Journal of Coastal Research	SI	94	768–772	Coconut Creek, Florida	2019

Case Analysis of the Boost Effect of Port Trade on Regional Transoceanic Economy Based on Industrial Cluster Effect

Yuwei Zhang*

School of Economics and Finance
Xi'an International Studies University
Xi'an 710128, China

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ABSTRACT

Zhang, Y.-W., 2019. Case Analysis of the Boost Effect of Port Trade on Regional Transoceanic Economy Based on Industrial Cluster Effect. *In:* Gong, D.; Zhu, H., and Liu, R. (eds.), *Selected Topics in Coastal Research: Engineering, Industry, Economy, and Sustainable Development. Journal of Coastal Research*, Special Issue No. 94, pp. 768–772. Coconut Creek (Florida), ISSN 0749-0208.

The study of the synergy development between industrial clusters and regional economies focuses more on the offshore areas. This paper introduces the mutual relation between port logistics trade and regional economic development, and aims to analyze how the two correlate each other under the industrial cluster effect. This is an exhaustive study of the concept, the development cycle of port logistics industry cluster and what factors play an effect on it. On this basis, the interactive development of it is systematically analyzed from quantitative and qualitative perspectives, that is, the idea of system dynamics is qualitatively traced to reflect the development relationship of the two by a causality map; then quantitatively, the Qingdao port trade and regional economy are instantiated and the location quotient is chosen as the evaluation indicator to conduct the analysis on three fronts: data analysis, Granger causality and prediction variance. Case analysis reveals that the cluster development of port trade plays an obviously positive effect on regional economy. In theory, it is significant that the industrial cluster effect plays an affirmative effect on the port economy development.

ADDITIONAL INDEX WORDS: *Industrial cluster, port logistics trade, regional economy, case analysis, location quotient.*

INTRODUCTION

In the context of the globalization, the international logistics trade has become more and more frequent. Coastal port, as the most important pivot of international logistics trade, plays an increasingly crucial part in the economic development of port areas. Tracing out the strategic idea of the ocean and offshore integration based on the industrial clusters, it has been a trend to recur the advantages of industrial clusters in offshore borne trade to the port trade, upgrade the competitiveness O local businesses, and boost the regional economic development in coastal ports (Tekken, Costa, and Kropp, 2009).

After 2010, China has successively launched the Economic Development Zones such as the Binhai New Area relying on Tianjin Port, the Zhejiang Coastal Economic Development Zone relying on Zhoushan Port, and the Pearl River Delta Economic Development Zone relying on Zhuhai Port. Driven by the ports, the regional economy has been developed to form an industrial cluster effect. It is no doubt an important driving force of regional economic development in our country (Cenci *et al.,* 2016). Domestic scholars have analyzed competitive advantages and industrial characteristics of port logistics clusters. These efforts have borne abundant fruits. However, there are rare literature on two-way analysis of port trade and regional economic development. In order to fill this gap, this paper introduces the industrial cluster effect to analyze to what effect the port trade boosts the regional economic development. In addition, a case analysis is also carried out to reveal this (Dou and Li, 2015).

This paper first explains the relevant theory foundations for the port logistics industry cluster. To demonstrate what's the relationship between port trade and regional economic development, the system dynamics model is used to establish a feedback mechanism in order to reveal the interaction between the two (Chen, Chen, and Han, 2015); quantitatively, it does that by taking the Qingdao Port, Shandong Province as study case and the location quotient as an evaluation indicator from the data analysis, Granger causality, prediction variance. The study is an important supplement to the documents on industrial clusters and regional economic development.

INDUSTRIAL CLUSTER FOR PORT LOGISTICS TRADE

Concept of Port Logistics Industry Cluster

Like the industrial clusters, the port logistics industry cluster refers to the economic situation in which the businesses in cooperation with many port logistics processes of labor division and relevant institutions congregate in dependence on the ports. The port logistics trade industry cluster is developed as an oceanic industry cluster based on successful cases of offshore industry clusters (Ronza *et al.,* 2006). There are successful industry clusters in China's offshore areas including the smallware industry cluster in Yiwu, Zhejiang, the ceramic industry cluster in Foshan, Guangdong, and the lamp industry cluster in Zhongshan, Guangdong, all of which not only lead the economic development in the industry, but also revitalize the regional economy. The port logistics trade clusters are

DOI: 10.2112/SI94-152.1 received 15 February 2019; accepted in revision 1 March 2019.
*Corresponding author: zhangyu123@163.com

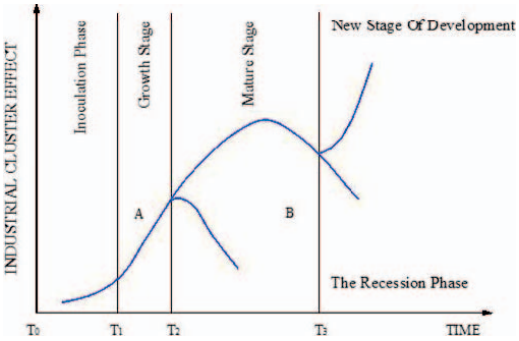

Figure 1. Life cycle of the industry cluster.

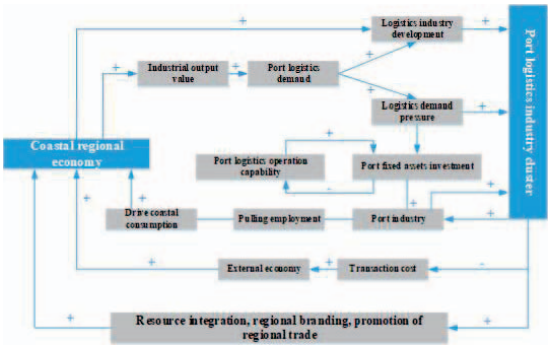

Figure 2. The Causality diagram based on system dynamics.

developed for the purpose of improving the cluster development of relevant industries such as infrastructure, R&D institutions, and management divisions based on successful cases of onshore industry clusters.

Influence Factors and Development Cycle of Port Logistics Industry Cluster

(1) Factors affecting the industrial clusters

With reference to pertinent literature, it is concluded that the industrial cluster has three elements: 1) Basic element, it includes the geographical natural conditions of the port, port resources and infrastructure; 2) Business elements, this is the port's attraction to the logistics companies and their visions to develop the business in the port. If they are attracted to the port for development, they will agglomate there and then drive the development of port logistics and relative economies; 3) Market element, the development of international trade of domestic companies and the surge of domestic orders from foreign companies offer a good international market environment to the port trade. The international market as a factor influence China's port industry agglomeration (Almotairi, 2012).

The influence factors of port logistics industry clusters are dynamic and multifarious. Under the market conditions, influenced by the international market, the national policies, and economic conditions of internal and external businesses, port logistics trade will be sluggish until the leading weight factors are grasped in a dynamically evolutionary environment (Bai and Lam, 2014).

(2) Development cycle of port logistics industry

Influenced by multiple factors, the port logistics industry agglomeration will show different development phases with the passage of time, as shown in Figure 1.

The life cycle of the port logistics industry cluster shows an increasing-moderate-decreasing trend. It is divided into the gestation (T0-T1), growth (T1-T2), maturity (T2-T3), and recession phases (>T3), in each of which the port logistics development presents distinctive features: in the gestation phase, the logistics companies gradually move in and agglomerate there. Port logistics industry is developed from the decentralization and internal specialization modes towards a simple market agglomeration with the improvement of business specialization level and production efficiency. In the growth phase, driven by the advantages of the port resources and the preferential government policies, the aggregations of regional talents and technologies are reached. The regional brand effect burgeons to provide the ports with good investment conditions. After the point A, the number of cluster businesses increases to make the industrial clusters develop rapidly; in the maturity phase, the port logistics cluster is at a relatively high level, and the regional economy also shows a benigh development momentum. The further development of the port logistics industry cluster requires innovating white energy to maintain the growth, otherwise it will continue to decline after point B; in the recession phase, due to the shortage of land resources, high labor costs restrain the development of logistics companies, so that cluster businesses are depressed (Bruzzone *et al.,* 2011).

In the different development cycles of port logistics industry cluster, the economy in port areas evolves diversely. The following sections describe it qualitatively and quantitatively.

QUALITATIVE AND QUANTITATIVE EVALUATION ON PORT LOGISTICS INDUSTRY CLUSTER AND REGIONAL ECONOMY

Qualitative Evaluation

The interactive development between regional economy and industrial clusters is dynamic and nonlinear. System dynamics underlines that the information feedback in the system has an edge in addressing dynamic problems. Therefore, based on system dynamics model, the causality between industrial clusters and regional economies is created to derive the facilitation effect of port trade on the regional economy from the qualitative angle.

As shown in Figure 2, it is a causality map based on the system dynamics. Obviously, there is a reciprocal feedback between the regional economy and the industrial cluster at the ports: the improvement of the regional economy will stimulate the demand for port logistics, and indirectly enhance the inputs in fixed assets there, attract more logistics companies to agglomerate there; the port logistics industry cluster will reduce the logistics transaction cost, create external economy and jobs to stimulate the consumption, let the conditions for regional economic development loose; port logistics industry cluster creates the brand effect to facilitate the integration of

Table 1. *The location quotient of Qingdao port from 2007 to 2014.*

Year	2007	2008	2009	2010	2011	2012	2013	2014
Location quotient (LQ)	1.039	1.068	1.658	1.584	1.595	1.625	1.675	1.731

resources in the surrounding areas and drive the economic development in the local areas (Yusuf *et al.,* 2014). The consumption in port areas and port logistics industry as two main driving factors spur on the two-way development of and the interaction between the regional economy and logistics industry agglomeration.

Quantitative Evaluation

(1) Quantitative evaluation measures

There is a complex relationship between the port logistics industry cluster and the regional economy (Peng *et al*., 2018). To measure it, the location quotient and per capita GDP are referral to as the evaluation criteria.

The location quotient is an indicator for measuring the specialization level of industrial agglomeration. The greater the location quotient, the higher the specialization level. It is calculated by the formula 1.

$$LQ_i = \frac{(e_0/E_0)}{(e_1/E_1)} \tag{1}$$

Where e_0 represents the throughput of port logistics; E_0 represents the throughput of nationwide port logistics; e_1 represents the marine industry yield of the port areas; E_1 represents the total yield of the marine industry in the port areas nationwide. The regional economic development is evaluated quantitatively based on the National Bureau of Statistics (NBS) data and per capita GDP (Bosona and Gebresenbet, 2010).

(2) Instance data statistics

The Shandong Peninsula as the China's largest one, has contributed to a good industrial cluster effect of the ports to drive the development of regional economies, for example, the typical Qingdao Port. In 2017, the throughput of Qingdao Port reached 508 million tons. Guided with the policies such as the country's Shandong Peninsula Blue Economy Development Plan, we have seen the rapid development of regional marine economy in Shandong Province (Berawi *et al.,* 2017).

According to the statistics, the location quotients of the Qingdao Port Logistics Industry Cluster from 2007 to 2014 are shown in Table 1.

Based on the information published by the NBS, the distribution of per capita RGDP in Shandong is shown in Table 2.

(3) Processing and analysis of instance data

1) Data processing method. Data is subjected to H-P filtering processing by the trend portion and the periodic cycle portion, and $y_t = r_t + c_t$is separated. Where r_t is calculated by the formula 2.

Table 2. *The RGDP distribution of Qingdao port from 2007 to 2014.*

Year	2007	2008	2009	2010	2011	2012	2013	2014
RGDP	1.684	2.013	2.367	2.798	3.342	3.613	4.221	4.750

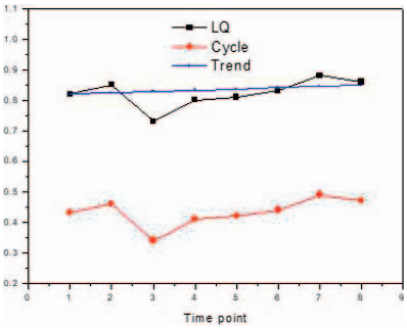

Figure 3. Hodrick-Presoctt of LQ (lambda=100).

$$r_t = Min\left\{\sum_{t=1}^{T}(y_t - r_t) + \lambda\sum_{t=1}^{T}[(r_t - r_{t-1})(r_t - r_{t-2})]\right\} \tag{2}$$

In the formula, $\sum_{t=1}^{T}(y_t - r_t)$ represents the measure of the periodic cycle; $\lambda\sum_{t=1}^{T}[(r_t - r_{t-1})(r_t - r_{t-2})]$ represents the measure of the smoothness of the trend (Tran and Zhang, 2014). Since the location quotient and per capita GDP in the port areas are both non-stationary array, the per capita GDP is first processed in logarithm, and then LQ and LN (RGDP) are processed by H-P filtering method, as shown in Figure 3 and Figure 4.

In the figure, Trend represents the long-term trend sequence decomposed, and the curve has a good smoothness and a certain trend. LQ and RGDP for the industrial cluster both show an upward trend.

2) Granger causality. Granger causality test proposed by mathematician Granger in 1969 believes that, if two variables can complement to each other in the prediction or one variable can increase the explanatory power of the other, it is called the Granger cause. As shown in Formula 3 and 4.

$$HPLNRGDP_t = a_0 + \sum_{i=1}^{m} a_i HPLQ_{t-i} + \sum_{i=1}^{m} b_i HPLNRGDP_{t-i} + \mu_{1t} \tag{3}$$

$$HPLQ_t = a_0 + \sum_{i=1}^{m} a_i HPLNRGDP_{t-i} + \sum_{i=1}^{m} b_i HPLQ_{t-i} + \mu_{2t} \tag{4}$$

In the formula, HPLQ and HPLNRGDP respectively represent the location quotient variable of industrial clusters and the per capita GDP variable representing the regional economic development. According to the data processing of H-P filtering, the Granger test derives the results as shown in Table 3.

In Table 1, the original assumption 1 believes that the HP filter Granger change of per capita GDP is not attributed to the HP filter of the location quotient. P is 0.00039<0.01, representing that the assumption is false at the 1% confidence level,

Table 3. *The Granger result of HPLQ and HPLNRGDP.*

Port	Original Assumption	F-Statistic	P Value	Conclusion
Qingdao Port	HPLQ Does not Relate with HPLNGDP	34.27	0.00039	Rejected
	HPLNGDP Does not Relate with HPLQ	3.54	0.108	Rejected

so it is not true. It is determined that there is a relationship between the two. Original assumption 2 considers that the HP filter Granger change of the location quotient is not subject to per capita GDP HP filtering. P is 0.108<0.11, which means that this assumption is false at the 11% confidence level, so it is not true. It is thus determined that there is the relationship between the two (Li *et al.,* 2010).

In addition, it can be believed that the Granger change of per capita GDP is more likely subjected to the location quotient, that is, it is more likely that the port industry cluster will boost the trans-ocean economy. We can learn from the empirical study of Qingdao Port industry cluster and regional economic development that there is a two-way interaction between the two.

3) Predicative variance decomposition. Although the Granger causality examines the interaction between industrial clusters and regional economic development, in order to further study the two-way relationship between the two, the predictive variance decomposition is used to test the two-way interaction between the location quotient H-P and per capita GDP filters (Sandberg *et al.,* 2014). For the decomposition results, see Table 4.

From the predicative decomposition results, it is known that the contribution of port logistics industry clusters to the regional economic development gradually increases from 0% to 34.38%; the contribution rate of regional economy to port logistics industry agglomeration hits upon 50.33%.

4) Positive analysis summary and development proposal. The port logistics industry cluster has created a brand effect for the port areas and enhanced the talents and investment attractiveness in the local. It is clear from the positive analysis of the Qingdao Port that the higher the degree of logistics industry cluster, the greater its contribution to the regional economy in port areas; The corresponding regional economic development will render a good environment for developing the port logistics industry with the advanced port infrastructure construction.

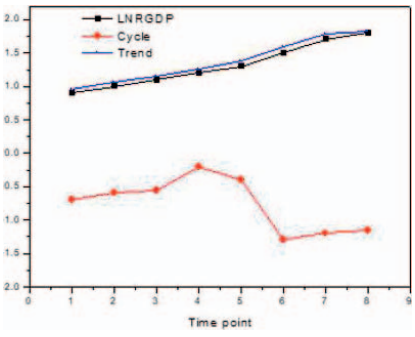

Figure 4. Hodrick-Presoctt of LNRGDP (lambda=100).

Up till now, the port logistics industry cluster is still in the growth phase in China. Only when the competitive advantage is improved greatly to facilitate the development of industrial clusters can the regional transoceanic economy get more flourishing.

The development of port logistics industry clusters has undergone different life cycles. There are various risks in the development process. The industrial cluster will tip into recession if not upgraded in time, which will exert an adverse impact on the economic development of the whole coastal areas. The ways the port logistics industry cluster get upgraded are to (1) improve the innovative capacity and learning skills of businesses, infuse energy into the port logistics development, enhance the sense of business cooperation and expand the inputs in R&D of new products and technologies; (2) actively integrate in the global value chain system, maintain a strong openness to learn advanced logistics concept, management experience and technical experience, and with integration and innovation as its own advantages, finally leap into the high value-added links of the logistics value chain.

CONCLUSIONS

There is the lack of theoretical study on the boosting effect of the industrial cluster on the marine economy development. This paper focuses on the interactive and mutually promotive relationship between port logistics industry clusters and trans-ocean economy in port areas, in conjunction with the quantitative and qualitative analysis on it. With the system dynamics model and Granger causality for demonstration, several conclusions are derived here:

The port logistics industry clusters and regional transoceanic economies have a causal relationship with each other based on system dynamics. (Guo *et al*., 2013; Guo *et al*., 2016; Li *et al*., 2015)

The location quotient and per capita GDP processed by HP filtering show a slow growth trend; Granger causality demonstrates the interactive relationship between port industry clusters and regional economy; the predictive variance decomposition demonstrates how the contribution of port industry cluster to the regional economies changes over time.

Table 4. *The predict variance decomposition results of HPLQ and HPLNRGDP.*

	Holnrgdp		Hplq	
Time	Holnrgdp	Hplq	Holnrgdp	Hplq
1	100	0	13.74	86.26
2	97.45	2.55	19.35	81.65
3	94.38	5.63	32.18	67.82
4	92.85	7.15	35.77	64.23
5	85.17	14.83	42.56	57.44
6	70.34	29.66	44.27	55.73
7	68.32	31.68	46.11	53.89
8	65.62	34.38	50.33	49.67

The industrial clusters in the port area should be further developed. Only in this way can the wider and deeper development of regional trans-ocean economies be realized.

ACKNOWLEDGEMENTS

2018 Xi'an International Studies University Research Project, "Market Selection of China's Unimpeded Trade with Countries along the Belt and Road", 18XWB21.

Sponsored by Xi'an International Studies University Innovative Research Team of the Belt and Road Economic and Trade Cooperation.

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