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Benchmarking the Synergistic Effect of China-ASEAN Seaport

Industry Development*

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Abstract

This paper is to explore a new way for analyzing and measuring the optimal growth path for an industry in the context of global production network. The special focus is on Tieshan Port Industrial Parks where clustered a number of energy intensive industries. Based on the strategic complementarity theory and the concept of multiple equilibrium in the Development economics, the study develops a concept analysis model as multiple equilibrium development system indices by integrating UNIDO's value chain diagnostics approach.

Keywords: strategic complementarity theory, multiple equilibrium, cross-border production, benchmarking method

1. Introduction

1.1. The Rationale

The object of this paper is to initiate a feasibility study on building a new benchmarking system to measure the cross-border operations of manufacturing industries between China and ASEAN seaport countries. The rationale thus based is on two major concerns: the first is from the perspective of regional economic governance, that the official launch of China - ASEAN Free Trade Area in 2010 is shaping the region into the world's third-largest free trade zone, which will facilitate closer regional strategic alliances among these countries. It can be envisaged that a distinct form of economic organization, the regional industrial network, is to be developed, which is featured with a cooperative and reciprocal organization of

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economic transactions, marked with power relations from the asymmetry of interdependence among the network's participants (Portnoy, 1999). The second is the concern about sustainable energy future and environment conservation in the region. The efforts by the Kyoto Protocol regime to mitigate greenhouse gases (GHGs) have brought about pressures on China and ASEAN countries for the increasing amount of GHGs emissions because of almost all of the member countries are following the same energy-and carbon-intensive development path as those industrialized countries have done. What it's more; some carbon-intensive industries in the industrialized countries are shifting their operations to China and ASEAN countries (World Bank, 2008).

1.2. Methodology and Structure

Built on the strategic complementarity theory (Ray,2001), the paper argues that the ongoing cross-border industrial interactions require coordination, and the measures taken by individual country to address climate change need to be fully compatible with China - ASEAN community's welfare goals for economic growth and human advancement including raising standards of living, optimal use of regional resources in accordance with the objective of sustainable development, and protection and preservation of the environment. However, the prevalent trade indicator analysis cannot capture the synergistic effects created by cross-border production networking and coordination failure caused by the network externalities.

In the paper, a multiple equilibrium indicator model is proposed to facilitate the policy making and study on optimal choices as to outsourcing, production relocation, spacial agglomeration and productivity. We use Tieshan Port Industrial District of Beihai in Guangxi Province, China as a reference point, making special focus on the cross-border production fragmentations located at seaport industrial parks of Beibu Gulf countries, particularly the energy- and carbon-intensive industries including oil refinery, pulp and paper production and ship building and repair. The purpose of this paper is suggestive rather than definitive in nature.

The paper is organized as follows. Section 2 discusses the cross-border industrial development in ASEAN region and the challenges for Seaport Industries at Beibu Gulf. Section 3 discusses the theoretic foundations for a multiple equilibrium indicator system model. Based on the discussions, Section 4 constructs a multiple

equilibrium development system indices. The final section presents some key inferences for this research.

2. Cross-border Industrial Development Prospect Analysis

In 2007, ASEAN and China reached an agreement to open each other's seaports for cargo and passenger transport, and in 2010, with the enforcement of Free Trade Area between the two parties, the seaports among these countries are endowed with three functions: an interface linking waterborne and land transport between ASEAN and China; a production base for industries and centre for distribution of products to the global markets. If measured by weight, the dominant volume of traded goods between the ASEAN 6¹ and all of the major trading partners, including China, rely on sea transport.

2.1. The Industrial Agglomeration at Tieshan Port District

Our empirical case for study is Tieshan Port Industrial District in Guangxi Beibu Gulf Economic Zone, one of the three economic zones in China's western region. As a district of Beihai City, which possesses four ports along the city coastline at tip rim of Beibu Gulf, Tieshan Port District has an area of 394 km² with a population of 160 thousand. In history, Beihai city was one of the famous departure ports in the marine silk route. It is one of the nearest ports from mainland China to the port cities in Southeast Asia, at the same time functions as the most convenient gateway to sea for the southwest region in China.

According to the Development Scheme (2010), by 2020, Tieshan Port District will be developed into a heavy industry urban town with petrol chemical, integrated project of forest industry, pulp and paper, container manufacturing, harbor machinery, ship repair and other supporting industries as pillar economic output. Being an industrial port and production base, with a target of tripling the resident population within next ten years, Tieshan Port District has to identify and design a strategic complementary framework for the coming years of construction.

Built-in Port Industry Clustering Effect

Clusters are defined as a population of interdependent organizations that operate

¹ In this paper ASEAN 6 refers to Malaysia, Singapore, Thailand, Vietnam, Indonesia and the Philippines

in the same value chain and are geographically concentrated (Ring 2009). By concept, Tieshan Port District has a function of two clusters: port and manufacturing industry clusters.

According to the survey², surrounding the Beibu Gulf there are about 6 port clusters, located respectively in Singapore, Malaysia, Thailand, Vietnam, the Philippines and China Beibu Gulf Economic Zone. Of which, Vietnam and China are just at startup stage and no detailed information available yet. Table 2.1 (to be attached) provides some general information about the port business operations in the region. According to the study by the World Bank (2009), current major ports in this area have suffered from serious congestion with rapid growth in freight demand over the past decade. This is partially caused by the increasing trade volume, and partially caused by insufficient capacity, inefficient facilities and good management in those developing countries. Especially today when the landed cost of products constitutes the key end factor, current academic thought is that supply chain excellence, superior customer service and lowest cost to serve will allow ports to compete as crucial links within global supply chains (Ring, 2009). Judged by the isolated operation nature of Tieshan Port, it now still stays at the first stage of port development. It needs to transcend itself up to the second stage to become a connected port, and on to the third stage, the port community and reach the highest stage-a port community connected to the world (Table 2.2, to be attached). It can be envisaged then that the potential competitive capacity building should be built on the built-in effect created by the port positioned in the regional marine industry network.

Industrial Agglomeration Effects

The firms located at the industrial parks in Teishan Port District ranged from petro-chemistry, new metallurgic industry, pulp and paper, wood production and shipbuilding and repair industries. An export processing zone is also planned in the port district. All of these are designed to be an integrated production model. The three enterprises ready for operation within next year are all leading transnational corporations. For the petro-chemistry, the flagship investor, the state-owned Sinopec Group, one of the top 50 global oil companies, will complete by September 2011 a 200 thousand tone-per-year polypropylene plant that produces plastic intermediates. It is also under the plan to build a 3.2 million cubic meter (20 million barrel) commercial

² Bureau van Dijk Editions Electroniques SA, **Osiris**, <http://www.bvdep.com> via <http://lib.bjut.edu.cn/>

crude oil storage base at the Tieshan Port. For metallurgical industry, Chengde Stainless Steel Co., Ltd, a private company, with a registered capital of 100 million Yuan, is to build up a stainless steel plant integrating the upstream to downstream productions into one site. For pulp and paper production, Store Enso, the world top paper product company is to establish large scale eucalyptus fiber base in Southern Guangxi and invest in setting up an integrated forest-pulp-paper industry at industrial park in Tieshan Port District.

By nature the format of Tieshan Port industrial parks is not a typical industrial cluster, as the firms there are all unrelated industrial sectors. According to UNIDO's analysis (2009), this type of industrial agglomeration is more closely related to urbanization. The externalities that arise from this type of clusters may be found mixing. From the economic development point, multi-industry cluster may create general manufacturing competence in less developed area at earlier stages, and push up the investment in local infrastructure and quick growth of GDP. At the same time it will expedite the progress of urbanization and upgrade the general living standards. But from the sustainable development aspect, the cluster of energy intensive industries in one area will undoubtedly raise the issues concerning measures to realize industrial energy efficiency and mitigate climate change. According to the studies by UNIDO (2009a), petrochemical, iron and steel, pulp and paper are on the top list of energy use, accounting for 51% in total industry energy use. The layout of industrial sectors at Tieshan Port District seems to fall into an energy trap. Potentially, there exists a risk of sacrificing the environment for economic growth.

2.2. Regional Cross-border Value Chain Effect

According to the statistics (ASEAN, 2008), the import share of manufacturing sectors in six ASEAN countries ranges between 54.1 % (Vietnam) to 83.5% (Malaysia). Comparatively the export share of manufacturing sectors ranges from 46.5% (Vietnam) to 79.4% (Thailand). Comparing the top 10 export and import commodities from ASEAN to China, there are six groups of commodities that are traded in the same category by 2-digit HS code, including electric machinery, equipment and parts, mineral fuels, mineral oils & products of their distillation, iron and steel, plastics and articles thereof. All of these together accounts for about 62% on average for the total trade share. This data helps testify that the development of cross-border intra-industrial production network between ASEAN and China is

picking up momentum.

For the case of Tieshan Port industrial establishments, the present business arrangements are rested on the advantages of seaport location and lower initial costs for startup. There is a prospect that these leading transnational corporations (TNCs) may assume a key role in organizing and controlling the cross-border network production systems, benefiting from location differences in costs, infrastructure, capabilities in manufacturing, marketing and logistic, and in trade and investment regimes (UNIDO,2004). It can be envisaged that the operation of cross-border network production will create positive effects on competitiveness, cross-national transfer of new technology, ideas, skills, knowledge and learning. But admittedly with the prospect of welfare gains creation, there must be a set of uncertain variables to be counted, of which there are issues concerning value-added production strategy, market analysis and coordinating the network partners for profit maximization and better governance.

To conclude, Tieshan Port District possesses geographical, marine logistic and industrial competence advantages, but at the same time confronts the bottleneck problems in both material and social resources efficiency. The challenges for Tieshan Port people are how to design a development strategy that may sustain a steady economic growth at the time ensure general social welfare and environment security.

3. The strategic complementarity theory and multiple equilibrium

3.1. The Concepts and literature review

The strategic complementarity in development economics is a concept of force created by network externalities for coordination among agents. According to Ray (Ray, 2001 and 2007),economic development is a series of coordination actions taken by multi-agents of investments. The externality effects created by the complementary actions could increase the marginal benefit to other agents taking similar coordinative actions. However, the gaps of aspirations between different agents may cause “a massive coordination failure”, because the deliberate actions taken by agents are conditioned by diverse factors including distribution of economic and political power, legal structure, traditions, specific institutional settings and so on. This coordination failure may lead to the occurrence of multiple equilibrium, which is ranked by welfare criterion. Different agents are tracked into different levels of equilibrium and with the complementary forces both external and endogenous, the transition from lower level

to higher level of equilibrium may occur.

Different from the conventional growth theory (Solow, 1956) that the law of diminishing returns will make all economies in the long run converge to one another, the strategic complementarity theory is built on no convergent growth notion, and the variables that potentially make for underdevelopment could also be affected and transformed by the development process. This raises therefore an issue of calibration, that is, what are the plausible parameters that lie at the heart of strategic complementarity and how to bridge the model to data, especially in the context of ongoing process of regional production integration?

By far, a lot of discussions have been focused on the nature and mechanism of strategic complementarity (Cooper, 1988 and Erikson, 2008), the empirical study on welfare assessment is somewhat limited and insufficient, not to mention a practical benchmarking index system.

3.2. The Application of Strategic Complementarity Theory in Empirical Study

In the context of China-ASEAN free trade agreement (FTA), the significance of the strategic complementarity has its value in two aspects. First, it helps us to look at the production networking from the point of cross-border Pareto-dominance. Based on the hypothesis that each member government would encourage the cross-border business operations on the assumption that they would create increasing returns on investment, but most often the aspiration failure may cause the expected collective actions unfulfilled, especially when relating to cross-border public goods where collective actions are the paramount for regional economic sustainability. Second, it sets up a theoretical framework for understanding and interpreting the different growth rates and economic results among developing countries.

Analytical tool

To facilitate the analysis, we adopt a value chain diagnostics for cross-border industrial production network to detect the dormant coordination failure and identify the optimal choice for value-added production chain and complementary opportunities for development. This is a generic approach to industrial development promoted by UN Industrial Development Organization (UNIDO, 2009). A value chain, by definition, is “a set of businesses, activities and relationships engaged in creating a final product or service”. It describes “how producers, processors, buyers, sellers, and

consumers, separated by time and space, gradually add value to products as they pass from one link in the chain to the next”. (UNIDO, 2009). The utility of this analytic tool is that it enables us firstly to identify the link points where the potential conflict may occur and where coordination may be required for intervention and collective actions and secondly to track down the threshold between each self-sustained operation system at different value chain links. As the cross-border production can be viewed as a set of connected, interdependent growth models, and the self-sustained equilibrium of each model is conditioned, sustained and then retargeted and remodeled through endogenous factors under the forces from external variables, the strategic complementary actions should be taken at the points where the collective actions fail or crash. To illustrate, Figure 3.1 sketches diagnostic tracking map for the component data blocks in one section of value chain. It is understood that a whole value chain is a set of sections, each functions as a self-sustained and dependent equilibrium system.

Parameter setting

Compared with the conventional growth theory that uses a set of economic and demographic calibrators for different development stages, the value chain diagnostics for strategic complementarity analysis, however, expands the scope of calibration to take in two more separate blocks of data: resources efficiency, environment conservation, and institutional factors. Each block of data is computed and a time series scoreboard is constructed for comparison and analysis (UNIDO, 2004). Though this eases quite a lot complicated mathematic work, it seems insufficient in providing plausible interpretations with measurable parameters. From the literature available on hand, by far there has been no generic econometric models devised for measuring the synergistic effects caused by interactions between different self-sustained economic equilibrium.

For the purpose of designing an econometric tool to measure different production behaviors in the value chain, we introduce a multiple equilibrium model system to integrate the separate data blocks into a multiple equilibrium development system indices.

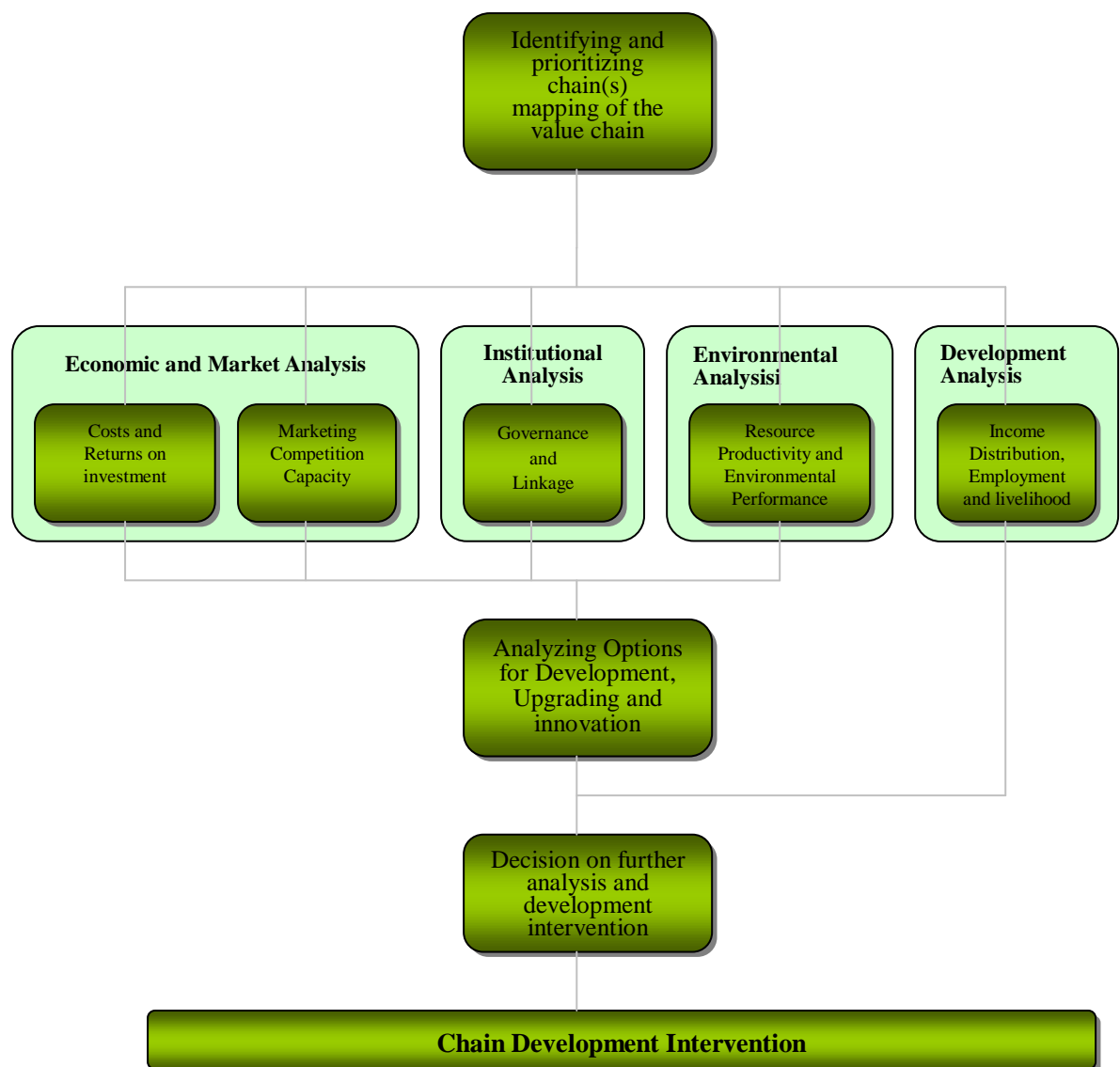
Based on the findings by UNIDO, we adopt its basic analysis framework and put in parameters that we consider of significant importance in deciding the production strategies. The whole analysis consists of four sections. The key data analysis sets

include four block analysis, to be explained as follows:

Step One: Identifying the types of value chains. For the study on Tieshan Port industrial development, we focus on cross-border operations type with a global value chains, specifically tracking down the potential trade route for petrochemical products, stainless steel products, paper products and ship repairs around the Beibu Gulf.

Step Two: Building blocks of value chain analysis. Based on the hypothesis that the efficient performance of a business operation should create positive externalities to be availed by linking section in the value chain. The major factors that we

Figure 1. Flow Chart for Single Section Generic Value Chain Analysis



Adapted from UNIDO, 2009

consider as closely related are:

(1) Economic and market calibrators. Within this block there are two subsets. The first set is production competitiveness capacity index including: costs, and returns on investment. The second set is marketing competitiveness. It includes market share index, pricing strategy effectiveness index and marketing efficiency index.

(2) Institutional analysis. For the cross-border production network to develop, the role of both international and domestic regulations is definite in coordinating the decision orientations among different actors, which will indirectly affect the mode of value generation. The parameters for this may adopt social network analysis method to digitalize the transaction costs involved into index signals.

(3) Environment and resource efficiency analysis. For the Tieshan Port industries, we adopt environment impact assessment (EIA); the major parameters included are sources of energy being used and efficiency at different level of the chain, water use and contamination at different levels of the chain, pollution potentials such as acidification, and greenhouse gas balances.

(4) Development analysis. This block of data reflects the actual gains that community may receive from the business operations. It includes target population to be benefit from the value chain promotion, the net income at each level of a chain and different groups of actors, the employment changes, health, education and housing indices, etc.

Step Three and Step Four are the conventional strategic analysis processes used in decision making process.

4. Constructing Multiple Equilibrium System Indices for Quantity Analysis

4.1. Connotation and Components of the Multiple Equilibrium System Indices

The analytic target of multiple equilibrium system indices (MESI) is to provide a measurable chart for decision-making groups and governments to pinpoint the loophole in the production value chain and coordinate each other's actions for upgrading cross-border welfare and competitiveness capacity. The hypotheses has it that the optimum performance of regional economies should be a set consisting of positive synergistic performances from all the subsets in all the value chain sections, which can be described as:

$$C \in \{ S_1, S_2, S_3, S_a, R \}$$

$$S_i \in \{E_i, C_i, F_i\} \quad i = 1, 2, 3$$

where S_1, S_2, S_3, S_4 represents respectively economic block, resources and environment block, institutional block and development block. E_i, C_i, F_i denotes respectively the factor endowments, structure and performance. R_a is corresponding system, the linking section in the value chain. T denotes time, to reflect the dynamic nature of the multiple equilibrium system. The selection of parameters is based on the four block parameters in the flow chart of generic value chain.

4.2. The mathematic expression of multiple equilibrium development system indices

Based on the hypothesis that efficiency of resources utility determines the production format and social welfare level. We take an approach by pegging the production performance first to regional resources utility efficiency and develop an equation for resource utility level as:

$$\frac{dU}{dt} = rU \quad (4-1)$$

where U denotes the regional resources utility level, t is time, and r is the growth rate of regional resources utility without constrains.

Assuming when there exist no resources constrains, the compound equilibrium systems (economic and social development) will sustain a steady growth, correspondingly the level of resources utility level will increase, expressed as $dU > 0$, displaying a J shape growth curve or exponential growth, to be called Malthus growth curve. But this situation is not possible unless within a very short time period. However, there exists a threshold (i.e. resource carrying capacity). With the effect of a damping factor the resources utility growth model becomes

$$\frac{dU}{dt} = r'U \quad (4-2)$$

in which, $r' < r$, r' reflects the regional resources carrying capacity.

$$r' = r(1 - \frac{U}{B}) \quad (4-3)$$

B is the threshold of resources utility level.

With equations (4-2) and (4-3), we differentiate the variables and get

Logistic differential form as:

$$\frac{dU}{dt} = rU(1 - \frac{U}{B}) \quad (4-4)$$

Logistic growth model can be used to simulate biological growth and the dynamic changes of renewable resources quantities (Seidl, 1999; Meyer, 1999). Given the initial condition that $U(t_0) = U_0$, then the Logistic curve can be:

$$U(t) = \frac{B}{1 + R \cdot e^{-r(t-t_0)}} \quad (4-5)$$

$$R = \frac{B}{U_0} - 1 \quad (4-6)$$

To further examine the process of resources utility and growth speed, we get a second and a third derivative respectively for $U - t$ as (4-7) and (4-8):

$$\frac{d^2U}{dt^2} = r(1 - \frac{2}{B} \cdot U) \frac{dU}{dt} \quad (4-7)$$

$$\frac{d^3U}{dt^3} = r[\frac{d^2U}{dt^2} - \frac{2}{B} \cdot U \frac{dU}{dt} - \frac{2}{B} \cdot (\frac{dU}{dt})^2] \quad (4-8)$$

Table 4.1. Logistic Curve Analysis and Regional Resources Utility Level Stages

t	$(0, t_1)$	t_1	(t_1, t_0)	t_0	(t_0, t_2)	t_2	$(t_2, +\infty)$
U	Slow growth	0.211B	Quick growth	0.5B	Quick growth	0.789B	Towards stable
$\frac{dU}{dt}$	> 0 $U - t$ up	0.167 rK (turning point)	> 0 $U - t$ up	0.25	0.25 rK	0.167 rK (turning point)	> 0 $U - t$ up
$\frac{d^2U}{dt^2}$	> 0 $U - t$ concave		> 0 $U - t$ concave		< 0 $U - t$ convex		< 0 $U - t$ convex
	$dU / dt - t$ up		$dU / dt - t$ up		$dU / dt - t$ down		$dU / dt - t$ down
$\frac{d^3U}{dt^3}$	> 0 $dU / dt - t$ concave		< 0 $dU / dt - t$ convex		< 0 $dU / dt - t$ convex		> 0 $dU / dt - t$ concave
	startup		growth		Sustainable growth		Recession

Based on the three zero points A_1, A_0, A_2 form $U - t$'s second and third derivatives, we can distinguish the *Logistic* growth curve into four growth stages with the labels as startup stage, growth stage, mature stage and recession stage as Table 4.1 illustrates.

From Table 4.1. There are two ideal growth paths for resources utility efficiency. One is with the constrains of resources utility threshold to maximize its potential to sustain the optimal growth speed at $0.25 rK$, and second is to keep away from two extremes $U = 0$ and $U = B$ to stay at point $[t_1, t_2]$, that is growth and maturity stages. These two stages are considered as a period when different systems can meet and coordinate each other's self equilibrium for steady and sustainable growth.

5. Benchmarking the synergistic development of the seaport industry between ASEAN and China

With the findings above, we attempt at a preliminary appraisal method for cross-border production and to measure out the scope and strength of the externalities each self-equilibrium may produce.

Assume that the development process of each self-equilibrium will undergo the four *Logistic* growth stages, and at each stage it maintains its dynamic equilibrium. The externality that each period of equilibrium may occur will be the threshold for transcendence. The critical issues here are how to detect the occurrence of the threshold and identify its evolving route before we can decide what measures we may take to intervene.

The proposed system indices analysis can be streamlined as the following:

1. With global value chain diagnostics techniques (Step 1-2), the first step is to identify and segment the whole production line in the value chain into different segments with different value-added stages as calibrators.
2. Do the resources utility analysis and identify an ideal development range in each segment of value chain.
3. Match the Step One results to Step Two's growth curves and weigh and compare to see if there is convergent growth trend between the two curves.
4. Integrate the findings into global value chain analysis step 3-4, and work out the solutions.

As this study requires further empirical studies for application and pragmatic purpose, the papers here is only our preliminary findings and there are still a lot of

uncertain issues concerning each step of analysis, and will take our further efforts to consolidate them and eventually get a satisfactory benchmarking scheme.

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