Optimizing Foreign Investment of Container Port in China

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Abstract. With the gradual deregulation of foreign investment into its port sector, China has formed a variety of port financing channels. Compared to the state investment and other sources of bank loans, self-raised funds and IPO, the study presents an analysis of the weight of the operation profit of foreign investment in the government’s objective and foreign investment proportion impacting on the tariff and social welfare of the port. The main finding is that the optimal foreign investment of container port is in existence to maximize social welfare of local port administration.

Introduction

China was relatively slow in allowing foreign investment into its port sector. Before the 1980s, Chinese port investments were 100% on the account of the state, especially the national fiscal budget. As the only investor, the central government carried out the policy of “two lines of revenue and expenditure”. The ports have no autonomy and all the revenues should turn over to the state. In 1978, China’s state-owned shipping company (China Ocean Shipping Company, abbr. COSCO) inaugurated mainland China’s first venture into the container transport business with a maiden voyage from Shanghai to Australia, but the fact was that over the whole period from 1978 to 1986, container ship could only use of bulk or general cargo quays for the berthing, there was almost no specialized container terminals in mainland China. With the development of the reforms and opening up, a seemingly ever-increasingly number of products was shipped from China to overseas. Especially, the capacity and quality of these ad hoc container terminals could not meet the burgeoning demand for the transport of containerized cargoes. The problem became acute when serious port congestion occurred in 1981, 1983 and 1985. Thereafter, a huge amount of investment was needed to pour into ports and infrastructure to support the growth of China’s container port industry.

In order to further expand the openness and utilize foreign investment, especially adapt to the new situation of entry into the WTO, the State Planning Commission, Commission for Economics and Trade, Ministry of Foreign Trade and Economic Department jointly promulgated the new “directory of foreign investment industry” on March 11, 2002. Among which, the construction and operation of the public port facilities were classified as encouraging industry directory to foreign investment, canceling the limitations on the proportion of share ownership. Meanwhile, the “directory of foreign investment industry” issued on December 31, 1997 was abolished, which set up the condition that Chinese party controls the shares. Soon afterwards, the “Port Law” was signed by NPC Standing Committee On June 28, 2003, pointing out that the state will continue to encourage economic organizations and individuals at home and abroad to invest and operate port sector, keeping the
greatest degree of opening to foreign and private capital, also stipulating that the legitimate rights and interests of port investor will be protected in accordance with law.

After the introduction of the “Port Law”, China has formed a variety of port financing channels, including the state investment, bank loans, self-raised funds, foreign investment and IPO. At the same time, many joint-stock companies emerged and listed port companies, even foreign-owned ports constantly appeared. According to the China Ports & Harbors Association’s China Port Yearbook 2015, the number of major container terminals in mainland China further increased to 99, among which 59 container terminals involving foreign investment, the proportion of foreign investment container terminals has risen to 59.6%.

Literature Review

Private sector participation increases the level of port efficiency and national welfare. Cheon, Dowall and Song [1] construct a panel data for port ownership, corporate structure, and port inputs and outputs for 98 major world ports, illustrating that ownership restructuring contributed to total factor productivity gains. Czerny, Höffler and Mun [2] investigate the effect of port privatization in a setting with two ports located in different countries, showing that there exist equilibria in which the two governments choose privatization and the national welfare of each port country is higher relative to a situation where ports are public. In the deficit of financial resources, the modernisation of the current assets and realisation of the new major projects are possible through public private partnerships (PPPs) [3], [4]. Alemán, Sarriera, Serebrisky and Trujillo [5] examine the evolution and drivers of productivity and efficiency changes across developing regions, indicating that private sector participation, the reduction of corruption in the public sector, improvements in liner connectivity and the existence of multimodal links increase the level of port efficiency.

In China, many ports have rapidly improved their infrastructure and superstructure following intensive investment through large-scale projects after deregulation of foreign investment. China’s tremendous growth momentum enabled many Chinese ports to enjoy record throughput growths, with investments in terminal capacity and operational efficiency, shipping lines might be induced to shift their transshipment activity from the incumbents to these upstarts [6]. Chinese ports now threaten to oust Busan in Korea as the regional hub, but enhanced port competitiveness requires not simply increased port investment but also high quality port service and technology focused port operations [7]. To quantify the characteristics of port regulation modes by using port reform experiences in China, the tariff, port efficiency level, port service demand and social welfare are higher under the decentralization mode [8]. Port infrastructure investment in China also contributes to growth of the regional economies involved [9]. Zhang [10] analyzes the Chinese quasi-landlord port financing model from a contract theory perspective, in which it can be viewed as a double-level principal–agent relationship and two-layer profit distribution contract with three participants.

Modelling of Port Investing

Over the past few decades, dozens of countries around the world have reformed restrictions on their port capital source in order to meet the huge capital demand of port infrastructure, with detailed arrangements of the privatization varying from mere commercialization (which involves dividing the port authority’s principal activities into separate autonomous operating units that are outsourced to private enterprises), liberalization (whereby statutory restrictions
on competition are eliminated, thus allowing the private sector to provide a full range of port services), or outright sale of assets or shares to the private sector.

The total cost faced by a shipper takes the form as follows:

\[ p = f + t \frac{q}{s} + e \]  

(1)

where \( f \) is the terminal charge, \( q \) is the demand absorbed by the terminal, \( t \) is the parameter of cargo waiting cost in the terminal, where \( s \) is the overall designed capacity of the port, \( e \) is carbon emission tax per cargo unit.

The profit functions, say for container port area is given:

\[ \pi = (f-\theta)q - \tau * s^2 \]  

(2)

where \( \theta \) indicates the marginal operation cost of container port area, \( \tau \) is the parameter of designed capacity investment and maintenance costs.

For simplicity, we consider a contain port with two kinds of capital nature, say port area 1 and 2, which are foreign investment and state investment respectively, the capacity of which are perfectly substitutable expressing by \( s_1 = r * s \) and \( s_2 = (1-r) * s \), where \( s \) is the overall designed container capacity of the port, \( r \in [0,1] \) indicates the proportion of foreign investment into container port.

From the perspective of local government, the surplus of shipper, terminal operators’ profits of the port area as well as carbon emission external cost should be comprehensively considered. The local government faces the following problem to realize the social welfare maximization:

\[ \text{Max } U = \alpha (q_1 + q_2) - \beta (q_1 + q_2)^2/2 - q_1 * p_1 - q_2 * p_2 + v * \pi_1 + w * \pi_2 \]  

(3)

where \( v, w \in [0,1] \) are the weights of port area operation profits of foreign investment and state investment in the objective of local government respectively.

Next we summarize the optimal port area tariffs to maximize the social welfare separately. By taking the derivative of Eq., then setting it equal to zero we get the optimal tariffs of the container port areas.

**Numerical Illustration**

There are two major container port areas playing a vital part in building Shanghai into an international shipping center. One is Waigaoqiao Container Port Area, which locates along the south bank of Yangtze River Estuary, including Waigaoqiao Phase 1, Phase 2 & 3, Phase 4, Phase 5 as well as Phase 6. Among which, Waigaoqiao Phase 1 was transformed into a professional container terminal in 1998. Since then Shanghai had begun large-scale construction of Waigaoqiao Container Port Area, especially, Waigaoqiao Phase 6 was put into operation on October 14, 2011, having three container terminals with the ability to berth 150 thousand tons container ship and designed throughput of 2.1 million TEUs. So far, Waigaoqiao Container Port Area has possessed 19 large container berths with total container throughput capacity of 10.55 million TEU, mainly bearing container ship handling operation of near-sea shipping line and oceanic navigation line.

The other is Yangshan Deepwater Port Area, which, including container terminals of Phase 1 & 2, Phase 3 and Phase 4. Especially, Shanghai began to construct and develop Yangshan in 2002 in order to solve the bottleneck of lacking deep-water port area, which is situated in
Shengsi County, Zhejiang Province. That means Shanghai and Zhejiang hold the operational management and administrative jurisdiction separately to Yangshan Deepwater Port Area. The whole size of Yangshan Deepwater Port Area is over 54.8 square kilometers, among which, Yangshan Phase 1 planned five container berths with the designed throughput capacity of 2.2 million TEUs, which was completed for opening on December 10, 2005. Yangshan Phase 2 possessed four container berths with the throughput capacity of 2.1 million TEUs, which was put into operation on December 10, 2006. Yangshan Phase 3 included seven container berths with the throughput capacity of 5.0 million TEUs, which was gone into service on December 6, 2008. At this point, Yangshan Deepwater Port Area has 16 container berths along 5.6 km shoreline with the throughput capacity of 9.3 million TEUs. Moreover, it should be noted that Yangshan Phase 4 was designed into a fully automated container terminal with the ability of “intelligent handling”, “unmanned pier” and “zero discharge”, which was constructed on December 23, 2014 and will be put into trial operation in 2017. According to the plan, Yangshan Deepwater Port Area will have 30 container berths along 10 km deepwater shoreline with the throughput capacity of 15.6 million TEUs, mainly undertaking handling operation of large ocean shipping vessel around the clock.

Before being able to perform the numerical analysis, we need to estimate the values of parameters used in our model as follows. According to the total container throughput of Yangtze River Delta in 2015, the demand scale of Shanghai port is assumed to be \( \alpha = 75 \) million TEUs. The designed capacity of two container port areas is set at \( s = 19 \) million TEUs. According to the annual report of SIPG in 2015, this paper calculates that anticipatory carbon emission tax per cargo unit is \( e = 0.24 \) $/TEU. As \( w \) is the weight of state investing container operation profit in the objective of government, the value is set at \( w = 0.95 \). This paper takes operational practice into consideration and sets the value in our model is \( \beta = 0.12 \). In the light of the survey conducted by Zheng and Negenborn (2014) and related data of the port of Shanghai in 2015, the values of the marginal operation cost and maintenance cost of terminals are \( \theta = 22.2 \) and \( \tau = 0.26 \) $/TEU.

The sensitivity analysis is performed to gain further managerial insights about encouraging foreign investment into container port area to what extent. As the weight of operation profit of foreign investment in the objective of government and the foreign investment proportion of container port area, the paper conduct the analysis by changing the parameters of \( v \) and \( r \), we find some interesting observations and the results are shown in the following figures.

First up, the container port area tariff of foreign investment under different \( v \) and \( r \) is shown in Fig. 1.

![Figure 1. Container tariff of foreign investment under different v and r.](image-url)
Secondly, the surplus of shipper, profit of port area as well as carbon emission external cost should be considered comprehensively from the perspective of local government. Specifically, when the weight of the operation profit of foreign investment in the government’s objective is in a lower status, such as $v \in (0.08, 0.10)$, the change of social welfare of the whole container port areas is shown in Fig. 2.

![Figure 2. Optimal foreign investment of whole container port areas under different v and r.](image.png)

As shown in the above figure, social welfare of the whole container port areas slowly decreased first then increased rapidly, subsequently decreased again. It can be noticed social welfare of the whole container port areas is at a higher position when foreign investment proportion of the whole container port areas is in the range of $(0.25, 0.4)$.

**Conclusions**

This paper focuses on port investing optimization under foreign investment entering into Chinese port sector, as Sino-foreign joint venture, even wholly foreign-owned terminal are permitted in China with the gradual deregulation, applying the model to two container port area in Port of Shanghai, China. Some interesting observations and results are founded to provide policy implications.

Heavier weight of the operation profit of foreign investment in the government’s objective not always causes higher social welfare of the whole container port areas. The important point is that the social welfare of whole container port areas is crawling in most cases; the social welfare of whole container port areas is in a rapid growth trend when the weight of the operation profit of foreign investment in the government’s objective is in a lower or higher status.

Our study discovers that it is more complex of foreign investment proportion of the whole container port areas against social welfare of the whole container port areas. If the weight of the operation profit of foreign investment in the government’s objective is at a lower level, social welfare of the whole container port areas is in a gradually heightening with foreign investment proportion of the whole container port areas. It should be noted that social welfare of the whole container port areas increased first and then decreased with foreign investment proportion of the whole container port areas under extremely high weight of the operation profit of foreign investment in the government’s objective.
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