**Clusters, Economic Performance, and Social Cohesion**

**A System Dynamics Approach**

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**Abstract**

Cluster policies pervade all the regions of the world to promote employment growth, innovation and entrepreneurship. Yet research mostly focuses on cluster economic performance but less on regional social cohesion, which is important when economic growth coexists with deprivation, poverty and inequality. This paper aims to understand both the economic and social dynamics of clusters by developing a theoretical model based on system dynamics. It shows that clusters with positive economic performance do not necessary lead to regional social cohesion. Multiple positive economic-related feedback processes can be mitigated by negative social-related feedback processes. Implications for academics and policymakers are proposed.

**Short running title: Clusters, Economic Performance, and Social Cohesion**

**Keywords:** Clusters, Economic Growth, Economic Development, Social Cohesion, System Dynamics

**JEL Codes:** R11, L26, M16, M14

1. **INTRODUCTION**

Interest in the role of spatial clusters –i.e. geographically proximate groups of interconnected firms and associated institutions in related industries-- has grown in regional studies over the last decades since the seminal work of Porter (1998; 2003). Hundreds of cluster initiatives have been launched in all the regions of the world (Porter, 2003; UNIDO, 2009) suggesting that, among other benefits, they promote employment growth, innovation performance and entrepreneurship (Delgado, Porter & Stern, 2010; 2014; Pietrobelli & Rabellotti, 2007).

The interest in clusters has been motivated by the goal of enhancing economic performance (Porter, 2003; Spencer et al. 2010) and is grounded in both theory (Romer, 1986; Lucas, 1988; Krugman, 1991; 2000; Audrestch & Feldman, 1996; Massard & Autant-Bernard, 2015) and empirical validation (Delgado, Porter & Stern, 2010; 2014; Rocha & Sternberg, 2005; Spencer et al. 2010; Uyarra & Ramlogan, 2012). However, as global interest in Thomas Piketty’s seminal work on *Capital in the Twenty-First Century* (Piketty, 2014) and the questioning of place-neutral policies (Barca et al. 2012; Massard & Autant-Bernard, 2015) reflect, concerns have broadened beyond economic performance to include both income distribution and social cohesion (Atkinson, Piketty, & Saez, 2011; Novy, Swiatek, & Moulaert, 2012; Stiglitz, 2012; Cobb, 2016).[[2]](#endnote-1)

Despite this burgeoning focus on social cohesion, the question of how clusters affect both economic performance and social cohesion within a region remains unexplored. This question is central to both academics in the regional studies field and policymakers. In fact, regional studies focuses on research spanning not only economic performance, but also the social, political and environmental dimensions influencing subnational change. In terms of policy, the sectoral-regional nature of clusters (Martin & Sunley, 2003; 2015; Rocha, 2004)) sheds light on the critical evaluation of place-neutral policies, which assume the translation of sectoral policies to the territory (Barca et al., 2012; Massard & Autant-Bernard, 2015; McCann & Argiles, 2015; Belussi & Trippl, 2018) and focus on economic drivers that ignore social community and informal institutions (Becattini, 1990; cf. Konstantynova & Wilson, 2017:458).

This paper aims to fill this important void in the literature by developing a theoretical model to analyze how and why a cluster affects both economic performance and social cohesion within the region in which operates.

To this aim, this paper uses system dynamics modelling (Davis, Eisenhardt, & Bingham, 2007; Sterman, 2000) to theoretically investigate the behavior of a cluster within a region. System dynamics was developed in the 1950s by Professor Forrester from MIT and it is based on principles of information feedback theory. It has been successfully applied to model large complex social and economic systems such as cities (Forrester, 1970) and societies (Forrester, 1971). System dynamics has recently captured the attention of regional studies’ scholars, especially of those who conceptualize clusters as “complex adaptive systems” (Martin & Sunley, 2015:1303) and propose formal models to capture the dynamic interaction between sectors and territories (Fratesi, 2015) to inform place-based policies (cf. Massard & Autant-Bernard, 2015: McCann & Argiles, 2015).

The novel contribution of this paper is to develop a theoretical model to understand how and why clusters affect not only the economic performance of regions (Porter, 2003; Delgado, Porter and Stern, 2014) but also social cohesion within a region. In particular, this novel contribution spans theory, methods, and policymaking in regional studies. As to theory, the model shows that the impact of clusters on economic performance and social cohesion within a region depends on the degree of integration between regional socio-economic factors and cluster dynamics to integrate different groups such as migrant specialized workers and local workers (both, specialized and non-specialized) and embed large firms within the region. As to methods, this paper uses a system dynamic methodology, which is employed for the understanding of the behavior of systems with complex causality and timing (Davis et al, 2007) such as regions and clusters (Fratesi, 2015; Martin and Sunley, 2015). Thus, this paper contributes to the emergent interest in system dynamics in regional studies by conceptualizing clusters as “complex adaptive systems” (Martin & Sunley, 2015:1303) and proposing a formal model at the meso level of analysis to capture the dynamic interaction between sectors and regions (Fratesi, 2015). Finally, as to policy, this paper shows that promoting sectoral clusters but ignoring regional social cohesion may be doomed to failure, or at least fall short of generating the enhanced economic performance of regions. Thus, our model sheds light on current policy debates such as the place-based vs. place-neutral policies (Barca et al. 2012) and the Washington-Silicon Valley Consensus vs. new required consensus that takes into account the time and geographic dimensions of trade and innovation (Piore & Schrank, 2018).

The structure of this paper follows the roadmap of Davis et al (2007) to perform simulation studies. First, it defines the research question -i.e, how do clusters affect both economic performance and social cohesion at the regional level and why? (Section 1). Second, it reviews the basic theories to define the concepts and explain the relationship between clusters, the economic performance, and social cohesion of regions (Section 2). Third, it develops the conceptual causal model using system dynamics (Sterman, 2000) to represent the feedback loops and key constructs described in the literature (Section 3). Fourth, it runs the simulation with hypothetical (not real) data and discusses the dynamics to answer the research question (Section 4). Finally, it summarizes contributions and lines for future research, focusing on calibrating the conceptual model with real data (Section 5). Table 1 summarizes the structure of the paper.

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Insert Table 1 about here.

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1. **Clusters, economic performance and social cohesion**

This section defines the key concepts and summarizes the main cluster approaches that help to explain the relationship between the cluster and the economic and social performance of regions.

* 1. **Clusters**

Extensive reviews of the evolution and definitions of clusters have been carried out elsewhere (Porter, 1998; Martin & Sunley, 2003; Rocha, 2004), suggesting the distinction between cluster as an economic phenomenon, cluster policy and cluster organizations[[3]](#endnote-2). In terms of conceptual definitions of the phenomenon, Porter defined clusters in sectorial terms that is, industries related by vertical and horizontal links in his first work on clusters (Porter, 1990). In contrast, Porter’s 1998 definition is more comprehensive and includes three main dimensions: the sectorial, the geographical (pp.227-230), and the socio-economic network (p.225-7).

Despite Porter’s new conceptualization of clusters and hypothesized socio-economic impact (Porter and Kramer, 2011), his methodology remains similar to his 1990 view: it first creates an industrial cluster template based on industrial interdependencies and, second, it applies this cluster template to different regional levels (Porter, 2001). Therefore, the specific causal mechanisms that link spatial and socio-cultural factors to both the process of clustering and the generation of competitive advantage are not included in the model. Porter continues this line of reasoning in his latest work, where he defines clusters as “groups of closely related industries co-located in a region” (Delgado et al, 2014:1785).

* 1. **Economic Performance**

Economic performance is better understood within the context of the concept of development. The historical evolution of the concept of development suggests three main conceptualizations: economic growth, economic development and development (Allen & Thomas, 2000; Todaro, 2000). Economic growth is defined as “a continued increase in the size of an economy, i.e. a sustained increase in output over a period” (Allen & Thomas, 2000: 31) and measured in terms of variation in either gross domestic product (GDP) per capita or in any of its constitutive components – i.e. growth in consumption and investment (both private and public sectors) and exports. Economic development is the enhancement of the productive factors of an economy – i.e. land, labor, capital and technology (Allen and Thomas, 2000) – and measured in terms of either innovation (R&D and/or patents) or, more specifically, productivity (total productivity factor; cfMalecki, 1997; Todaro, 2000; Capello & Lenzi, 2015). Finally, development is defined as the expansion of capabilities (Sen, 1999) and is measured by either multi-item indices such as the Human Development Index (HDI) – i.e. weighted average of income per capita, literacy rate and life expectancy – or more simple ones such as employment (Sen, 1999). The latter is a proxy for development, given the human, social and economic implications of getting a job.

In this paper, we define economic performance in terms of economic development.

* 1. **Social Cohesion**

Researchers interested in developing theory in the field of social cohesion are confronted with a complex body of work that involves various definitions, specialized literatures on particular dimensions, and lines of inquiry at different levels of analysis (cf. Kearns & Forrest 2000; Friedkin, 2004; Cheong et al. 2007; Chan, To & Chan, 2006; Novy, Swiatek, & Moulaert, 2012). For example, Novy et al. trace back the origin of the concept to the work of Durkheim and analyze four approaches to social cohesion: socioeconomic, which emphasizes solidarity and social inclusion; cultural, which emphasizes common values and identity; ecological, which stresses sustainability and ecological justice; and political, with its emphasis on citizenship and participation (Novy, Swiatek, & Moulaert, 2012).

This plurality of approaches has led some authors to focus on typologies and dimensions of social cohesion. For example, Kearns and Forrest (2000), after an extensive review of the literature, suggest that the core dimensions of social cohesion are “the need for a shared sense of morality and common purpose; aspects of social control and social order; the threat to social solidarity of income and wealth inequalities between people, groups and places; the level of social interaction within communities or families; and a sense of belonging to place” (pp. 2128).

In this paper, we define social cohesion as the level of social integration between different groups in a geographical area (cf. Kearns & Forrest, 2000; Novy, Swiatek, & Moulaert, 2012; cf. Section 2.3). These different groups include, in the context of dynamic clusters within a region, specialised workers, non-specialised workers, and migrant specialized workers attracted by the growth of the cluster in the region. This definition captures the potential impact of relevant phenomena such as the capacity of foreign firms to embed themselves in local networks (Cantwell, 2009), the possible dangers to social cohesion represented by growing immigration flows and ethnic diversity (Cheong et al. 2007), the embeddedness of innovation dynamics (i.e. knowledge spillovers and knowledge transfer) within a region (McCann & Argiles, 2015), the influence of training programmes to develop new required skills and, more generally, the impact of place-based vs. place neutral policies on “reducing persistent social exclusion” (Barca, 2009: p. VII).

* 1. **Regional and Cluster Approaches**

This section summarizes different regional and cluster approaches to discover the different variables and their relationships leading to the economic and social dynamics within a region.

As to the economic performance literature, two economic theories are relevant to explain the performance of regions: endogenous growth (Romer, 1990; Lucas, 1988) and endogenous development (Friedmann, 1979; Garofoli, 1992; Moulaert & Sekia, 2003) theories.

As to the cluster literature, two streams are relevant to explain the socio-economic dynamics within regions: the economic stream (Porter, 1990; 1998; Krugman, 1991) and the socio-economic and innovation stream. The economic stream of clusters focuses on external economies (Marshall, 1920), competitiveness (Porter, 1990; 1998; 2001) and new economic geography dynamics (Krugman, 1991). The socio-economic and innovation stream of clusters highlights the territorial, social, institutional, and cultural factors underpinning cluster dynamics and includes sociological constructs such as embeddedness (Granovetter, 1985), social networks (Nohria & Eccles, 1992), and untraded interdependencies (Storper, 1997). This stream encompasses several approaches: the Italian School of Industrial Districts (Becattini, 1990; Brusco, 1992); the innovative milieu school (Aydalot, 1986; Camagni; 1991), the Nordic School of innovation and learning (Lundvall & Johnson, 1994; Malmberg & Maskell, 1997), the geography of innovation approach (Jaffe, 1989; Feldman, 1994; Audretsch & Feldman, 1996; Asheim & Gertler, 2005; Massard & Autant-Bernard, 2015), and the cultural-institutional approach (Powell, 1990; Saxenian, 1994; Ingram & Roberts, 2000).

Given the scope of this paper, we focus on the content of the approaches most closely related to our conceptual model (for a detailed review see Rocha, 2004 & Gilbert, 2017). Appendix A summarizes the main variables explained by each approach, which will be part of the system dynamics model.

1. **Causal Modeling: Clusters, Economic Performance and Social Cohesion**

This section develops the conceptual causal model based on the set of constructs and their linkages discussed in the literature (Section 2), which are summarized in Table 2. To this end, it uses system dynamics modeling (Davis et al, 2007; Sterman, 2000) to represent the feedback loops and key constructs at the territorial level (Fratesi, 2015) and strives for an endogenous theory of the dynamics among clusters, economic performance and social cohesion.

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Insert Table 2 about here.

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We proceed as follows. First, we employ the increasing returns to agglomeration theoretical concepts (Krugman, 1991; Delgado et al, 2014) as our basic Economic Performance theory (section 3.1). Then, we investigate how the increasing number of firms in a region leading to higher employment rates impact on social cohesion (section 3.2). Third and finally, we create a theoretical computational representation of the conceptual causal model (section 3.3) to simulate the dynamics of the cluster given the theoretical assumptions. Theoretical simulations are employed to explore the consequences of theoretically derived processes, e.g. the values of variables change over time based on theoretical reasoning, even when the outcomes cannot be assessed empirically (Harrison et al, 2007, page 1232-3). This approach has been employed in computational research (Lomi and Larsen, 2001; Garavaglia, 2010) with the purpose of adding the temporal dimension to the causal modelling and evaluate the dynamic performance of systems (section 4).

* 1. **Economic Performance Model**

Economic growth in a cluster facilitates the creation of new firms and the entry of large firms, which accumulate over time expanding the existing market, which positively affects the location of upstream and downstream producers in the same location (Krugman, 1991; 2000). The resulting impact on demand benefits the creation of new firms because customers located within close geographic proximity not only increase the likelihood of sales but also minimize transportation costs. In addition, Porter (1990) stresses the importance of the competitive environment within industrial clusters, providing lower entry and exit barriers because of reduced uncertainty in terms of prices, costs, and way of doing business, all of which foster the creation of firms.

In turn, the agglomeration of firms within clusters leads to economies of scale and scope that further enhances the economic performance of the cluster, creating a positive reinforcement process which is depicted as increasing returns to agglomeration in Figure 1 (see R1). The literature has tended to contrast two potential types of agglomerating forces: localization (increasing returns to activities within a single industry) and urbanization (increasing returns to diversity at the overall regional level). As to localization, assuming that upstream and downstream producers are subject to increasing returns and barriers to trade are reduced, backward and forward linkages tend to concentrate firms in a single location (Krugman, 2000: 55). Krugman explains the reasons for localization of industries in terms of Marshall’s sources of external economies –that is, local pool of specialized labor, local subsidiary industries, and technological spillovers (Krugman, 1991: 36). The existence of increasing returns to scale means that individual producers are motivated to concentrate their production geographically in order to benefit from the resulting economies, leading to reinforcing processes. This agglomeration leads to knowledge spillovers and knowledge spillovers attract new firms (see R2a-b in Figure 1). As to urbanization as a catalyst of agglomeration of economic activity, it is argued that interdependencies across complementary activities give rise to increasing returns and, thus, to agglomeration through economies of scope. Porter and colleagues have moved beyond the trade-off between localization vs. urbanization and found that both are present within clusters of related industries, therefore positively affecting economic performance (Delgado et al, 2014).

Moreover, the creation of new firms and the entry of large firms creates new knowledge, further expanding the stock of knowledge existing in the region, which leads to spillovers and new innovation processes. This agglomeration leads to knowledge creation, spillovers and innovation in Figure 1 (see R2a, R3, and R4). According to endogenous growth theory, technological change or innovation explains not only the growth of output or economic growth, but also the rate of growth or economic performance. Technological change, in turn, is based on innovations fostered by investments in R&D (Romer, 1990), existing knowledge and knowledge spillovers, which tend to be spatially restricted (Audretsch & Feldman, 1996).

One important consequence of large firms in the region is their financial capacity to invest in R&D which fosters new innovations and, in turn, augments the stock of innovations in the region leading to even better economic performance, a process of agglomeration which leads to innovation in Figure 1 (see R3). According to endogenous growth theory, technological change is conducive to imperfect competition, which can enhance the incentive to invest in new technologies, given that investment is partially excludable by intellectual property rights such as patents. In this scenario the firm will invest to improve technology and therefore innovation is determined within the model. The innovations generated from investments in R&D produce both an absolute increase in the stock of technology and a change in the rate of technological progress, therefore positively affecting the rate of growth (cf. Solow, 1994) or economic performance.

In turn, investments in R&D increase the level of knowledge and technology not only directly through capital investment (in a broad sense including not only physical but also human and R&D capital) but also indirectly through spillover effects on the rest of the economy, agglomeration processes that lead to knowledge creation and knowledge spillovers in Figure 1 (see R2a and R4). Spillover effects imply that knowledge is a non-rival good, and therefore it generates increasing returns at the aggregate level –that is, Marshallian external economies (Romer, 1994: 14). Therefore, investments in R&D increase the level of public knowledge fostering new innovations, adding to the accumulation of a pool of innovations which contribute to the economic performance of the region. Figure 1 depicts the processes discussed within the Economic Performance Model and the Social Cohesion Model we describe below.

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Insert Figure 1 about here.

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* 1. **Social Cohesion Model**

The social cohesion model is based on two main assumptions. First, economic performance is driven by economic factors rooted in spatial, social and cultural characteristics reflected by local embeddedness (Granovetter, 1985), social networks (Nohria & Eccles, 1992), informal ties, and untraded interdependencies (Storper, 1997). Second, these factors operate mainly at the regional rather than at the industry and sectoral levels. Therefore, the main unit of analysis is the region rather than the industry or the region-industry as in the case of the Economic Performance Model.

Social cohesion, territorial embeddedness of agglomerated firms and inter-organizational networks among firms and institutions reinforce each other at any given level of social cohesion (R5, R6 and R7 in Figure 1), creating a symbiotic relationship among these factors for both new firms and existing large firms.

In the case of new firms, people usually start businesses at the location where they were born, have worked or already reside (Cooper & Dunkelberg, 1987), which goes some way towards explaining why nascent entrepreneurs are very well established in their careers, lives and communities (Reynolds & White, 1997). Also, economic activities by new firms embedded in their specific environment are shaped by local history and institutions (Aldrich, 1999). Established relationships such as existing networks of colleagues or relationships from previous work contexts provide the credentials to overcome the lack of history of new businesses. In addition, links to formal institutions which enhance legitimacy and provide access to resources, are important and result in a positive relationship between links to formal institutions and entrepreneurial activity (Baum & Oliver, 1996). Finally, local embeddedness cements established relationships and inter-organizational networks, facilitating the economic and non-economic resources to start and sustain new businesses.

In the case of existing large firms, their degree of regional embeddedness and inter-organizational networks are key factors related to social cohesion within the region. Both positive and negative examples illustrate this point. For example, on the positive side, large local firms in the Irish medical technology cluster (Giblin, 2011) and MNCs in Malaysia (Malecki, 1997: p.229) and Costa Rica (UNCTAD, 2004; Oxfam, 2002) enabled the upgrading of the local industry and the participation of the relevant stakeholders in the distribution of the value created. On the negative side, the Irish software cluster (Giblin, 2011), the Brazilian car industry, the maquilas and blue jean cluster in Mexico, the Dominican Republic and China (cf. Malecki, 1997; Oxfam, 2002; UNCTAD, 2004; McCann & Argiles, 2015) are examples of lack of embeddedness and capturing of value mainly by MNCs.

Therefore, the effect of new large firms on social cohesion is a function of both the way they are integrated in inter-organizational networks and embedded in the region. In particular, clusters of few dominant MNCs (Chinitz, 1961; Duranton & Puga, 2001; cf. McCann & Argiles, 2015), especially those with hierarchical governance structures combined with lack of embeddedness in the region (Rocha, 2015) are a potential source of socio-economic divides.

Therefore, clusters including both new firms and existing large firms, especially local ones, show a positive feedback process between embeddedness, inter-organizational networks and social cohesion at a given initial level of social cohesion, leading to reinforcing processes (R5, R6, and R7).

Inter-organizational networks have a positive impact on economic performance both directly and indirectly through knowledge spillovers. The direct effect is based on explanations from both the cultural-institutional approach and the endogenous development theory. The former argues that the social, institutional, and cultural factors underlying the interdependence of economic actors, when they are embedded in a web of relationships among them, are conductive to local economic development (cf. Saxenian, 1994). In fact, ties embedded in social relationships enhance collaboration, mitigate competition, and foster information exchange. Additionally, in clusters with a strong division of labor, the differentiation among clustered firms leads to functional complementarities that create mutualistic effects and therefore neutralize the negative effect of sourcing from the same resource pool. For example, as endogenous development theory suggests, inter-organizational networks such as subcontracts between new and established large firms through quasi-vertical integration improve the economic performance of clusters, not only through the reduction of transaction costs (Storper & Scott, 1989) but also through innovation diffusion (Garofoli, 1992) or knowledge spillovers.

As to the indirect impact, inter-organizational networks are conductive to knowledge spillovers, which are key processes for innovation and economic performance according to the geography of innovation approach, given that knowledge spillovers are important to innovation and tend to be spatially localized within close geographic proximity to the knowledge source (Jaffe, 1989; Feldman 1994;Audretsch & Feldman, 1996.

Marshall’s sources of external economies include not only knowledge spillovers (Figure 1) but also local pools of specialized workers, and both factors lead to a reinforcing process named agglomeration that leads to employment and knowledge creation (see R9). Preliminary evidence suggests a positive impact of clusters on job creation both in developed and emerging countries (cf. OECD, 2002; Porter, 2003; Spencer et al. 2010; EC, 2010; Temouri, 2012; Rocha, 2015; Delgado et al, 2014).

The pool of specialized workers in the region, which includes both local and migrant workers, also increases the attractiveness of the region for new and large firms, processes identified as specialized workers attract firms (R11 in Figure 1). In the medium term, the creation of firms and the growth of existing firms attracted by the pool of specialized workers (R11) will increase the migration of specialized workers to the region if there is a paucity of specialized local workers, not only fostering employment (R9) but also changing the mix of non-specialized workers-specialized workers.

Economic growth generates a process of integration of existing workers in the region when there is a common vision (Forrest & Kearns, 2001) or a sense of community (Sen, 2009) among local actors supporting training and skills upgrading. Such processes influence economic growth along with a common vision, which leads to social integration in Figure 1 (see R10) By contrast, economic growth hinders integration when a common vision, especially among specialized and non-specialized workers, is lacking, because it creates strong cohesive groups that “could be in conflict with one another and contribute to a divided and fragmented city” (Forrest & Kearns, 2001:2128). In fact, economic growth driven by economic activities that reshape occupational structures and opportunities could drive different groups toward opposite economic poles (Castells, 1998), which lessens integration.

Summing up, we have described the integrated Economic Performance and Social Cohesion model, depicted in Figure 1. Clusters are dynamically complex systems because of the many feedback loops driving their behavior, e.g. ten reinforcing or positive feedback loops and one balancing feedback loop. Inherently, cluster dynamics originate from strong agglomeration forces and positive returns to scale leading to continuous economic growth and employment (loops R1 to R9). However, the impact of social forces embedded in, and fostered by, a balancing feedback loop (B8) can curtail the strong economic positive feedback loops. Positive economic performance generates economic growth which attracts new firms and has a positive impact on the growth of existing firms, thereby enhancing economies of scale and economic performance. A short term potentially divisive dynamic is generated by new firms and the entry of firms in the regional cluster, which import technology and human resources, as they may recruit workers from other regions. An unbalanced employment process weakens the integration of the workers belonging to the cluster in the region, which leads to reducing social cohesion and hurting informal ties (Figure 1, B8). Declining informal ties and inter-organizational networks can affect knowledge spillovers and innovation, limiting future economic performance. The ultimate result can be the stagnation and withering of the cluster.

* 1. **Computational representation of the causal model and calibration**

We create a computational representation of the conceptual causal model depicted in Figure 1 based on the constructs and operational definitions used in the literature (Table 2). This representation uses a set of integral equations to compute the state of the different variables comprising the cluster over time (Davis et al 2007, Sterman, 2000). The integral equations are the mathematical representation of feedback processes where the state of the cluster at time t-1 is the basis for calculating endogenously the state of the cluster at time t. Then, we use logical data for the simulation -e.g. values that resemble the results that can be obtained from collecting real data- to run and calibrate the model (Lomi and Larsen, 2001; Garvaglia, 2010). Logical data is obtained from the evaluation of the empirical literature to identify a minimal set of values that explain observations related to the state of the cluster (Boros et al, 2000). *For example, a meta-study of more than 500 clusters in US, Germany, other OECD countries, and Latin America concludes that, on average, inter-organizational linkages are higher in clusters of developed countries than in Latin American countries, which leads to a higher impact of clusters on economic performance in the former countries (Rocha, 2013). Based on this empirical result, our model considers the value of the variable 'Inter-organizational Networks" with an initial value of 4 in a scale between 1-7, and a direct relationship with the variable 'Economic Performance', using a weight of 0.33[[4]](#endnote-3). Thus, a decrease in the value of inter-organizational networks in one unit will reduce the economic performance of the cluster by 0.33”.* Figure 1 depicts the theoretical causal modelling without the temporal dimension; Figure 2 shows the dynamics between economic growth, economic performance and social cohesion explained in sections 3.1 and 3.2 for a period of 14 years after running the simulation with hypothetical data. Appendix B includes the detailed steps we follow to create the computational model and run the simulation; the next section discuss the dynamics between clusters and socio-economic performance.

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Insert Figures 1 and 2 about here.

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1. **DISCUSSION**

As theoretically explained in Section 3, Figure 2 shows that the economic performance of clusters does not necessarily lead to social cohesion within the region where the cluster operates, which questions the assumption of an expected linear relationship between the number of firms and employment, so that more firms will hire more people leading to a decline in poverty and improving social cohesion. Cluster dynamics are inherently driven by strong agglomeration forces and positive returns to scale leading to continuous economic growth and employment. However, the impact of social forces can curtail the strong economic positive feedback loops in the middle term. As firms expand and new firms enter the cluster, the limited number of specialized people in the region will attract people from other regions (since firms cannot wait to train the local workers). When non-resident employees are attracted, the ratio between local and migrant workers changes and the social cohesion tends to decline, compensating for the initial impact on local workers employment. When social cohesion declines, informal ties, embeddedness, social proximity and inter-organizational networks also decline, which reduce knowledge spillovers and innovation, hurting future economic performance. Firms subsequently stop coming to the region, leading to stagnation or even deterioration due to the diminished social cohesion.

In sum, the final balance between economic performance and social cohesion is a function of three factors. First, the initial levels of integration and social cohesion among specialized and non-specialized workers within the region; second, the factors harmonizing growth in employment and social cohesion (such as cluster governance mechanisms, the integration of economic sectors within the region, and internal training programmes for non-specialized workers); third and finally, the degree of embeddedness of migrant workers and new firms within the region. This conclusion is in line with previous studies in which factors such as the embeddedness of MNC and their degree of foreign ownership, the initial level of regional development, and the degree of diversification and integration among sectors in the region are important for the dynamic interaction between economic performance and social cohesion in Latam (Rocha, 2015; Birkinshaw and Hood, 2000), USA (Porter, 2003; Cobb, 2016), and Europe (Fratesi, 2015; Konstantynova and Wilson, 2018).

Both economic and sociological approaches explain the dynamics of clusters, economic performance and social cohesion. From an economic perspective, agglomeration exerts a countervailing force on regional performance. In the presence of agglomeration economies, growth is *increasing* in the level of economic activity (Glaeser et al, 1992), which can increase inequality across regions over time (Dumais, Ellison & Glaeser, 2002). Also, agglomeration of economic activity leads to the clustering of economic activity and the concentration of development in specific areas creating center-periphery patterns, which produce regional divergence due to a process of cumulative causation and inflexibility (Arthur, 1989; Krugman, 1991). Therefore, both a strong economic performance and a low degree of social cohesion could potentially co-exist within a given region. From a sociological perspective, the arguments developed for the interaction between neighborhoods and cities could be used to explain the integration between migrant specialized workers and local workers (both, specialized and non-specialized). A cohesive cluster could contribute to unite a divided and fragmented region because actors will have a strong sense of place attachment and loyalty to their respective location: “thus, whether society is said to face a crisis of social cohesion depends upon what spatial scale one is examining and the relative strength of the countervailing forces operating at each scale.” (Forrest & Kearns, 2001:2128).

These economic and social explanations are in line with both regional studies and economic geography literatures. First, as to regional studies, our model shows that regional change requires the harmonization of innovation, growth in employment and social cohesion, which is in line with recent studies in regional economic development (Fargerberg et al. 2013; Barca et al. 2012) and the geography of innovation (Feldman, 1994; Masard & Autant-Bernard, 2015; McCann & Argiles, 2015). In this harmonization process, initial conditions are key, given that the innovation and economic dynamics could negatively affect less-developed regions –i.e. those with low initial conditions. Our model sheds light on previous findings on the need to consider both technological and social capabilities (Fargerberg et al. 2013), innovation and embeddedness (McCann & Argiles, 2015), as well as historical-institutional factors (Barca et al. 2012) for regional change. For example, research suggests that the embeddedness of information and communication technologies across different sectors could affect the balance in employment leading to social cohesion. In most OECD countries the “adoption, adaptation and application of information and communication technologies across a wide range of industries appears to have exacerbated the differences between core and none-core regions” (McCann & Argiles, 2015:1294). Therefore, the economic performance of a region that results from innovation and new occupational structures may negatively affect social cohesion when the diffusion of ICTs is not linked to “tailored skills training or actor-networking related to ICTs” (McCann & Argiles, 2015:1299).

As to economic geography, which pays special attention in explaining how regional disparities arise and why they persist over time (Armstrong & Taylor, 2000), our model shows potential threats to social cohesion represented by growing immigration flows and innovation dynamics neither integrated nor embedded within a region. For example, the growth of the IT cluster has been concomitant with a growth in social cohesion while the demise of the aerospace cluster has been associated with a decline in social cohesion in the region (Storper et al. 2015). These divergent results among sectors could be explained by the different initial levels of integration and the embeddedness of specialized and non-specialized workers and firms. In other words, our model highlights the relationships among immigration, innovation and geography and the role of integration, embeddedness and inter-organizational networks or, in terms of economic geography, “embeddedness, relatedness and connectivity” (McCann & Argiles, 2015:1296).

1. **Conclusions**

A rich and important literature has emerged focusing on the links between clusters and their impact on economic performance of both firms and regions. However, the extant literature has not analyzed how clusters affect both economic performance and social cohesion –i.e. the level of social integration between different groups in a geographical area- at the regional level. This oversight is striking, because social cohesion has recently emerged as a priority for both scholars as well as policymakers. In addition, even as scholars and thought leaders in public policy highlight the potential for cluster policies to enhance economic performance, ignoring the impact of clusters on social cohesion is fraught with peril and may ultimately undercut the economic impact of policies. Only by explicitly analyzing the impact on social cohesion as well as economic performance can the overall impact of such policies be fully analyzed and understood.

This paper is one of the first studies to investigate how clusters affect both economic performance and social cohesion at the regional level. This novel contribution is particularly important to the regional studies literature, which is concerned on the dynamics of economic, social and political factors to understand how and why regions evolve. Clusters involve both sectoral and territorial dimensions (Martin & Sunley, 2003; 2015; Rocha, 2004) and, therefore, understanding the co-evolution of economic performance and social cohesion in regions in which clusters operate could contribute to understanding how and why regions evolve.

This novel contribution spans across theory, methods, and policymaking in regional studies. As to theory, it answers the *How* and *Why* questions: the impact of clusters on economic performance and social cohesion within a region depends on the interaction of regional and cluster factors to integrate different groups such as migrant specialized workers and local workers (both, specialized and non-specialized) and embed new and large firms within the region; the reason is the differential causal dynamics and pace between sectoral-economic-driven factors such as large firms, technology and innovation and regional-social-driven factors such as a common vision, embeddedness and local inter-organizational networks. As to methods, this paper uses a system dynamic methodology, thus contributing to the recent interest of regional studies scholars that conceptualizes clusters as “complex adaptive systems” (Martin & Sunley, 2015:1303) and propose formal models at the meso level of analysis to capture the dynamic interaction between sectors and regions (Fratesi, 2015). Finally, as to policy, by showing that promoting sectoral clusters with the goal of convergence could not only lead to lower economic performance but also social exclusion within regions, this paper contributes to current policy debates such as the place-based vs. place-neutral policies debate (Barca et al. 2012) and the Washington-Silicon Valley Consensus vs. new required consensus that takes into account the time and geographic dimensions of trade and innovation (Piore & Schrank, 2018).

Economic development policies could lead to social exclusion at both inter and intra-regional levels (cf. McCann & Argiles, 2015; Barca et al 2012:139) if their focus is solely on the sectoral (Massard & Barnard-Autant, 2015; Konstantynova & Wilson, 2017), innovation or (McCann & Argiles, 2015), technological (Fargerberg et al. 2013) dimensions and/or core agglomerations in the territory (Barca et al. 2012; Belussi and Trippl, 2018) with the goal of convergence. By contrast, our conceptual model shows that policies creating the conditions for a common vision (Forrest & Kearns, 2001) or a sense of community (Sen, 2009) among specialized (both migrant and local) and non-specialized workers could foster both economic performance and social cohesion in the medium term. Therefore, our model is aligned with policy recommendations that acknowledge the importance of places, embeddedness and informal institutions (Uyarra and Ramlongan, 2012; Barca et al. 2012), focusing on place-based policies (Barca et al. 2012; Massard & Autant-Barnard, 2015; McCann & Argiles, 2015; Konstantynova & Wilson, 2017) and partnerships between different levels of governance (cf Barca et al. 2012:148) for sustainable and social development (Barca et al. 2012).

This paper opens opportunities for further research such as to calibrate the model using real data and evaluate it in different industries. First, the conceptual model requires calibration using real data to test the relationships, evaluate policy impact and create more precise paths to economic performance and social cohesion in regions. Appendix B includes the units of measurement of each variable and real data can be collected using both statistical sources and surveys of experts as it is standard in cluster research (cf. Porter, 2003; Pietrobelli and Rabellotti, 2007; Delgado et al. 2014; Rocha and Sternberg, 2005; Rocha, 2013). In particular, our model could complement the much needed evaluation of the impact of cluster policies and institutions (cf. Uyarra & Ramlogan, 2012; Fratesi, 2015; Konstantynova and Wilson, 2018; Aranguren et al. 2014).

Second, the model is general enough to evaluate the dynamic behavior of different industries using sensitivity analysis with industry data for variables such as size of firms, availability of workers, speed of creation of new enterprises, economies of scale and initial level of social cohesion. For example, social imbalances seem to occur more in high-technology than in other sectoral clusters. It is possible to expect some displacement effects when the fast growth of a cluster is not linked to the growth of other industries and places within the same regions. Empirical studies show that, although high-growth technology clusters contribute to the wealth of the region, they also create social divides (Keeble & Wilkinson, 2000), as in the case of Bangalore (OECD, 2002), and Silicon Valley (Harrison, 1994; Rose, Ciechanover, & Modi, 2015; Forbes, 2015). Porter has found that high-technology clusters only contribute to less than 3 per cent of the employment in the US economy (2001: p.25; 2003: p.564) but have an average wage almost three times higher than that provided by local industries (2003: p.560; 564). These benefits do not trickle down to people employed in the local industries. In effect, the correlation between high-tech employment and local wages is only 14.4 per cent (2003: p.564), and the correlation between regional innovation and employment growth is negative (2003: p.557). Research in Latin American countries is in line with these results, given that clusters in natural resource-based and specialized services have a positive impact on collective efficiency, but clusters in traditional manufacturing and complex products do not (Pietrobelli & Rabellotti, 2007; Rocha, 2015).

These lines of future research will improve the understanding of the economic performance and social cohesion in regions advanced in this paper.

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**Figure 1. Economic Performance and Social Cohesion Causal Model**



**Figure 2. Economic growth, employment and social cohesion**

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**Table 1. Structure of the Paper and System Dynamics Modelling**

|  |  |  |
| --- | --- | --- |
| **Step** | **Section of the paper** | **Associated Appendix, Table and Figure** |
| Formulate the research question | 1 | - |
| Review the basic theories | 2 | Appendix A |
| Develop the causal theoretical model using system dynamics modelling | 3 | Table 2Figure 1  |
| Create the computational representation of the model and run the simulation using hypothetical (not real) data to add the temporal dimension and evaluate the dynamics of the model | 3.3 | Appendix B - Tables 3 and 4Appendix B - Figures 3 to 6 |
| Discuss the dynamics of the Model  | 4 | Figures 2 Appendix B - Figures 3 to 6  |
| Collect real data and calibrate the model | 5 (future research) | - |

**Table 2. Constructs and relationships considered in the causal model**

|  |  |  |  |
| --- | --- | --- | --- |
| **Construct** | **Description** | **Reference** | **Verbal Description of the Equation** |
| Economic growth | Growth in economic output such as GDP per capita | [a]; [b]  | Economic growth reflects directly the wealth in the region generated by the economic performance of the firms. |
| Economic performance | Increase in productive capabilities  | [a]; Bernstein, 1983 | Economic performance in firms is the result of the economies of scale, innovation and inter-organizational networks. |
| Innovation | Level of Process and Product innovations | [c]; [g] | Innovation is generated by knowledge (stock), knowledge spillovers, knowledge created (flow), and R&D investment. |
| Strength of related industries | Quality of local suppliers and supporting industries and level of interaction between local firms and the cluster’s firms. | [a]; [c] | This is a constant reflecting the strength of the related industries (see table 2), which together with the number of specialized workers in the industry, affects the number of firms entering into the cluster. |
| New and existing firms’ growth | Level of entrepreneurialism and the success of small and large firms  | [b]; [c] | Firms are created as result of economic growth, knowledge spillovers, and the availability of specialized inputs, such as workers. |
| Economies of scale  | Easiness to trade and benefits obtained by upstream and downstream producers  | Krugman (2000: 55) | Economies of scale and scope originated from the existence of a population of firms in the region which interact under a common vision for the industry-region. |
| R&D investment | It indicates the output of R&D investment. | [a]  | R&D investment results from the investment of large firms. |
| Knowledge | Strength of the knowledge existing in the region such as specialized research centers, talent base, etc.  | [a]; [d]  | Knowledge in the region originates from informal ties and inter-organizational networks between specialized workers in the region as well as entrepreneurs, who are starting new firms in the region.  |
| Knowledge spillovers | Knowledge externalities among actors that could be measured objectively (e.g. patent citations) and subjectively (e.g. survey data on transfer of knowledge from research institutions).  | [a]; Jaffe et al. 1993  | Knowledge spillovers are originated from informal ties and inter-organizational networks together with the knowledge in region and the existence of a population of firms. |
| Informal Ties | Ties embedded in the region. We consider a subjective appreciation of its level. | [h]; [i]  | Informal ties are developed through the existence of social cohesion among the workers in the clusters and their social proximity. |
| Employment growth | It reflects the percentage of new specialized workers being employed every year | [a]; [d] | It is a ratio between the increase in employees with respect to the total workers in the industry |
| Specialized local workers | Availability of specialized local workers in a certain region.  | [a]; [b]; [f] | Specialized local workers results from the employment of workers with the skills in the main industry, training from workers in other industries and the migration of specialized workers from other regions. |
| Specialized migrant workers | Specialized workers attracted from other regions to join the workforce in the cluster. | [a]; [b]; [f] | Specialized migrant workers are attracted to the region due to its economic growth, which reflects better wages, and the lack of available specialized workers residing in the region. |
| Non-specialized local workers | Number of workers in the region that don’t work directly in the main industry of the cluster.  | [a]; [c]; [d] | It is the number of workers, who are not specialized but live in the region, that can be integrated given the economic performance of the cluster and the existence of a common vision  |
| Social Proximity | Presence of an active community of people engaged in the main industries of the cluster.  | [j]; [k]; Brusco (1992) | Social proximity is directly related to the level of social cohesion  |
| Social cohesion | Integration between specialized migrant workers attracted by the economic performance of the clusters and local specialized and non-specialized workers living in the region. | [e] | Social cohesion reflects the proportion of specialized workers in the region, except migrant specialized workers who are not yet integrated, with respect to the total number of workers.  |
| Inter- organizational Networks | Relationships between firms, governmental institutions and non-governmental organizations. We consider a subjective appreciation of its level. | [l]; [m]; Camagni (1991) | The inter-organizational networks result from the social proximity, informal ties and the territorial embeddedness. |
| Territorial Embeddedness | Level of integration of the economic activities to the territory and social ties existing in the cluster.  | [k]; [o] | Territorial embeddedness reflects the social cohesion existing in the cluster while it also influences the integration of migrant work |
| Common vision | Level of engagement of the firms located in the cluster into the development of the cluster through common activities to enhance externalities such as economies of scale or a pool of specialized workers.  | [e] | This is a constant. |
| Integration | It reflects the active support, which originates from a common vision, from the cluster to integrate non-specialized workers in the region. | [e] | It is equal to the number of local non-specialized workers multiplied by a percentage per year. Related to the economic growth and the value of the variable Common vision |

**Reference**: [a] Delgado et al (2014); [b] Temouri (2012); [c] Porter (2001); [d] Porter (2003); [e] Forest and Kearns (2001); [f] Wennberg & Lundqvist (2010); [g] Pietrobelli&Rabellotti (2007); [h] Audretsch and Stephan (1996); [i] Ingram and Roberts (2000) Ingram and Roberts (2000); [j] Becattini (1989); [k] Becattini (1990); [l] Saxenian (1994); [m] Aydalot (1986); [o] Keeble and Wilkinson, (2000)

1. Corresponding author [↑](#footnote-ref-1)
2. Social cohesion is defined as the level of social integration between different groups in a geographical area (cf. Kearns & Forrest, 2000; Novy, Swiatek, & Moulaert, 2012; cf. Section 2.3). [↑](#endnote-ref-1)
3. [↑](#endnote-ref-2)
4. Economic Performance is the result of Inter-organizational networks (weight 0.33), economies of scale (0.33), and innovation (0.33). See Appendix B, Table 2. [↑](#endnote-ref-3)