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Logistics clusters: The impact of further agglomeration, training and firm size on collaboration and value added services

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ABSTRACT

Collaboration and the provision of value added services are key benefits for companies located within logistics clusters. We hypothesize that within the context of logistics clusters, further agglomeration within the more defined logistics parks and the availability of training opportunities enhance those benefits. We control for the effect of firm size in the projected relationships and propose that firm size positively impacts the degree of benefits obtained. Based on data from a survey conducted in the Zaragoza (Spain) Logistics Cluster, and using structural equation modeling, we demonstrate that further agglomeration into a logistics park positively impacts collaboration, and more specifically transportation capacity sharing. We also demonstrate that training positively impacts collaboration between cluster residents, both in terms of transportation capacity sharing and resource sharing, as well as the provision of value added services. These causal relationships are the same for big and small firms. Finally, we confirm that larger firms show higher levels of collaboration and value added services. Implications for managers and policy makers are provided.

1. Introduction

The study of industry clusters and their economic impact has been a topic of interest for governments and firms since the work of Marshall (1920) on agglomeration economies. Porter (1998) defined a cluster as "the geographic concentration of interconnected companies in the same industry, which both compete and cooperate". Some examples of clusters can be found in the high tech industry (Silicon Valley), the fashion industry (Macchion et al., 2015), the automotive industry (Morris et al., 2004), and the oil and gas industries (Yusuf et al., 2014). Among the advantages of co-location he identifies increased productivity, new technological and delivery possibilities, easier access to information, ease of new business formation, and benefits rooted in working together with other institutions like universities and public organizations.

Logistics clusters, a specific type of industrial clusters, are defined as the geographical concentration of: (i) firms offering logistics services, (ii) the logistics functions of manufacturers and retailers, and (iii) companies with logistics intensive operations (such as automobile manufactures or bulk commodities distributors) for whom logistics is a large part of the cost (Sheffi, 2012). Logistics clusters constitute a relevant context of analysis because of two key characteristics, as outlined in the following.

First, logistics clusters are relevant because they offer a context for further agglomeration into logistics parks. A logistics park has clearly defined ownership and geographic property boundaries, in contrast to a logistics cluster that is an amorphous agglomeration of companies and facilities with logistics-intensive operations with fuzzy borders and no central management (Sheffi, 2012). A logistics cluster may include one or more logistics parks. Examples of logistics park owners include port authorities, airport authorities, and real estate developers. These entities manage a group of logistics operations located on their property. Logistics parks can be developed and managed by either private or public agencies.

Logistics parks are likely to further facilitate the previously mentioned benefits of clustering, because companies located in parks are more "sticky", in other words closer to each other and that closeness may facilitate interfirm activities, as well as increase the cost of relocation (Appold, 1995; Battezzati and Magnani, 2000). There are only a few publications referring specifically to logistics parks (see for instance Amrani, 2007; Giraldo, 2009; Dai and Yang, 2013; Sako, 2003). These studies are mostly based on interview data, and suggest that logistics parks are an important source of advantages for logistics firms, and more specifically benefits related to collaboration and value added services (VAS).

Second, logistics clusters are relevant because they offer the right conditions for labor market pooling, better access to

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specialized skills, and better on-the-job training (Marshall, 1920). The latter, training, has received few attention, despite its relationship with the firm's ability to arrogate cluster benefits (Enright, 2000). Training involves multiple actors beyond the firm, such as public and private educational institutions and universities. Empirical results on the impact of training so far have been inconclusive. For example, De Langen and Visser (2005) in a study of the Lower Mississippi Port Cluster find consistent evidence suggesting limited training on the job and the absence of public–private partnerships undermine potential benefits of colocation. Nonetheless, there is also evidence pointing to the contrary: training in logistics parks is actually limited because of firm-specific educational requirements (Yamawaki, 2002) and because of the high costs of educating entry-level workers (Power and Lundmark, 2004).

Based on the foregoing, this paper aims to empirically assess the impact of two key cluster characteristics – agglomeration into logistics parks and training – on key benefits related to collaboration and VAS. Such benefits will be further translated to final customers. Customer-oriented postponement and customization activities bring tailored products and services to consumers (Sheffi, 2012). For instance, Hewlett-Packard operates a late customization center at a Netherlands distribution center and the results translated into reduced inventory costs for the company and higher customer service levels, providing language-specific packages and serving country-specific consumer needs throughout Europe (Feitzinger and Lee, 1997). Another valuable example is the Memphis cluster where FedEx is located, which fostered the creation of customer-focused flight patterns and continuous service. This way, FedEx final customers enjoy end-of-the-day pick up and early-in-the-day delivery. Customers benefit from competitive prices for highly efficient services that clustered companies provide (Sheffi, 2012).

An added factor in the assessment of the relationship between cluster characteristics and benefits is company size. Interview data have suggested that the size plays a role in impacting the degree of benefits of clustering. Unfortunately, evidence in the literature on this topic is inconclusive. Some authors claim that clustered large companies enjoy higher benefits (see for instance Reichhart and Holweg, 2008; Nadvi, 1999), while others argue the opposite (i.e. Rabellotti, 1999; Stank and Daugherty, 1997). Larger companies are also more capable of affording workers' training than smaller ones (Power and Lundmark, 2004) and, at the same time, the smaller ones fear more training will incentive workers to leave their jobs for better positions in other companies (Morgan, 2012). Therefore, the second aim of the study is to empirically assess if size matters for the degree of clustering benefits obtained. More precisely, we aim to understand if size impacts the relationship between cluster characteristics and obtained benefits, as well as if size influences the absolute degree of collaboration and the provision of VAS within the logistics cluster.

The study uses data from a survey conducted in the Zaragoza logistics cluster, in Aragon (Spain). Data are analyzed through structural equation modeling, and more precisely (multi-group) confirmatory factor analysis, path diagram analysis, and equivalence tests.

The rest of the paper is organized as follows. Section 2 presents the literature review leading to the specific hypothesis development, while Section 3 presents the research methodology, including a description of data collection, the questionnaire, the sampling and the statistical analyses performed. Section 4 describes the results. Section 5 presents the discussion and conclusions, including managerial and public policy implications.

2. Review of literature and hypothesis development

This section reviews the literature and presents the hypotheses. First, it summarizes the literature on the benefits of clustering in general. Then, it investigates two drivers that may explain those benefits: companies' decision to agglomerate into logistics parks and training. Finally, it looks at the impact of size; verifying if the previously established links are different for small versus big firms, as well as the impact of size on the degree of collaboration and VAS provision.

2.1. Benefits of clustering

Co-located firms experience positive externalities. The seminal contributions of Marshall (1920) and Porter (1998) regarding industrial clusters were already mentioned above. In the case of the logistics industry, co-location provides additional benefits resulting from reduction in transportation costs, increased levels of customer service, resource sharing, increasing value added services, higher levels of employment and upward mobility (Sheffi, 2012; Rivera and Sheffi, 2014; Van Den Heuvel et al., 2012; Bowen, 2008).

Transportation and warehousing are the core activities of logistics firms (Kasilingam, 1998). Given that such logistics activities do not depend on the specific characteristics of the good that is being handled inside the box (Sheffi, 2012), co-located companies experience operational advantages resulting from the sharing of tangible assets such as transportation capacity, equipment and warehousing space, and intangible assets such as knowledge and information. Van Den Heuvel et al. (2012) reports that firms that collaborate tend to send part of their freight in the trucks of colleague firms. Schuldt and Werner (2007) also mention that under high levels of communication and strong inter-company linkages, shipping companies will share spaces in containers and will ultimately cooperate to design more efficient shipping routes. The authors find a strong and positive relation between the number of companies in the clusters, the number of containers, and the number of conversations among the company's managers. Pekkarinen (2005) contends that long-term relationships among firms allow them to bundle air-cargo and implement new warehousing activities, as well as easily adopt information technologies. Logistics clusters also allow firms to take advantage of low transportation costs because of competition between freight carriers (Limao and Venables, 2001). Thus, the agglomeration of logistics firms increases the demand for logistics services, making them more specialized and effective (Jing and Cai, 2010).

Transportation and warehousing are not the only resources shared within logistics clusters. Co-location also fosters strategic alliances where companies share their productive factors and existing facilities, leading to lower costs and higher performance (Chapman et al., 2003). In logistics clusters firms use, lend or rent the repair and maintenance facilities of other co-located companies (Van Den Heuvel et al., 2012), and exchange workers and equipment to cope with demand volatility generated by seasonality or product launches (Sheffi, 2012). Lannone (2012) in a study of seaports stated that the implementation of procedures aimed at increasing productivity within the regional logistics system (such as inspection or administrative controls) takes place whenever infrastructure managers, shipping lines, intermodal carries and customs agents cooperate, share resources and integrate processes.

The concentration of different firms in logistics clusters facilitates the development of value added services. Value added services are commercial offerings that go beyond the standard logistics offering of transportation and warehousing. When developing high-end services, logistics companies tend to specialize around a single product. Some examples of value added services include tagging, kitting, labeling, returns management, repairs, recycling, packaging, preparing for retail display and many other activities. They impact distribution costs, customer service levels and delivery strategies like just in time (Skjøtt-Larsen, 2000; Reichhart and Holweg, 2008). Value added services also include post-manufacturing activities like quality checks, final assembly, repair and returns management and recycling (Reichhart and Holweg, 2008; Van Hoek and Van Dierdonck, 2000). Logistics establishments can become more competitive by providing these additional services because they allow the logistics service providers to be more "sticky" – in other words, more difficult to replace when they offer an array of services. In addition, the logistics service providers can become more efficient by having a more complete picture of the customer's needs, thus value added operations represent new business opportunity for the logistics service providers (Appold, 1995; Battezzati and Magnani, 2000; Lam et al., 2015).

2.2. Further agglomeration into logistics parks and the impact on clustering benefits

Does further agglomeration into logistics parks incentivize and enable collaboration and VAS benefits for firms? Logistics parks further facilitate the benefits of clustering because firms are part of a larger institution (the park) that help strength inter- and intra-companies' links (Appold, 1995; Battezzati and Magnani, 2000). Rosenthal and Strange (2003) argue that co-location advantages arising from geographical proximity within an industry decrease rapidly over the first few miles of distance between firms. Thus, logistics parks, closed and delimited agglomerative environments, offer higher benefits than open clusters where firms locate at somewhat greater distances.

Co-located companies in logistics parks share information and communicate constantly, enabling and improving just-in-time operations (Kaplan and Norton, 2001; Ramalho and Sanyana, 2002; Morris et al., 2004; Pfohl and Gareis, 2005; Czuchry et al., 2009). These benefits lead to increased productivity, for co-located buyer–supplier dyads but also for co-located supplier networks of focal buyers (Sako, 2003). Logistics parks offer extensive transportation services, equipment and warehousing sharing with other co-located companies, as well as certain tax exemptions, and foreign-trade zone advantages (AllianceTexas, 2015).

Logistics parks also encourage the provision of VAS in order to enhance the park residents' productivity and competitiveness (McKinnon, 2001; Juhel, 1999; Appold, 1995). Amrani (2007) finds that the park's administrators encourage the provision of value added services such as customization, labeling, testing and inventory tracking, especially in large logistics parks like the Port of Rotterdam and PLAZA, in Zaragoza, Spain.

Conversely, Barnes et al. (2003) list three traditional arguments against the development of industrial parks. First, sharing information exposes companies to the mercy of their partners and the park's administrator; second, small companies in the park are unlikely to set up information systems for inventory management due to its high cost; and third industrial parks increase the length of the supply chain because they basically constitute another intermediation point. In the case of logistics parks, Musso (2013) argues logistic service providers usually partner around specific product or market-related projects, making their relationships unstable, and their benefits limited. If a partner is inefficient or incapable of performing certain tasks, another company in the park can easily replace it. Hence, there is no clear justification for investments in information systems or physical resources, and distrust could emerge between parties. Howard et al. (2006) also address asset specificity as a problem for collaboration between manufacturers and logistics parks. Jurásková and Macurová (2013) identifies additional issues surrounding logistics parks: the location of parks usually does not facilitate taking advantage of transport multimodality; parks cannot expand due to environmental constraints hence benefits are constrained; and, the periodical change of the park's tenant provides little support to the synergies established earlier.

Based on the foregoing, the following hypothesis and sub hypotheses are presented:

H1. Further agglomeration in logistics parks positively impacts cluster benefits.

H1a. Agglomeration in logistics parks positively impacts transportation collaboration.

H1b. Agglomeration in logistics parks positively impacts resource collaboration.

H1c. Agglomeration in logistics parks positively impacts the provision of VAS.

2.3. Training and the impact on clustering benefits

Logistics clusters provide opportunities for training, educational facilities, and knowledge creation centers (Enright, 2000). As a result, firms' location in a cluster reduces not only the cost of transportation and warehousing, but also the cost of training personnel (Rabinovich et al., 1999). Besides training of existing personnel, supply of adequately trained employees becomes more feasible, ultimately enhancing firm's capabilities (Sheffi, 2012). In order to reap the benefits of training, however, it is vital that the cluster community is actively involved in improving the training infrastructure (De Langen and Visser, 2005).

The most immediate impact of training is higher productivity: skilled employees are responsible for the use and adoption of new technologies (Husing, 2004). For instance, companies like Fed-Ex and UPS invest in training their "blue-collar" workers because they require higher skills to deal with automation and new technologies. De Fontenay and Carmel (2001) show that clusters in general incentivize intense on-the-job training in order to reduce turnover rates.

When firms co-locate, it becomes important to develop and maintain their relationship (Bathelt, 2005). Consequently, selected employees have to adopt boundary spanning roles, which implies learning new skills, advancing in their career paths. Training in that regard determines whether or not workers are able to collaborate and integrate processes (Lannone, 2012; Pateman et al., 2016). Besides the positive impact on collaboration, Velzen (2007) suggests there is a positive relation between training and value added services. The development of VAS in the logistics interface requires workers to specialize and companies to provide numerous possibilities for professional and vocational training (Sheffi, 2012). The lack of qualified logistics personnel can be the cause of service deterioration. Therefore logistic service providers are challenged to invest in their worker's formal preparation (Kam et al., 2010). More educated workers understand that collaboration with selected buyers or suppliers and stronger levels of value added services may lead to win–win situations, enabling them to find more opportunities for cooperation.

There is another stream of research that states there is actually no significant relation among training and collaboration. Yamawaki (2002), in a study of industrial clusters in Japan, finds that training and skill acquisition may be too firm-specific for it to be useful for other companies. De Blasio and Di Addario (2004) find that working in industrial clusters reduces the returns to education. Power and Lundmark (2004) also note that the requirement of new skills for developing VAS in co-located companies involves costly investments in training and higher costs for ongoing projects due to the longer adjustment periods needed to develop and implement those skills. In other words, the development of high-end services may be discouraged by the direct and indirect costs of training.

In order to shed more light on the previous statements we present the following hypothesis and sub hypotheses:

H2. Training positively impacts cluster benefits.

H2a. Training positively impacts transportation collaboration.

H2b. Training positively impacts resource collaboration.

H2c. Training positively impacts the provision of VAS.

2.4. The impact of size in the context of logistics agglomeration

The general relationship between drivers and benefits as elaborated above may not apply equally across different environmental circumstances (Lawrence and Lorsch, 1967). In the context of industry clusters, firm size is an important contingency that has the potential to alter estimated benefits (Grando and Belvedere, 2006). The firm size of co-located firms impacts the perceived attractiveness of logistics parks and the reaped benefits (Fisher and Reuben, 2000). Suburban areas as airports and logistics parks tend to agglomerate more firms of smaller size while outer areas concentrate larger firms. Similarly, Power and Lundmark (2004) claim that investments on education and training are more likely to be done by large clustered firms than by small ones because the latter cannot afford them. In fact, Altenburg and Meyer-Stamer (1999) suggest that even if small and medium-sized firms cluster it is very unlikely for them to even acquire loans for training programs. On the contrary, as clusters and firms grow larger, new management techniques are implemented including outsourcing of non-core activities such as training and maintenance.

Thus, in order to control for the effect of size we propose the following hypothesis:

H3. The positive impact from further agglomeration and training on cluster benefits (as tested in H1 and H2) does not change when controlling for size.

The impact of firm size may go beyond a moderating role in the projected relationships. Some authors argue that large companies enjoy more co-location benefits because they have the manpower and resources required to engage within each other (Rugman and Verbeke, 2003; Reichhart and Holweg, 2008). Large companies can offer more cooperative opportunities in collaboration regarding technical upgrades, production organization, and labor training (Nadvi, 1999). Carrie (2000) argues that the relocation decisions of large multinationals account for the development of VAS and have a positive effect on the regions where they relocate. But, when the agglomeration is made up of small firms, multinationals would not enter and the extent of VAS offerings would be lower.

Other authors argue that small companies have more incentives to join others and enjoy the benefits of economies of scale and scope, while minimizing their administrative burdens (Grando and Belvedere, 2006). Rabellotti (1999) shows that small firms in the shoe cluster in Mexico exhibit high levels of cooperation and increased horizontal and vertical linkages, which in turn improved their performance. Similarly, Park (1996) states that small companies in industrial districts are keen to collaborate with multinationals because they are interested in their research and development capabilities (f.i. the case of Xian's technology parks). Soinio et al. (2012) find that small companies move faster and more easily to offer value added services than large companies. Small shipping companies have greater needs for technological assistance than larger ones. Hence, they are more interested in contracting with third-party logistics providers who can offer VAS (Maltz, 1994).

The conflicting points of view lead to our fourth hypothesis:

H4. Larger firms in clusters are more inclined to engage in transportation capacity sharing, resource sharing and VAS than smaller firms.

3. Research methodology

3.1. Sample characteristics and data collection

The survey method (Saris and Gallhofer, 2014) was employed to gather data from companies located in the Zaragoza Logistics Cluster in Aragón, Spain. This cluster is one of the biggest in Europe. It comprises rail, road and air infrastructure, as well as several logistics parks, including PLAZA – Plataforma Logística de Zaragoza (the largest logistics park in Europe), PLATEA – Plataforma Logística de Teruel, PLHUS – Plataforma Logística de Huesca and Mercazaragoza. The surveyed companies were located either inside or outside of these logistics parks.

An on-line questionnaire was tested through a pilot survey during July 2010. It was sent to six companies inside and six outside the Zaragoza logistics parks, spanning different sizes: four large, four medium and four small companies. Minor adjustments were made based on the pilot test.

The questionnaire was designed in Spanish (local language) considering three different versions with different sequence of questions to avoid the response order problem (Schuman and Presser, 1996).

The survey was conducted in collaboration with the Zaragoza Chamber of Commerce and staff from the Zaragoza Logistics Center. It was directed at 1790 logistics establishments in Aragon in seven sectors: transportation, logistics services, distribution, warehousing, retail, manufacturing, information technology and consulting. The online questionnaire was sent by email and the sample was built using stratified sampling. The data-gathering process took two and a half months (February to mid-April 2011).

The survey resulted in 550 responses. After cleaning the data and screening out incomplete responses in which less than half of the questions were answered, 448 surveys remained, accounting for a 25% response rate. As shown in Table 1, the distribution of companies by primary activity of the final sample showed no significant difference from the population distribution, suggesting that selection bias was minimal. Approximately half of the sample ($n=187$) comprised smaller companies (with less than 10 local employees and average size of five employees). The other half ($n=205$) comprised bigger companies (with more than 10 local employees and average size of 45 employees). The remaining 56 companies did not report their size. Approximately half of the sample ($n=230$) comprised companies located within the cluster, but outside the logistics parks, while the other half ($n=218$) comprised companies agglomerated within one of the logistics parks. Appendix A shows the companies' location within the cluster.

Table 1
Population and sample distributions by sector.

Facility primary activity	Population (%)	Survey (%)
Manufacturing	50.4	49.7
Distribution/Retail	30.9	33.3
Transport/logistics service provider	13.8	12.1
Information technologies/consulting	4.9	4.9

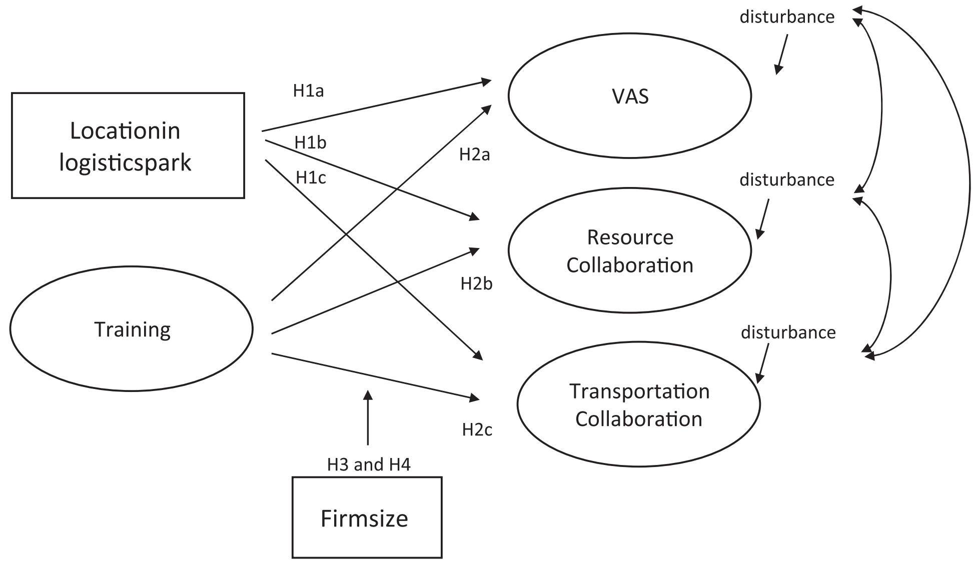

Fig. 1. The research model.

3.2. Research model and measures description

Our model involves three outcome variables, two antecedents, and one moderating variable. Four of these six variables are latent and two are observed variables, as visualized in Fig. 1. Measurement of the latent variables is based on the multiple-items method, which enhances confidence in the accuracy and consistency of the assessment. Responses to the questions related to latent variables had to be given on a 1–5 scale with all categories labeled (ranging from 1 = never to 5 = always). Fig. 1 shows that we expect the disturbance terms of the three latent outcome variables to correlate. This is because we acknowledge that clustering benefits may be affected by many variables, not only those included in our research model.

The three outcomes variables refer to transportation capacity sharing, resources sharing, and VAS. Items reflecting transportation capacity sharing referred to the frequency with which firms share space in trucks, ocean containers, and air cargo. Items reflecting resource sharing referred to the frequency with which firms share warehousing capacity, labor, and equipment. VAS were measured by the frequency of providing value-added services such as price tagging/labeling/bar coding, kitting/final assembly, repair management, reverse logistics, customs services and quality assessments.

The two antecedents refer to location and training. The data for location was based on the addresses of the facilities. Location is a binary dichotomous variable, which takes the value of 1 if located within a park, or the value of 0 if located outside the parks. We have assigned this value by comparing the addresses of the facilities with the addresses of the parks, using ARCGIS to check whether the address for each facility was located inside or outside logistics parks. Training was specified in terms of financial aid provided by the firm for obtaining university degrees, basic courses in logistics and management, and master degrees in logistics management.

Table 2 presents the latent variables and the associated items, which are further explained in Section 4.1.

Table 2
Measurement items and validation.

Latent variable	Items	Factor loading	AVE	CR
Resource collaboration	For the following activities, please indicate if you have collaborated with any company located within the cluster regarding:			
	Equipment sharing	0.72	0.46	0.72
	Employee exchange/sharing	0.64		
	Warehouse capacity sharing	0.68		
Transportation collaboration	For the following activities, please indicate if you have collaborated with any company located within the cluster regarding:			
	Truck space sharing	0.75	0.57	0.80
	Ocean container sharing	0.79		
	Air cargo space sharing	0.72		
VAS	With what frequency does your firm offer the following logistics services?			
	Kitting and final assembly	0.67	0.43	0.82
	Price tagging/labeling/bar coding	0.66		
	Repair management	0.50		
	QA testing and inspection	0.71		
	Customs services	0.73		
	Reverse logistics/recycling/returns	0.63		
Training	The firm offers financial support for:			
	University degrees	0.65	0.65	0.85
	Basic course in logistics and management	0.82		
	Master degrees in logistics and management	0.93		

3.3. Statistical methods

The analysis builds upon structural equations modeling (SEM) (Bollen, 1989) using maximum likelihood (ML) estimation within LISREL (Jöreskog, 1969) and raw data as input. The ML-estimator provides robust parameter estimates when categorical observed variables are used (Saris and Stronkhorst, 1984). Building upon confirmatory factor analysis (CFA), we first evaluated the quality of the measurement model of the four latent variables (transportation collaboration, resources collaboration, VAS, and training). Then building upon path analysis, we evaluated the quality of the structural model inherent to the first and second hypothesis. After that, building upon multi-group confirmatory factor analysis (MGCFA), we assessed differences across sub-samples (defined by size) to evaluate hypotheses 3 and 4.

We complemented the standard test of the overall model fit (Hu and Bentler, 1998) with a procedure that iterates between the evaluation of misspecifications and subsequent partial and theoretically justified modifications of the model (Saris et al., 2009). As such, we reduce dependence upon the power of the test. In other words, the standard test and fit measures can only detect misspecifications for which the test is sensitive. Therefore, rejection of the model may be due to very small misspecifications for which the test is sensitive while acceptance of the model does not necessarily mean that the model is correct but may rather indicate a lack of power of the test. The analysis of misspecifications on the other hand is supported by modification indexes (MI) and expected parameter changes (EPC) provided by Lisrel. Cut-off sizes to consider misspecification are 0.40 for factor loadings, 0.10 for causal effects, 0.10 for correlations, and 0.05 for mean structures (Saris et al., 2009).

Hypotheses 3 and 4 imply comparisons across sub-groups of the sample. To make meaningful comparisons, we have to test for measurement equivalence, a practice still rarely performed in operations management research (Knoppen et al., 2015). Measurement equivalence can be expressed on a continuum (Bollen, 1989), but is most commonly tested in three steps (Horn et al., 1983; Meredith, 1993; Steenkamp and Baumgartner, 1998). We start with the weakest constraints and proceed to the most binding. First, *configural* equivalence may be established when the same measurement model fits the data in the different groups; in other words, when items load significantly on the same factors across groups and the correlations between the latent constructs are significantly less than one, guaranteeing discriminant validity (Steenkamp and Baumgartner, 1998). Second, *metric* equivalence may be established when the factor loadings (i.e., the slopes of the measurement model) across the different groups are the same. It implies that relationships between the evaluated construct and other constructs can be compared across groups. Third, *scalar* equivalence may be established when slopes and intercepts of the measurement model are the same across groups. It assesses the extent to which systematic upward or downward bias exists in the responses across different groups and implies that relationships and means can be compared across groups (Rungtusanatham et al., 2008). Hypothesis 3 of our study implies the comparison of path models across subgroups in our sample, and thus requires *metric* measurement equivalence before proceeding to compare the path models. Hypothesis 4 implies a comparison of mean values across sub-groups in our sample, and thus requires *scalar* measurement equivalence before proceeding to compare mean values.

4. Results

This section first presents the basic results regarding the quality of the measurement model, or the dimensionality of the latent variables of our research model. Then, it presents the results of testing hypotheses 1 and 2. Next, it analyzes if firm size impacts the established relationships as reflected in hypothesis 3. Finally, it compares mean values across sub-groups defined by size, to test hypothesis 4.

4.1. Dimensionality of the latent variables

For identification purposes, the factor structures of the four latent variables of our model (transportation collaboration, resources collaboration, VAS, and training) were jointly analyzed, as correlated first-order constructs: $\chi^2=216.28$; DF=84; χ^2/DF=2.6; RMSEA=0.059. An analysis of mis-specifications pointed to a correlated measurement error between the VAS items "kitting and final assembly" and "price tagging/labeling/bar coding". This makes theoretical sense: both items share a unique component (source of error variance, see Saris and Gallhofer, 2014) that has nothing to do with the other four items, but rather with primary value chain activities, required for transforming a product. Introducing the correlated error improves the fit: $\chi^2=174.97$; DF=83; χ^2/DF=2.1; RMSEA=0.050. No further misspecifications were detected. Table 2 presents descriptive statistics of the latent variables, based on this final solution (i.e., the model of four correlated first-order factors with one correlated error). Average variance extracted (AVE) and composite reliability (CR) were calculated in line with Fornell and Larcker (1981). AVE ranges between 0.43 and 0.65 and CR between 0.72 and 0.85. Finally, Table 3 shows the correlations between the variables of the model.

Table 3
Correlation matrix.

	Resource collaboration	Transportation collaboration	VAS	Location	Training
Resource collaboration	1.00				
Transportation collaboration	0.57	1.00			
VAS	0.46	0.46	1.00		
Location	0.13	0.15	0.11	1.00	
Training	0.43	0.31	0.47	0.11	1.00

4.2. The path model for the pooled dbase

Test statistics of overall model fit are satisfactory: $\chi^2=184.04$; DF=94; χ^2/DF=1.96; RMSEA=0.046. And more importantly, the analysis of misspecifications did not point to misspecifications. Hypotheses H1c, H2a, H2b, and H2c are confirmed. Hypotheses H1a and H1b are not confirmed, however. Fig. 2 highlights the confirmed paths, as well as the parameter estimates. Fig. 2 also show the correlation of the disturbance terms of the outcome variables; i.e. the part of variance that is explained by variables from outside the model.

4.3. The path model: controlling for size

We repeated the previous structural model test, but now through MGCFA with sub-groups based on size ($n=187$ for smaller companies and $n=205$ for bigger companies). Therefore, first measurement equivalence tests have to be performed. The first line of Table 4 shows that the test statistics of the configural test, based on the model of Section 4.2, are satisfactory. Moreover, the analysis of misspecifications does not point to misspecifications. The second line of Table 4 shows that test statistics do not deteriorate when imposing the restriction of equal loadings across groups. Moreover, the analysis of misspecifications does not point to misspecifications. In other words, data show metric equivalence and therefore path models can be compared. Second, we introduced the restriction of equal gammas (the impact from an exogenous on an endogenous variable in the model) across groups. The third line of Table 4 shows that test statistics do not deteriorate when increasingly this restriction. More importantly, the analysis of misspecifications does not point to misspecifications, and therefore we have to conclude that the path models are the same for small versus big companies.

4.4. The degree of collaboration and VAS going on: the impact of size

Hypothesis 4, just as hypothesis 3, calls for the definition of subsamples based on the size of the companies: $n=187$ for smaller

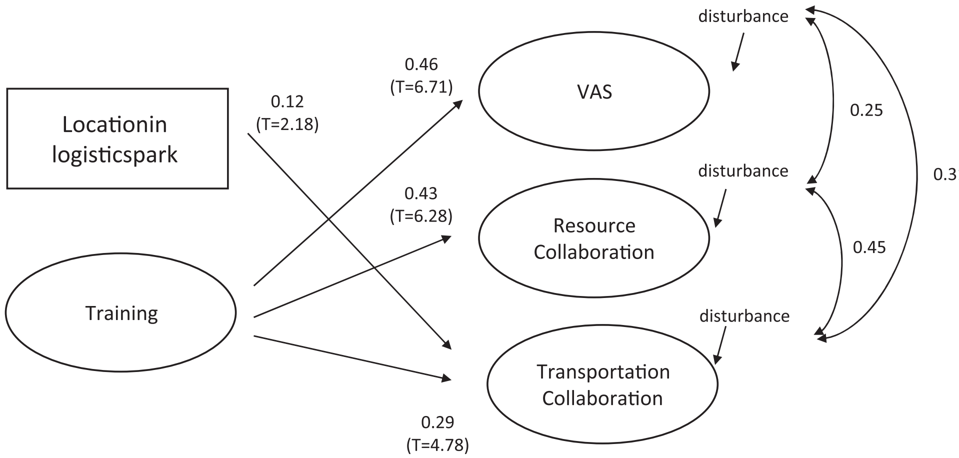

Fig. 2. Results on hypotheses 1–2.

Table 4
Test statistics of measurement model and path model equivalence tests, for subgroups based on size.

	DF	χ^2	χ^2/DF	RMSEA	Misspecification analysis
Measurement model equivalence test					
Configural equivalence	188	263.64	1.40	0.046	Ok
Metric equivalence	199	274.58	1.38	0.045	Ok
Path model equivalence test					
Impose equal path estimators (gamma)	205	280.88	1.37	0.044	Ok

companies and $n=205$ for bigger companies. Now we have to test scalar equivalence of a model with 3 (not 4, as the training variable does not form part of this model) latent variables.

The first three lines of Table 5 present the test statistics of the configural, metric and scalar tests, which all are satisfactory. A complementary analysis did not point to misspecifications in the model. Consequently, we established scalar equivalence and can therefore proceed to compare mean values across the sub-samples. The last line presents test statistics, when we impose the restriction that mean values should be invariant across groups. We observe that χ^2 increases by 42.3 points for only 3 extra degrees of freedom. Moreover, RMSEA increases considerably. In other words, the fit of the model decreases markedly, indicating that the latter restriction does not hold.

Table 6 shows that the mean values of the three latent variables are significantly different per group: they are structurally higher for bigger companies. In other words, empirical data confirm Hypothesis 4 and large clustered companies enjoy higher levels of collaboration and VAS than smaller ones.

5. Discussion and conclusions

The agglomeration of logistics firms is getting increased attention among companies and policy makers. Rising global trade has generated a higher demand for logistics services, favoring the spatial agglomeration of logistics firms since it leads to larger conveyances and higher conveyance utilization (and thus lower costs as well as lower carbon footprint), in addition to higher levels of service. This paper has focused on collaboration and value added services, as potential benefits of clustering, in line with interview data (Rivera et al., 2015). Collaboration is referred to in this paper in terms of transportation capacity, equipment, employees and warehouse resource sharing. We analyzed the effect of further agglomeration within logistics parks and training on the

Table 5
Test statistics of measurement equivalence tests, for subgroups based on size.

	DF	χ^2	χ^2/DF	RMSEA	Misspecification analysis
Configural equivalence	98	161.04	1.64	0.059	Ok
Metric equivalence	107	171.28	1.60	0.057	Ok
Scalar equivalence, same pattern of means	116	186.58	1.61	0.057	Ok
Scalar, imposing same means	119	228.83	1.92	0.070	Misspecifications of all means

Table 6
Mean values across different groups, for subgroups based on size.

	Smaller companies (mean; standard deviation)	Larger companies (mean; standard deviation)
Resource collaboration	1.71; 0.07	1.99; 0.08
Transportation collaboration	1.73; 0.07	2.01; 0.08
VAS	1.87; 0.10	2.68; 0.11

mentioned benefits of logistics clusters.

The empirical part of the study has focused on the Zaragoza (Spain) logistics cluster. We have analyzed data using SEM and MGCFA. We found that firms' decisions to further agglomerate from the broader cluster into the more concentrated logistics parks impacts actual transportation collaboration between cluster residents. The results also showed that higher levels of training, facilitated by the cluster, encourage more collaboration and value added services. These results are the same for big and small firms. On the other hand, we demonstrated that bigger firms reap more clustering benefits than smaller firms.

A first contribution of the paper lies in its embedded level of analysis, including firm level and logistics parks levels of analysis. Extant literature focuses mostly on logistics clusters and hubs, but not on parks, which is a smaller unit of analysis that helps understand the clustering effect at a more granular level and also explain contradictory results in the extant literature. Firms located in logistics parks are part of an organized institution with clearly defined ownership and geographic property boundaries. Logistics parks leaders, operators, and owners play a supporting role encouraging collaboration practices like transportation capacity sharing between companies located on parks by identifying common routes and promoting larger conveyances use and higher utilization. Logistics parks may help reduce the cost of basic equipment, allowing access to facilities that otherwise would not have been possible to install due to high opportunity costs, increasing quality of transport by removing bottlenecks through transport capacity sharing, and creating environmentally friendly solutions to distribution activities (Jurásková and Macurová, 2013).

A second contribution of the paper is to provide empirical evidence on the impact of two key characteristics of clusters on the key benefits related to collaboration and VAS. We confirm the positive link from location in logistics parks to transportation capacity sharing and the positive link from training to all the benefits (transportation capacity sharing, resource sharing and VAS). Thus, the greater the opportunities for training, educational and technical courses offerings, the greater the degree of collaboration and value added services. More qualified workers not only can identify opportunities for collaboration and value added services provision, but also implement better collaboration and VAS initiatives. This is in line with the findings of Sheffi (2012) and Rivera et al. (2015) that showed that clustered logistics companies promote employees training by offering financial aid or facilitating the connection between the park and education institutions.

A third contribution stems from our acknowledgment of firm size, a key contingency in the study of clusters (Grando and Belvedere, 2006) that has the potential to moderate projected relationships as well as to impact observed mean values of key phenomena. We observed in this regard that after controlling for size the results on the causal relationships did not change. On the other hand, when comparing the absolute degree of collaboration and VAS going on in small versus big companies, we conclude that larger companies collaborate more and provide more VAS than smaller firms. Large firms develop strong linkages and outperform small ones in technical upgrade, labor training and product organization (Reichhart and Holweg, 2008; Nadvi, 1999). Moreover, large companies have the resources and scale to facilitate the provision of value added services and customization though postponement activities.

Future research can integrate the perspective from economic geography that suggests that the decision to co-locate follows actual and ongoing collaboration (Bowen, 2008; Anderson et al., 2003). In other words, causality flows in more than one direction. This integration of perspectives can be done building upon research that highlights positive feedback loops; i.e., the iterative nature of the relationship between agglomeration and its benefits (Paige and Nenide, 2008). It is important in this regard to include instrumental variables in the research design: one instrumental variable for each variable involved in a bi-directional causal relationship (Saris and Stronkhorst, 1984).

Our results are based on just one cluster, and future research is required for replication in other clusters. Another avenue for further research is to obtain an in-depth understanding of how location decisions evolve over time, influenced by prior experience and current incentives. One way to do it is with a comparative case study design, studying if the clustering behavior of firms depends on regional paths related to benefit seeking, would provide greater insight on the matter.

Since our study's data include relatively small companies (average size of the bigger companies sub-sample was 45 employees), additional research should focus on clusters that include bigger companies and multinationals to see whether, for instance, there are diminishing returns to size. This research could use a similar cross-sectional survey methodology, employing MGCFA and distinguishing between more than two sub-groups related to size when analyzing the data.

5.1. Managerial implications

The results of this paper are relevant for companies that are faced with location decisions and are looking at the possibility of location in logistics clusters and parks. Results are also relevant for logistics parks authorities and real state developers that aim to attract firms to the parks. Park managers may play a facilitator role that enhances the development of collaboration practices and value added services between co-located firms within the park and other firms located outside. In other words, park managers should think more in broader entities (dyads or triads of collaborating companies versus single companies) as potential customers. Further research is needed on understanding how these facilitating mechanisms might work.

More value added services represent opportunities for new market development and for closer ties to customers, which may represent opportunities of growth. The closer location of firms within a park helps horizontal collaboration practices, because core and non-core activities of co-located companies are closely related encouraging the development and the implementation of social and formal governance models. Closer location also reduces training costs and increases collaboration. More educated workers understand the value of collaboration and help develop stronger levels of value added services. Moreover, logistics is an information intensive industry – and therefore it is important that IT development is easier and faster in logistics clusters compared with isolated firms (Rivera et al., 2015).

Results show that co-located large firms are prone to gain more benefits from geographical proximity. However, smaller firms should develop strategies to reduce the gap between their opportunities in logistics parks and those of larger firms.

Learning with and from bigger companies should facilitate the smaller companies´ growth. Geographical proximity fosters not only competitiveness and efficiency but also joint learning and innovation to all the companies.

Finally, for the final customer this means better service and better information about the price. The natural competition and collaboration developed among neighboring companies improves efficiency, increases the portfolio of services and their quality, while offering competitive prices, which is key for time and price sensitive consumers. Clusters also promote higher service levels by fostering postponement and customization, late-pickup, early delivery and fast repairing (Sheffi, 2012). Furthermore, the cost advantages that clusters create for co-located companies are often passed along the supply chain until the final costumer, who enjoys the accumulated savings in the form of price reductions (Visser, 1999).

5.2. Policy implications

Governments can play an active role in enhancing the benefits of logistics clusters and parks. For instance, by providing reliable infrastructure, clear regulation, efficient administrative processes and training and education programs for workers in clusters or parks. Specifically, they can foster further interfirm collaboration and value added services by supporting the park's layout management and encouraging pilot projects and training programs.

We found positive effects of further agglomeration in logistics parks and higher levels of training on the benefits of logistics clusters. Thus, Governmental promotion of clustering should be directed first to those firms that are located in logistics parks and offer more opportunities for training to their employees. Also, incentives should be aimed at large sized companies who can gain greater benefits from spatial concentration and generate more spinoffs (including small companies).

All in all, organization and administrative support in logistics parks may facilitate company interaction and collaboration, which increase competitiveness. Policy makers may also support research and planning in the field as well as training support and further educational and technical opportunities. Thus, further government understanding of the contribution of logistics parks and training might show policy makers a path to foster regional economic growth.

Appendix A. Geographical reach of the survey

See Fig. A1.

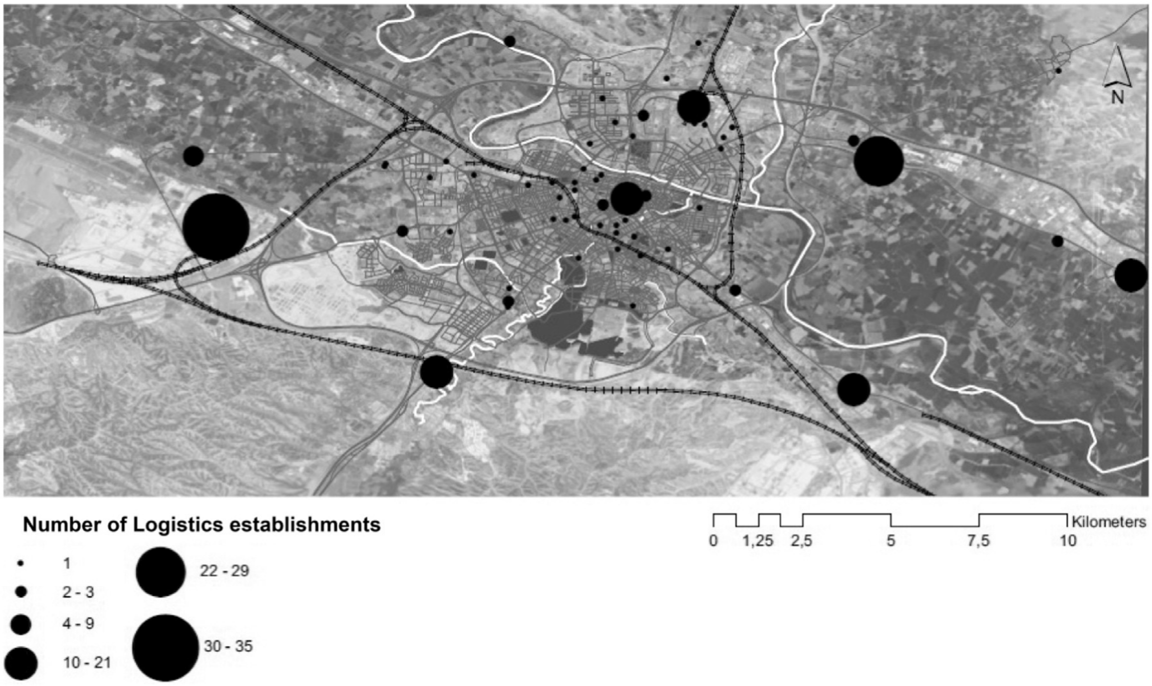

Fig. A1. Location of the surveyed companies in the Zaragoza Logistics Cluster. *The Zaragoza Logistics Cluster comprises the geographical area of the City. The map presents a closer look of the area to facilitate visualization of logistics companies within the cluster.

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