space transforms over time into a real space where new structures and sectors are created and concentrated. This formation is historically influenced, dependent on its past and the collective actions of individuals who establish an institutional foundation that is dynamically adapted and transformed in a genuine temporal co-evolution. Therefore, as Boschma and Frenken (2006, p. 290) state, "[...] regional development is more about path dependence than place dependence, although some places may be better in renewing their institutions than others [...]".

3 GEOGRAPHY ECONOMIC GEOGRAPHY AND PROXIMITY DYNAMICS

The concept of proximity is currently a widely discussed topic in various fields of science, such as regional science, organizational science, and innovation studies[9] (Knoben; Oerlemans, 2006). These ideas seek to unveil the intricate innovative process that has as its central hypothesis the need for communication and interaction between agents. Geographical proximity enters this mechanism as a resource capable of reducing distances and facilitating communication and the exchange and generation of knowledge[10], becoming an important element to assist in the decision-making of the actors in an environment of constant competitiveness and surrounded by uncertainties (Boschma; Frenken, 2006; Bouba-Olga *et al.*, 2015; Carrincazeaux; Lung; Vicente, 2008; Knoben; Oerlemans, 2006).

In summary, according to Schiller (2004, p. 161),

> [...] the transition to post-Fordism and highly mobile relationships results in the revaluation of local dimensions. It is the interplay of immaterial factors that is truly responsible for characterizing the new productive dynamics. Considering this hegemony, a firm's competitiveness levels depend on the relationships among actors and the characteristics embedded in the territory [...].

8 In Evolutionary Economic Geography, endogenous factors refer to the internal characteristics of a region that shape its capacity for innovation, technological development, and economic evolution over time. These factors are contrasted with exogenous influences, which come from outside the region.

9 The theme of proximity has expanded its space in the academic field and has been gaining interest in specialized journals. From a chronological point of view, special issues have been published in the *Revue d'économie régionale et urbaine (1993), L'industria (1998), Cambridge Journal of Economics (1999), Economie Rurale (2004), Economie et Institutions (2005), Regional Studies (2005) and Economie Régionale e Urbaine (2008).* The theme took on new proportions when treated together with the evolutionary perspective in economic geography. From this new perspective, special issues can be found in the *Journal of Economic Geography (2007), Economic Geography (2009), Regional Studies (2015)* and *Journal of Economic and Social Geography (2015).*

10 According to Rallet and Torre (1999, *apud* FELDMAN, 1994, p. 1), "[...] knowledge traverses corridors and streets more easily than continents and oceans [...]".

In short, proximity *per se* refers to the existence of interactions (from diverse nature) and refuses the exclusive appeal of transport costs of spatial analysis, based on reasoning based on only in the physical conception of the relation. These interactions can be in different ways: formal, informal, commercial, complementary, adoption and diffusion (of innovation), complementarities (technological), etc. Moreover, the distinction between intentional and unintentional interactions is not trivial (Rallet; Torre, 1995). The analyses of an unintentional nature originate from the works of Marshall (1920), with the notion of external effects present in agglomerations at the local level. Intentional interaction analyses are characterized by exchanges in the market, cooperative relationships or partnership relationships and deal with the interactions that are intended to be established with other partners (competition) that may be trustworthy, information or technical, but mainly concern their strategies (Schiller, 2004).

This difference in interaction makes it possible to establish, for example, a boundary between the relationships that are inherent to everyday life and those that depend on technical conditions or distance and analytically support the introduction of the action of economic agents in the analysis of proximity (Rallet; Torre, 1995). The frequency of interactions also matters. Here the dynamic character is signaled, which contrasts with the static aspect of the location of the firms. It is from density and extension that the modifications and adjustments of the system are understood. In other words, it is the dynamism of the interaction that makes clear the process of separation and connection or proximity and distancing of agents, firms, organizations, activities, etc. (Schiller, 2004). Understand the number of interactions, the way they are reproduced, their perenniality and their transversality becomes a concern for any researcher who intends to unravel the relationships of proximity.

In essence, schools of proximity (French, Scandinavian, Dutch) associate the role of geographic proximity with knowledge sharing and innovation. Supported by the argument that the exchange of tacit knowledge requires face-to-face contact, there is a large literature that emphasizes interaction as an element highly sensitive to geographical distance. The co-location of firms, therefore, can offer competitive advantages to firms and regions. Recent literature discusses the existence of various dynamics of proximity, and several concepts are being proposed in the world literature, such as: cultural proximity (Gertler, 1995), social proximity (Uzzi, 1997), institutional proximity (Kirat; Lung, 1999), optimal proximity (Noteboom, 1999), organized proximity (Rallet, 2002), technological proximity (Greunz, 2003), cognitive proximity (Giuliani; Bell, 2005), temporary proximity (Torre; Rallet, 2005), proximity of *status* (Godart, 2012), mediated proximity and relational proximity (Bouba-Olga, Grossetti; Ferru, 2014).

According to the evolutionary current of economic geography, for a complete understanding of the innovative dynamics of the firm, proximity studies must be considered in five dimensions: cognitive, institutional, social, geographic and organizational. This classification would make research on proximity dynamics more analytical and would fit into the new agenda promoted by specialists interested in measuring and identifying the types of proximity between agents. For Boschma (2005), this delimitation opens up a new field of research for innovative dynamics when it deals with proximity beyond geographical

aspects. In addition, five proximities enable a division of the forces that induce the location of firms and seeks to deepen the individual understanding of each component in the intricate innovative mechanism.

Cognitive proximity, contrary to suggested by Arrow (1962), currently understands that knowledge is not an exogenous[11] and freely accessible good in the economy. Nelson and Winter (1982) argue that knowledge is a resource developed in the internal and external environments of the firm, which depends on its potential to accumulate, develop and absorb new ways of learning. As a result, the cognitive basis of the actors differs substantially due to the heterogeneous character. This implies that the knowledge is dispersed (in the firm, in organizations, in industry), which requires a hard ability to capture, organize, decode, interpret and recombine it to transform it into new knowledge (Cohen; Levinthal, 1990). For this reason, the ability of actors or firms to absorb new technologies requires cognitive proximity, that is, their cognitive basis must be close enough to new knowledge in order to communicate, process and understand these elements successfully (Boschma; Lambooy, 1999). Furthermore, it is not only about efficiency or speed of information acquisition, but, above all, about expanding the scope and spectrum of cognition (Nooteboom, 1999). In summary, cognitive proximity is able to facilitate communication and occurs more effectively between agents who have the same ability to absorb it.

Organizational proximity is restricted to the extent of relationships that are shared in an organizational arrangement both, within and between organizations. For GEE, organizational proximity involves a rate of autonomy and a certain degree of control that can be exercised by the organization in this type of arrangement. Here, the degree of strategic interdependence that two organizations have is of interest, since this relationship reduces uncertainties about the behavior of the partner in the relationships. In other words, organizational proximity is understood as a specific form of proximity between firms of the same group (subsidiaries, *joint ventures*, and other similar relationships) that can share knowledge. The degree of organizational proximity is defined by the deepening of autonomy and control induced by the connection between firms. When actors share a high organizational proximity, it is easy to avoid unintended knowledge flows and reduce uncertainties by also reducing collaboration costs, favoring the exchange of work groups such as engineers, researchers, etc. (Balland, 2012).

Organizational proximity is understood to be beneficial for learning and innovation because the creation of new knowledge accompanies uncertainty and opportunism. To reduce these factors, rigid control mechanisms (contracts, intellectual property, etc.) and rewards for investment in new technology are developed in the market. In organizations, this mechanism is perceived as a transaction cost (Coase, 1937; Williamson, 1981) and, in order to reduce it, the relations between organizations and intraorganizations are understood as viable alternatives.

11 Knowledge is not exogenous because that knowledge does not arise externally or independently from economic agents; instead, it is created and diffused through social, institutional, and organizational processes of learning and innovation.

Social proximity has its origins in Granovetter (1985). In essence, the literature indicates that economic transactions have, to a certain extent, the influence of social relations *rooted* (*embedded*) in the local context. In addition, this literature suggests that the more socially rooted the firm's relationships, the greater the interactive learning and innovative *performance*. Therefore, social proximity is defined as the ingrained social relations (micro-level) of the agents and is geared towards trust, friendship, and past joint experience. The ability of organizations to learn and innovate requires a certain amount of social proximity. The central reason lies in the idea that trust facilitates the exchange of tacit knowledge, which is, by nature, the most effective knowledge for innovative action and of greater difficulty. It is important to emphasize that social proximity does not deal with situations in which people share values (ethnic or religious) that are linked to the macro level (related to the cultural aspect and that will be debated in institutional proximity). Centrally, social proximity is interested in the role played by trust that is positively related to the logic of social encouragement and the *openness of communication* between agents (Broekel; Boschma, 2011).

While social proximity is defined as rooted relationships between individuals (microlevel), institutional proximity is linked to the institutional environment (macrolevel), that is, formal (laws and rules) and informal (habits and norms) institutions that influence the extensions and manners of the actors or the coordination of the actions of organizations. It must be understood, therefore, the social, organizational and institutional proximity are connected forms of proximity, due to the character and influence of institutional regimes. The rationale behind this statement is that institutions can allow or restrict mechanisms that affect knowledge transfer, interactive learning, and innovation. In essence, institutional proximity is defined by informal restriction and formal rules shared between actors and that commonly represent the routines and incentives that allow organizations to efficiently carry out knowledge transfer (Balland, 2012). In other words, the notion of institutional proximity includes both the idea of economic actors sharing the same *rules of the game*, as well as the set of existing cultural habits and values. Common language, shared habits, the system of laws, intellectual property, etc., form the basis for economic coordination and interactive learning. In short, institutional proximity allows stable conditions for the interactive channel to become effective (Boschma, 2005). For Gertler (1995), information is transmitted more efficiently in places where culture is close and language is common to the actors.

In analytical terms, GEE understands geographic proximity as the spatial or physical distance between economic agents in an absolute or relative way. It is important to make it clear from the outset that the geographical dimension must be analyzed in isolation from other forms of proximity. In this case, it is possible to say that the transfer of knowledge takes place without the need for interaction or coordination between agents. The mechanism behind this statement lies in the idea that face-to-face contact provided by geographical proximity is the central factor in the process of knowledge and information transfer. In other words, each firm located in an agglomeration can benefit from the physical proximity of the firms installed in that environment, and this effect, *per se*, becomes the great element of geographic proximity (Boschma, 2005).

However, it is difficult to imagine that imitative processes can occur without cognitive proximity (at any intensity). Firms need some capacity (competence) to absorb and process external knowledge. Therefore, it is assumed that geographic proximity combined with some cognitive proximity becomes sufficient for learning to occur. Hausmann (1996) goes further and indicates that geographic proximity can only act as a complementary proximity in the interactive learning process, indicating that social proximity or organizational proximity may be more important than physical proximity, but understands that geographic proximity can facilitate communication. The relative consensus in the literature is that geographic proximity acts as a complementary force in the construction of social, organizational, institutional or cognitive proximity dynamics and facilitates interorganizational learning.

It is important to note that exaggerated proximity can be unfavorable for learning and innovation. First, there is the risk of *lock-in* that occurs in this type of exchange. Asymmetric relationships lead to high dependence on specific relationships, limiting access to new sources of resources and information. For Boschma (2005, p. 65), "[...] *search for novelty often requires going out of the established channels* [...]". Second, the implementation of the novelty requires organizational flexibility. Organizational proximity reflects a structural hierarchy that is unable to offer flexibility for actions. The more dependent the relationships are in the organizational arrangement, the fewer initiatives beyond the relationship, causing negative effects on flexibility and innovation (Boschma, 2005). Third, relationships in which there is exaggerated loyalty can compromise the actions of actors who tend to underestimate latent opportunities. For Uzzi (1997), a behavior of great loyalty can develop negative consequences in a world where there are constant technological changes, and where opportunism is the common conduct in the market. In addition, lasting relationships enclose individuals to their established social connections and patterns, increasing the cost of learning and innovative capacity.

Finally, Boschma (2005) and Uzzi (1997) propose the existence of a proximity paradox and point out an "*inverted U" relationship* between proximity and the innovative performance of the firm, indicating that there is a *tradeoff* between these dimensions and that, after a certain point, proximity ceases to be a beneficial effect and becomes a negative element for the firm. In other words, the adaptive capacity of the actors can be increased considerably when the relationships consist of a balance between keeping the firm open (with a flexible mind) and building relationships of trust (low transaction cost and reliable exchange of knowledge).

The Table 1 presents the chronological evolution of the publications that, in a seminal way, build the theoretical framework and that helped in the composition of the five dimensions proposed by the geographic evolutionary current. It was organized according to a historical-analytical bibliographic research strategy. Briefly, this method systematically identifies and periodizes seminal works, situates them within their intellectual contexts, and analytically traces conceptual and methodological linkages across sources to uncover cumulative trajectories. Sources were selected via iterative screening of core journals and citation chaining, then comparatively assessed to map how core constructs coalesced into the five proposed dimensions (Mcmullan; Dann, 2020).

Table 1 - Proximity dimensions: literature review.

Autor	Journal / Year	Main	Analysis	Extend Proposition
Granovetter, M.	American Journal of Sociology (1973)	External Ties	"Weak Ties" established between external links to relations environment may be responsible for building important links (bridges) that benefit the resource flows.	Evaluate the performance of network structures; understand the relationship between strong ties and the hierarchical structure networks.
Gertler, M.S.	Economic Geography (1995)	Cultural Proximity	Physical proximity alone cannot translate the dynamics of innovation between agents.	The success in advancing new technologies is due to cultural proximity (sharing norms, codes, languages and practices) between actors.
Uzzi, B.	Administrative Science Quarterly (1997)	Social Proximity	Relations between firms has confidence building, information transfer and joint problem solving.	Advance research on the cognitive relations, institutional and policy.
Kirat, T. Lung, Y.	European Urban and Regional Studies (1999)	Institutional Proximity	Institutional knowledge.	Forward research considering the institutional proximity as a mean element in learning.
Nootebom, B.	Cambridge Journal of Economics (1999)	Optimal Proximity	Excessive relationship with the same environment promotes situations of "lock in". The balance between strong and weak ties is necessary.	Empiric application.
Rallet, A. Torre, A.	GeoJournal (1999)	Geography and Non-Geography Proximity	There are no means to replace the geographical proximity.	Combining local relationship / non-local relationship broad the understanding of the influence of non-local factors development.
Torre, A. Gilly, J. P.	Regional Studies (1999)	Geography Proximity and Organizational Proximity	Determine geographical and organizational proximity and discusses the role of interactions (non-intentional and voluntary) as central to the close relations.	Reinforcing the role of institutions and local development policies.
Howells, J. R. L.	Urban Studies (2002)	Cognitive knowledge	The interactions are formed by the time (the diffusion force) and influenced by geography (local training, habits, knowledge base).	Evaluate how the geography and time influence the process of disseminating knowledge.
Rallet, A.	IPPUR (2002)	Geographical Proximity and Organized Proximity	Multiple dimensions of proximity vision (relational, technological, cognitive, emotional).	Researchers must deepen the efforts in relationship spillovers x innovation processes.
Greunz, L.	Regional Science (2003)	Technological Proximity	The technological proximity is as important as geographical proximity in the formation of knowledge.	Deepen research on the benefit of public programs aimed transferring technology and knowledge between different regions.
Torre, A. Rallet, A.	Regional Studies (2005)	Temporary Geographical Proximity	Companies allow temporary proximity times on times where interaction or co-production are key process.	Deepen the negative and positive effects of geographical proximity.
Giuliani, E. Bell, M.	Research Policy (2005)	Cognitive Proximity	Companies are heterogeneous and have different knowledge base.	Limits and amplitudes of public policies in the performance of the territory.
Boshma, R. A.	Regional Studies (2005)	Cognitive, Organizational, Social, Institutional and Geography Proximity	Conceptualization of the five dimensions of proximity: Cognitive, Organizational, Social, Institutional, Geographic.	Identify individual effects of dimensions beyond determine more precisely the way that decisions are related to each other; measure the effects of proximity innovation over time.
Boshma, R.A. Frenken, K.	Working Paper (2009)	The Evolutionary Economic Geography	Correlation literature developed for analysis of surrounding networks and dimensions of proximity. Understand the economic activity and social reproduction over the time.	Three research fields: Different forms of proximity as a driving force for the formation of relationships in space; the use of network dynamics to explain the endogenous evolution; understand how the evolution of networks of structures affects the forms of proximity.
Balland, P.A.	Regional Studies (2012)	Measure the composition and interactions of actors	Understand how the different forms of proximities interaction and find the key factor for a type of proximity overcome another type of proximity.	Measure different types of proximity and their dynamic interaction.
Bouba-Olga, O. Grossetti, M. Ferru, M.	Regional Development and Proximity Relations (Book) (2014)	Geographical, Relational and Mediation Proximity	The relationship may be established by market coordination (organizational resources) and interpersonal coordination (individual contact).	Keep efforts in studies of interpersonal, relations and organizational proximities.

Source: author.

4 FINAL REMARKS

Regarding the contributions of GEE and the dynamics of proximity to the discussion of technological change, it is noteworthy that since 1920, questions about geographic proximity have drawn attention in the literature focused on the understanding of industrial dynamics and production systems. During this period, Marshall sought to understand the effects of externalities produced in clusters of firms and their relationship with industrial activity. This focus lost strength after the emergence of the Fordist model, which highlighted the large firm as a central actor in productive activity, and which lasted until the post-war period. From the decline of the *business school*, alternatives to theories of industrial development emerged, and in the mid-1970s, Piore, Becattini, Sabel, among others, extensively demonstrated that there are alternative models of industrial organization. Advances in this area demonstrate what Marshall had already realized at the beginning of the twentieth century, namely, that the agglomeration of firms may be able to introduce innovations and articulate with the market differently from the conventional perception based on economies of scale and high investments in R&D within the firm.

It is in this new scenario that the dynamics of proximity are presented as an element to be unveiled. With the French school, proximity ceased to be eminently geographical and began to gain new dimensions and propositions. The relationship of the agents, which used to be essentially spatial, now also takes into account other factors such as learning for product development (temporary proximity), the introduction of a new technology (technological proximity), etc. However, it is clear that for innovation to occur, there must necessarily be, to some extent, cognitive proximity.

Even after advances in the area, a cunning path is still needed to fully unravel this dynamic. First, it is necessary to understand how the relationship between proximity dynamics and the advancement of information and communication technology (ICTs) develops. In other words, will ICTs be able to shorten distances and reduce the need for proximity in the near future? Some clues in this direction are proposed by Howells (2002) and Rallet and Torre (1999) who defend the condition of personal contact (tacit knowledge) as a central element in the dissemination of knowledge, which is difficult to replace by technological tools. On the other hand, the new generation advances in a surprising way in the relationship and management with digital media, combined with decreasing rates of information decoding costs. Johnson and Lybecker (2012) evaluated the transfer of biotechnological knowledge for twenty years and concluded that knowledge is currently more likely to travel long distances. For the authors, the standardization of products and the advancement of the means of communication form elements that provided a leap in the transfer of knowledge to the biotechnological articles industry. Huber (2012) reaches similar conclusions by researching the Cambridge Information Technology (IT) cluster in England.

The author argues that the local community does not find real benefits in the agglomeration of companies for the exchange of knowledge. Doloreux and Shearmur (2011) also research knowledge transfer in capital-intensive segments and draw similar conclusions. In short, the advancement of society, from the early relationship of the new generation with the new means of communication and technology to issues of proximity, should not be

denied. In addition, a series of questions still remain open, such as: for which business segments is proximity most relevant? are the size of firms relevant to the development of specific proximities? what kind of proximity benefits from the advancement of ICTs?

Secondly, the statistical studies developed in the area present results that are not yet considered robust within the academic environment. Since the seminal work of Jaffe (1993), there have been numerous attempts to measure in a Cartesian way the formation of *knowledge spillovers* and their benefit in Innovation Systems. Broekel *et al.* (2014) present several models that demonstrate potential to capture the flows of knowledge and information (gravitational model, multiple quadratic regression, exponential randomization models and the actor-based stochastic model oriented). Ter Wal and Boschma (2009) argue that social network analysis emerges as an important alternative to capture interaction and knowledge flow. However, the results are still questionable. Here the criticisms of Krugman (1991) who claims from the academic community the need for a formalization and measurement of knowledge flows, understanding that *"*[...] *knowledge flows are invisible, they leave no paper trail by which they may be measured and tracked* [...]" seem to make sense and this is a great challenge for the advancement of researchers in the area.

Thirdly, statistics, in addition to measuring proximity dynamics, need to be able to identify the optimal limit. To put it differently, if proximity is understood as a crucial element in the interaction of agents to promote and exchange knowledge, its excess can cause damage to innovative performance. Boshma (2005) already warned of the existence of a paradox of proximity. There are reasons to believe that a certain distance should be maintained to improve learning. In the construction of new knowledge, a wide range of unequal information is required that ends up triggering new ideas and stimulating creativity. In this regard, distance has the potential to stimulate the new, and the firm that has the ability to encode disparate information and translate it for its benefit will also be able to stand out in the market. It is difficult to forget habits and routines that were successful in the past, but that end up redundant over time and can lead to a process of lock-in, in which the routine and the search for new (but similar) methods keep the trajectory encapsulated in a single direction. In short, more than measuring distance, it becomes crucial to find the optimal proximity for each type of proximity (social, cognitive, institutional, organizational and geographic) and for each segment of industry (capital goods, intensive technology, services, etc.) a task that still needs to be pursued.

Fourth, the evolutionary challenge. Starting from the assumption and concepts of Evolutionary Economic Geography, innovation arises from micro-relationships and considers that understanding agglomerations means understanding local and global relationships between individuals, institutions and their co-evolution. Experiences and skills acquired over time by individuals and institutions determine the present configuration and future trajectory of a region. For Padgett and Powel (2012) "*in the short run, actors create relations; in the long run, relations create actors...".* It is necessary to develop studies that appreciate the dynamic results, where the time variable occupies a central role in the process and proximity issues are intimately involved. In essence, what is meant is that in order to fully understand the process that involves proximity and ties of knowledge, it is necessary to change perspective from the static to the dynamic condition, that is, only the temporal

look will allow us to understand if proximity and networks of relationships come together because of a selection process based on the organization's decision or if proximity is a social construction inherited from joint knowledge ties.

Finally, it is important to point out that the existing geographic currents do not take into account the evolutionary perspective for the complete understanding of issues such as geographic technological progress, the dynamics of comparative advantages, the economic restructuring of the region and economic growth. In this context, GEE promises to investigate the mechanism and process in which the economy *transforms itself from within,* in a dynamic, complex and past-dependent way.

The field of research for proximity dynamics and for Evolutionary Economic Geography presents an important intellectual fertility for the understanding of innovative dynamics. Furthermore, the approximation between the neoclassical field and the institutional area in geography proposes the appreciative element and intellectual gains that a school in isolation cannot offer. As usual in any evolution, time will bring answers that momentarily need to be revealed.

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