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STUDY OF A RELATIONAL-COGNITIVE NETWORK IN COSTA RICA: THE CASE OF THE SPECIAL ECONOMIC ZONE FOR MEDICAL DEVICES IN EL COYOL, COSTA RICA

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Abstract

The global medical device industry has been experiencing and is expected to experience an annual continuous growth of 5,6% in the 8 year period 2017 until 2024 (Evaluate, p. 10). This represents an amount in sales of approximately US$595,000. Costa Rica is not an exception to this medical device producers' expansion. As a result of the government's promotion of Special Economic Zones (SEZs) with interesting fiscal and corporate benefits for multinational (MT) firms since the early 1990´s, the country has become the ''second largest exporter of medical devices in Latin America'' (Coalición Costarricense de Iniciativas para el Desarrollo, 2019, para. 3) This paper's aim is to develop a relational economic geographic and cognoscitive geographical approach towards the analysis of how 'knowledge´ relational networks; formed by local universities and the medical device MT producers, can contribute to the creation of socio-spatial interactions aiming at concrete economic changes and outcomes. Such relational networks also experience a "multiplying cognitive process, that increases the size and quality of intellectual and social capital that is embedded in a particular place" (Rullani, p. 2). These would in turn be reflected in a harmonious and sustainable business relationship with the host country, and the local territory in which the SEZ is located. Informal institutional arrangements (actions and practices such as participation in job fairs and in conjunction with the local universities) are strong motivations for the medical MT firms in El Coyol, Costa Rica to maintain a harmonious and sustainable business relationship with the host territory.

***Keywords*:** Special Economic Zones, Clusters, Relational networks, Costa Rica

***JEL Classification*:** R12, P45, F23

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1. Introduction

Since 2017, the global medical devices industry has experienced continuous annual growth at a rate of 5.6%—a trend that is expected to persist until 2024 (Evaluate, p. 10), representing approximately US$ 595 billion in sales. Costa Rica is no exception to this expansion. In the early 90s, the government began fostering the establishment of Special Economic Zones (SEZs) by providing multinational (MTN) firms with attractive fiscal and corporate benefits; this, in turn, enabled the country to become the "second largest exporter of medical devices in Latin America" (Coalición Costarricense de Iniciativas para el Desarrollo, 2019, paragraph 3).

This paper will apply a relational economic-geographical and cognoscitive-geographical approach in order to analyze the manner in which 'knowledge' relational networks (formed by local universities and MTN producers of medical devices) could develop harmonious, sustainable relations with the host territory, and whether they could contribute to creating socio-spatial interactions that bring about concrete economic changes and outcomes. These relational networks experience a "multiplying cognitive process, that increases the size and quality of intellectual and social capital that is embedded in a particular place" (Rullani, 2003, p. 2), which would be reflected in a harmonious and sustainable business relationship with the host country and the local territory in which the SEZ is located. Consequently, the two main research questions that will guide this paper are as follows:

1.Do the relational and cognitive networks comprising local universities and MTN medical device firms, developed in El Coyol SEZ (Alajuela, Costa Rica), provide MTN medical device firms with a motivation to establish a harmonious and sustainable business relationship with the host territory and country?

2. Do the relational and cognitive networks comprising local universities and MTN medical device firms, developed in El Coyol SEZ (Alajuela, Costa Rica), provide MTN medical device firms with a motivation to create knowledge?

A mixed qualitative-quantitative methodology was applied to test these two research questions. Firstly, an exploratory study was carried out through the review of relevant bibliographical resources on relational economic and cognitive economic geographies. Two seminal papers serve as a theoretical foundation for this paper: a. "Rethinking relational economic geography," by Yeung (2005), and b. "The industrial district as a cognitive system," by Rullani (2003). Secondly, 20 closed-ended questionnaires were distributed to 20 business leaders from MTN medical device firms in El Coyol SEZ, between April and May of 2019, which allowed for collecting quantitative primary data. Thirdly, a logistic regression model was developed, in which the independent variable is of a binary nature, representing whether MTN firms have developed a relational network with local universities, and whether these firms are motivated to create knowledge as a result of these networks. The following aspects were considered as dependent variables: a. participation in job fairs at universities (years), b. relationship with employment offices that have ties to universities (years), c. internship relationship (years), and d. number of research initiatives developed. Although it is limited to only one SEZ in Costa Rica, this study focuses on the most important MTN medical device cluster in the country.

2. Theoretical Framework

The interaction between technology, organizations and territories (Storper, p. 39) at various geographical levels is the result of "socio-spatial" interactions between different actors (Yeung, p. 37), each of which manifests varying degrees of power. According to Allen (2003), power is "a relational effect of social interaction" (p. 2). Yeung (2005) further expands this concept by providing a more pragmatic and functional definition, stating that power represents the "relational effects of the capacity to influence and the exercise of this capacity through actor-specific practice" (Yeung, 2005, p. 44).

Relational geographies—which are socially constructed through the interrelation of economic actors and their "actor-specific" (Yeung, 2005, p. 44) practice and action—build institutions (norms, habits and cultural expressions) that control, regulate and establish boundaries for the relationality between them. Relational geography is also context-influenced, culturally-determined and power-derived in the form of networks. According to Yeung (2005), these relational geographies are neither actors (e.g. individuals and firms) nor structures (e.g. class, patriarchy and the State), but rather "configurations of relations between and among them–connecting actors and structures through horizontal and vertical power relations" (Yeung, 2005, p. 44).

Power relations are manifested through relationality, and this relationality facilitates power as an effective means for achieving results and outcomes, through the "emergent effects of social practice among actors" (Yeung, 2005, p. 45). This creates "spatial configurations" (Yeung, 2005, p. 37) that serve as foundations for "relational geographies" (Yeung, 2005, p. 37). Although actors and structures per se may not necessarily hold power, they may have demonstrated that they are capable of obtaining outcomes while interacting within professional networks. This facilitates the relationality between actors and structures of any network, since power can actually be distributed based on previous performance, rather than on a position or hierarchy. Depending on the reason for which a network is established, it is also important to consider power as a social construct that is constantly influenced by the organizational culture, the context in which it is embedded, as well as actor-specific practices and actions.

The reasons that motivate specialized firms to form clusters, industrial districts or agglomerations can be analyzed from a relational economic-geographical perspective. Under this lens, tensions, frictions and power relations between the relevant economic actors are studied and depicted "to incorporate actor-specific practice into our analysis of contemporary economic change" (Yeung, 2005 p. 44). For the purpose of this essay, it is interesting to consider the reasons for which specialized MTN firms, such as those in El Coyol, Costa Rica that develop medical supplies, have gathered in the corresponding geographical area. One the one hand, it could be due to the advantages afforded by their proximity to important urban centers and infrastructure. On the other hand, in terms of relational geography, proximity to local and regional universities could represent a strong enough incentive to continue doing business in the country and to attract new MTN firms to the country. According to Yeung (2005, p. 46) "the emergent power embedded in these relations provides a major force to drive association and interconnections and to produce socio-spatial outcomes." Regardless of how strong relational geographies are in a series of specialized firms, the 'learning' region and local embeddedness play an important role in prompting economic changes and outcomes.

The efficacy and efficiency of relationality is determined by the application of "emergent power" (Yeung, 2005, p. 46)—that is, the strong interconnections and associations of relational networks developed in business clusters. This relationality can capitalize on the learning that occurs in a place or context, as well as spatial trends, in order to generate concrete economic changes, mobilization and practice. This eventually can provide a very important catalyst for local and regional development. Marston describes it as "a complex mix that also includes space, place and environment–all of which interactively make the geographies we live in and study" (Marston, 2000, p. 221).

To be able to analyze how these 'knowledge' relational networks function, it is important to clarify two categories of power relations that Yeung (2005) utilizes to render this methodology functional: relational complementarity and relational specificity. The first one describes the manner in which firms and universities (the main actors of the 'knowledge' relational network described by this study) utilize their power relations to construct a spatial geometry "to benefit from each other's co-presence and engagement" (Yeung, 2005, p. 46). Through stronger co-presence and engagement from the network's actors, less friction and opposition will arise, given that the power relations are utilized to obtain "spatial change and outcomes" (Yeung, 2005, p. 46). In the case of this study, the MTN firms in El Coyol SEZ and local and regional universities may decide to cooperate with one another to take advantage of each other's complementary assets: the firms' labor market knowledge and the regional universities' competitive professional profiles. Although this complementarity may involve unequal power relations, cooperation agreements between the main actors will facilitate the process of applying actor-specific practices, actions and mobilizations through which economic changes and expected outcomes can be achieved.

Relational specificity is another type of power relation "in which dedicated commitment is enforced among constituents in dyadic and heterogeneous relations" (Yeung, 2005, p.46). The salient feature of this specificity is the manner in which the main actors of the relational network rely on and are attached to their "ongoing power relations" (Yeung, 2005, p. 47), which allows for enhancing their spatial configurations and, in turn, driving economic changes and outcomes. The topological characteristics of the relationality present in the specific geometrical network, like the university-firm networks at El Coyol SEZ, are shaped by these specific power relations. "Dedicated commitment" from each of the main actors of the relational network is necessary in order for this relational specificity to function effectively, without friction or resistance. This specificity can also be demonstrated through the analysis of actor-specific practices and actions, with the aim of achieving economic changes and outcomes, both at the local level and beyond the cluster. Based on Yeung's argument (2005, p. 46) regarding the emergent effects of complementarity and specificity, "the efficacy of such an emergent effect is contingent on the practice of a variety of actors such as firms, unions and agencies entering into all sorts of heterogenous relations—a relational practice that activates this emergent effect. In other words, the emergent nature of power is experienced through action and practice."

Organizations (firms and universities), interactions (practices and communication based on power structures), evolution (development path) and innovation (new ideas and knowledge creation) play an important role within a context of relational geometries. These elements, described by Bathelt and Glucker (2003, p. 117) as the "the four ions of

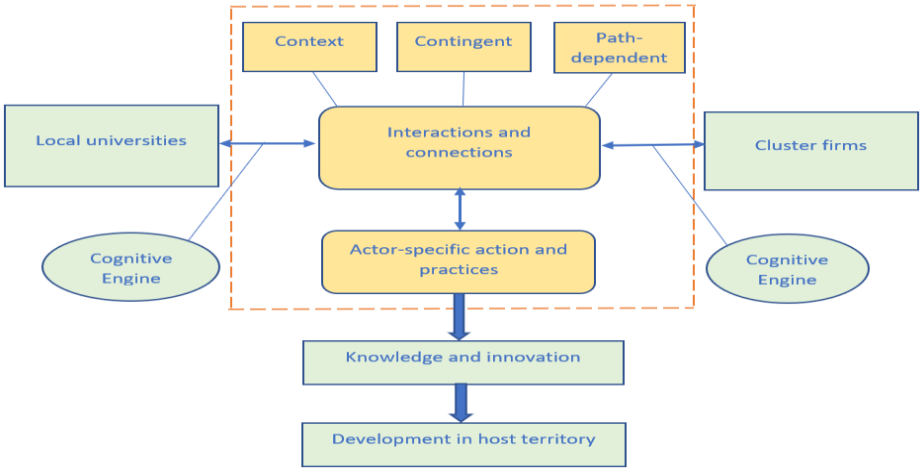
economic geography in a relational perspective," are contingent on a "multiplying cognitive process" (Rullani, 2003, p. 2). Consequently, this paper establishes a theoretical connection between Yeung's (2005) relational networks based on power relations and Rullani's (2003) cognitive multiplying process. This link will reinforce the idea that development in a territory can be enhanced by experienced, learned institutions that form part of these 'knowledge-based' networks and that generate economic changes and outcomes.

According to Rullani (2003), economic changes and outcomes are associated with a multiplying cognitive effect "that increases the size and quality of intellectual and social capital that is embedded in a particular place" (Rullani, 2003, p. 2); they are also the result of shared knowledge obtained through cooperation among relevant actors in the relational network. Rullani (2003) describes knowledge as being costlessly re-produced and re-created through "ideas, models, laws, etc." (Rullani, 2003, p. 2). According to Rullani, the territory is one of the elements required in order for the multiplying effect to function and to generate "unique, localized knowledge" in a specific territory. Nonetheless, Rullani does not include in his analysis the emergent effects that power relations have on the spatial configurations that shape relational geometries. On the other hand, Rullani (2003) considers territories to be "a depository of culture and habits [that] accumulates forms of tacit knowledge, and channels of communication . . . and they are embedded in the anthropological-social system grown up in each place" (Rullani, 2003, p. 3).

Rullani's depiction (2003) of the territory as a depository of culture, habits and tacit knowledge resulting from multiplying cognitive processes, allows for establishing linkages with Yeung's (2005) argument of relational networks based on emergent power relations. The relational network that Yeung (2005) proposes is dependent on power relations in which the various actors participate through experiences, thoughts and senses, which are basically cognitive processes. These power relations and their emergent effects are the result of interactions happening in the relation network, which are expected to create value and a 'knowledge' economy for the benefit of the firms and universities, thereby creating a new 'place' of shared knowledge and expected economic change. The interactions in the relational network include multiplying cognitive processes through which new ideas, creations, practices and, in general, new institutions are developed for the benefit of the spatial configurations where these firms and universities are located.

Bathelt and Glucker (2003) describe a relational perspective in which the relational action, from a spatial perspective, can result from the relationship between the organization, evolution, interaction and innovation. As noted by these authors, the idea behind these basic concepts is to understand how they "are being constructed and reconstructed" under the aegis of a relational perspective, with new input from the multiplying cognitive processes involved in their development and interaction (see Figure 1). This heuristic approach can be utilized to better understand the consequences of the relational perspective on each of these concepts: specifically, how they are influenced by the relationality of the network under analysis—with input from the cognitive process—and how they influence knowledge and value creation on behalf of the cluster or industrial districts—in this case, El Coyol SEZ.

Figure 1: Spatial relational network



The main organizational problem that characterizes the relational network comprising El Coyol firms and local universities is the coordination of the labor force. On the one hand, firms are constantly demanding labor from the Costa Rican and regional labor market; on the other hand, universities must incorporate recent graduates into the local job market.

The relational network, which comprises both firms and universities, is contingent on the power relations that each of the constituents engages in and commits to upon entering the network. Regardless of the types of actions and practices that the actors decide to undertake as part of their efforts to achieve economic changes and outcomes on behalf of their territory and cluster, "organizational structures are embedded in social, cultural and institutional structures and relations which cannot be separated from the economic sphere. The existence of accepted rules, habits, norms and other institutional arrangements creates a reliable environment for interactive learning" (Bathelt and Glucker, 2003, p. 133). These knowledge-based relational networks benefit from the cognitive engine that begins to operate under the conditions afforded by a stable relational network. For instance, the cognitive multiplying effect triggered by the various actors' practices and actions can enhance the interactions that commonly characterize the firm-university relationship, such as the organization of job fairs or collaboration through internships. This cognitive engine will generally "reduce information costs, generate information spillovers and enable for more efficient communication" (Bathelt and Glucker, 2003, p. 133).

With respect to its evolution, El Coyol SEZ is embedded in an anthropological, social and economic context that has changed over time. As economic and social processes have evolved in this territory, so has the relational network comprising firms in El Coyol and local universities. To quote Bathelt and Glucker (2003), the changes that have been implemented by this relational network are "path dependent in that they follow particular histories of decisions, actions and their consequences." Therefore, the firm-university relational network comprises a series of practices, actions and habits that shape its

institutional framework; these institutions, in turn, have emerged as a result of power relations and the use of their cognitive engine as a means of accelerating the creation of knowledge and innovation.

The evolution of the firm-university relational network in El Coyol is path dependent, but this does not mean that it is deterministic. This network's creation and re-creation of new knowledge, as well as its enhancement of social capital, is dynamic and characterized by topological features that are unique considering its socio-economic context, but it is "experience-based and develops over time from a historical process" (Bathelt and Glucker, 2003, p. 134). The effective application of power relations within the institutional context, with input from the cognitive engine, strengthens the creation of new knowledge. Eventually, the combination of these elements results in "future path-development and context-specific developments" (Bathelt and Glucker, 2003, p. 134). This network in particular specializes in the development and manufacturing of advanced medical devices, as a result of previous decisions made by MTN firms, universities and other relevant actors, such as government trade promotion agencies. The country's international trade strategy in recent years is reflected in the path-dependent decisions that have been made with respect to the labor market and the professional profile that MTN firms and universities aim for.

The other relevant dimension is innovation. The relational perspective applied in this research study allows for analyzing the power relations between the different constituents of the firm-university relationship, while also bearing in mind the goal of knowledge creation. The heuristic framework applied in this study views the cognitive engine as a catalyst for increasing and multiplying the effect of network linkages, especially with respect to the creation and re-creation of new knowledge and social capital. As stated by Bathelt and Glucker (2003), "the creation of new technologies is viewed as an interactive social process, characterized by a particular social division of labor within a firm and between firms of the value chain as well as between firms and universities" (p. 135).

Cognitive engines are extremely important when the relational network is implementing actor-specific practices, habits or actions. Cognitive processes are based on experience and interactive learning, as well as on innovation that depends on "continuous feedback from various stages in research, testing and production, reflexive patterns of economic behavior, and interactive learning between the agents involved" (Bathelt and Glucker, 2003, p. 135). Cognitive engines are motivated by the institutional framework represented in routines, heuristics and cognitive scripts (DiMaggio, 1997). The actions and practices undertaken by the constituents of the relational network, resulting from the power relations involved, serve as catalysts for economic change and outcomes; this, in turn, allows for achieving local territorial development.

Based on the three aforementioned dimensions—organization, evolution and innovation—interaction represents a binding element that facilitates continuous interconnection between relevant actors or the constituents of the relational network. According to Bathelt and Glucker (2003, p. 136), "the nature and extent of interaction changes over time in various workplaces, firms, and formal institutions and authorities." As a result of the cognitive engine and relationality in the network, there is a continuous process of interactive learning, creativity, as well as creation and re-creation of collective

intellectual and social capital, "which link the organization and innovation ions and generate an evolutionary dynamic" (Bathelt and Glucker, 2003, p. 136).

El Coyol SEZ firms and the local universities in their relational networks are able to develop spatial and organizational configurations at various levels thanks to their interactions, which enable the network constituents "to modify and refine heuristics and routines along existing trajectories or to develop new technologies towards new development paths" (Bathelt and Glucker, 2003, p. 136). Actor-specific actions, practices and routines, among others, become more sophisticated and complex as the cognitive engine and its multiplying effect retrieve information, in a prospective manner, from an institutional memory of successes and failures. Learning through interaction is experience-based, relationally-determined and path-dependent. Specialized industry clusters such as the one in El Coyol are characterized by "inter-firm interaction, proximity and learning. They enable efficient information and knowledge transfer" (Bathelt and Glucker, 2003, p. 136). Eventually, the outcomes achieved by the firm-university relational network are expected to produce a development path, both within and beyond the industrial district or cluster.

3. Origins of Special Economic Zones in Costa Rica

In the 1960s, 70s and early 80s, import substitution industrialization proved to be an ineffective way to drive development in Costa Rica; consequently, the country needed to find a new development model that could provide hope. The situation grew even more challenging in the 1980s due to the international debt crisis, macroeconomic management and the collapse of international commodity prices for products like coffee and bananas.

In search of a new economic development model, Costa Rica began to implement structural adjustment programs in the mid-1980s. This led to the intensification of economic liberalization as a means of attracting foreign direct investment and transnational capital. An attempt was made in 1981 to create the first SEZ through Law No. 6695 on Export Processing Zones and Industrial Parks (Exp. 7870, 1981, Tomo 2: 611), which sought to drive the development of specific regions of the country that were less developed (Puntarenas and Limón), boosting their capacity to export and re-export to third markets. However, there were geographical limitations, and the law provided limited fiscal benefits such as tax exemptions on raw materials, sales of exported goods, and capital.

In 1984, the country began the process of adapting the structural adjustment program under a new development model that focused on an export-led strategy. This required the initial law to be updated and adapted to the country's reality at that moment in time. Consequently, the country enacted Law No. 6951 on Special Economic Zones. In contrast to the geographical selectivity that characterized the 1981 law, the new law enabled SEZs to be established in other regions of the country, subject to the approval of Congress (Exp. 9304, 1984. Tomo 2: 591). Fiscal exemptions were expanded to a 100% exemption on a firm's corporate tax during the first six years of operations, and a 50% exemption for the following four years.

In 1990, Law No. 7210 was enacted with the aim of improving conditions for foreign and local firms that were willing to accept the conditions of working under a SEZ regime. The most important fiscal exemption improvements afforded by this law, which is still in effect today, are related to fiscal benefits. Corporate tax exemption, which was previously limited to a firm's first six years of operations (according to the 1984 law), was expanded to eight years for firms in SEZs of the Greater Metropolitan Area. The exemption for the following four years was maintained at 50%, as established in the 1984 law. Furthermore, the corporate tax benefit for less developed regions of the country (Enlarged Greater Metropolitan Area) was doubled, from the first six years of operations to the first twelve years of operations; however, the benefit for the following four years of operations remained unchanged at 50%, as established in the 1984 law.

The 1990 SEZ Law provided a very appealing package for attracting foreign direct investment as well as local investment. As previously mentioned, fiscal corporate profit exemption is one of its most attractive aspects; nonetheless, the fiscal benefits vary greatly, as shown in the following table:

Table:1

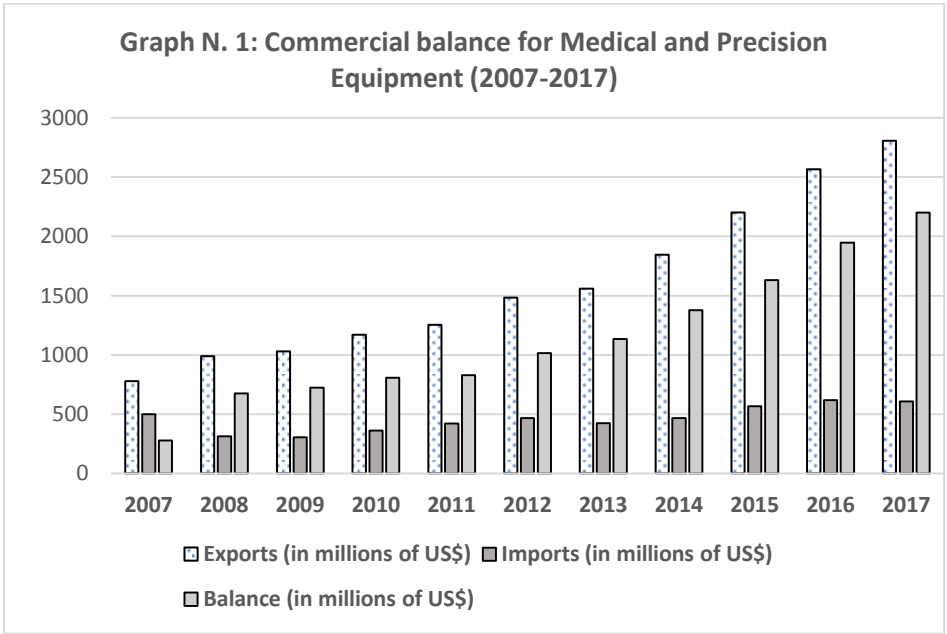
Exemptions of the 1990 SEZ Law	Description
Importing of goods necessary for the operation and management of the company	Machinery and equipment, semi-elaborated manufacturing products, other products necessary for operation, packaging materials, spare parts, components and parts.
Importing of vehicles with the following characteristics:	Chassis with cabins with one to two-ton load capacities, trucks or truck chassis, pickup trucks with one- or two-ton load capacities, vehicles with a minimum capacity of fifteen passengers.
Domestic purchases of goods and services	
Exports	
Conveyance of real estate	For a period of ten years
Municipal permits	For a period of ten years
Remittances	
Profits: This benefit is awarded in accordance with company's location and category	-Greater Metropolitan Area: No corporate tax during the first eight years of operations. For the remaining four years, there is a 50% exemption. -Enlarged Metropolitan Area: No corporate tax during the first twelve years of operations. For the remaining four years, there is a 50% exemption.

	This percentage depends on the firm's location and category, as well as its size.
Access to training and education programs	

Source: https://www.procomer.com/en/freetradezone-investor#2

4. The Medical Devices Sector as a Propeller of Economic Growth

Thanks to the creation of SEZs and industrial parks as part of an export-led growth strategy, as well as the implementation of Law No. 7210, specialized economic clusters have emerged and proven to be very important propellers of economic growth. The global medical devices industry is one of the most dynamic sectors of the global economy, and Costa Rica is reaping the economic benefits afforded by this positive trend. As shown in Graph 1, the commercial balance of the medical and precision equipment sector in Costa Rica (the name utilized by the Central Bank of Costa Rica to describe the medical supplies sector) has been very positive.



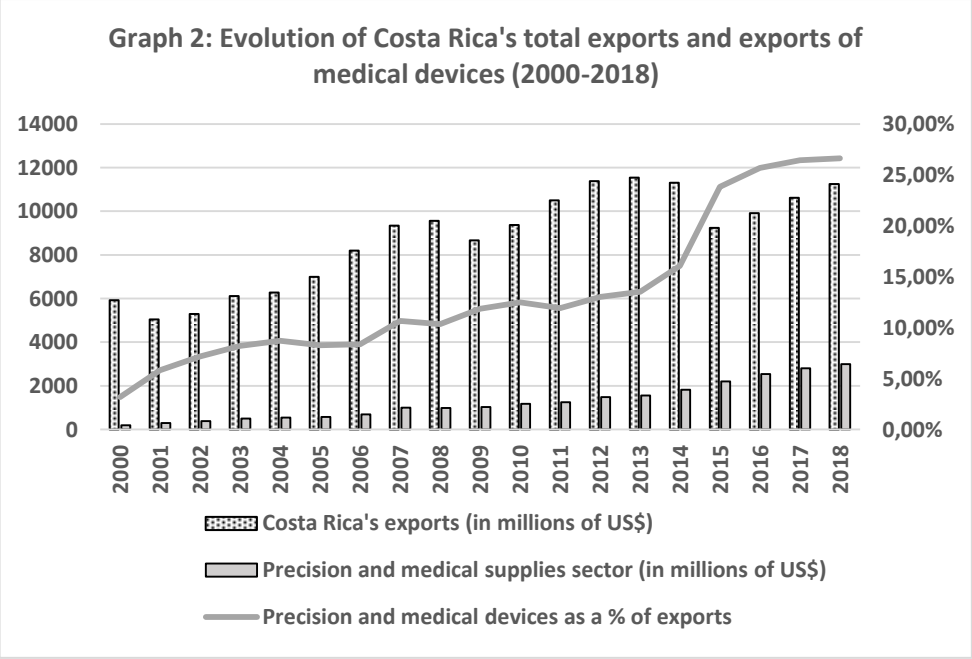
Source: By author with data from Anuarios Estadísticos, Procomer, 2008-2017.

In 2007, the commercial surplus of the medical supplies industry in Costa Rica was US$ 279 million. By 2017, this surplus had reached US$ 2200 million, representing an enormous increase of 873.18%.

It is worth noting that North America and the European Union are the two most important regions of the world that receive exports of medical supplies from Costa Rica. In 2008, North America received 83% of these exports, followed by the European Union, which received only 10%. Interestingly, this trend shifted slightly in 2017, when the European Union received a greater number of exports of medical supplies from Costa Rica, although North America remained the top destination of these exports. That year, North America and the European Union received 69% and 22% of exports of medical supplies from Costa Rica, respectively; while North America's participation in receiving exports decreased by 14%, that of the European Union increased by 14%.

The country that stands out as the most important buyer of medical supplies from Costa Rica is the United States. In 2007, the U.S. purchased US$ 498.1 million in medical supplies, representing 63.9% of the total exports of medical supplies; in 2017, the country purchased US$ 1884.70, representing 70.4% of the total exports. This represents an increase of 278.37% during the period analyzed.

Overall, the export industry for medical devices has become the most important sector of Costa Rica's economy. At present, the sector accounts for 26% of Costa Rica's total exports, as illustrated in Graph 2.



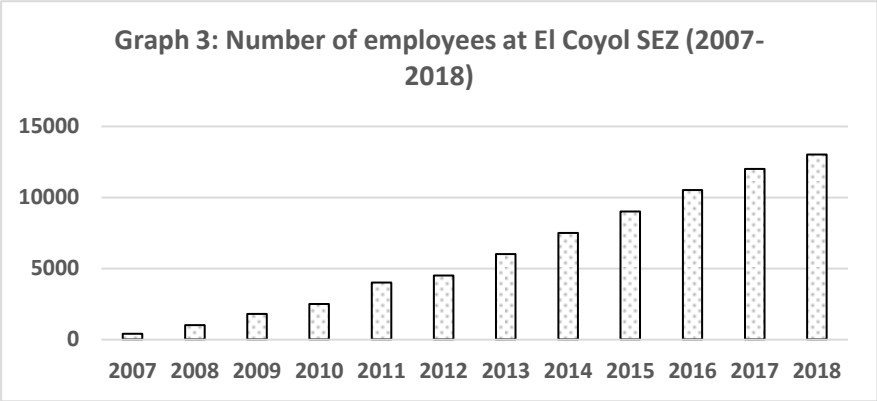
Source: By author with data from Central Bank of Costa Rica, 2000-2018.

Graph 2 analyzes exports of medical supplies as a percentage of Costa Rica's total exports during the 2000-2018 period. In the year 2000, the medical supplies sector contributed a modest US$ 3.19 million to the country through exports. By 2018, the sector's participation in Costa Rica's total exports had grown impressively, reaching 26.62%. The medical supplies sector is now Costa Rica's main exporting sector, and its participation in the economy is expected to continue increasing in the years ahead.

As a result of the incentives provided by Law No. 7210, as well as Costa Rica's locational, human capital, political and economic advantages, El Coyol SEZ began operating in 2007 in an area spanning 107 hectares in the province of Alajuela, Costa Rica (https://www.cinde.org/en/incentives/manufacturing-parks/coyol-free-zone-business-park). The SEZ began recruiting companies from the life sciences and advanced manufacturing industries, and Hollogic was the first to join, serving as an "anchor tenant" (https://www.cinde.org). El Coyol SEZ now hosts 24 MTN firms specializing in the advanced manufacturing of medical devices as well as research and development in this field. This SEZ is strategically located at a distance of 11 kilometers from Costa Rica's main international airport, and is only 56 kilometers away from the most important Pacific port.

As of December 2018, El Coyol SEZ produced and exported 63% of the total amount of medical devices produced in the country. This represents 1.2% of Costa Rica's Gross National Product (Revista Summa, May 8, 2019). The SEZ has also tripled its contribution to exports of medical devices, from "US$ 578 million in 2014" (Revista Summa, March 21, 2018) to "US$ 1976 million in 2018" (Revista Summa, May 8, 2019). In just 4 years, this single SEZ has increased its exports by 241.86%.

El Coyol SEZ employs more than 13,000 people, focusing on hiring talented personnel who have received higher education, which is one of the requirements within the life sciences and advanced manufacturing sector. The following graph illustrates the general employment trend in this SEZ:



Source: By author with data from Anuarios Estadísticos, Procomer, 2008-2017.

The employment outlook for the near future is very positive, given that El Coyol SEZ is currently at 60% of its hosting capacity. In 2018, SEZs in Costa Rica employed a total of

106,707 persons; El Coyol SEZ in particular employed 13,000 persons as of late 2018, accounting for approximately 12% of the total number of jobs generated by SEZs in Costa Rica.

5. Econometric Model

Two main research questions are tested by this study:

1.Do the relational and cognitive networks comprising local universities and MTN medical device firms, developed in El Coyol SEZ (Alajuela, Costa Rica), provide MTN medical device firms with a motivation to establish a harmonious and sustainable business relationship with the host territory and country?

2. Do the relational and cognitive networks comprising local universities and MTN medical device firms, developed in El Coyol SEZ (Alajuela, Costa Rica), provide MTN medical device firms with a motivation to create knowledge?

For the first research question, the following logistic econometric model is proposed:

$$\boldsymbol{L_{i-rel} = \ln \frac{Pi}{1-Pi} = \alpha + \beta X_1 + \beta X_2 + \beta X_3 + \beta X_4 + u_i,}$$

The model comprises the following variables:

L_{i-rel}: Is interaction with local universities key for a sustainable relationship with the territory?

X_1: Years participating in job fairs organized by local universities.

X_2: Years collaborating with local universities through internships.

X_3: Number of research initiatives undertaken with local universities since the start of operations.

X_4: Years coordinating with employment offices that have ties to local universities.

Binary logistic regression is based on having a dichotomous dependent variable, $\boldsymbol{L_{i-rel}}$; this conditional probability that $Y_i = 1$ is a non-linear function of the continuous explanatory variables. The basic idea behind this first version of the logistic model is predicting whether the interaction ($\boldsymbol{L_{i-rel} = 1}$) or lack thereof ($\boldsymbol{L_{i-rel} = 0}$) with local universities is key in order for the cluster of MTN medical supplies firms to achieve a sustainable relationship with the host territory. The following explanatory variables are included in the model: 1. number of years during which the MTN firms in this cluster have been participating in job fairs organized by local universities (X_1); 2. the amount of time, measured in years (X_2), during which the MTN medical supplies firms have been collaborating with local universities through internships; 3. the number of research initiatives (X_3) that have been undertaken with local universities since the start of operations of the medical supplies firms in El Coyol SEZ; and 4. the amount of time, measured in years (X_4), coordinating with employment offices that have ties to local universities.

For this purpose, we can analyze the likelihood ratio (LR) chi-square test, which basically tests whether the model containing our predictors represents a significant improvement in fit over a null model with no predictors (i.e. a model with only the

constant). In this particular case, this LR-chi-square test has 4 degrees of freedom and a table value (with a 0.05 margin of error) of 9.488. The computed value of LR-chi-square needs to be greater than the table value of 9.488 in order to be statistically significant. The specified model would be significantly better at predicting $\boldsymbol{L_{i-rel}}$ than a model without the predictors X_1, X_2, X_3 and X_4. Additionally, the p-value obtained should be less than 0.05 in order for the specified model to be statistically significant as well.

Once the LR-chi-square test and the p-value are calculated, and the model utilized demonstrates that the model that includes $\boldsymbol{L_{i-rel}}$ fits the data statistically and significantly better than the model without it, then each odds ratio can be interpreted. A one-unit change in the predictor variable L_{i-rel} will enable the odds ratio to achieve an expected change, with all other variables in the model held constant.

For the second research question, a second logistic econometric model is proposed, as follows:

$$\boldsymbol{L_{i-know} = \ln \frac{Pi}{1-Pi} = \alpha + \beta X_1 + \beta X_2 + \beta X_3 + \beta X_4 + u_i,}$$

The model is composed of the following binary dependent variable:

$\boldsymbol{L_{i-know}}$**:** This represents the interaction between MTN medical device firms in El Coyol SEZ and local universities, which is key for knowledge creation. The explanatory variables, X_1, X_2, X_3 and X_4, are the same ones utilized in the first logistic econometric model.

The criteria utilized to determine whether the model is statistically significant are the same as in the first logistic econometric model with the LR-chi-square test, the p-value, and the subsequent analysis of each odds ratio.

The following chart presents the results of the binary logistic regressions:

6. Analysis of the Econometric Results

Table:2

Model 1 results		**Interpretation**	**Model 2 results**		**Interpretation**
Binary variables			**Binary variables**		
$\boldsymbol{L_{i-rel}}$			$\boldsymbol{L_{i-know}}$		
$\boldsymbol{X_1}$ **- Odds ratio**	1.4747	A one-unit change in the predictor variable L_{i-rel} changes the odds ratio of X_1 by 1.4747	$\boldsymbol{X_1}$ **- Odds ratio**	1.1476	A one-unit change in the predictor variable L_{i-know} changes the odds ratio of X_1 by 1.1476
$\boldsymbol{X_2}$ **- Odds ratio**	7.8027	A one-unit change in the predictor variable L_{i-rel} changes the odds ratio of X_1 by 7.8027	$\boldsymbol{X_2}$ **- Odds ratio**	3.0704	A one-unit change in the predictor variable L_{i-know} changes the odds ratio of X_1 by 3.0704

X_3 - Odds ratio	1.7291	A one-unit change in the predictor variable L_{i-rel} changes the odds ratio of X_1 by 1.7291	**X_3 - Odds ratio**	0.3060	A one-unit change in the predictor variable L_{i-know} changes the odds ratio of X_1 by 0.3060
X_4 - Odds ratio	2.1313	A one-unit change in the predictor variable L_{i-rel} changes the odds ratio of X_1 by 2.1313	**X_4 - Odds ratio**	4.7554	A one-unit change in the predictor variable L_{i-know} changes the odds ratio of X_1 by 4.7554
Chi-square for model	0.0369	Model is statistically significant	**Chi-square for model**	0.0071	Model is statistically significant
Likelihood ratio chi-square	10.22	Model is statistically significant	**Likelihood ratio chi-square**	14.05	Model is statistically significant
Number of observations	20		**Number of observations**	20	

Source: By author with data obtained from questionnaires (March-April 2019)

Based on the results presented above, it is possible to conclude that both binary logistic regressions have statistically significant models, given that both the LR-chi-square test and the p-value meet the abovementioned criteria. This means that both models contain our predictors and represent a significant improvement in fit over a null model with no predictors. In the case of the first logistic regression (binary variable $\boldsymbol{L_{i-rel}}$), the LR-chi-square test obtains a value of 10.22, which is greater than the table value for 4 degrees of freedom and a margin of error of 0.05, which is 9.488. Additionally, in the case of the second logistic regression (binary variable $\boldsymbol{L_{i-know}}$), the LR-chi-square test obtains a value of 14.05. This is obviously greater than the previously mentioned table value of 9.488.

Given the fact that both models have proven to be statistically significant, it is possible to continue with the analysis by interpreting the odds ratio results.

For the first logistic regression model, the highest odds ratio is 7.8027 (predictor variable X_2). This means that the odds of MTN medical device firms having a harmonious and sustainable business relationship with the host territory increase by 7.8 times with every one-year increase in collaboration between MTN medical firms and local universities through internships, provided that all of the other variables in the model remain constant.

The first model also tests whether the MTN medical device firms can establish a harmonious and sustainable business relationship with the host territory by examining the effect of a one-year increase in coordination with employment offices that have ties to local universities (predictor variable X_4). This increases the odds of MTN medical device firms achieving a harmonious and sustainable business relationship with the host territory by 2.13 times.

The effect of two other predictor variables on the odds ratio for a harmonious and sustainable business relationship between the host territory and the MTN medical device firms is also examined; those variables are the number of research initiatives undertaken with local universities since the start of operations (predictor variable X_3), and the number of years participating in job fairs organized by local universities (predictor variable X_1). In the case of the first variable, an increase of one research initiative undertaken with a local university increases the odds of MTN medical device firms establishing a harmonious and sustainable business relationship with the host territory by 1.72 times. In the case of the second variable, an increase of one year of participation in job fairs organized by local universities, increases the odds of MTN medical device firms establishing a harmonious and sustainable business relationship with the host territory by 1.47 times.

Based on the results of the first logistic regression model, it is possible to assert that El Coyol SEZ and its MTN medical device firms, together with local universities, have constructed a 'knowledge' relational network that has driven the development of a spatial geometry based on their "associations and interconnections" (Yeung, p. 46). This relational network contributes to the achievement of a harmonious and sustainable business relationship with the host territory (El Coyol, Alajuela and Costa Rica) through "actor-specific practice" and action (Yeung, p. 44), such as commitment on the part of the MTN medical device firms to collaborate with local universities through internships, relations with employment offices, and, to a lesser extent, research initiatives and job fairs.

In the case of the second logistic regression model, the highest odds ratio is 4.77 (predictor variable X_4)**.** This means that the odds of MTN medical device firms creating knowledge in the host territory as a result of their interaction with local universities, increases by 4.77 times with every one-year increase in coordination with employment offices that have ties to local universities.

The second model also tests whether the MTN medical device firms are motivated to create knowledge in the host territory by analyzing the effect of one additional year of collaboration with local universities through internships (predictor variable X_2). In this regard, a one-year increase in this type of interaction with local universities increases the odds of the firms becoming motivated to create knowledge in the host territory by 3.07 times.

Two other predictor variables are taken into account to determine their effect on the odds ratio of creating knowledge in the host territory as a result of interaction with local universities: the number of years participating in job fairs organized by local universities (predictor variable X_1), and the number of research initiatives undertaken with local universities since the start of operations (predictor variable X_3). For each additional year participating in job fairs organized by local universities, the odds of MTN medical firms becoming motivated to create knowledge in the host territory as a result of interaction with local universities increases by 1.14 times. Conversely, for each additional research initiative undertaken with local universities since the start of operations, the odds of MTN medical firms becoming motivated to create knowledge in the host territory as a result of interaction with local universities decreases by 0.30 times.

Based on the findings yielded by the second logistic regression model, as well as the intellectual contributions provided by Rullani's (Bathelt and Glucker, 2003) cognitive engine, it is possible to assert that, together with the local universities, El Coyol SEZ and its MTN medical device firms have formed a 'knowledge' and 'learning' business cluster that has provided motivation to create knowledge and innovation. This relational network comprises a series of practices and actions that have shaped its institutional framework. As demonstrated by the results of the second regression model, the action-specific practices and actions that have contributed to the creation of knowledge and innovation are the different forms of collaboration between MTN medical producers and local universities, namely through employment offices, internships, and, to a lesser extent, job fairs and research initiatives.

7. Conclusion

El Coyol SEZ in Alajuela, Costa Rica, is contributing significantly to the Costa Rican economy and labor market. It has become an iconic representation of specialized industrial clusters comprising MTN medical device firms in the country. This raises interesting questions which this study has aimed to address, particularly regarding the ways in which a 'knowledge' relational network made up of local universities and MTN medical device firms could be contributing to the establishment of a harmonious and sustainable relationship with the host territory, as well as the ways in which this relational network is contributing to the creation of knowledge and innovation as a result of its interconnections and relationality.

These questions are answered by two binary logistic regression models, which result in two statistically significant models. The first logistic regression model with a binary dependent variable assesses whether the MTN medical device firms have achieved a harmonious and sustainable relationship with the host country. The results allow for concluding that interaction between the medical device firms and local universities via specific actors' actions and practices, such as collaboration through internships and coordination with employment offices, contribute to a greater probability in this regard. This, in turn, undoubtedly contributes to the achievement of outcomes and results on behalf of the host territory.

The second logistic regression model with a binary dependent variable assesses whether MTN medical device firms are motivated to create knowledge and innovation. Based on the results, it is possible to conclude that interaction between the medical device firms and local universities, through coordination with employment offices and collaboration through internships, has served as motivation in this sense.

These results allow for encouraging El Coyol SEZ and other SEZs in Costa Rica to develop 'knowledge' relational networks that can not only foster harmonious and sustainable business relations with organizations and actors in the host territory, but also accelerate the creation of knowledge and innovation. Not only does this yield benefits for specific network actors, but it also enhances the overall development of the host territory.

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