Feasibility Analysis of Partial Cooperation between Government and Port in the Multiple Port System

This paper aims to consider the possibility of cooperative relationship among ports and government for efficient port management in the southern part of Viet Nam. First, we obtain parameters of the Vietnamese shippers' port choice behavior by using the disaggregated data. Second, we start with the equilibrium analysis under this situation as the base case. Third, we carry out the feasible study of the government port vertical cooperation for improving social benefits. Our results show that the government-port vertical cooperation scheme for port charges is feasible and more efficient than the port expansion in the southern part of Viet Nam.

Keywords ***port coordination, vertical cooperation, shipper' behavior***

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1――Introduction

The seaborne freight transport occupies about 80 percent in the global trade. Moreover, this share is even higher in most of developing countries[1). China has become one of the largest consumption market, and the trend of relocating production plants from China to Southeast Asian countries have been stimulating the intra-Asia container shipping market. Looking at the shipping connection and service level in the intra-Asia, these have been improved significantly for last two decades. The number of direct services has increased at not only hub ports but also feeder ports[2)], such as Ho Chi Minh City (HCM) and Cai Mep (CM) port.

Along with the rationalization of small-medium sized container ports with high growth rate in the export-based countries, such as Viet Nam, these ports have created new trends for container port developments. However, one common problem for Southeast Asian countries including Viet Nam is the "big gap" in transport infrastructure development among countries. The growth rate in container freight and passenger vehicles has exceeded the increase rate of capacity of surface infrastructure in megacities. Although Viet Nam has followed the socialist's orientation for controlling the market since 1986, in the era of internationalization, many stakeholders in freight transport market, say, shippers, carriers, and freight-forwarders may not have a place for policy making in Viet Nam. Hence, the government-planned mechanism reveals its weaknesses when trying to re-bundle freight commodity flows in the multiple stakeholder port system.

As for researches about container port competition, various papers have studied the competition and cooperation among (major) ports. They challenge this target by the network design approaches[3)-5)]; game theory[6)]; contestability[7), 8)], and the multitude of participants concern[9)]. When dealing with cooperative schemes in transportation, there are two main research streams defined as "vertical cooperation" and "horizontal cooperation". Horizontal cooperation has been studied among ports[5), 8), 9)], among shippers[10)-12)], and among carriers[13), 14)]. These researchers have the following assumption: ports aim to seek revenue or market share growth; carriers mainly aim to reduce costs in the competitive market. As for shippers, they are assumed to collaborate in order to negotiate better rates with carriers. Asgari et al.[5)], study the vertical cooperation between shipping companies and the hub port, and they find that forming strategic alliances with leading shipping companies can help to guarantee the market share in medium and long range.

The researches mentioned above researches mainly focus on the competitive and cooperative relationships among a few mega hub ports: Hong Kong vs. South China Port, Busan vs. Shanghai, Singapore vs. Klang port, etc. These ports whose waterfront and infrastructure for port connectivity has been sophisticatedly built can provide high productivity and good service for port users. But, on the other hand, few ports can enjoy the success in the competitive market. Studying the relationships among stakeholders relevant to these successful ports will contribute to the emerging and newly developed ports: in particular, the policy and implications will be beneficial for infrastructure and port development.

One possible strategy is the "co-opetition." This idea means the partial cooperation in the competitive market[8]. This strategy has been widely applied in the supply chain and logistics management. A prominent example of this relationship is the General Mills Yogurt and Land O' lakes butter delivered by the same truck, en route to the same supermarket[15]. Chen and Chang[16] investigate the "co-opetitive" strategy of a closed loop supply chain which incorporates with remanufacturing. Li and Zhang[17] propose a new model that allows shipping forwarders to share their shipping capacity before setting the selling prices and satisfying demand from shippers. Caballini et al.[18], study the collaboration among multiple truck carriers in the seaport containerized environment for maximizing their total profit. Hafezalkotob[19] applies the concept of "co-opetition" to consider how to improve energy-saving efforts to improve the performance of rival green supply chains given the financial interventions of the government.

Regarding port "co-opetition", Song[8] proposes this interesting idea of selective competition or partial cooperation. He argues that the desired competition scheme for major ports in the future is to "find the companies, get together and compete with rivals." Their suggestion also means that the port consortium can improve their port productivity by economy of scale. The important point is to find "what kind of partial cooperation works well." But, both United Nations Conference on Trade and Development[20] (UNCTAD) and Song[8] confirmed that a balance between cooperation and competition should be found to secure commercial and social interests, and this balance varies with the case, the country, and the region. UNCTAD suggests that a cost/benefit analysis should be carried out to know if it is better to compete or to cooperate.

This paper aims to form a competition model by which we can measure the welfare included port users' benefits. We also carry out the scenario studies on the partial coordination of port/government-shipper and evaluate the feasibility of the partial cooperation.

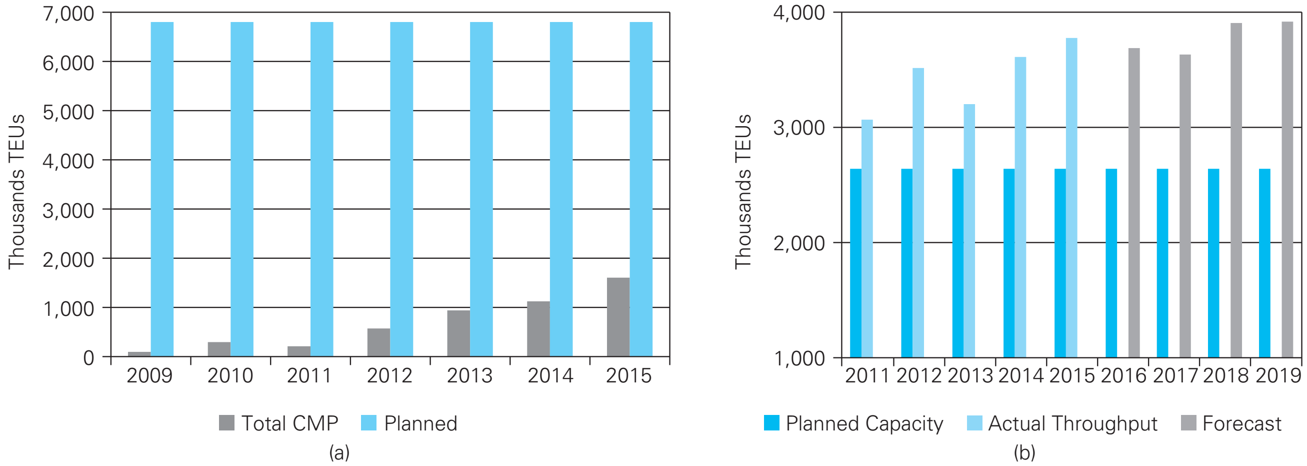
This paper has four bodies. Section 1 is introduction. Section 2 describes model structure and formulation. Section 3 demonstrates port choice model with parameter estimation for short-haul transport for shippers from the southern part of Viet Nam, finding the best response strategies for each port when there is no cooperation, and shows the results of scenario studies of CM port/government coordination. Then we discuss the feasibility of subsidy plans in each case. Concluding remarks are presented in the final part.

2——The model

2.1 Description of problem

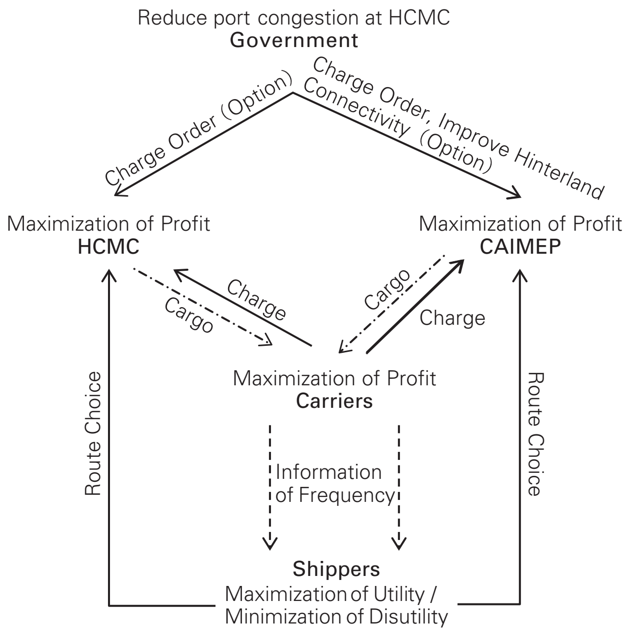
In this paper, we focus on the situation in the southern part of Viet Nam. This area has two ports: one is HCM and the other is CM.

Port 1 (HCM), which locates nearby the Central Business District-/CBD, holds about 70 percent of total regional container handling throughput. Port 2 (CM) has been newly developed port since 2009 and it has a deep draft which can invite bigger vessels compared with HCM. Thus, CM is more competitive against HCM for long-haul transport cargo. But, in terms of short-haul transport services, most shippers choose HCM port for export. Choosing HCM export has a long history and then this "custom" cannot be changed easily



Source: authors composed data from Tran and Takebayashi [2014][22)]

■Figure—1 Observed throughput and planned capacity of CM 2009-2015 (a); Planned capacity 2011-2019, observed throughput 2011-2015, and forecast 2016-2019 for Cat Lai Terminal of HCM (b)



■Figure—2 Relationships among stakeholders for freight transportation market in South Vietnam

because (i) most of the trading contracts are signed in f.o.b (free-on-board) terms by which exporters are responsible for paying inland-drayage cost to port of loading, (ii) the close proximity of HCM port is attractive for shippers to minimize the transport cost. Viet Nam becomes more integrated into regional economic activity and then the economic initiatives such as ASEAN Economic Community, Free Trade Agreement with ASEAN-China, and potential Trans Pacific Partnership/TPP will stimulate seaborne freight cargo flows in the intra-Asia. HCM port works as a gateway port for South Viet Nam, and then HCM will face serious port congestion within a decade.

The cause for congestion could be traced back to the Five-Year Master Plan of Port Development since 2011[21)]: the central government ordered that the new port CM takes over the role of gateway port for the southern part of Viet Nam because HCM port cannot expand its capacity. One might think that HCM port can act as the secondary port gradually. However, five years later, the government's survey suggests that the market does not perform as what had been planned. Panel (a) and (b) of Figure—1 show the big gap between planned data and market data of two ports.

To find a solution for the problem of over-investment in CM and heavy congestion in HCM, it is necessary that we set up the central government's objective in a larger context where we consider the benefit of shippers, ports and carriers. Figure—2 shows a model structure that includes all stakeholders in the market. Looking at Figure—2, we consider four types of player Ministry of Transport is placed in the top layer on behalf of the central government; terminal operators is in the second layer; the carrier is in the third; shippers are at the bottom. The behavior of terminal operators affects the carriers' and shippers' behavior. The relation between carriers and shippers is dependent on each other. Thus, this problem can be regarded as the family of supply-demand interaction problem.

The government has some options of port management policy. The government has a strong presence in the market that has the power to influence shippers' decision by requesting ports their handling charges. The government is the major shareholder of both ports, and the government is also in charge of constructing waterfront infrastructure, navigational channels, and surface transport connectivity with ports. Then, the government has an opportunity to control cost factors such as terminal handling charges (THC), ship tonnage tax, and inland drayage cost, and time factors such as inland drayage time. We will proceed to the scenario studies for evaluating the policy options.

In addition, we assume that the government aims to reduce the port congestion at HCM port. Improving the welfare consisting of shippers' utility and ports' profit will be discussed from the different point of view later.

Although the full model is shown in Figure—2, it is too complicated to handle. Since we focus on shippers' route choice behavior reflecting each port's strategy, we simplify the model structure as the carriers take the passive roles. This means that carriers change service frequency for matching the cargo flow but they do not change charges. Eventually, we have three players: the shippers, the ports, and the government.

2.2 The general formulation of the model

2.2.1 The government

The government aims to minimize the congestion on the inner-city port. The port congestion formulation is given as

$$TP^h / PC^h \ , \tag{1}$$

where TP is the throughput at port h; PC is the planned capacity. The objective functions of the government is relevant to the scenarios and then we show them in the scenario study part.

2.2.2 Terminal operator/ Port

Terminal operator i's purpose is to maximize its profit by controlling port charges loaded by carriers. Let the port charge of terminal operator i at port h be ρ_h^i; ρ_{-i} is port charge of the rival port . In the following formula, l^n means the link operated by carrier n. Gathering containers bring more profit to the terminal operator, and then the profit maximization is formulated as

$$\Pi^i\left(\rho^i, \rho^{-i}\right) = \sum_h \rho_h^i \sum_{l^n} x_{l^n} \delta_h^{l^n} \ , \tag{2}$$

subject to

$$x_{l^n} = \sum_{rs} \sum_k x_k^{rs} \delta_{l^n}^{rsk} \text{ for } \forall l_n \in I^n \ , \tag{3}$$

where x_{ln}: cargo flow on link l^n; δ_h^{ln}: binary variable take one when link l^n at port h, otherwise take zero; x_k^{rs}: path flow on kth route of rs OD pair (origin r destination s); δ_{ln}^{rsk}: binary variable take one when link l^n on kth route of rs OD pair, otherwise it takes zero. l^n: a set of links operated by carrier n.

2.2.3 Carriers

The intra-Asia transport market is assumed to work as the perfect competitive market. Then we skip the identification of carriers and drop n from the formula. Under the perfect competition, carriers can gain maximum profit as zero, and the ocean tariff q_l should be given as the marginal cost. Operating cost per vessel is defined as C_l, and the capacity is v_l. When the carrier sets the service frequency with 100 percent load factor, the tariff should be constant and shown as:

$$q_l = C_l / v_l \ . \tag{4}$$

2.2.4 Shippers

Shippers' aim is to maximize the utility as much as possible. In order to achieve this, they decide to choose the routes and ports carefully. Their objective function is given as

$$u_k^{rs} = (+)\beta_1 \sum_l Size_{l,c} \delta_{rsk}^l (-)\beta_2 \sum_{l,c} \frac{1}{Ofreq_l^c} \delta_{rsk}^l \ , \tag{5}$$
$$(-)\beta_3 T\cos t_k^{rs} (-)\beta_4 Ltime_k^{rs}$$

where

$$T\cos t_k^{rs} = OF\delta_{rsk}^l + THC_k^h + L\cos t_k^{rs} \tag{6}$$

The signs in the brackets are the expected signs by the parameter estimation.

In the eqn. (5), we define: *Size*: vessel capacity of carrier c in TEU on link l; $\Sigma 1/Ofreq$: inverted sailing frequency in one month; *Ltime*: inland drayage time (in days); *Tcost*: generalized total cost; *OF*: ocean freight; *THC*: container handling charge at port of loading h; *Lcost*: inland drayage cost for shipment kth.

3——Parameter estimation and scenario studies

3.1 Parameter estimation

We need to estimate the parameters for applying our shipper model. In this subsection, we briefly show the process of parameter estimation.

3.1.1 Data

We aim to develop the port choice model for shippers based in the southern part of Viet Nam, particularly the intra-Asia transport flows; our targets are Hong Kong, Kobe, Manila, Nagoya, Osaka, Shenzhen, Tokyo, and Yokohama ports. The reason we decided to choose short-haul transport market is that HCM port are now dominating in the intra-Asia transport, while CM takes over the transpacific transport. Our research goal is to help proposing plans to reduce the congestion at HCM. Hence, in this sub-section, we decided to find out attributes influencing port choice of shippers in the intra-Asia freight market.

For this aim, we need to gather the comprehensive OD data, but unfortunately, Viet Nam does not provide the comprehensive OD data. Thus, we built the dataset by contacting multiple port stakeholders in Viet Nam. First we collected individual container information (shipping route from origin port to final destination port via transshipment port, carrier, type of service, port dwell time, and vessel size) from major container terminal ports in the southern part of Viet Nam, namely Cat Lai Terminal in Ho Chi Minh City, Tan Cang International Terminal and Cai Mep International Terminal in Ba Ria Vung Tau Province in May 2015. Second, we interviewed several Ho Chi Minh City-based container carriers, trucking companies, and Tan Cang Waterway Transport JSC about the ocean freight and local transport costs. Third, we gathered the information about the ocean service frequency from MDS Transmodal. By combining the information from the several sources, we have a unique dataset which is composed of totally disaggregated information.

We obtain four alternatives of port-inland drayage model. The inland drayage factors include “total transport cost” and “local transport time”. Our hypothesis is that ocean freight for the intra-Asia trade routes do not vary with the port of loading. The dataset includes 5,760 samples composed of eight OD pairs: each shipper has four shipping route alternatives, namely CM-Barge, CM-Truck, HCM-Barge, HCM- Truck. For CM, 52.5% of shipments were delivered by river barge, and 4.67% came by truck. HCM port, by contrast, received 39.4% of shipments from truck and 3.33% from barge.

3.1.2 Results

For estimating parameters, we apply the maximum likelihood method using N-LOGIT ver 4.0. The summary of result is shown in Table—1. Three out of four coefficients are statistically significant (see P-statistic in Table—1). All the signs of obtained parameters are as expected in eqn. (5). McFadden’s R^2 is 0.16, which is approximately 0.45 which is equivalent to R^2 of the linear regression model[23].

In the detail of estimation, we can say that shippers prefer port that can attract larger container ships. Increasing the service frequency would be desirable for shippers. This factor can be regarded as the most critical factor because the absolute value of parameter is 3.58. The second rank of significance is the generalized total cost, while the inland-drayage time is not so important to shippers.

Figure—3 depicts the comparison of the

■Table—1 Parameter estimation

Variable	Coefficient	Standard Error	Z-statistic	P-Statistic
Vessel size (TEU)	0.00086	0.0000193	44.41	e^{-4}
Inverted Frequency (vessel/month)	−3.588	0.354	−10.13	e^{-4}
Total cost (USD)	−0.0126	0.00026	−48.06	e^{-4}
Inland time (days)	−0.00201	0.0058	−0.34	0.73
Loglikelihood (base)	−4339			
Loglikelihood (coefficient)	−5032			
Pseudo R^2	0.16			

observed and computed OD cargo flows. Seeing Figure—3, the model overestimates or underestimates in some OD flows. However in spite of the limited information, the model can provide relatively good reproduction. Thus, we can use this model for further scenario studies.

3.2 Scenario studies

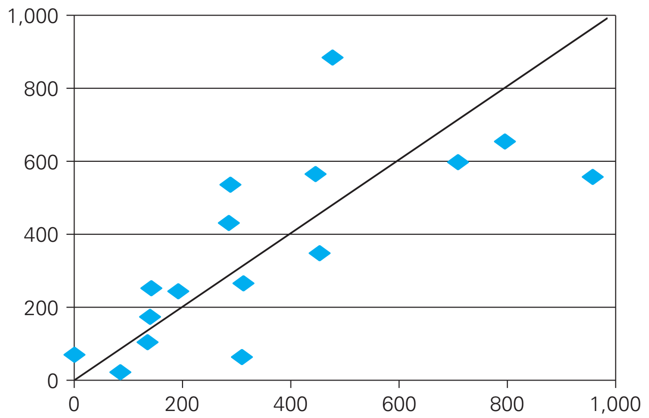
In this subsection, we carry out some policy scenario studies to confirm the workability of policy options we set up. We start with non-cooperative situation as Base Case. As for the solution, we adopt the Nash equilibrium as the equilibrium solution in the port competition layer. After analyzing Base Case, we turn to the scenarios of partial cooperation between the government and one port (CM), while two ports are competing against each other.

3.2.1 Non-cooperative situation

Under the non-cooperative situation, the government has no chance to improve the port congestion at HCM without forcing.

In the following study, we assume "one port one operator" because we mainly want to focus on the competitive relation between ports and avoid handling too much complex structure of the market. Under this assumption we consider each port aims to maximize their profit by controlling the handling charges. Based on the formulation shown in eqn. (2) and (3), the problem of port h can be simplified as

$$\max_{p^h} \pi^h\left(p^h, p^{-h}\right) = \sum_r \sum_s \sum_k p^h x_k^{rs} \delta_h^{rsk} \qquad (7)$$



■Figure—3 Comparison of observed and computed distribution of shipments (unit: boxes)

Subject to $p_l^h \leq p^h \geq p_2^h$.

In the formulation, we define: p^h: handling charge at port h, p^{-h}: handling charge at rival port; x: cargo flow from r to s on kth route; δ_h^{rsk}: binary variable which takes one when route k on rs OD pair use h; otherwise takes zero.

We assume the logit type flow allocation, and then the cargo flow x_k^{rs} is given as

$$x_k^{rs} = X^{rs} \frac{\exp\left(u_k^{rs}\right)}{\sum_{k'}\left(\exp\left(u_{k'}^{rs}\right)\right)}. \qquad (8)$$

In this application, we propose three different levels of handling charge for one twenty-foot equivalent unit (TEU), which are 20, 40, and 82 USD. The upper limit, 82, is the official port handling charge[24]. There are exactly nine combinations shown in Table—2.

The matrix (i.e., the nine squares in Table—3) contain the payoffs, i.e. profit, to HCM port (on the left-hand side) and to CM port (on the right-hand side), corresponding to above combinations. Table—3 shows the matrix of profit of each port and we can find a Nash equilibrium. Table—3 says that both ports choose the highest possible price, 82 USD per TEU. The gained profits of HCM and CM port are 258,710 USD and 377,774 USD, respectively. The market shares of CM and HCM at Base Case are 58 and 40 percent, respectively. The rest of shipments are diverted to other port. The total disutility of shippers is obtained as -11925.

3.2.2 Partial cooperation between government and the port

When we consider the cooperative situation

■Table—2 Matrix of port charge combination

	CM 20$	CM 40$	CM 82$
HCM 20$	(HCM20, CM20)	(HCM20, CM40)	(HCM20, CM82)
HCM 40$	(HCM40, CM20)	(HCM40, CM40)	(HCM40, CM82)
HCM 82$	(HCM82, CM20)	(HCM82, CM40)	(HCM82, CM82)

■Table—3 Profits of HCM and CM port under the non-cooperative situation(in USD/month)

	CM 20$	CM 40$	CM 82$
HCM 20$	(63700, 93300)	(72680, 168400)	(89420, 275356)
HCM 40$	(149160, 82260)	(127480, 185640)	(148920, 330214)
HCM 82$	(160884, 116960)	(187370, 220400)	(258710, 377774)

Unit: USD/ month

■Table―4 **Four scenarios of CM- government coordination**

Case	Description
1	CM reduces THC to 40 USD per TEU
2	CM reduces THC to 40 USD per TEU, Trucking cost to CM decreases by 25%
3	CM reduces THC to 20 USD per TEU
4	CM reduces THC to 20 USD per TEU, Trucking cost to CM decreases by 50%

■Table―5 **Profits of HCM and CM port under cooperation (in USD)**

HCM	Case 1 (1)	Case 2 (2)	Case 3 (3)	Case 4 (4)
20$	(72680, 168400)	(68580, 176720)	(63700, 93300)	(63820, 93180)
40$	(127480, 185640)	(128200, 185240)	(149160, 82260)	(84480, 113780)
82$	(187370, 220400)	(169002, 229840)	(160884, 116960)	(116850, 128460)

among players, we need to assume the following conditions.

1) Ports can have cooperation if and only if all players have the cooperation. Otherwise, they compete with each other.

2) Under cooperation, each player accepts the contract of "keeping the improving ratio bigger than ε(%)."

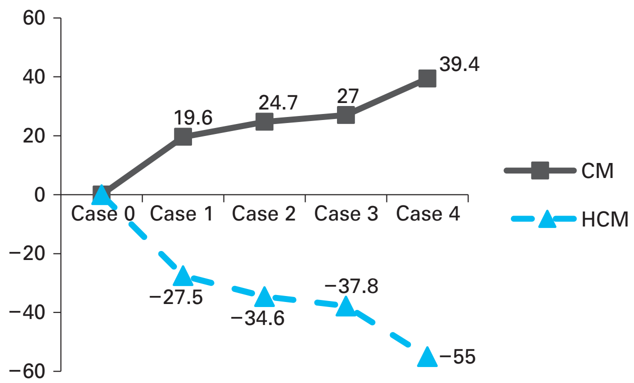
Condition 1) is for avoiding the cartel among ports. Under this competitive situation, the Nash equilibrium is equivalent to the cartel solution. Then, usually this kind of situation is not desirable for other players i.e. government and shippers. Thus, we have the strict assumption that this kind of cartel is acceptable if and only if the government and shippers' benefit is improved.

Condition 2) seems to be a strict condition for obtaining the rational solution as the cooperation. We consider the negotiable solutions among players. Then, ε should be given by scenarios. The government always considers improving total shippers' utility (ε_1) and HCM port congestion (ε_2) as much as possible. The improvement of shipper's utility (ε_1) in this case is the percentage of decrease in total (dis)utility of the market from eqn. (5) compared with Base Case. Next, the improvement of port congestion (ε_2) in HCM port is defined

$$\varepsilon_2 = \left(X_n - X_0\right) / X_0 , \qquad (9)$$

where X: total cargo volume (TEU) of HCM port in scenario n; 0: Base Case.

We set up some scenarios in Table―4. First, we consider the simple cooperation between government and CM: the government negotiates with



■Figure―4 **Impact of THC and Trucking cost at CM on cargo volume change (%)**

CM port about lowering handling charges (Case 1 and 3). The following scenarios are of additional "incentives" for succeeding the CM port coordination: we set up that the trucking cost to CM is decreased by c_1 and c_2 percent (case 2 and 4). For each change in charging policy of CM port, we assume that HCM port faces the competitive situation, thus, it will choose the pricing strategy that maximizes profit. The corresponding profits are shown in Table―5 (see column (1), (2), (3), (4)). In each cell, HCM's profit is on the left hand side, and CM's is on the right hand side. The Nash equilibrium between two ports under cooperation can be obtained when HCM chooses the highest possible price (82 USD) to gain the highest possible profit.

Figure―4 describes the impact of port charges and trucking charge policy on cargo volume of CM and HCM. From the figure, we understand that the reduction of port charge and/or trucking charge at CM will directly decrease the share of HCM port.

Table―6 compares the ε_1, ε_2 improvement of shipper's utility and port congestion under different scenarios which are proposed by government.

From Table—5, our findings are:

1) Even though CM port's cargo share is increased in each case (see Figure—4), it does not compensate for their loss of profit (see column (3) of Table—6). Then, subsidy programs are needed to have CM port's coordination. From the government viewpoint, the solutions seem to be feasible if the subsidy is less than the value of improvement on port congestion and shippers' utility.
2) If the government aims to reduce congestion by less than 30 percent, scenario 1 is an option. CM port's coordination is charging the THC by less than 50 percent of Base case. Their loss of revenue is 157,374 USD a month.
3) If the government aims to reduce congestion by less than 40 percent, scenario 2 and 3 are acceptable. In Case 2, trucking companies share the loss of revenue with CM if they agree to charge less than 25 percent for delivering shipments to CM port. In case 3, CM port reduces its THC to 20 USD per TEU, and then shippers will choose CM more. As a result, the total disutility decreases by 26.2 percent.
4) If the government intends to reduce congestion more, say, more than 50 percent, CM handling charge needs to be declined by 75 percent, and the trucking rebate is 50 percent (see case 4). Shippers and government have the biggest benefit in this case, but the trade-off for this is the total loss of 480,316 USD per month.

3.2.3 Feasibility study of subsidy plans

As mentioned above, evaluating the feasibility of these coordination is an important step to confirm whether cooperation will bring benefit to each port, shippers and the society (in terms of reducing port congestion). A subsidy plan seems to be feasible if it is smaller than the total improvement of port congestion and shipper's disutility. To measure the disutility (ε_1) and port congestion (ε_2) in monetary value ($), we formulate

$$\varepsilon_1^{\$,n} = \sum_n V_k^{rs} \Big/ \beta_3 \ , \qquad (10)$$

where $\sum_n V_k^{rs}$: total disutility of shippers in scenario n; β_3: estimated parameter for generalized total cost in (5).

The total amount of the budget of Ho Chi Minh City Authority to improve HCM port connectivity infrastructure for 2016-2020 period[25), 26)] is 242 million USD, and then this cost can be regarded as the total congestion cost by the government. Assume that every percent of decrease of ε_2 (see column (2) of Table—6) equals to the savings ratio of congestion cost. The monetary value of congestion improvement equals

$$\varepsilon_2^{\$,n} = \varepsilon_2^n \times 242000000 \times 4\% \big/ \left(5\,years \times 12\,months\right), \qquad (11)$$

where 4% is the share of in-sampled cargo in our computation compared with the total intra-Asia trade volume.

Table—7 lists the corresponding results of improvement for shippers and port congestion in monetary value in each case.

The result in Table—7 shows that there are two feasible port cooperative schemes, case 1 and 3. Both cases can generate more total improvement for the society than the subsidy (see column (3) and (4)), thus both social and commercial interests are secured. This implies that the coordination strategy with CM port where they discount handling charges for shippers might be feasible in practice.

■Table—6 Pay-offs of players under scenarios

Case	ε_1 [a] of disutility (1)	ε_2 [b] of port congestion (2)	Loss of CM port [c] (3)	Loss of trucking charge[d] (4)
1	−16.6	−27.6	157,374	0
2	−16.5	−34.7	147,934	102,123
3	−26.2	−37.8	260,814	0
4	−34	−55	249,314	231,002

[a, b]: in %, [c, d]: USD per month

■Table—7 Cost/benefit analysis for CM port and drayage charge policy (in USD)

Case	Disutility improvement (1)[e]	Congestion improvement (2)[f]	Total improvement (3)=(1)+(2)	Total subsidy (4)[g]
1	157,143	44,528	201,671	157,374
2	156,111	55,983	212,094	250,057
3	248,333	60,984	309,317	260,814
4	321,429	88,733	410,162	480,316

[e]: $U_n^{\$} - U_0^{\$}$ according to eqn. (10); [f]: according to eqn. (11); [g]: total loss of revenue of CM and trucking company in Table—5

3.2.4 Other forms of cooperation

Besides port-government vertical relationship, we tried other scenarios about the barge carrier-government cooperation (case 5) and horizontal cooperation between two ports (case 6, 7) under the government financial intervention. In case 5, river barge cost to CM is reduced by 25 percent. In case 6 and 7, HCM agrees to fix the THC at 150 USD, while CM's THC is 40 and 20, respectively. In the same way, the cost/benefit analysis on these cases is conducted. Table—8 represents the result. As total improvement is less than total subsidy, we find that these forms of collaboration are not feasible.

4——Concluding remarks

This paper deals with the port management issue in the southern part of Viet Nam and discusses the feasibility of government-port vertical cooperation for solving the management issue. We apply the game theoretical approach for tackling this issue considering Vietnamese shippers' route choice behavior. By setting some scenario studies, we carry out the feasibility study on port and drayage charge policy coordination between the government and CM port in order to reduce congestion at the inner-city port, and to improve shippers' benefits.

Our results suggest that the port charge coordination plan with subsidy can be feasible and more efficient than the port expansion of HCM. This suggests that the port expansion is not the only way to reduce the congestion and to improve shippers' benefit in the southern part of Viet Nam. The vertical (partial) cooperation between the government and not-congested port, i.e. CM, can be more efficient and workable in terms of cost/benefits. Viet Nam has suffered from the big gap between the planned capacity and the actual demand, and then the approach from the viewpoint of management of multiple port system can be a useful option. But, this workability, of course, should be confirmed from the wider viewpoint of regional economies because we just deal with the transport market so far.

Before closing this paper, we need to note our analysis is done under some strict assumptions. We consider the feasibility of the partial cooperation considering the improvement of shippers' benefits. However, we cannot address the improvement of a "social welfare" because we assume that carriers act as passive players, but in the real world, the carriers play active, i.e. changing their fares as well as constructing routes. To avoid too much complexity, we neglect of the effect of the carriers' active behavior. Our next research should handle this effect to evaluate the feasibility of partial cooperation from the viewpoint of the improvement of social welfare.

■Table—8 Cost/benefit analysis

	Case 5	Case 6	Case 7
Loss of HCM	52,562	62,810	79,460
Loss of CM	(54,530)	120,534	246,294
Loss of barge carrier	179,248		
Total subsidy	179,248	183,344	325,754
Disutility improvement	130,237	76,093	199,832
Congestion improvement	32,778	94,550	100,226
Total improvement	163,015	170,643	300,058

Unit: USD

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垂直的協調を考慮した複数港湾システムにおける部分協調の可能性に関する研究

本稿ではベトナム南部の港湾を対象として複数港湾の効率的運営方法について考究した. 特に, 政府と港湾との垂直的協調の可能性について検討した. まず, 非集計データによるベトナム荷主の港湾選択行動についてパラメータ推定を行った. 次に同定した荷主モデルを用いて2港湾の競争状態における解を求めた. 続いて港湾と政府のとの垂直的協調について検討し, その結果, 垂直的協調を行う場合, 政府補給金を伴う港湾費用引き下げ政策は港湾の拡張政策よりも有効である可能性があることを示した.

キーワード ; **複数港湾運営, 部分協調, 荷主行動**