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Logistics cluster dynamics and firm evolution: a study of the impact of institutional change on clusters and individual firm behaviour

Marie-Laure Baron *† [1], Hamdi Radhoui * ‡ [2]

[1] Normandie Univ, UNIROUEN, UNICAEN, UNIHAVRE, NIMEC, 76 600 Le Havre, France – Université Le Havre Normandie, France., EA NIMEC – 25, rue Philippe Lebon, 76 600 Le Havre, France
[2] Normandie Univ, UNIROUEN, UNICAEN, UNIHAVRE, NIMEC, 76 600 Le Havre, France – Université Le Havre Normandie, France., Normandie Univ, UNIROUEN, UNICAEN, UNIHAVRE, NIMEC – 25, rue Philippe Lebon, 76 600 Le Havre, France

ABSTRACT

Logistics clusters have recently become the object of greater attention (Sheffi, 2013, Rivera et al. 2014). They are however often studied under an economic perspective. We propose to adapt a more managerial view by considering firm strategies, and therefore cluster evolution, as intertwined in the context of change.

Purpose: The purpose of this paper is to investigate the transformation of firms and clusters under environmental change.

Method: We study 3 logistics clusters located within a new logistics corridor. We use data related to the events declared by firms, the collection ranges over 11 years, from 2008 when the corridor was announced up to 2019. We use cluster analysis to describe our sample of clusters and identify evolutions throughout the development of the corridor.

Results: Our results show clusters along the corridor specialize in different activities and that the edification increases specialization.

Theoretical contribution: This paper contributes to the growing literature on logistics clusters by highlighting how logistics corridor building affects clusters and individual firms. To the general literature on clusters, it also contributes to knowledge on complex systems composed of multiple clusters.

Managerial contribution: European and national authorities alike promote Logistics corridors. However, there is a debate about the ability of authorities to interfere within business activities to generate growth. By giving indications on how the corridor edification affects logistics clusters and businesses, we help public and private managers to adapt their decisions in

*Speaker
†Corresponding author: marie-laure.baron@univ-lehavre.fr
‡Corresponding author: hamdiradhoui2@gmail.com

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Logistics has become a key industrial sector within the global industrial organizations. As partners or subcontractors, logistics firms, whatever the environmental conditions, provide for transport, warehousing, planning operations and adequate service such as on time delivery. They therefore add value to multiple sectors' supply chains, and improve competitiveness (Rivera et al., 2014), notably in worldwide trade (Rodrigue and Hesse, 2006). They also account for a substantial number of jobs. It is therefore useful to understand how logistics firms evolve and adapt to ongoing market conditions.

A remarkable feature of logistics activities is that they often agglomerate close to large cities, within ports and airports. As these geographical agglomerations combine a variety of firms, institutions and activities, they have been analysed as clusters. "*Logistics clusters are communities of companies that come together to share logistics expertise and know how*" (Sheffi, 2012). The construct of clusters implies that firm and institutional interactions provide mutual benefits such as scale economies and spillovers (Porter, 2003). Clusters are also embedded in an institutional environment and firms and institutions co-evolve (Boschma and Frenken, 2011). The outcome of industrial organization is then the result of a combination of institutional interference and firm responsiveness to new market conditions.

This view is consistent with that of organization ecology where organizations, populations of organizations (industry, cluster level) and their environments (i.e. institutional change) are interdependent outcomes. Organizations co-evolve with changes in the organizational population and in the environment. Thus, change appreciation should be conducted at multiple levels to capture the changes at the organizational, industry and global level. Moreover, capturing an evolution calls for studying organizations over time (McKelvey, 1999) within a historical context (Stinchcombe 1965).

In this paper, we investigate the co-evolution of logistics firms and logistics clusters as linked to institutional change. We study the case of the conscious corridor building process in France along the river Seine, between Le Havre and Paris and the advent of Haropa. We examine the evolution of two logistics clusters over eleven years within the environmental change brought by the European and national public policies of framing a more integrated and larger logistics system. We therefore contribute to the understanding

of logistics clusters evolution under institutional change. From a managerial point of view, our work adds to the knowledge related to logistics firms' strategies and adaptation, as well as to logistics clusters' evolution. It thus contributes to guide public and private managers involved in such institutional changes.

1. LOGISTICS CLUSTER AND INSTITUTIONAL CHANGE

While ports and the maritime industry are often regarded as clusters (Klink and de Langen 2001, De Langen, 2002, 2004, Lazzeretti and Capone, 2010, Chang 2011), logistics clusters in general have attracted little attention until recently (Van den Heuvel et al., 2011, Sheffi, 2013). It is noteworthy yet to recognize that, next to the logistics villages in Germany, the distribution parks in Japan or the Logistics platfoms in Spain, many of the logistics clusters proposed in Sheffi (2013) revolve around ports: Singapore, Rotterdam, Antwerp, Venlo, are some examples of logistics clusters. The author also observes one can apprehend clusters at multiple scales. While one may consider Rotterdam as a standalone, it is also as part of the Antwerp-Rotterdam-Duisberg triangle. This highlights the interest of considering clusters within their broader environment.

1.1. Sources of efficiency of logistics clusters

While agglomeration refers to the localization of firms within the same location, Marshall (1881) noted that increased competition due to the agglomeration dynamics led to increasing firm differentiation. Later building on the notion of clusters, Porter (1998) recognizes the benefits of both, agglomeration and complementarity. Though clusters may now be virtual or dislocated, clusters usually refer to the geographical location of firms where proximity plays an essential role in spreading the benefits. Sheffi (2013) argues logistics cluster provide cost and service advantages such as economies of scope, sale, density and frequency of transportation services in and out of the cluster. The concentration of logistics activities and the induced attractiveness of the cluster enables operators to benefit from return freight and balance outgoing with incoming flows, which reduces overall transport costs. Because transport equipment is mainly made of fixed elements, scale and volume also reduce unit costs besides justifying investment in specific infrastructure and large equipment such as the recent ocean carriers. With freight concentration, carriers can offer more direct connections carriers, which again reduces handling costs and waiting times. Due to density, logistics clusters can group small loads

and increase service frequency. Moreover, logistics providers within clusters share assets to improve customer service together (i.e. DHL, Fedex and Kuhne Nagel in Singapoor) as well as trained and specialized workforce. Rivera et al. (2014) note firms share equipment, lease space to each other to deal with freight volume variations, and work together when a contract is moved. Due to the agglomeration and complementarities, clusters can adapt to strategic evolution of firms and ease the provision and evolution of logistics services. The advantages lead to a virtuous circle where key logistics locations tend to develop more than other regions (Van den Heuvel et al., 2011 on the Netherlands, Rivera et al, 2014 in the USA). The performance derived through the clustering process therefore enhances global supply chain performance (Rivera et al. 2014). Competition within the cluster fosters productivity and new business formation (Delgado et al. 2010) which strengthens existing locations.

The location of a logistics cluster is usually dependent on the environment (Keppler, 2010). The initial formation of logistics clusters, before agglomeration economies could perform, rests on the environment: proximity to a port or a specific junction gave birth to the cluster. Transport infrastructure is a decisive driver of logistics clustering, and logistics clusters often have a long history as a specific junction. A modification in the environment may therefore modify the role and function of the logistics cluster. Due to evolving demand or evolving industry locations, initially loosely connected clusters could associate more. Conversely, the involvement of different clusters into a larger logistics cluster induces adaption on the part of cluster members. How then do clusters adapt to on going changes?

1.2. Adaptation within logistics clusters

Though they have their own strategy, firms need to adapt to the external conditions. Relationships with the environment materialize in the resources (sales) procured by the environment and in the nature of the roles and skills needed for the organization to function. A change in the environment thus questions resource acquisition patterns as well as elements related to the role and function of the firm within the new setting.

Recurring to the ecological metaphor, Hannan and Freeman (1977, 1984) show that when firms face environmental change, surviving firms are the best adapted to the new environment. In the organization field, March (1991) or Lewin et al. (1999) sustain strategic and organization adaptations coevolve with institutional change in the environment. New organizational forms mutate and emerge from the existing population

of organizations (Lewin et *al*., 1999). In reference to species' behaviour, firms faced with change and seeking to adapt may either rely on old certainties and exploit the existing niche or explore new ideas and knowledge to find new alternatives (March, 1991). Exploitation of existing capabilities involves rationalizing and reducing cost. Adaptation and performance over time rely on a balance between exploitation behaviour that guarantees current revenue and exploration that provides for the future. Adaptation patterns are framed in the firm's legacy, i.e. core competencies and established relationships with customers or suppliers. Legacy is a firm characteristic, but also an industry characteristic. In our context, firm adaptation to change may depend on the cluster it belongs to (location). In their studies of cluster evolutions, geographers argue the evolution process is not only path-dependent, but also place-dependent (Martin and Sunley, 2006, Boschma and Frenken, 2011). The history of the logistic cluster, its location relative to others (spatial location matters) and its specialization may then affect the ability of firms to adapt and path dependency may be strong. Moreover, the exploratory behaviour may be hindered by high competition or the availability of slack resources. Recent work shows new transport infrastructure induces accessibility and growth. Enhanced accessibility may attract more industry within a given region (Hong, 2007), but accessibility also attracts more logistics businesses (Bowen, 2008, van den Heuvel et al. 2014). The edification of a logistics corridor could therefore attract new industry and new logistics players, which means more competition. Adaptation to new circumstances may rather call for an exploitation of existing niches to fight incoming competitors exploring opportunities.

1.3. Edification of a transport corridor and evolution of logistics clusters

The Trans-European Transport Network (TEN-T) defined in 2013 comprises 9 transport corridors that are designed to become the core European network enabling fast and efficient (green, fast, cheap) mobility across Europe. The EU supports the plan by dedicating specific infrastructure investments to these corridors notably to increase the share of multimodal transport. The aim of providing fast and efficient transport within the corridors require a better articulation and combination of operation process. They also involve behaviours to shift to new transport modes. On the other hand, investments and improved efficiency should attract growing flows and possibly new competitors. As noted by Rothengatter et al. (2016), the majority of logistics costs are controlled by private actors and the majority of innovations in logistics take place outside pure transportation

technologies. The success of transport corridors then partially relies on how firms adapt to evolving market conditions, which is consistent with views that qualify institutional involvement into clusters. From our literature review, the logistics corridor is to become a cluster comprised of several former existing clusters. New conditions should lead firms and clusters to adapt.

In this context, we study the evolution of two clusters that occupy different positions and functions within the logistics corridor to analyse the changes observed. We analyse the changes over 11 years. A first comment on these changes is that firm and cluster adaptation partially depend on available slack resources and on absorptive capacities. Moreover, the decision to set up a corridor does not immediately translate into change. Therefore, firm and cluster adaptation do not occur simultaneously after the corridor edification is decided.

H1: Logistics cluster adaptation is a gradual process and changes do not occur immediately.

Logistics clusters within the corridor occupy different functions. The corridor edification indeed involves two functions. One is concerned with moving massive quantities of merchandise fast, while the other function relates more to distributing local flows. The literature review suggests clusters located differently evolve differently. Evolution of clusters as well as of firms within these clusters are path dependent and rely on location as well as on former core competencies. Firms Within the supply chain, along the corridor that occupy different functions in the supply chain may either change focus or exploit their position deeper. Clusters that are located at one end of the corridor and receive massive quantities of merchandise should specialize in managing those massive flows. Conversely, clusters that are located in an intermediary position within the cluster may lose control over massive flows and dedicate more to breaking-up and redistributing local flows. Thus, logistics clusters located at one end of the corridor would tend to specialize (exploit) while intermediary clusters would need to diversify more (explore). This is consistent with the idea that the prospect of setting hands on the merchandise should attract more competitors at the end of the corridor in the activities that enable to take control. While complementary activities favour growth and innovation (Delgado et al., 2010), in a logistics corridor, complementarity may be understood at another level, as the complementarity between distinct clusters that are specialized.

H2: Logistics clusters located differently have a different role within the corridor.

H3: Different logistics clusters thus involve different individual and collective behaviour.

There is an ongoing debate on the ability of public authorities to infuse synergies within clusters and to interfere efficiently. However, a concern with the edification of a logistics corridor is that increased flows, perceived attractiveness and incoming investment, invite new competitors exploring business opportunities. Competitive pressure may in turn stimulate cluster development but induce an exploitation behaviour with a focus on performance among existing firms to offset the strained environment. Low barriers to entry in some activities such as medium or long haul road transport, local transport activities and non-asset based activities such as freight forwarding could favour the entry of new competitors

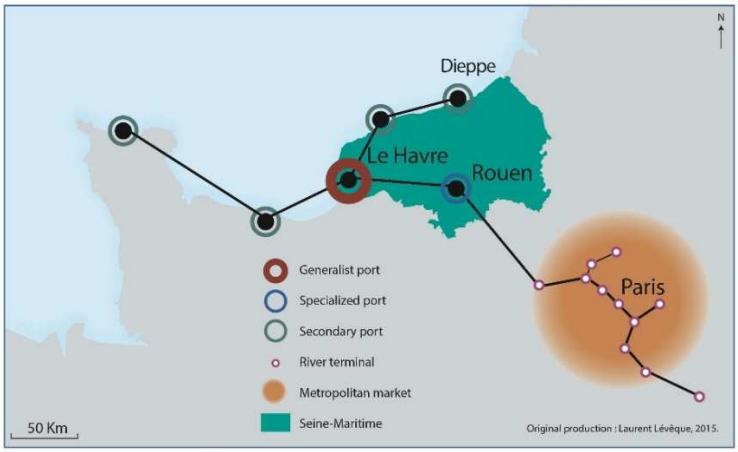
H4: increased competition (exploration from newcomers) within the corridor promotes an exploitation behaviour within existing logistics clusters.

2. SETTING & METHODOLOGY

The part of the Atlantic Corridor we investigate links the world with maritime ports of Le Havre and Rouen, which is a maritime and inland port, and Paris. The portion of the European transport network considered is often included as part of the plan of making Paris a key node in the global economy, a world city. While the inclusion within the TEN-T dates from 2013, the specific plan of linking Le Havre more efficiently to Paris in the Seine valley dates from 2008 and was sponsored by government involvement. The successive arrangements made included port reform (2008, but final implementation was in 2012) and the progressive integration of the ports of Le Havre, Rouen and Paris in a move to more efficient resource coordination and planning. Besides these very visible changes, of course, many forces are at work to reach for economic, social as well as environmental efficiency.

Le Havre is the second seaport in France and pertains to the North range with competitors like Antwerp, Rotterdam or Hamburg. The port deals with a large variety of goods, but it is number one in France for containerized goods. Its hinterland is wide but notably includes the metropolis of Paris, which has its own river port with several terminals (Genevilliers being the largest). Rouen, though inland, is also a Maritime Port but it is more specialized and mostly dedicated to cereals. Rouen holds an intermediary position

within the corridor. Within a regional metropolis closer to Paris, the local logistics cluster could dedicate to local delivery and final allocation. Finally, our sample includes the smaller seaport of Dieppe, which offers ferry services to Britain for freight and passengers and some industries that have nurtured the development of a smaller logistics cluster.



Graph 1: The Seine valley logistics corridor

Our three ports therefore start differently within the corridor and offer diversified and complementary profiles that should explain variations in evolution patterns. They are all included in our study as three distinct logistics clusters.

1.1.Data and organization

To test our assumptions, we used a set of data from the official bulletin that gathers legal commercial announcements for all major changes in a business (BODACC). Events reported relate to changes in capital, social form, name, activity, address, firm creations, firm dissolutions, changes in management, the lease of the company, mergers. We collected data related to the Seine Maritime area, which includes the ports of Dieppe, Le Havre and Rouen. This study did not include Paris and therefore only one end of the corridor is considered (the port of Le Havre). We retained all declared and registered events by local firms from September 2008 to September 2019, as long as they concerned a firm in the logistics sector. Indeed, officials announced the political decision of integrating the Seine Axis in 2008. After cleaning up the database from irrelevant items and duplicates. A total of 1944 events were taken into account over the 11 years. The number of firms that provide these events was of 502 in 2008 and 918 in 2018, most of which were located in Le Havre and Rouen. The events were initially only listed

depending on the firm location (village, town) and we grouped them around our three areas according to the administrative organization (arrondissement).

	Major area	**Le Havre**		**Rouen**	
Activity Sector	**Year**	**2012**	**2015**	**2012**	**2015**
Chartering & transport organization(freight forwarding)		94	107	28	27
Port and Maritime function		44	54	26	28
Inland Transportation *Of which local transport*		107 *41*	103 *39*	195 *102*	161 *97*
Warehousing		30	36	9	10
TOTAL		275	300	258	226

Table 1: Number of firms in Le Havre and Rouen per major functions identified in 2012 and 2015 (Source: Insee).

Land Logistics	Port and Maritime Logistics	Freight forwarding	Warehousing
Rail freight transport Inter-city freight road transport Proximity road freight transport Rental of trucks with driver Transport by pipeline Auxiliary services for land transp. Express freight Truck rental and leasing	Sea and coastal freight transport River freight transport Auxiliary Services for water transport Port handling Equipment hire. & lease Water transport	chartering & transport organization	warehousing and refrigerated storage warehousing and non-refrigerated storage non-port handling Packing and conditioning activities

Table 2: Classification of activities within logistics functions

Looking into the period we studied, environmental aspects were important: the 2008 crisis must influence behaviour and induce more defensive reactions than ordinarily expected. In order to verify **H1** and to select a relevant split when change begun to be felt, we split

the data into two sets with one period ranging from 2008 to 2013 and another period starting in 2014 to 2019 that we expected to be, more representative of the corridor dynamics. In the first period, we expected firms burdened by the economic changes and port reform would not have the slack resources and absorptive capacities to get involved in the corridor. Therefore, though we date the corridor edification from 2008, we expect proper corridor dynamics only to begin by 2014. The data was organized according to the sector of activity declared by the firm. The official classification (National Institute of statistics, INSEE) involved many different sectors, which we grouped into 4 major functions: land logistics (mainly long/medium haul road carriage, local road transport), Port and maritime activities (terminal operators, shipping agents), chartering and transport organization (freight forwarders) and packaging and storing activities (warehousing). Table 2 gives relevant information on the classification used. For investigation purposes, and to identify cluster specializations, we further distinguished local transport from medium/long haul transport.

Table 1 synthetizes the way we grouped the data relative to firm density per major function in Le Havre and Rouen. It shows how both clusters feature specific and complementary characteristics. Le Havre is logically more specialized in the maritime business, while Rouen, the major city and metropolis is more involved in city/local logistics. Finally, we analysed the various events in detail to understand how and why they happened. This allowed us to interpret and classify our data so that it would reveal cluster/activity growth, cluster and firm adaptation, predation by incoming firms or business conditions and available resources.

For example, during the period observed, many companies adopted a simplified joint stock legal form (SAS, SASU). Such forms facilitate entrepreneurship (Azarian, 2017) but also provide for uncertainty management (Cartier and Mayrhofer, 2007). We therefore classified such changes as well as capital changes as “governing” which is relatively neutral in our setting. In academic literature, key determinants of management turnover are environmental-lack of munificence, instability, and complexity (Wieserma and Bantel, 1993). Instability in the environment also induces strategic change, which, in turn, provokes management turnover. One of the main instruments used in corporate governance to boost poor performance is CEO change (Dardour et al, Jenter and Kanaan, 2015). A complex and changing environment might induce manager changes. However, the logistics sector comprises mainly family firms and former research shows CEO

turnover in family firms does not necessarily link to performance. Family CEOs can extend their mandate even when performance dwindles and family shareholders prefer to secure a CEO that defends family interests (Dardour at al., 2018). We classified this change as "governing" too. Changes such as firm creation were classified as "development", and we noted miscellaneous events were declared when business was fine, as if then, managers had time to deal with them. Auditors are responsible for controlling the reliability and integrity of financial information. However, audits are mainly conducted (declared) in stable periods and are associated with growth. Market exists were a signal of selection by the environment and were classified in "disappearance" to reveal difficulties in given activities. Change in head quarters' address linked in our sample to shrinking business: when scrutinizing the events one by one and linking them to firm history, we observed head quarter offices were closed, and moved to other formerly existing premises (i.e. warehouse premises), in an attempt to reduce costs. We therefore considered address change as well as activity change were a form of adaptation to ongoing change. While address change reflects an effort to rationalize (exploitation), activity change reveals a more exploratory behaviour. Finally, mergers and company leases revealed new competition. to a type of adaptive strategy.

Abreviation	Definition	Developt	Adaptab.	Governing	Disapp.	Predation
BusCr	Business creation	X				
LfSc	Legal form and capital share			X		
HqAd	Head quarter's address		X			
DENO	Denomination			X		
Coact	Cessation of activity				X	
Mer	Merger of companies					X
MvAc	Change in activity		X			
MiAm	Miscellaneous amendments	X				
Man	Management change			X		
Leas	Leases					X
Aud	Auditors (change of)	X				

Table 3: Events and classification of events

The classification of events in development (growth), adaptability, governing, disappearance and predation categories (Table 3), along with the evolution in firm numbers and events enabled us to capture the transformations within our three clusters. Table 4 presents how the events were assigned

1.2.Using tree analysis and clustering to explain event generation

We try to understand how logistics firms and logistics clusters evolve in a changing environment. Events reveal behavioural changes as linked to the perception of ongoing changes along the corridor. The building of the corridor should induce increased traffic, more specifically at the port level. Indeed, the number of events in the logistics sector in the area investigated was significantly correlated to port activity measured by volume handled and heading for the hinterland. The correlation observed was higher for typical port activities but was also observed for land logistics.

With the data set organized, we used a qualitative methodology. We employed cluster analysis in SPSS (CHAID) to help us interpret the data. Clustering techniques "*group the objects into a number of classes, such that objects within classes are similar in some respect, and unlike those from other classes*" (Everitt, 1974). Hierarchical clustering is often used as an exploration technique as well as an alternative to multiple regression, especially when the dataset is not perfectly suited for regression analysis. Hierarchical cluster analysis starts from the raw data, to group similar objects into clusters: n objects Xi that are vowed to be grouped, are subsequently partitioned in 1 to n clusters (divisive method) or the other way round (agglomerative method). In the divisive method we used, at least one cluster is subdivided into two new clusters. The distance measured between the various characteristics of the events allow us to perform the grouping.

Resolution method: Chi-square Automatic Interaction Detector (CHAID)

It was a technique created by Gordon V. Kass in 1980. CHAID is a tool used to discover the relationship between variables. CHAID analysis builds a predictive model, or tree, to help determine how variables best merge to explain the outcome in the given dependent variable. In CHAID analysis, nominal, ordinal, and continuous data can be used, where continuous predictors are split into categories with approximately equal number of observations. CHAID creates all possible cross tabulations for each categorical predictor until the best outcome is achieved and no further splitting can be performed. In the

CHAID technique, we can visually see the relationships between the split variables and the associated related factor within the tree. The development of the decision, or classification tree, starts with identifying the target variable or dependent variable, the root. CHAID analysis splits the target into two or more categories that are called the initial, or parent nodes, and then the nodes are split using statistical algorithms into child nodes. Unlike in regression analysis, the CHAID technique does not require the data to be normally distributed.

Merging: In CHAID analysis, if the dependent variable is continuous, the F test is used and if the dependent variable is categorical, the chi-square test is used. Each pair of predictor categories are assessed to determine what is least significantly different with respect to the dependent variable. Due to these steps of merging, a Bonferroni adjusted p-value is calculated for the merged cross tabulation.

Decision tree components in CHAID analysis

In CHAID analysis, the following are the components of the decision tree:

- Root node: Root node contains the dependent, or target, variable.
- Parent's node: The algorithm splits the target variable into two or more categories. These categories are called parent node or initial node.
- Child node: Independent variable categories which come below the parent's categories in the CHAID analysis tree are called the child node.
- Terminal node: The last categories of the CHAID analysis tree are called the terminal node. In the CHAID analysis tree, the category that is a major influence on the dependent variable comes first and the less important category comes last.

According to (Ritchard. G, 2013), this method was initially used (1980) only with a categorical dependent variable. It is nevertheless most often implemented with an option for handling also quantitative dependent variables. CHAID introduced by Kass (1980) is nowadays the most popular classification technique (Ritchard, 2013). The main characteristics of CHAID that contributed to its popularity are:1) At each node, CHAID determines for each potential predictor the optimal n-ary split it would produce, and selects the predictor on the basis of these optimal splits. 2) It uses p-values with a Bonferroni correction as splitting criteria.

Illustrative data

We consider the data of the 1944 events that took place between 2008 and 2019 in Seine Maritime. The data will be used to find out how businesses in each logistics cluster (1.Le Havre, 2.Rouen, 3.Dieppe) of each sector of activity behave in a corridor development. The response variable is thus the category of events (1. Adaptability, 2. Development, 3. Disappearance, 4. Governing, 5. Predation). The predictors retained are geographical zone, Sector of activity of each business (1. Land. Log, 2. Port and Maritime.Log, 3. Freight forwarding, 4. Warehousing), and Period of decision. We divided the period between 2008 and 2019 into two: period of the economic crisis and the after crisis period (1. OnPeriod, 2. OutOfPeriod). Although in our dataset the 2008 economic crisis may have delayed the time when firms can appropriate the new context, this split also more generally represents the time between the political decision of investing in the corridor and the time when firms become actually aware of new opportunities and threats.

Operation of the algorithm

Consider the contingency Table 2 between the dependent variable (Category of events) and the geographical zone. The latter predictor has c = 3 categories, namely: Le Havre, Rouen and Dieppe. We would like to look at all possibilities of segmenting the population (events of businesses) by means of these 3 categories. The number of such possibilities is given by the number of ways of splitting into 2 groups, plus the number of ways of splitting into 3 groups, and so on until the one way of splitting into c groups is found.

Table 4. Evolution of firms by Geographical Area

	Le Havre	Rouen	Dieppe	**Total**
Adaptability	231	259	47	537
Development	176	318	50	544
DisappearClosure	66	106	20	192
Governing	281	220	42	543
Predation	59	57	12	128
Total	813	960	171	**1944**

In our case, the predictor is purely nominal: there is no restriction as to how to partition the 3 categories, the total number of ways of partitioning them is known as the number of Bell (B(c)), it is obtained through the recursive formula:

$$\mathcal{B}(c) = \sum_{g=0}^{c-1} \binom{c-1}{g} \mathcal{B}(g)$$

With:

$$\mathcal{B}(c)\ set\ equal\ to\colon \begin{cases} 1 & if\ c = 0 \\ \sum_{g=1}^{c} S(c,\ g) & otherwise \end{cases}$$

where $S\ (c,\ g)$ is the Stirling number of the second kind giving the number of ways of splitting c values into g groups.

Table 5. Characteristics of CHAID algorithm:

Local split	**Dependent variable**	**Splitting criterion**
n-ary	quantitative/categorical	Association/p-value

As a starting parameter, we forced the algorithm to start with the category (geographic area). So we will necessarily find in level 1 of the classification the geographical areas of the Seine Maritime.

E**mpirical correlation :**

	ActivSect	**EventCATGORY**	**GeogrArea**	**PeriodOfDecis**
EventCATGORY	0,153	1,000	-0,047	-0,097

Table 6. The main components

Rotated Component Matrix[a]		
	Component	
	1	**2**
ActivSect	**,785**	,036
Logistics cluster (geogr.area)	**-,738**	,006
DecisPeriod	,131	**-,760**
EventCATG	,162	**,723**
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.		
a. Rotation converged in 3 iterations.		

Besides showing the initial specialization of logistics clusters (component 1) and the correlation of events with the period considered, the component analysis demonstrates CHAID is the corresponding technique to be applied to the data compared to a regression analysis which also requires the data to be normally distributed.

Table 7. Model summary for events in Seine Maritime

Model Summary		
Specifications	Growing Method	CHAID
	Dependent Variable	Eventcategory
	Independent Variables	ActivSect, PeriodOfDecis, GeogrArea
	Maximum Tree Depth	3
	Minimum Cases in Parent Node	100
	Minimum Cases in Child Node	50
Results	Independent Variables Included	GeographicalArea, ActivitySector, PeriodOfDecision
	Number of Nodes	18
	Number of Terminal Nodes	10
	Depth	3

Based on the decision tree generated by the CHAID procedure, geographic area was identified as the first significant segmentation ($p \leq 0.005$). The result shows two opposed segments (Figure 1). On the one hand, there is Le Havre whose major event category was "Governing" along the period from 2008 until 2019, while on the other, a second group exists consists mainly of Rouen and Dieppe where evolution is more of the type "Development". The evaluation of the quality of the clustering model is provided in Table 8.

Figure 1: Results for CHAID analysis (Classification of the Maritime Seine according to evolution of firms)

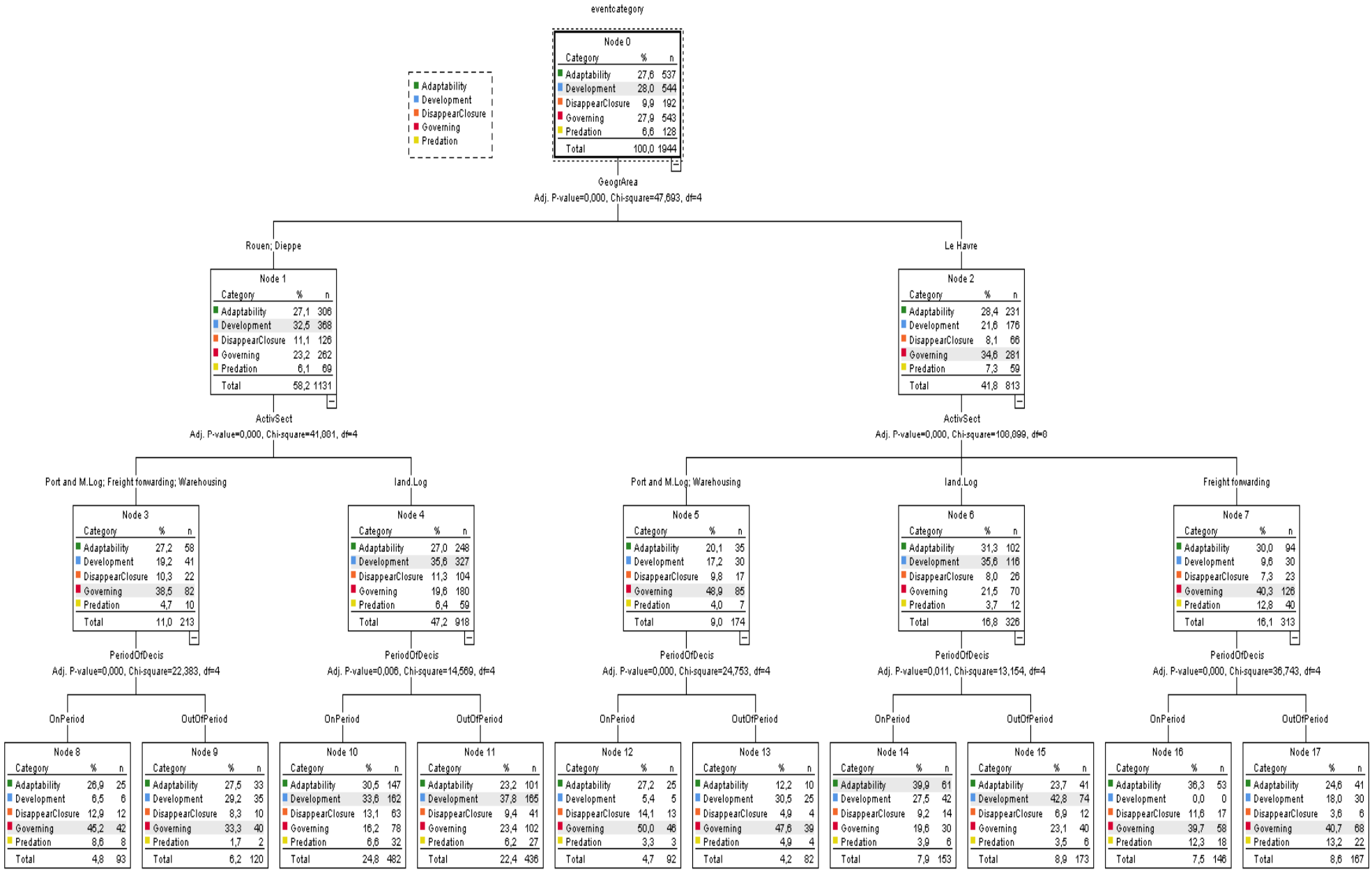


Table 8. Significance of the clustering model

Level	Classes	Chi-square	*p*-value
1	-Le Havre; -Merged {Rouen, Dieppe} ;	119.456	0.000
2	• Le Havre: **Freight forwarding; {Warehousing + Port and Maritime. Log}; Land. Log**	108.899	0.000
	• {Rouen, Dieppe}: **{Freight forwarding + Warehousing + Port and Maritime. Log}; Land. Log**	41.881	0.000
3	• Le Havre: - {Freight forwarding} / **OnPeriod/OutOfPeriod**	36.743	0.000
	- {Warehousing + Port and Maritime. Log} / **OnPeriod/OutOfPeriod**	24.753	0.000
	- {Land. Log} / **OnPeriod/OutOfPeriod**	13.154	0.011
	• Rouen, Dieppe, Bayeux : - {Freight forwarding + Warehousing + Port and Maritime. Log} / **OnPeriod/OutOfPeriod**	22.383	0.000
	- {Land. Log} / **OnPeriod/OutOfPeriod**	14.569	0.006

3. RESULTS AND DISCUSSION ON THE EVOLUTION OF LOGISTICS CLUSTERS ALONG THE NASCENT CORRIDOR

To perform the segmentation of Seine Maritime firms' evolution in order to model their dynamics in a logistics corridor, an analysis based on the CHAID procedure was carried-out. The aim of the research was to define evolution of logistics clusters by capturing firm dynamics. The solution was to find which of the sample's characteristic variables most accurately predict the evolution of logistics clusters in Seine Maritime during the development of a Logistic corridor.

Aside providing answers related to cluster dynamics, our framework gives a good description of the different logistics clusters in Seine Maritime: types of activities deployed, recent evolution, behaviour. Before we go into detail, a glance at the graph produced gives a quick idea of logistics cluster differentiation between Dieppe, Rouen and Le Havre. The complexity of the tree accounting for events in Le Havre testifies to the specificity of firm behaviour in Le Havre, the leading maritime port in the sample. This is true whatever the type of activity. Another general comment relate to the "absorption" of Dieppe by Rouen. This is due to the very specific combination of activities in Le Havre, which make Dieppe and Rouen more alike in our analysis. In our results, Dieppe does not have a place of its own. Another general comment is that warehousing activities, whether in Le Havre or Rouen, mesh with port activities rather than land logistics. This suggests that warehousing businesses in Seine Maritime depend more on the maritime and port business than on other types of flows. Finally, the form of the graph we obtain indicates that activity specificity is more significant that the period considered. Activities within each cluster therefore have an identifiable and differentiated behaviour that is consistent over time and only lightly changes depending on environmental changes.

Our first hypothesis was that firms would not readily adapt to new circumstances, either because they had no slack or absorptive capacities, or because they would wait for commitment by public authorities before they move. Considering the importance of the 2008 economic crisis and port reform, we had considered a split around the year 2014 by separating events before 2014 and after 2014. The split seems to fit Le Havre very well and indicates that **H1 verifies. Firm involvement into new opportunities required time**. The assumption is verified for Rouen and Dieppe, but to a lesser extent as land logistics do not seem to be affected by a before and an after. Events within port and maritime activities or warehousing differ significantly whether before 2014 and after 2014. The significance of the split for port and maritime activities whatever the port indicates that port reform has played a significant role on firm behaviour within these activities.**H1** is therefore verified for Le Havre whatever the activity and for Rouen, only for port and maritime activities. This shows the higher reliance and specialization of the Le Havre logistics cluster on maritime and port activities. In contrast, Rouen and Dieppe prove less dependent and more versatile especially as they offer a great deal of local transport services.

The differences observed in our results reveal logistics clusters of Le Havre and Rouen/Dieppe are significantly different before 2014 and after 2014. We therefore verify **H2: Logistics clusters located differently have a different role within the corridor**. Significant differences relate for instance to the importance of freight forwarding activities that are much more important in Le Havre than in Rouen. This is explained by environmental conditions of being located next to the larger port. Another difference that is not visible on the graph is the importance of local road transport activities (proximity), which are much denser in Rouen than in Le Havre where they are mostly inexistent. Various arguments can explain the importance of local road transport within the logistics cluster in Rouen: first, it was mentioned Rouen was a regional metropolis. It does not however outsize Le Havre that much. Rouen however is located in the intermediary zone along the corridor. Unlike Le Havre, that faces the sea and can only drive to the hinterland, Rouen is in a position to drive in many directions in a relatively short trip. East, West, North or South, Rouen may have a local redistributive function to break-up incoming massive flows. Finally, compared to Le Havre, the relatively less important port and maritime activity contributes to promoting other types of logistics activities such as land logistics activities. Our two main clusters therefore serve different functions within the corridor and are complementary. One is more specialized in transport and warehousing while the other is more fully dedicated to maritime activities.

H3: Different logistics clusters involve different individual and collective behaviour.

It is may be expected that different logistics clusters, combining different varieties of firms behave differently. The logistics cluster in Le Havre cluster is specific due to the density of maritime and port logistics related firms whereas Rouen is more involved in road transport and warehousing. It is therefore reasonable to find that truck companies do not behave like port terminal operators. Our results per category of events indeed show different dynamics in Rouen and Le Havre. They also show some regularities across clusters. For example, all along the period, port and maritime related activities take more governance related and adaptive decisions. This is true in Le Havre and in Rouen, for port maritime activities as well as for freight forwarding activities even though governance decisions are proportionally more important. 38.5% of decisions within maritime activities in Rouen are governance decisions. In Le Havre, they account for 48.9% of all decisions in port & maritime logistics and in warehousing, and 40.3% of all decisions of freight forwarders. Another regularity is the growth of land logistics in both clusters. Land

logistics include local and long haul road transport activities. They developed across the period, though more since 2014. Development accounts for 35.5% of all decisions in land logistics in the Rouen/Dieppe cluster and 35.6% in Le Havre. The adaptive behaviour comes second with 31.3% of decisions in land logistics in Le Havre, and 27% in Rouen. Such activities feature low barriers to entry and easily attract newcomers that eventually later exit the market, particularly in local transport. The relatively high rate of market exits (disappearances) in land logistics reflects this. The context of corridor building and increased traffic may well explain the specific dynamics of land logistics and transport across clusters. Transport activities benefit. The importance of freight forwarding business, which develops into a specific branch in Le Havre's cluster, distinguishes the two logistics clusters. This branch accounts for the diversity of goods handled in Le Havre compared to Rouen. Another difference previously reported relates to the importance of local transport in Rouen (more than 50% of the 918 events) while Le Havre, at one end of the corridor offers essentially medium/long haul transport. Position along the corridor therefore matters. Over the 11 years, in link with the former elements, the logistics cluster in Rouen appears more dynamic (more creations and more market exits) than the Le Havre logistics cluster which is composed of more stable activities but adapts constantly to ongoing changes.

H4: increased competition (exploration from newcomers) within the corridor promotes an exploitation behaviour within existing logistics clusters.

Several authors have argued investment in logistics clusters induces local development (van de Heuvel et *al*., 2014) and we proposed this might generate increased competition. The total number of firms in our logistics sectors was of 502 in 2008 and of 908 by 2018, which means the industry attracted newcomers within the corridor. Most creations took place in Rouen/Dieppe logistics cluster and in land logistics. Our data shows some tensions notably in the Le Havre cluster, and in the freight forwarding activity. Freight forwarders are the business that commands merchandise flows. They are connected with customers and select transport modes to organize on time delivery for their customers. Not only do they have access to customers, but they are located at one end of the corridor and will command imprt/export flows going through the major French container port and through the corridor. Freight forwarders, throughout the period studied, take mostly governance decisions (40.3%) which include decisions regarding capital or legal form. Governance decisions are even more important proportionally after 2014 in this area

(41,7%). The second most important type of decision relates to adaptation (change of address and of activity, 28%). Finally, whatever the period, in our data, this type of business is the most concerned with mergers (12% to 13%). Looking into the mergers, some are local mergers, which indicate consolidation among local players (less creations than in other activities). Others concern newcomers, particularly from Paris, buying out local firms. These elements indicate a higher degree of competition in the logistics cluster of Le Havre, which leads to an exploitation behaviour. Local firms exploit their position in terms of core competencies (dealing with door-to-door international trade) and of specific access to the corridor. Other and new player that explore local opportunities challenge incumbents. A detailed reading of firm behaviour (looking at firm profiles individually) shows firms are consolidating and rationalizing the organization of diversified logistics businesses (freight forwarding, transport, warehousing) into more coherent groups. Some firms also changed names to be more attractive and easy to find. Conversely, in the Rouen/Dieppe cluster, port and maritime activities, freight forwarding and warehousing need to adapt, while competition seems to be greater in transport activities (less growth than in Le Havre, predation). This means local firms will have to concentrate on exploiting their current niche.

Conclusion

Throughout this paper, we have explored the premises of ongoing change within logistics clusters pertaining to a logistics corridor. One of these clusters lies at the opening of the corridor, the other one, though a maritime port lies in the midst of the corridor. Each original cluster differentiates in terms of function within the initial pattern, and these functions and relative specialization reinforce. While the Le Havre cluster reinforces its specialization in maritime activities and merchandise handling by rationalizing, Rouen reinforces its speciality in inland transport and local transport. The edification of the corridor seems to increase specialization and therefore complementarity of the different sub-clusters within the large cluster in creation.

Firms are path dependant on the clusters they belong to and their original location (initial resource that justified the emergence of the cluster). Throughout our data set, we found very few connections between firms of the two clusters, which is consistent with the fact that the two ports have different activities and are complementary. This does not mean there are no relationships, they are just not visible here.

This work has a number of limitations. The most important of all is the type of data we worked on which only enables us to identify stylized facts. This preliminary work would need to be completed with interviews to understand how firms effectively perceive and adapt to the corridor. Another limitation is that firm changes seem to be spontaneous. However group or public actions may be at work to obtain given results. There again, work should be conducted to consolidate our findings and reveal the mechanisms that guide individual transformations.

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