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Dual clusters in dual economies: understanding innovation in clusters of developing countries

Pablo Galaso[1,*], **Adrián Rodríguez-Miranda**[1] and **Antonio Vázquez Barquero**[2]

[1]Instituto de Economía, Facultad de Ciencias Económicas y de Administración, Universidad de la República, Gonzalo Ramírez 1926, Montevideo 11200, Uruguay. e-mail: pablo.galaso@fcea.edu.uy, adrian.rodriguez@fcea.edu.uy and [2]Universidad Autónoma de Madrid, Facultad de Ciencias Económicas y Empresariales, Francisco Tomás y Valiente 5, Madrid 28049, Spain. e-mail: vazquez-barquero@uam.es
*Main author for correspondence.

In developing countries, clusters not only have a dual configuration with pronounced differences in company performance but are also embedded within the framework of dual economies. This restricts the capacity of networks to facilitate the innovation processes of local firms. We provide empirical evidence that supports this hypothesis by analyzing local and multinational firms in 18 Latin American clusters. Our findings can improve the understanding of innovation processes in underdeveloped countries, suggesting that dualism should be considered as a determining factor.

JEL classification: O00, O31, R00

1. Introduction

The relevance of local interactions and networks in innovation processes has been extensively studied in the cluster literature (Lazzeretti *et al.*, 2019). Previous research has documented a positive relationship between cluster networks and innovation for both developed and underdeveloped countries (Giuliani, 2011, see also Section 2). In particular, the literature has shown that clusters that combine strong local networks with multiple connections to global networks achieve better results in knowledge diffusion and innovation (Bathelt *et al.*, 2004; Morrison *et al.*, 2012). However, previous literature has not yet examined how, in the case of developing countries, these networks operate within contexts of dualism and how this might influence (constrain) the innovation of (local) firms.

Clusters in developing countries exhibit a dual structure, characterized by a significant gap in innovation and competitiveness between small local firms and large firms or multinational corporations. Additionally, these dual clusters are embedded in local contexts characterized by a dual economy. In a dual economy, two types of economic activities coexist: first, one (small) part of the productive system functions with high productivity and is connected to global markets, and second, another (large) part of the economy operates in a framework of high informality to develop very unproductive activities oriented to the domestic market (Lewis, 1955).

This paper aims to contribute to the literature by incorporating both types of dualism (cluster dualism and the dual economy context) into the analysis of innovation networks and clusters. To

do so, we draw on a theoretical framework that integrates cluster studies—especially those focusing on local development and utilizing social network analysis techniques—with the literature on dual economies in underdeveloped countries.

Our work postulates that cluster dualism and the dual nature of the economy reinforce the difference between local and multinational firms within clusters of developing countries, especially the way in which both types of firms innovate. On the one hand, multinational firms are not affected by collaboration networks, nor is their ability to innovate constrained by the local dual economy context. On the other hand, local firms, particularly small and medium enterprises (SMEs), remain tied to—dependent on—the local context and networks.

To empirically test this hypothesis, we use data from extensive fieldwork with 865 interviews to managing directors of firms located in 18 clusters of four Latin American countries: Chile, El Salvador, Paraguay, and Uruguay. The empirical evidence provided by these data is particularly valuable since, to the best of our knowledge, there are no previous studies in Latin America with primary data of this magnitude. Selected clusters contemplate a wide range of sectors, including food processing and manufacturing, natural resource-based industries (other than food), complex activities, and specialized services. For each cluster, we trace collaboration networks connecting firms and support organizations, combining social network analysis with logistic regression techniques to estimate the determinants of innovation. To measure cluster dualism, we use the innovation gap within firms in the cluster. To measure the dual economy framework where these clusters are located, we use the rate of informal employment in the labor market.

Our findings support the hypothesis that cluster networks are crucial for local firms to innovate, particularly to carry out research and development (R&D). In addition, cluster dualism and the local dual economy have a very negative impact on the innovation of local firms, while multinational firms are not affected by these factors. Thus, the main contribution of our paper lies in highlighting that, in developing countries, beyond the positive effects of networks, local firms' performance is constrained by the existence of dual clusters, which are embedded within the framework of a dual economy.

These results can improve the understanding of innovation processes in underdeveloped countries. Furthermore, this evidence has also relevant policy implications, suggesting that cluster policies should take dualism into account, designing policy programs and instruments that support local firms to face the adverse environment conditions.

The rest of the article is structured as follows: Section 2 presents the theoretical framework of the study; Section 3 explains the research context and describes the data and methodological aspects; Section 4 presents the results; and finally, Section 5 concludes.

2. Theoretical framework

Our theoretical framework is based, first, on the literature about territorial development and clusters, particularly studies that adopt a social network analysis approach (Section 2.1). Second, we draw from the literature on dualism and underdevelopment (Section 2.2), analyzing how local and multinational companies operate within contexts of dualism (Section 2.3). Building upon these arguments, we formulate our hypotheses (Section 2.4).

2.1 Clusters, networks, and local development

Since the seminal works on industrial districts (Becattini, 1979), clusters (Porter, 1990), and innovative *milieus* (Aydalot, 1986), the literature from different streams of research has extensively analyzed how territorial factors can determine innovation processes. Such processes enable structural change, economic growth, and local development (Maillat, 1995; Vázquez-Barquero, 2002).

Marshall described how the agglomeration of firms working in the same sector and located in the same territory creates an "industrial atmosphere" of mutual trust and knowledge capable of sustaining and boosting local industry (Marshall, 1890). This atmosphere reduces transaction costs (common codes, diffusion of information, and trust) and generates economies external to

the firms, but internal to the district, due to the existence of a specialized labor market and local know-how specific to the territory.

Based on these ideas, the cluster concept has been widely discussed in the literature. In this paper, we use a broad definition of cluster, understood as a set of firms and support organizations presenting a certain level of sectoral specialization and territorial agglomeration. Previous literature has emphasized that clusters rely heavily on networks of interaction and collaboration, which may facilitate knowledge diffusion, reduce opportunistic behavior, and provide access to specialized labor force (Phelps *et al*., 2012). Given the relevance of networks, a growing stream of literature has inquired into the process of emergence and dissolution of links, giving rise to network structures (Boschma and Ter Wal, 2007; Balland *et al*., 2013; Capone and Lazzeretti, 2018). Other studies have analyzed how the networks may facilitate or constrain knowledge flows within clusters (Fleming *et al*., 2007; Giuliani, 2007; Galaso and Kovářík, 2021). According to these studies, network structural properties, like internal cohesion and external connectivity, can be considered a collective capital of the territory, since they rely on all the actors connected to the network and benefit local actors by enhancing knowledge diffusion [see Galaso (2018) for a review].

Although research on clusters has emerged in developed countries, there is also an interesting literature that has studied clusters in developing countries (Nadvi and Schmitz, 1994; Schmitz, 1995; Bell and Albu, 1999; Van Dijk and Rabellotti, 2005). Many of these papers have analyzed the evolution of clusters, describing the main phases they go through (Van Dijk and Sverrisson, 2003; Parrilli, 2004; Fri *et al*., 2013; Gancarczyk, 2015). Others have focused on cluster development policies (Altenburg and Meyer-Stamer, 1999; Figal Garone *et al*., 2015; Casaburi *et al*., 2016). Some studies have also analyzed the relationship between global value chains (GVCs) and clusters in developing countries (Humphrey and Schmitz, 2002; Giuliani *et al*., 2005; Morrison *et al*., 2008).

However, research on networks and innovation in clusters of developing countries is scarcer (there are some exceptions such as Giuliani and Bell (2005), Giuliani *et al*. (2019), or Galaso and Rodriguez Miranda (2021)). This is a fundamental aspect given that, as argued by Bell and Albu (1999), analyzing how knowledge networks evolve in the specific context of underdevelopment is essential to understand the long-term dynamics of clusters. Our article seeks to contribute to the literature on this topic by analyzing networks and innovation within the specific local context of dual economies.

Together with networks, other territorial aspects, such as cultural and institutional factors, in interaction with entrepreneurial and industrial policies, constitute a local framework that may facilitate (or restrict) innovation processes in clusters (Rodríguez-Pose, 2013, 2020; Vázquez-Barquero and Rodríguez-Cohard, 2019). In this regard, the endogenous development approach states that a combination of socioeconomic, historical, cultural, and institutional factors constitutes an environment—unique for each territory—that shapes the local development process (Vázquez-Barquero, 2002, 2009).

Despite its relevance, the literature on clusters from social network analysis approach has hardly studied the territorial environment in which the networks are embedded (Broekel *et al*., 2021). With a few exceptions (Glücker, 2007), the literature has not sufficiently considered how the structure of networks and the local economic context coevolve and influence each other.

Furthermore, the theories and models explaining networks and knowledge diffusion in clusters were essentially designed to explain realities observed in developed countries; therefore, these models may apply relatively well to the local contexts of developed economies. However, given the context-specificity of innovation processes, applying such models to the underdeveloped world can be problematic if underdevelopment factors are not considered. The next sections deal with these conditions of underdevelopment.

2.2 Dual economy and underdevelopment

A dual economy is one where most economic activities are characterized by very low productivity, coexisting alongside a few highly productive activities. This problem has been widely studied in Asian countries (Alavi, 2006; Lee, 1997) and is also a characteristic feature of Latin American industrial development (ECLAC, 1965).

The early work of Lewis (1955) presented the problem of development as a process of transition between sectors in a dual economy, where a traditional, informal, and very low-productivity sector predominates, coexisting with a modern, high productivity sector. The most striking symptom of low productivity in traditional sectors is the high levels of informality, which can, therefore, be considered a characteristic feature of dualism in underdeveloped economies. The development process involves the transition of employment from the traditional to the modern sector, while the traditional sector is also transformed and modernied. However, this transition is very difficult, as the surplus labor in the traditional sector does not have the necessary skills and qualifications to enter the modern sector, thus reinforcing the dual functioning of the economy.

In Latin America, structuralist authors developed the theory of the core–periphery system (Prebisch, 1950). This theory states that underdevelopment is not a phase prior to development, but a particular condition of peripheral capitalism. Economic development in peripheral regions is based on a specialization in raw materials and primary-based manufactures that causes a deterioration of their terms-of-trade relationship, which favors the core economies. There is no universal propagation of technical progress from the core to the periphery, and technology penetrates the peripheral economies in an unequal way, oriented toward export sectors based on natural resources and in a way that is functional to the development of the core–periphery system (ECLAC, 2002). This generates high-productivity sectors that are connected to the global economy, while others remain low-productivity and largely informal sectors.

The idea of structural heterogeneity is thus not only manifested between central and peripheral countries but also expressed in significant disparities in the processes of technological development within the peripheral countries. Although labor productivity differences within and across sectors can be found in all types of economies, what is specific to underdeveloped countries is the large magnitude of these differences (Cimoli and Porcile, 2014). Therefore, technical progress penetrates and develops unequally at the subnational level, concentrating in regions and sectors with high dynamism that coexist with their own internal periphery (Pinto Santa Cruz, 1976, 1989; Rodríguez, 1977).

More recently, neo-structuralist streams of research have integrated different elements of evolutionary economics to study the link between technology, structural change, and economic growth (Bárcena and Prado, 2015). From this perspective, the persistent structural lag observed in underdeveloped countries is associated with low-productive diversification, the slow diffusion of technical progress, and the widening of the internal and external production gap, with the inevitable consequences of low productivity, slow output growth, wage inequality, and, therefore, regressive income distribution (Cimoli and Porcile, 2015).

Economic growth in Latin America, despite experiencing periods of significant expansion, has been marked by high volatility and relatively low productivity in the long term compared to other regions of the world (Bértola and Ocampo, 2013). A recent World Bank study (Ianchovichina, 2024) underscores the importance of recognizing the dual nature of Latin American economies to understand their relative lag in economic growth and productivity. The study points out that since the 1980s, the region began to experience an early deindustrialization, while the agricultural and agro-export sector registered significant growth starting in the 2000s, especially during the commodities boom (Ocampo, 2017). However, agricultural growth was based on significant labor-saving technification, so the employment lost in the industry shifted toward less dynamic and relatively unproductive nontradable activities, with a significant increase in the informal sector, which acted as a buffer against unemployment (Dix-Carneiro and Kovak, 2019; Ponczek and Ulyssea, 2022).

As a result of this process, the territories of Latin America have been configured as extremely unequal spaces, divided into very poor and very prosperous areas, which are also poorly connected, negatively affecting human capital, intergenerational mobility, information flows, and social capital (Ianchovichina, 2024). This fragmentation leads to dual economies, with negative effects on overall productivity, restricting the net benefits of agglomeration economies (even generating diseconomies) and hindering the proper utilization of economic resources (Ianchovichina, 2024). Residential segregation, social inequality, and informality in the economy are the characteristics that describe this dualism in Latin American territories, creating an unfavorable environment for local firms.

2.3 Dualism, local firms, and multinational firms

As introduced earlier, underdeveloped economies present substantial productivity differences within and between sectors. Although productivity dispersion has been documented for developed countries (Ito and Lechevalier, 2009; Syverson, 2011), in the case of developing countries, the magnitudes of these differences are substantially larger. In a recent study focused on Latin American firms, Figal Garone *et al.* (2020) reported a considerable productivity gap, with the 90th percentile firm producing nearly seven times more than the 10th percentile firm.

In clusters of developing countries, significant productivity and performance gaps between firms are related to the overall context of a dual economy. Burger *et al.* (2022) found that not all firms in developing countries benefit from agglomeration economies: multinationals benefit more than domestic firms, and large firms benefit more than small ones. Additionally, small formal firms particularly suffer negative effects on their performance due to unfair competition from the informal sector (Burger *et al.*, 2022). Given that the informal sector accounts for up to half of economic activity (La Porta and Shleifer, 2008), this is a very relevant factor to consider when analyzing the performance of local firms (both formal and informal) in developing countries.

Venables (2020) emphasizes the importance of agglomeration economies, which capitalize on the benefits that companies gain from the presence of other firms in the same area. In cities where the percentage of employment in tradable goods and services sectors is disproportionately high, this generates opportunities for growth and economic positioning on a global scale. However, Jedwab *et al.* (2022) found that these opportunities do not arise in the case of Latin American territories. This outcome is linked to the dual nature of Latin American regions, which present high levels of informal employment and/or specialization in low-productivity sectors and nontradable goods (Ianchovichina, 2024).

Drawing from the findings of Ianchovichina (2024), Burger *et al.* (2022), and Jedwab *et al.* (2022), we argue that the context of local economies in Latin America hinders firms in benefiting from economies of agglomeration and restricts their access to specialized human capital and strategic services, thereby limiting the development of knowledge-intensive innovation activities.

Faced with the constraints imposed by the local environment, integration into GVCs can facilitate local firms upgrading, offering a pathway for peripheral economies' development (Humphrey and Schmitz, 2002). However, governance patterns in GVC involving firms in developing countries may limit functional upgrading and market diversification, leading to local firms' dependency on a few powerful customers (Schmitz and Knorringa, 2000). Recent research (Crescenzi *et al.*, 2022) revealed that greater multinational leadership in global innovation networks correlates with reduced collaboration and knowledge exchange with local firms. Furthermore, relationships between local and multinational firms in GVCs do not typically follow information-intensive cooperation models, often limiting direct interaction due to technology codification (Gancarczyk, 2015). Giuliani *et al.* (2005) found that GVC integration follows quasi-hierarchical governance, primarily fostering product and process innovation, rather than inter-sectorial or functional innovation.

Considering the previous arguments, we propose that multinational firms operating in Latin American clusters do not rely on local networks to develop their innovation processes. The dual economy context limits the potential for developing a local innovation system and a formal local market with sufficient scale for the development of local SMEs. Local conditions restrict the possibility of knowledge spillovers within local networks, leading multinational enterprises to likely prefer relying on global networks to develop innovations. This scenario does not apply equally to local firms, which depend on territorial conditions and local networks.

Three avenues can help local firms to compensate for the constraints of the local context. First, linking with cluster support organizations, such as development agencies, business associations, or local research centers. Unlike clusters in developed countries with established regional innovation systems, in developing countries, there are generally structural limitations that result in weak and disconnected networks (Bianchi *et al.*, 2023). Innovation in underdeveloped territories lacks systemic behavior (Arocena and Sutz, 2000) and often occurs in scarcity contexts (Srinivas and Sutz, 2008). In such environments, cluster support organizations play a crucial role, engaging with firms, contributing to network development, and providing a wide array of services that

enhance firm competitiveness (Watkins *et al.*, 2015; Papaioannou *et al.*, 2016). These organizations facilitate the introduction of knowledge flows from outside the cluster and offer local firms' guidance, assistance, and monitoring to improve their innovation performance (Schwartz and Bar-El, 2015; Galaso and Rodríguez Miranda, 2021). Additionally, support organizations provide a safety net by offering advice, routines, and practices to overcome the limitations of low-performing clusters (Giuliani *et al.*, 2019).

Second, the scale of firms can also help to mitigate the constraints imposed by the local environment. Large domestic firms have more internal resources than small ones, and they are also often supported by the state or have tax advantages. In addition, they usually maintain stronger connections with local research centers and other key organizations of the national innovation system.

Third, collaboration with external innovation networks (e.g., related to transnational firms and GVCs) can help to overcome scarcity and access resources not locally available. However, within the context of dual economies and internal cluster dualism, multinational enterprises may find it unattractive to participate in local networks for innovation, as other locations may offer greater advantages for these activities. In such cases, local collaboration networks and environmental conditions are irrelevant to multinational innovation strategies, thus promoting the acquisition of innovation generated in other regions rather than fostering local innovation generation. This limitation may restrict opportunities for local firms to develop, within the framework of GVC, more sophisticated innovation activities such as R&D.

2.4 Hypotheses formulation: dual clusters embedded in dual economies

Within the cluster literature, some scholars have studied the dual configuration in clusters, distinguishing between core and peripheral firms (Harrison, 1997; Fujita and Hill, 1998), but these are studies related to developed countries and, therefore, cannot observe the dual economy context that characterizes underdevelopment. On the other hand, studies associated with underdeveloped countries, even those from a local development approach that analyzes territorial heterogeneity in terms of sectors and economic agents (Scott and Garofoli, 2007), have also failed to consider the general framework of the dual economy in which clusters are embedded. Other studies focus on institutional factors claiming that, although developing countries are increasingly participating in GVC, their local firms fail to benefit from these connections to external knowledge, and therefore, they assume marginal roles in innovation processes (De Marchi *et al.*, 2018). In summary, both the cluster and the GVC literature, when investigating cases in underdeveloped countries, focus on analyzing specificities of the territory and its actors, institutional weaknesses, or firm strategies but do not study the relevance of the dual functioning of local economies.

We propose to further explore this issue by integrating dualism in the study of network dynamics and innovation processes in clusters of developing countries. For this purpose, we differentiate between (i) cluster dualism and (ii) the dual economy in which the cluster is embedded.

First, *cluster dualism*, describes the coexistence, within the same cluster, of two distinct groups of firms: highly innovative companies, predominantly large and multinational enterprises with access to global innovation networks, and less innovative firms, primarily local businesses, especially SMEs.

Second, a *dual economy* is defined by a disconnection between a group of high-productivity sectors linked to the global economy and most of the local economy focused on low-productivity activities and informal sectors. This condition is accompanied by the formation of dual territories, characterized by significant residential and social segregation within a framework of strong socio-spatial inequities, which limits the development of local human and social capital. These factors collectively constrain firms from harnessing agglomeration economies associated with business concentration and urban density.

The fact that dual clusters are embedded in the context of dual economies restricts the capacity of local networks to facilitate the generation and diffusion of knowledge. This leads to two distinct forms of innovation within clusters in developing countries. On the one hand, innovation processes of multinational companies do not depend on local environment and networks. On the other hand, the innovation of local companies is highly conditioned by the local context and networks.

According to the above arguments, we propose the following two hypotheses:

H1: The innovation performance of local companies is positively associated with cluster networks but negatively affected by both cluster dualism and the dual economy context.
H2: The innovation performance of multinational firms is unaffected by cluster networks, cluster dualism, or the dual economy context.

3. Data and methods

To empirically test our hypotheses, we analyze 18 clusters located in four Latin American countries: Chile, El Salvador, Paraguay, and Uruguay. The clusters were selected from a previous study (Rodríguez Miranda *et al*., 2019) based on three criteria.

First, the spatial concentration of firms in a specific sector: we choose territories with a productive specialization higher than the national average in some sectors and with a certain level of agglomeration of firms in those sectors. Second, the potential existence of cooperation dynamics between firms: we aim to focus on sectors with a strong presence of SMEs, while discarding industries dominated by few large firms. Third, we choose clusters specialized in sectors that represent relevant economic activities in terms of the generation of industrial gross value added or exports both at the national and regional levels.

Within these three criteria, we seek to study various types of clusters, so our selection includes a wide range of territories and sectors of economic activity. The four countries studied present a certain economic diversity within the Latin American context. Regarding income levels, we have two cases of high-income countries (Chile and Uruguay) and two cases of low-income countries (El Salvador and Paraguay). They also register variations in their productive specializations, with an important weight of agriculture and agro-industries in Paraguay and Uruguay, mining and agro-industries in Chile, and coffee, sugar, textile, and the *maquila* industry in El Salvador. It is also noteworthy that the four countries show sharp differences in terms of institutional quality, with Uruguay and Chile registering indicators much higher than those of El Salvador and Paraguay. At the regional level, we observe clear differences between the territories in which our clusters are located, with informality levels ranging from 22% to 79%. Beyond the particularities of each territory, given the high levels of informality, we can consider the regional contexts where our clusters are located as dual economies.

As presented in Table 1, the 18 selected clusters can be classified into four large groups, according to the type of activity they carry out: (i) food clusters, including clusters specialized in food processing and manufacturing, (ii) natural resource-based clusters, other than food, (iii) clusters specialized in non-agro-based complex industries, and (iv) services clusters.

We obtained our data from extensive fieldwork, conducted between September 2016 and July 2017, in which semi-structured interviews were applied to managing directors of 865 firms. The data collection process started with an analysis of administrative records from the statistical institutes of the respective countries, which provided secondary information about firms operating in the sectors and territories under study. All companies in these records, except micro-enterprises, were contacted, achieving high response rates in each cluster, ranging from 81% to 50%. Despite the variation in response rates, interviews were conducted with all relevant actors in each cluster. Additionally, extra cases (not listed in the administrative records) were included and interviewed based on mentions by the previously interviewed companies. All companies in this study are formal. A detailed explanation of the fieldwork process and the complete questionnaire are available in Rodríguez Miranda *et al*., (2019).

Semi-structured interviews allowed us to obtain two types of information. First, data on firms' characteristics and performance, e.g., size, age, main activities, exports, or innovation. Second, data on collaboration links connecting the firm interviewed with other companies and/or cluster support organizations. Support organizations are business chambers, universities and research centers, training institutions, and public–private technical assistance centers, as well as public policy agencies and programs.

Based on these data, we elaborate 18 collaboration networks, one network for each cluster. The nodes of the networks are both firms and support organizations, while the links represent

Table 1. Selected clusters

Natural resource-based clusters (other than food)—NNRR
1. Wood and furniture sawing industry in Chile (Araucanía region).
2. Textile industry in El Salvador (San Salvador, La Libertad, and La Paz regions).
3. Textile industry in Paraguay (Central and Ñeembucú regions).
4. Nonmetallic mineral industry (including glass manufacturing, ceramic products, cement, lime, plaster, and stone) in Paraguay (in the Central, Cordillera, and Itapúa regions).
Food processing and manufacturing clusters—Food
5. Dairy industry in Uruguay (Florida, San José, Colonia, Río Negro, Paysandú and Montevideo regions).
6. Dairy industry in Paraguay (Boquerón, Central, Itapúa, and Caaguazú regions).
7. Meat industry in Paraguay (Asunción, Boquerón, Central, and Itapúa).
8. Grain production cluster in Chile (Araucanía region).
9. Food processing industry in Chile (Araucanía region).
10. Food processing industry in Paraguay (Asunción, Boquerón, Central, Itapúa, Caaguazú, and Guairá).
Non-agro-based complex industries—Complex
11. Rubber and plastics industry in El Salvador (San Salvador and La Libertad regions).
12. Rubber and plastics industry in Uruguay (metropolitan area of Montevideo).
13. Pharmaceutical industry in Paraguay (city of Asunción and Central region).
14. Pharmaceutical industry in Uruguay (metropolitan area of Montevideo).
15. Chemical industry in Paraguay (city of Asunción and Central region).
Clusters of specialized services—Services
16. Remote business services in El Salvador (San Salvador and La Libertad).
17. Financial intermediation services in Chile (Temuco commune).
18. Transportation and logistics in Paraguay (city of Asunción and Central and Alto Paraná regions).

different forms of collaboration between nodes (e.g., collaboration for exports, sharing transport costs, logistics and/or product distribution, joint purchase of raw materials and supplies, or joint training programs).

In order to measure innovation, we follow the Oslo Manual (OECD/Eurostat, 2005) identifying different types of activities carried out by firms. In particular, we measure whether or not the firm interviewed performs each of the following four innovation activities: (I) research and development activities (both in-house and external); (II) organizational innovation; (III) acquisition of licenses, patents, and technological consulting services; (IV) acquisition of machinery and equipment.

To analyze how the cluster network may influence the innovation of firms, we focus on two aspects that the literature on network analysis has identified as determinants of innovations. First, we measure the overall cohesion of the network, i.e., the extent to which nodes are reachable and accessible. To do so, we calculate the share of nodes connected to the largest component of the cluster network (variable: *LC*). A component is a group of nodes that are directly or indirectly connected among them but disconnected from the rest of the network. The largest component is the one with the highest number of nodes. This variable has been found to be positively related to the dissemination and transmission of knowledge (Fleming *et al.*, 2007). Therefore, by including it in our models, we can measure whether the overall cohesion of the network to which the firm is connected facilitates innovation.

The second aspect of the networks that we are interested in analyzing is the firm's centrality. According to the literature, centrality brings benefits due to better access to resources flowing in the network, such as knowledge (Ahuja, 2000; Borgatti, 2005), although it may also imply costs associated with the resources devoted to link maintenance (Giuliani and Bell, 2005; Giuliani, 2007). To measure centrality, we use degree centrality (i.e., number of adjacent links), differentiating between links with other firms (variable: *Firmlinks*) and links with support organizations

(variable: *Orglinks*). This allows us to empirically analyze not only the importance of occupying a central position in the network but also the role that inter-firm collaboration and support organizations play in cluster networks.

On the other hand, to analyze the relationship between dualism and innovation, we measure the two types of dualism proposed in our theoretical framework: cluster dualism and dual economy. We measure cluster dualism based on the gap between small and large firms in terms of innovation (variable: *Gap_inno*). According to our theoretical framework, dual clusters are characterized by consisting of two clearly differentiated groups of companies in terms of their innovative activity. Therefore, we can approximate cluster dualism by calculating the ratio between the percentage of large companies that innovate and the percentage of small companies that innovate. Small firms are considered to be those with up to 20 employees (the results do not change if another value is taken). Appendix Table A1 shows the values of this variable for each cluster.

To measure the second type of dualism, i.e., the dual economy context, we calculate the percentage of informal employment in the regional economy where the cluster is located. We use informality data since there are no productivity indicators for economic sectors at the subnational level in the four Latin American countries studied here. Although informality can be interpreted in different ways, according to La Porta and Shleifer (2008, 2014), the dual view of informality seems to be the most appropriate explanation for underdeveloped countries: informality reflects the coexistence of two distinct sectors, one with high productivity and the other with low productivity. On the other hand, as previously noted, informality is a major characteristic of dualism in Latin American territories (Ianchovichina, 2024). This informality leads to lower net performance in agglomeration economies compared to what is observed in core economies. Therefore, we consider that this indicator is a good proxy for the dual context of local economies.

We estimate logistic regression models aiming to measure the extent to which cluster networks and dualism are associated with the probability of developing innovations by local and multinational firms. The estimated models can be expressed as follows:

$$\begin{aligned} Inno_{ij} = {} & \alpha + \beta_1 LC_j(L) + \beta_2 Firmlinks_{ij}(L) + \beta_3 Orglinks_{ij}(L) + \beta_4 Gap\_inno_j(L) \\ & + \beta_5 Informality_j(L) + \beta_6 LC_j(1-L) + \beta_7 Firmlinks_{ij}(1-L) \\ & + \beta_8 Orglinks_{ij}(1-L) + \beta_9 Gap\_inno_j(1-L) \\ & + \beta_{10} Informality_j(1-L) + \beta_x' X_{ij} + \varepsilon \end{aligned}$$

where:

- $i = 1, \ldots, n$ (*firms*)
- $j = 1, \ldots, m$ (*clusters*)
- $Inno_{ij}$ is a dependent variable. It is a dummy that takes the value of 1 if company i, operating in cluster j, engages in any innovative activity, and 0 otherwise. We calculate four different variables, considering the four types of innovative activities mentioned earlier: research and development (*i_R&D*); organizational innovation (*i_O*); acquisition of licenses, patents, and technological consulting services (*i_L&C*); and acquisition of machinery and equipment (*i_M&E*). For each of these variables, we estimate a different model.
- L is a dummy that takes the value of 1 if the firm is local, and 0 otherwise. This dummy variable allows us to differentiate the estimation of parameters for each independent variable according to the two groups of companies identified in our two hypotheses: local firms (H1) and multinational firms (H2).
- The independent variables are $Orglinks_{ij}$, $Firmlinks_{ij}$, LC_j, Gap_inno_j, and $Informality_j$. They are calculated as explained earlier.
- X_{ij} is a vector of control variables aiming to represent other factors that may be associated with innovation. In particular, we consider (i) firm size, measured by the number of employees expressed in logarithmic scale ($Size_{ij}$); (ii) export orientation, using a binary variable that takes 1 if the firm exports, and 0 otherwise ($Export_{ij}$); (iii) share of technical professionals in total employment ($Human\_capital_{ij}$); (iv) year in which the firm started its activities ($Start_{ij}$); (v) sector in which the cluster specializes, using four dummies ($Food_j$, $NNRR_j$, $Complex_j$, and $Services_j$) each of them taking the value of 1 if the firm is located in a cluster classified into

one of the four categories presented in Table 1, and 0 otherwise. We also control for the other three types of innovation different from the dependent variable. This allows us to consider the fact that firms often carry out different types of innovation activities simultaneously and carrying out one type of innovation may increase the probability of carrying out another type.

According to our first hypothesis, we expect *LC*, *Firmlinks,* and *Orglinks* to have a significant (and positive) effect, while *Gap_inno* and *Informality* will have a significant and negative effect on the innovation of local firms. In accordance with our second hypothesis, we expect that none of the independent variables will have a significant effect on the innovation of multinational firms.

We estimate logistic regressions with robust variance adjusting for within-cluster correlation. In this estimation method, the observations are independent across groups (clusters) but not necessarily within groups, which is particularly adequate for our data. We present as indicators of goodness of fit the positive and negative predictive value rates, the area under the receiver operating characteristic (ROC) curve, and the results of the Hosmer–Lemeshow goodness of fit test for logistic regression. Descriptive statistics and the correlation matrix for all the variables are available in Appendix Tables A2 and A3.

4. Results

The descriptive analysis presented in Table 2 reveals that, beyond particularities of each case, the 18 clusters are made up mostly of local SMEs, with the presence of large multinational firms. On average, cluster firms present a low ratio of qualified human capital. The clusters are located in regions with high or extremely high informality levels and show significant gaps between the innovation levels of small and large companies. Therefore, we can assume that our data are appropriate for empirically analyzing dual clusters embedded in dual economies. Regarding innovation, and in line with previous literature in Latin America (Jiménez *et al*., 2011; Crespi *et al*., 2014), the acquisition of machinery and equipment is the most relevant innovation activity carried out by firms, while R&D is less frequent.

A comparative analysis of the innovation activities developed by different types of companies confirms what emerges from the literature: small and local firms innovate much less than large and foreign firms (Figure 1).

Figure 2 shows the collaboration networks in the 18 clusters. Beyond the particularities of each case, we can observe that cluster networks have relatively high levels of cohesion, as most firms and organizations are connected to the largest component of each network, while only a small proportion of actors remain isolated or form smaller components. This facilitates the circulation of knowledge among a large part of the cluster actors, enhancing innovation processes.

The structure of the networks also reveals a low inter-firm collaboration level: in relative terms, there are far fewer links connecting two firms than links connecting support organizations with firms. This central role of support organizations is crucial to keep networks cohesive, thus facilitating knowledge flows within the cluster.

The interviewed companies reported that their connections with organizations contributed in multiple ways. In particular, public policy organizations and agencies support companies in areas such as technology, quality improvement, and international market integration. Business chambers and other private organizations typically work to advocate for company interests in regulatory, normative, and market access matters. Universities and research centers often collaborate with companies through projects and technical and laboratory services. In some cases, collaboration between public and private organizations of various kinds leads to inter-institutional agreements, the establishment of service centers focused on the needs of cluster companies, and the creation of development plans for the sector or the cluster's production chain.

Table 3 presents the results of the logistic regression models. As explained earlier, we estimate four different models, using as the dependent variable in each of them one of the four types of innovation. Descriptive statistics and a correlation matrix are available in the Appendix.

Table 2. Main characteristics of the selected clusters

Variable	Natural resource-based clusters (other than food)				Food processing and manufacturing clusters					
	Textile-Py	Textile -Sv	Wood-Ch	Non-metalic mineral-Py	Meat-Py	Grain-Ch	Food-Py	Food-Ch	Dairy-Py	Dairy-Uy
Firms interviewed	63	120	29	92	15	56	27	27	13	40
Average firm size (employees)	54	340	59	19	278	42	70	20	157	106
Local small firms (%)	81.0	27.2	80.6	91.3	33.3	78.9	53.6	92.6	30.8	67.5
Local big firms (%)	14.3	24.3	9.7	7.6	60.0	15.8	39.3	3.7	61.5	25.0
Multinational firms (%)	4.8	48.5	9.7	1.1	6.7	5.3	7.1	3.7	7.7	7.5
Exporting firms (%)	11.1	79.2	13.8	4.3	46.7	19.6	40.7	7.4	23.1	37.5
Qualified human capital (%)	13.1	20.3	23.8	9.9	19.1	24.2	23.8	24.3	20.1	17.4
Start year (av.)	1996	1996	2001	1995	1988	1992	1982	2003	1988	1990
i_R&D (%)	6.3	29.2	17.2	2.2	33.3	30.4	7.4	14.8	15.4	35
i_L&C (%)	14.3	49.2	17.2	4.3	60	42.9	29.6	22.2	15.4	42.5
i_O (%)	7.9	48.3	17.2	1.1	26.7	32.1	18.5	18.5	23.1	27.5
i_M&E (%)	38.1	65.8	65.5	21.7	66.7	67.9	51.9	55.6	76.9	65
Firmlinks (av. links per firm)	0.11	1.48	0.79	0.10	0.33	0.45	0.74	0.30	0.77	1.73
Orglinks (av. links per firm)	0.30	0.88	0.38	0.22	1.47	0.54	1.04	0.30	1.15	2.15
LC (nodes in largest component)	72	86	16	43	82	48	43	25	68	89
Gap_inno (innovation in big/small firms)	2.50	1.27	0.70	3.31	1.09	1.40	2.67	1.09	1.20	1.81
Informality (% of informality in the region)	75.7	66.9	47.2	79.4	69.7	47.2	76.1	47.2	76.7	25

Notes: Ch: Chile; Py: Paraguay; Sv: El Salvador; Uy: Uruguay. Regional informality data are calculated from household surveys conducted by the national statistical offices of these four countries. *Source*: Own elaboration.

Table 2. (continued)

	Non-agro-based complex industries					Clusters of specialized services		
Variable	Plastic-Uy	Plastic-Sv	Pharma-Uy	Pharma-Py	Chemical-Py	Financial-Ch	Business Service-Sv	Logistic-Py
Firms interviewed	116	14	44	24	57	38	21	69
Average firm size (employees)	28	308	58	165	82	63	877	37
Local small firms (%)	81.4	29.4	45.7	45.8	54.4	75.0	13.6	73.9
Local big firms (%)	10.2	41.2	23.9	41.7	35.1	17.5	13.6	10.1
Multinational firms (%)	8.5	29.4	30.4	12.5	10.5	7.5	72.7	15.9
Exporting firms (%)	31	92.9	50	45.8	43.9	7.9	90.5	71
Qualified human capital (%)	13.6	16.4	34.4	39.1	26.7	54	39	21.7
Start year (av.)	1988	1984	1976	1981	1988	2001	2009	1998
i_R&D (%)	44	71.4	54.5	33.3	19.3	10.5	23.8	5.8
i_L&C (%)	20.7	78.6	45.5	45.8	29.8	26.3	66.7	13
i_O (%)	24.1	50	29.5	12.5	22.8	18.4	81	10.1
i_M&E (%)	46.6	78.6	68.2	54.2	64.9	31.6	71.4	39.1
Firmlinks (av. links per firm)	1.09	0.50	1.61	1.04	0.21	0.32	1.62	0.22
Orglinks (av. links per firm)	0.99	1.36	1.34	0.75	0.61	0.39	0.33	0.58
LC (nodes in largest component)	80	82	79	62	39	79	31	28
Gap_inno (innovation in big/small firms)	1.31	1.20	1.48	1.63	2.19	1.36	1.34	1.14
Informality (% of informality in the region)	22	62.1	22	65.8	65.8	47.2	62.1	70.4

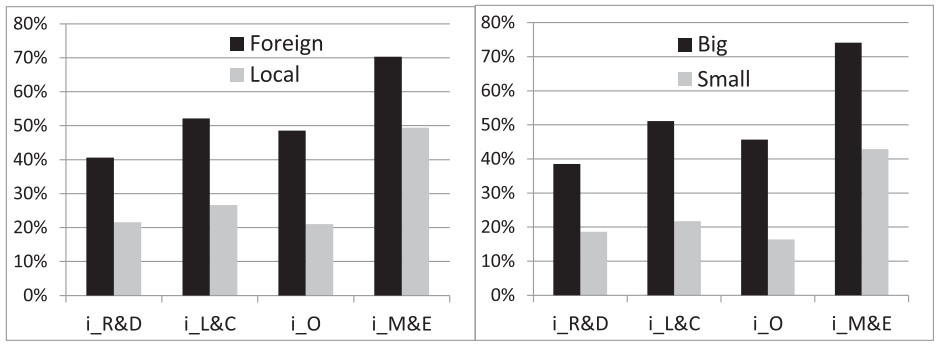

Figure 1. Innovation in small vs. large firms and local vs. foregin firms.
Source: Own elaboration.

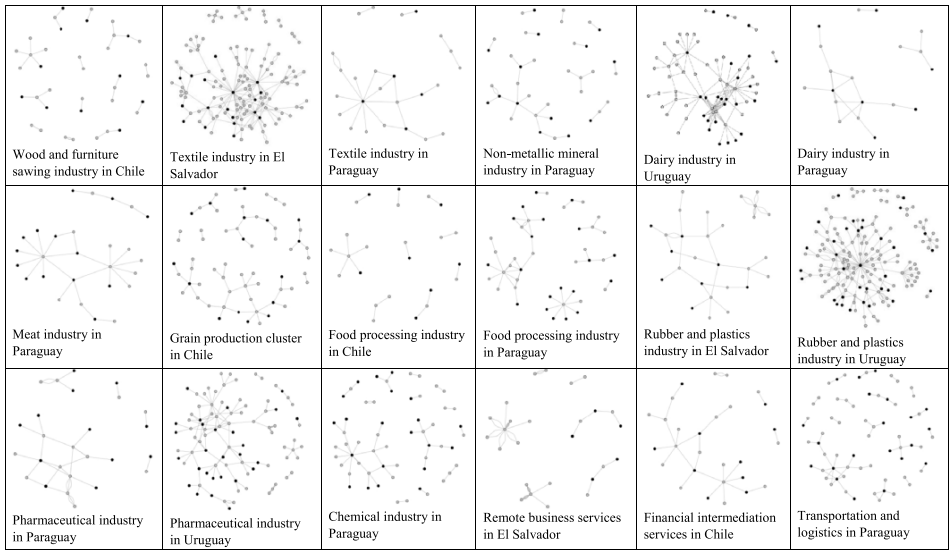

Figure 2. Collabration networks of the 18 Latin American clusters.
Note: gray nodes are firms and black nodes are cluster support organizations.
Source: Own elaboration.

All the models reported in Table 3 show good indicators of goodness of fit. Furthermore, if some control variables are removed or alternative specifications are estimated, the results are maintained.

Before analyzing the independent variables of interest, we highlight that the results obtained for all the control variables are reasonable and in line with expectations. Among these variables, company size is particularly significant and positively associated with innovative performance across all four types of innovation. Human capital is also highly significant and positive, though with a low coefficient, in explaining R&D and patent and consulting acquisition. Additionally, the variables representing cluster sectors are significant, highlighting differences in innovative performance across sectors. Furthermore, engaging in one type of innovation generally has a positive and significant relationship with undertaking other types of innovation. The remaining control variables are generally not significant.

Table 3. Logistic regressions (average marginal effects)

	Model 1. Dependent variable: i_R&D	Model 2. Dependent variable: i_L&C	Model 3. Dependent variable: i_O	Model 4. Dependent variable: i_M&E
*LC * L*	0.001**	0.002***	0.000	–0.002***
	(0.000)	(0.001)	(0.001)	(0.001)
*Firmlinks * L*	–0.011***	0.017**	0.007	0.023
	(0.004)	(0.009)	(0.007)	(0.017)
*Orglinks * L*	0.036***	0.013	0.015	0.016
	(0.008)	(0.014)	(0.012)	(0.021)
*Gap_inno * L*	–0.073***	–0.049**	–0.063**	–0.072***
	(0.016)	(0.026)	(0.034)	(0.022)
*Informality * L*	–0.296***	0.202	–0.087	0.053
	(0.053)	(0.145)	(0.126)	(0.105)
*LC * (1 – L)*	0.000	–0.001	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)
*Firmlinks * (1 – L)*	0.003	0.011***	0.015***	–0.004
	(0.006)	(0.004)	(0.006)	(0.008)
*Orglinks * (1 – L)*	0.001	0.023	–0.018	–0.026
	(0.023)	(0.022)	(0.020)	(0.028)
*Gap_inno * (1 – L)*	–0.053	0.069	–0.049	0.061
	(0.058)	(0.063)	(0.066)	(0.081)
*Informality * (1 – L)*	–0.184	0.281	–0.006	–0.233
	(0.117)	(0.179)	(0.141)	(0.173)
Size	0.028***	0.032***	0.030***	0.066***
	(0.010)	(0.012)	(0.008)	(0.021)
Human capital	0.002***	0.001**	0.001	0.000
	(0.000)	(0.001)	(0.001)	(0.001)
Start year	0.000	0.001	0.000	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Export	0.000	0.000	0.000	0.000
	(0.000)	(0.001)	(0.000)	(0.000)
	i_R&D	0.110**	0.097***	0.126***
		(0.048)	(0.037)	(0.030)
i_L&C		0.103***	0.182***	0.139***
		(0.042)	(0.021)	(0.038)
i_O	0.108***		0.202***	0.115
	(0.036)		(0.022)	(0.063)
i_M&E	0.084***	0.107***		0.084**
	(0.022)	(0.029)		(0.039)
Complex	0.106***	0.054	–0.044	0.019
	(0.031)	(0.042)	(0.051)	(0.042)
NNRR	0.014	0.096**	–0.026	0.077**
	(0.027)	(0.050)	(0.042)	(0.036)
Services	–0.119***	0.011	–0.001	–0.101***
	(0.035)	(0.036)	(0.057)	(0.025)
No. of obs. (firms)	862	862	862	862
Positive predictive value (%)	65.07	70.00	64.94	73.19
Negative predictive value (%)	84.36	82.82	84.46	67.67
Correctly classified (%)	81.09	79.70	80.97	70.42
Area under the ROC curve	0.8604	0.8480	0.8567	0.7828
Test H-L (Ho: good model fit)	Non reject***	Non reject***	Non reject***	Non reject***

Notes: i) standard errors in parenthesis; ii) all models include constant terms; iii) model VCE: clustered sandwich estimator; iv) statistical significance: 1% (***), 5% (**); v) test H-L: Hosmer-Lemeshow Test,non-reject Ho means good model fit.
Source: own elaboration.

4.1 Testing Hypothesis 1: The innovation performance of local companies is positively associated with cluster networks but negatively affected by both cluster dualism and the dual economy context

In the case of local firms ($L = 1$), the cluster network appears to be very relevant for explaining different innovation activities. Specifically, engaging in R&D is positively and highly significantly associated with their connections to support organizations. Moreover, the probability of local firms conducting R&D increases (with a positive and highly significant relationship, though with a small coefficient), as the size of the largest component of the network grows (*LC*). However, an unexpected finding is that inter-firm cooperation (*Firmlinks*) presents a negative and significant relation with R&D activities in local firms. This result may suggest that, for local firms, the costs of cooperation outweigh the benefits of collaborating on R&D. On the other hand, inter-firm cooperation (*Firmlinks*) positively and significantly correlates with the probability of local firms innovating through the acquisition of licenses and consulting services. Furthermore, the overall cohesion of the network (*LC*) also positively and significantly correlates with local firms' innovation through the acquisition of licenses and consulting services but shows a negative and significant relationship with innovation through machinery and equipment purchases (with very small coefficients in both cases).

Regarding cluster dualism, a larger performance gap between small and large companies (*Gap_inno*) is associated with a lower probability of local companies engaging in all four types of innovation. This relationship is highly significant, with a negative and high coefficient in all types of innovation. As for the effect of a dual economy on local firms' innovation, the models show that *Informality* negatively correlates with local companies' engagement in R&D, with a very high and highly significant coefficient.

In summary, the results corroborate the first hypothesis: the cluster network is relevant for explaining innovation in local companies, with the most significant effect attributed to links with support organizations in fostering local R&D, which is the innovation activity requiring the most systematic efforts and larger investments. Overall network cohesion and inter-firm cooperation also seem to facilitate different forms of innovation, although they exhibit smaller coefficients and some ambiguous results. On the other hand, both types of dualism (cluster dualism and the dual economy context) have a significant, negative impact on innovation in local firms.

4.2 Testing H2: The innovation performance of multinational firms is unaffected by cluster networks, cluster dualism, or the dual economy context

In the case of multinational firms ($L = 0$), none of the models show any relationship between innovation and the overall cohesion of the cluster network (*LC*) or the connection with support organizations (*Orglinks*). However, there is a positive and significant relationship with inter-firm cooperation (*Firmlinks*) for innovation in licenses and consulting and organizational innovation. Regarding the effects of cluster dualism (*Gap_inno*) and the dual economy context (*Informality*), none of the models show a significant relationship with the innovative performance of multinational firms.

Therefore, the reported evidence also confirms our second hypothesis: multinational companies are not affected by dualism, and local networks do not appear to be significant sources of innovation. An exception is the relationship between cooperation with other local firms and innovation in licenses, consulting, and organization. These forms of innovation require less systematic effort and may be more adaptive to the specific environment in which firms operate, so it makes sense that connections with local actors facilitate these activities. On the other hand, the R&D activities of multinational firms are not associated with cluster networks or the local context where they are located.

5. Conclusion and agenda

In clusters of underdeveloped countries, territory-specific factors such as local networks and the local environment do not have the same impact on the innovation of multinational vs. local companies. On the one hand, innovation in multinational firms hardly depends on these local

factors. On the other hand, for local companies the situation is very different: while collaboration networks can facilitate their innovation processes, dualism significantly restricts their innovation. Furthermore, the effects of dualism on local firms can be observed both considering the configuration of the cluster and the general context of a dual economy.

Here lies the main contribution of our paper: in developing countries, collaboration networks within dual clusters are embedded in a territorial environment characterized by a dual economy. While dual clusters also exist in developed countries, the dual economy context is a defining characteristic of underdeveloped countries. Therefore, the disadvantage of the local firm vis-à-vis the large multinational firm, which can be clearly established anywhere in the world by access to internal resources and global networks, becomes a much more important and complex issue to analyze in an underdeveloped environment with a dual economy.

The dualism of peripheral economies, which implies that most of their human capital is linked to low-productive and informal activities, places an important constraint on growth and innovation in local firms. Developing innovation processes requires an environment that offers highly skilled labor markets, agglomeration economies, and a business climate of cooperation and competition. These positive environmental conditions, as established by classical local development theories, are restricted in dual economies, which put local firms at a clear disadvantage compared to multinational firms.

In this context of dualism, multinational companies will have few incentives to rely on local networks as a source of innovation. This is consistent with a profile of multinational corporations operating in regions like Latin America, which may prioritize other factors such as access to natural resources, cheap labor force, or emerging markets over local knowledge networks. Yet, our findings reveal a nuance to this profile: we observe a positive and significant relationship between cooperation with other cluster firms and the purchase of licenses, consulting services, and organizational innovation by multinational corporations. Although other aspects of local networks (such as overall cohesion or connections with support organizations) do not affect multinationals' innovation, this finding suggests a potential avenue for the upgrading of local firms. It highlights how the relationship between local companies and multinationals in clusters of developing countries could serve as a path for joint innovation.

Needless to say, our research has limitations, particularly associated with the measurement of dual economies. Since there are no measures of sectoral productivity at the subnational level that are comparable across Latin American countries, we use the labor market informality indicator as a proxy for the dual economy. In future research, it would be interesting to deepen the analysis of regional dual economies in search of other alternative or complementary indicators to the one used here. However, beyond the interpretation of informality as an expression of dualism, the literature has shown that informality not only reflects productivity differentials in the economy but also significantly restricts the innovation potentials of formal firms in underdeveloped countries (La Porta and Shleifer, 2008, 2014; Cimoli and Porcile, 2014, Allen *et al*., 2018).

On the other hand, according to our results, the relevance of the local network to promote R&D in local firms depends essentially on connections with support organizations. The low impact of network cohesion and inter-firm cooperation on the innovation of local firms suggests a significant difference between Latin American clusters and local development models in developed countries, such as Marshallian districts in Italy (Becattini, 1979), new industrial spaces in the United States (Saxenian, 1994), or innovative milieus in France (Aydalot, 1986), where firm collaboration is crucial for driving innovation. However, our findings are in line with what Giuliani *et al*. (2019) showed for clusters in Latin America, where the most innovative firms cooperate less with other firms in local networks.

Therefore, in contexts of dualism, support organizations seem to play a key role in networks to promote R&D in local firms. The relevance of these organizations is also observed in clusters in developed countries, highlighting the importance of public policies and organizations serving as channels for them to reach SMEs (Dei Ottati, 2018). However, our work draws attention to the fact that in underdeveloped regions the design and implementation of policies for the promotion of clusters and collaborative networks should go beyond the Marshallian theory and contemplate the particular restrictions of dual economies. Future research should incorporate the

characteristics of peripheral economies in order to properly assess the role of public policies and support organizations in building up clusters' capacities to innovate.

In a changing world, the challenges of territorial development require innovative local actors who can take advantage of the opportunities generated by globalization (Vázquez Barquero and Rodríguez Cohard, 2020). But this kind of innovative local actors could be discouraged by a strongly adverse environment. Therefore, designing public policies to strengthen support organizations within dual clusters appears essential for building a competitive and innovative territorial system.

In this regard, future research should bring into dialogue the studies of clusters in peripheral regions and the role of local institutions in reducing dualism problems. While structuralist approaches to development problems have often ignored territorial specificities, the cluster approach has often replicated models from the developed world without considering the problems of dual economies.

Further studies should focus on how local institutions and development policies can better contribute to improving local market conditions, removing obstacles to the transition from low-productive activities to high-productive ones, and promoting local firm's cooperation and innovation. Our findings suggest that this research agenda should be differentiated from the proposals applied to regions with mature development processes, placing greater emphasis on the limitations faced by local firms that operate in underdeveloped dual economies.

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Appendix

Table A1. Cluster dualism indicator: innovation gap between large and small firms

Clusters	Small firms (as a % of the total number of firms)	Share of firms that innovate (%)		Cluster dualism indicator: B/A
		Small firms (A)	Medium and large firms (B)	
Business Service-Sv	13.6	66.7	89.5	1.34
Non-metalic mineral-Py	81.5	16.0	52.9	3.31
Chemical-py	29.8	41.2	90.0	2.19
Dairy industry-py	23.1	66.7	80.0	1.20
Dairy industry-uy	47.5	52.6	95.2	1.81
Financial services-ch	70.0	42.9	58.3	1.36
Food-ch	66.7	61.1	66.7	1.09
Food-py	25.0	28.6	76.2	2.67
Grain-ch	52.6	63.3	88.9	1.40
Logistic-Py	63.8	45.5	52.0	1.14
Meat industry-py	26.7	75.0	81.8	1.09
Pharma-py	33.3	50.0	81.3	1.63
Pharma-uy	43.5	65.0	96.2	1.48
Plastic-sv	35.3	83.3	100.0	1.20
Plastic-uy	66.9	64.6	84.6	1.31
Textile-py	71.4	33.3	83.3	2.50
Textile-sv	23.0	64.5	81.9	1.27
Wood-ch	67.7	71.4	50.0	0.70
Mean (all clusters)	46.7	55.1	78.3	1.59

Table A2. Descriptive statistics (logistic regression models variables)

Variable	Mean	Std. dev.	Min.	Max.
i_R&D	0.24	0.43	0.00	1.00
i_L&C	0.30	0.46	0.00	1.00
i_O	0.24	0.43	0.00	1.00
i_M&E	0.53	0.50	0.00	1.00
Orglinks	0.76	1.30	0.00	10.00
Firmlinks	0.76	2.18	0.00	28.00
LC	60.80	23.10	15.80	88.60
Gap_innova	1.71	0.72	0.70	3.31
Informality	0.56	0.21	0.22	0.79
Size	122	330	1	3494
Human capital	21.71	21.37	0.00	100.00
Start year	1992	19	1893	2016
Export	22.44	36.63	0.00	100.00
Food	0.06	0.24	0.00	1.00
Complex	0.30	0.46	0.00	1.00
NNRR	0.21	0.41	0.00	1.00
Services	0.15	0.35	0.00	1.00

Table A3. Correlation matrix

	Orglinks	Firmlinks	LC	Gap_inno	Informality	Size	Human capital	Start year	Export	i_R&D	i_L&C	i_O	i_M&E	Complex	NNRR	Services
Orglinks	1.000															
Firmlinks	0.194	1.000														
LC	0.213	0.155	1.000													
Gap_inno	−0.115	−0.122	−0.160	1.000												
Informality	−0.189	−0.144	−0.381	0.481	1.000											
Size	0.347	0.146	0.147	−0.183	0.109	1.000										
Human capital	0.068	0.093	−0.022	−0.170	−0.064	−0.028	1.000									
Start year	−0.264	−0.102	−0.131	−0.037	0.134	−0.245	0.024	1.000								
Export	0.229	0.114	0.092	−0.272	0.107	0.467	0.108	0.066	1.000							
i_R&D	0.325	0.134	0.233	−0.204	−0.287	0.266	0.115	−0.165	0.142	1.000						
i_L&C	0.268	0.219	0.164	−0.180	−0.071	0.353	0.137	−0.084	0.210	0.356	1.000					
i_O	0.258	0.210	0.151	−0.208	−0.085	0.351	0.107	−0.061	0.259	0.344	0.467	1.000				
i_M&E	0.207	0.157	0.078	−0.191	−0.090	0.342	0.054	−0.091	0.160	0.267	0.327	0.303	1.000			
Complex	0.096	0.059	0.233	−0.132	−0.555	−0.008	0.031	−0.247	−0.120	0.255	0.045	0.018	0.062	1.000		
NNRR	0.119	0.000	−0.078	−0.073	−0.122	0.005	0.004	−0.036	−0.134	0.003	0.073	0.013	0.107	−0.330	1.000	
Services	−0.083	−0.049	−0.324	−0.265	0.137	−0.043	0.229	0.176	0.220	−0.120	−0.032	−0.002	−0.083	−0.268	−0.209	1.000