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Abstract

This paper analyzes the effect of airport ownership structure on management efficiency as reflected through their credit ratings. A game-theoretical model is proposed to examine the role of credit ratings in mitigating the moral hazard problem of public-owned airports. The analytical results derived from the model are then used to supplement a supporting case study.Notwithstanding the fact that the less competitive environment of a public-owned entity and its credit ratings might bring some welfare loss , this research concludes that public-owned airports have some advantages.

Keywords: Airport, Ownership, Revenue Bond, Credit Rating, Incentive Contract, Moral hazard, Hidden Action, Management Efficiency

1. INTRODUCTION

Over the recent years, private sector involvement in public sector projects has been growing. . Private sector involvements are particularly notable in privatization of various transport infrastructure projects pertaining to the constructions and expansions of airports, railways and roads in many countries.

There are two ends to the spectrum of private sector involvement in managing transport infrastructure. One involves complete privatization with 100% flotation; the other involves nationalized projects. This research focuses on the privatization issues in airport industry and seeks to achieve two goals. First, the research examines how the difference in ownership structure will affect social welfare. Second, the effect of credit ratings on

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ownership schemes in airport management is investigated.

This paper is organized as follows: The next section provides the background of the Asia airport industry. Section 3 presents the game-theoretical model. Section 4 related the model and the airport credit ratings. Section 5 concludes.

2. BACKGROUND

Airports are vital economic assets and generators of increased economic activity in a country. For countries wishing to attract new industries and foreign investments, the presence of airports offers a strong inducement for companies to set up their businesses in a particular location. The economic activity generated by an airport is a result of operations carried out by the management, tenants and supporting and complementary businesses. These organizations contribute to their host countries by employing local residents, consuming locally supplied goods and services and by contracting port construction and capital improvements. Airports are also said to be the focal point at which economic benefits of aviation activities converge. In itself, an airport supports the overall development of a country such that taxes on passengers and shippers and income taxes on airport employees that are payable to government can be used to finance improvement programs on infrastructure, health care and education. Airports are also at the heart of travel and tourism industry. Tourism strengthens cultural ties between countries, in addition to the creation of many job opportunities in a diverse range of service and manufacturing industries. Other spin off benefits such as reducing cost of trade and movements, attracting new businesses, support for development of new technology and distribution process based on the rapid movement of people and goods.

The increase of airport capacity is seen to be urgent and important because capacity limitation and congestion may be a major potential impediment to air transport growth.

Governments and airport operators experience perennial tensions in comparing the case for stretching existing facilities with that for the expansion of new facilities. While this problem is, perhaps, more prevalent in Europe where land restrictions new noise standards impose severe constraints on the scale of airport development, the reality that airport expansion and development projects absorb considerable land and financial resources cannot be understated. In recent years, the outlay to develop a new airport or upgrade an existing airport has increased significantly with at least two new cost drivers becoming very prominent. The first relates to the need for any new airport to address the whole dimension of security threats which have been identified following the 911 events. These have to be factored into the designs relating to runway and vehicular approaches to the airport, the circulation and layouts of terminal buildings and the introduction of new security and baggage handling systems and processes. The second cost driver arises from the provision of facilities to enable an airport to deliver higher service and performance levels. One example is the service demands with the arrival of the new age of mega aircraft in the mode of the A380s and the Boeing Dream Liner. Any new airport with pretensions to be an air hub can no longer rely on remote stands but to offer at least 80 percent full contact gate facility if it intends to mount a credible pitch for connectivity.

According to Changi International, the construction cost[2] is between US$25 and US$30 million per million passengers per annum (mppa) for an international airport terminal building in the 15 to 30 mppa range. Thus, a terminal building with a capacity of 25 mppa will be expected to cost between US$620 and US$750 million. This order of capex transforms into a whole complexion of airport development financing and leads to a surge in airport privatization programs and the use

[2] This unit cost relates to the construction cost of the basic terminal building only, including support systems such as building services and baggage handling but excludes interior fit out costs and consultancy fees.

public-private partnerships in financing landscape of airport developments. Table 1 shows cost of construction and development of some huge airports in Asia between 1994 and 2008.

Table 1 Major Airport Developments and Expansions in Asia, 1994 – 2008

Airport	Date of Completion	Purpose of Development	Estimated cost
Osaka – Kansai	Sep 1994	New airport to serve the international traffic previously handled by Osaka Int. airport	USD 20 billion
Kuala Lumpur	Jun 1998	New airport to replace Subang airport	USD 3.5 billion
Hong Kong – Chek Lap Kok	Jul 1998	New airport to replace Kai Tak airport	USD 20 billion
Shanghai – Pudong	Oct 1999	New airport to serve the international traffic previously handled by Shanghai Hongqiao Int.	USD 1.7 billion
Seoul – Incheon	Mar 2001	New airport to replace Gimpo Int.	USD 5.4 billion
Guangzhou – Baiyun	Aug 2004	New airport	USD 2.4 billion
Nagoya – Chubu	Feb 2005	New airport	USD 7.3 billion
Kobe	Feb 2006	New airport	USD 2.9 billion
Kansai	Aug 2007	Addition of runway	USD 8.0 billion
Beijing - Capital	Aug 2008	Addition of the world's biggest passenger terminal	USD 3.0 billion

Source: Low (2008)

Therefore, the idea that an airport is a sacrosanct infrastructure on which considerations of national security and sovereignty reigns and the ownership of an airport should be left largely in the hands of the government or at least be government controlled is fast changing. In Japan, Narita International Airport has been commercialized and prepared for complete privatization. Singapore Changi is also expected to be privatized in the near future. More noteworthy, some of the major airports in emerging economies such as China and India such as Beijing, Shanghai, Shenzhen, New Delhi and Mumbai have already developed

significant experience in this direction. Other airports that have been partially privatized includes the Malaysian airports under the Malaysia Airports Holdings Berhad. Meanwhile, the emergence of infrastructure funds from the private sector has now imposed new benchmarks for financial performance of airports. Investment returns on airports are being compared with those generated by utilities.

2. THE MODEL

This section proposes a model to show private-private ownership (called PPP[3] firm) based on Tezuka and Yasuda (2004). The formulation of the profit of the PPP firm assumes that the profit of the firm consists of revenue from user and government transfer. Hence, the profit function of PPP firm is defined as:

$$\Pi_{PPP} = t + \alpha y x(\quad) - C(\quad) \cdots\cdots\cdots \qquad (1)$$

where t denotes lump sum transfer from the government to the firm and y represents the marginal monetary effects of welfare. y is interpreted as the unit benefit resulting from the performance of effort x. Herein, x is a parameter that represents the degrees of welfare increased and reflects the associated cost reductions and effective products resulting from the input of effort.

[3] PPP denotes "Public Private Partnership". We assume some privatized infrastructure such as airports, toll roads are not "perfectly privatized." For example, the share of Japanese airports such as Narita and Kansai are "partly" hold by governments. Sometimes, it is called "commercialization." However the concept of PPP includes "commercialization." Therefore we call such firm as PPP firm.

That is, we cannot observe *x* directly but can explicitly observe yx resulting from effort[4]. For example, revenue can be interpreted as increased profit by the efforts of cost reduction.

The performance parameter x involves uncertainty. To reflect this element of uncertainty, we define $x \equiv e + \varepsilon$ where $e \in [0, +\infty)$ denotes the levels of effort and ε is a stochastic variable with $N(0, \sigma^2)$. In the last term of the right side in (1), $C(e)$ is a cost function with respect to the effort of the firm. The cost function is assumed to be a private cost function and cannot be observed by a third party.

α is an important parameter to compare PPP against the public ownership. It reflects degrees of competition with an inverse relationship (i.e., the smaller the α, the more competitive is the environment). If competitive pressure exists, the firm might not receive enough resulting rent from the effort input. A smaller α implies less rent extracted, while the rent would spread and redistribute among society. We set αyx as the explicit revenue the firm receives; hereafter, we see the parameter α as the effect of competition and we set $\alpha \in (0, 1]$[5].

With regards to Japanese PPP firms such as Kansai airport, some schemes of competitive pressure seem to be built into operating stages (inter-airport competition among the other airports). Generally speaking, a PPP firm does not always enjoy a monopolistic position to extract a monopoly rent. In such cases, we might be able to see that $\alpha < 1$ holds in PPP schemes. In addition, if the firm is purely public owned and operated firm, it could avoid competitive pressure from market. So in that case, we set $\alpha = 1$ to denote complete

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[4] The revenue yx which stems from the input of effort, and we assume yx is represented in monetary terms. This revenue can be interpreted as profit from the users of the service.

[5] For the same setting, see Petersen and Rajan (1995), Chan, Greenbaum and Thakor (1992). we exclude the fully competitive case $\alpha = 0$ and assume $\alpha > 0$.Because we assume a risk-averse firm, which requires a risk premium, and the reservation profit would be higher than in a perfectly competitive environment.

as public operation.

It is reasonable to assume that the purpose of government is to maximize the expected social welfare by controlling lump sum transfer t. We can interpret the value t as an operational subsidy or payment by the government. Furthermore, we assume that each firm (i.e., the airport operator) is risk averse and has a constant absolute risk aversion (CARA) utility function. The utility function is a specialized function expressed as $u(\Pi_{PPP}) = -\exp(-r\Pi_{PPP})$ where parameter r shows the degrees of risk aversity. Without loss of generality, we assume the reservation utility (profit) of a firm is -1. Then, we can derive the object function of the PFI firm using a certainty equivalent function CE_{PPP} from the profit function Π_{PPP}.

$$CE_{PPP} = t + \alpha ye - C(e) - \frac{1}{2} r\alpha^2 y^2 \sigma^2 \qquad (2)$$

By using the equivalent function, we can define the expected social welfare function of PPP as follows:

$$\begin{aligned} W_{PPP} &= S - (1+\lambda)t + CE_{PFI} + (1-\alpha)ye \\ &= S + (1-\alpha)ye - (1+\lambda)\left\{C(e) + \frac{1}{2} r\alpha^2 y^2 \sigma^2 - \alpha ye\right\} - \lambda CE_{PPP} \end{aligned} \qquad (3)$$

where S denotes the expected social surplus from conducting business and has a constant number. We assume the value of *S* is large enough to operate. The second term in (2) represents the marginal cost of public funds λ that would occur when the public sector pays for the firm. The main feature of the expected social welfare function is as follows: If the competitive mechanism could work well and α decreased, then all else being equal, it could increase social welfare (see the second term in equation (3)).

It is important to note that if the competition mechanism was over-worked, then the incentives for cost reduction would reduce. As a result, the benefit of competition could be offset by the disincentive (under-input of effort) of cost reduction.(see the third terms in (3)). This can be interpreted as the costs and benefits of competitive pressure. Given that the

objective of the government is to maximize social welfare, we present our problem as follows:

Problem:

$$\max \quad S+(1-\alpha)ye-(1+\lambda)\left\{C(e)+\frac{1}{2}r\alpha^2y^2\sigma^2-\alpha ye\right\}-\lambda CE_{PPP}$$

$$s.t. \quad CE_{PPP}=t+\alpha ye-C(e)-\frac{1}{2}r\alpha^2y^2\sigma^2\geq 0,$$

$$e^{PPP}=\arg\max\ t+\alpha ye-C(e)-\frac{1}{2}r\alpha^2y^2\sigma^2$$

The problem represents the case whereby the government seeks to maximize the expected social welfare subject to constraints, which are called "participation constraint" and "incentive compatible constraint". Assuming that the government cannot directly observe the efforts of the firm, incentive compatibility constraints could correspond to the conditions for the firm's profit maximization from a social welfare viewpoint.

For a specialized firm's cost function of effort given as $C(e)=\frac{k}{2}e^2$ where $k>0$, ., the PPP firm will set its effort as $e^{PPP}=\frac{\alpha y}{k}$ under the incentive compatibility condition. From its functional purpose, it is optimal to set $t^{PPP}=CE_{PPP}$. That is, the government sets its lump-sum transfer equal to the firm's participation constraint (reservation profit).

It follows that the expected social welfare under a PPP scheme W_{PPP} can be derived by substituting the above solutions into its object function.

$$\begin{aligned} W_{PPP} &= S+(1-\alpha)ye-(1+\lambda)\left(\frac{k}{2}e^2+\frac{1}{2}r\alpha^2y^2\sigma^2-\alpha ye\right) \\ &= S+\frac{(1-\alpha)\alpha y^2}{k}-\frac{1}{2}(1+\lambda)\alpha^2y^2\left(r\sigma^2-\frac{1}{k}\right) \end{aligned} \tag{4}$$

Then we obtain the following proposition.

Proposition (Tezuka and Yasuda 2004)**:** If $r\sigma^2 - \frac{1}{k} > 0$, *it does not hold that* $\alpha \to 0$ *can always enhance the expected social welfare. In other words, increasing competition is not always preferable. The expected welfare is maximized at* $\alpha^* = \frac{1}{2 + (1+\lambda)(r\sigma^2 - 1)}$

Proof：We define the right hand side of (4) as the function of α, $F(\alpha)$. Then, we obtain:

$$F(\alpha) \equiv S + \frac{(1-\alpha)\alpha y^2}{k} - \frac{1}{2}(1+\lambda)\alpha^2 y^2\left(r\sigma^2 - \frac{1}{k}\right) = -\left\{\frac{y^2}{k} + \frac{1}{2}(1+\lambda)y^2\left(r\sigma^2 - \frac{1}{k}\right)\right\}\alpha^2 + \frac{y^2}{k}\alpha + S$$

If $r\sigma^2 - \frac{1}{k} > 0$, the coefficient of α^2 is negative. Then if there exist α such as $F'(\alpha) = 0$, it then maximizes $F(\alpha)$. Q.E.D.

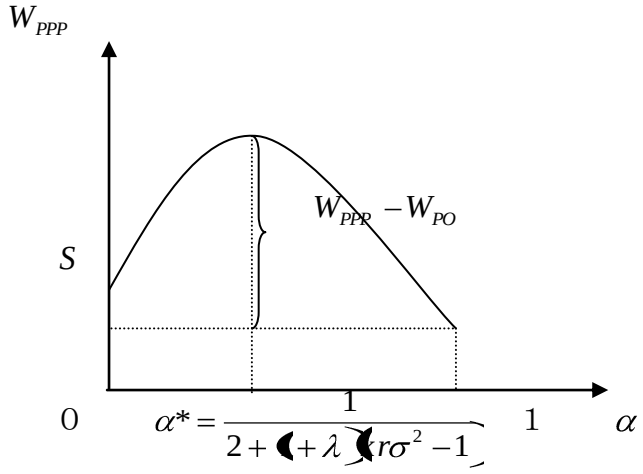
Corollary 1: *The higher* λ*, the lower the value of* α^* *that maximizes the expected social welfare.*

An intuitive interpretation of the proposition is as follows: In the case where the PPP firm is faced with uncertainty as $r\sigma^2 - \frac{1}{k} > 0$, the expected social welfare could increase by increasing α in $\alpha^* < \alpha < 1$. Within this area, increasing competition and rent exaggeration could enhance welfare.

On the other hand, the introduction of excessive competition would decrease social welfare in $0 < \alpha < \alpha^*$ owing to a lack of incentives for cost reduction[6]. As we have seen in corollary 1, all things being equal, the larger cost of λ, and the more competitive the environment (lower α alpha), the more the expected welfare we could obtain.

[6] The case where k is large enough, expected welfare maximizes at $\alpha \cong 0$.

Figure 1 Welfare Difference between PPP firm and Public ownerships



The figure 1 shows the welfare of PPP firm, which varies with the degrees of competition. As mentioned above, the value of α denotes the degrees of competition. Since α = 0 in the purely public owned (PO) firm, then PPP firms always dominate the PO firms. The difference of welfare between PPP and PO is maximized at the point of α^*.

The next section highlights some implications and related the analytical findings with the credit ratings.

3. PUBLIC OWNERSHIP AND CREDIT RATINGS

The analytical results in the preceding section suggested that a PPP scheme under a competitive environment is preferred to a perfectly public ownership in respect to social welfare. Despite the fact that the less competitive environment of a full public-owned entity might discourage input effort by the operator (i.e. moral hazard) and bring some welfare loss, the analytical results from the model reveal those public-owned airports do possess some advantages

Table 2 shows the scale and level of public airport ownerships in the US. In comparison to the case of UK where some airports in UK are fully privatized, most of the US airports are owned by the government.

Table 2　Hierarchy of Public Ownerships in US Airports (2007)

Ownership	large hub	midium hub	small hub	non hub	Total(%)	
Local Government	17	16	36	200	269	(51.7)
Municipalities	10	12	26	116	164	(31.5)
County	5	4	9	74	92	(17.7)
Others	2	0	1	10	13	(2.5)
Federal Government	0	0	2	5	7	(1.3)
State Government	2	4	5	69	80	(15.4)
Airport Authority	6	13	20	82	121	(23.3)
Port Authority	5	3	3	16	27	(5.2)
Others	0	2	2	12	16	(3.1)
Total	30	38	68	384	520	(100.0)

注) Total number is not included GA airports and is extracted from CATS data of FAA.

The reason why most of US airports are owned by the government will be clear shortly. The bottom line　is whether a PPP firm would face more competitive environments after privatization, as compared to other forms of ownership. In some cases, even joint ownership firms can face such environments. Joint ownership firms are sometimes considered as less risky by investors. It can be expected that the government would like to avoid bankruptcies and protect such firms, especially in the case of Japan.

Our model in the previous section describes the tradeoff between the introduction of competition, the extraction of rent and incentives in transport infrastructure projects. From the proposition, we derive the optimal level of extraction, i.e. the degrees of competition. Our model also implies that excessive competition and rent extraction would decrease welfare by causing disincentives to improve efficiencies and reduce costs.

Firstly, regarding competitive environments, it might be considered that the US airports face competitive pressure by bond rating. Table 3 shows the use of bond issue in financing the operations and investment in US airports and transportation-related industries account for shares about 10%. These bonds are rated by bond rating company and the ratings could affect the late (?) of bond. The latter implies that　the rating could function as

"market competitor." Under such considerations, it could be interpreted that the credit rating can affect the parameter of α even if the airport is publicly owned and we can obtain similar results to PPP firms in section 3.

Table 3 Ratio in use of bond issue (%)

	1990-94	1995-99	2000-04	2005-09
Transportation	10.2	10.7	11.2	11.2
Airport	2.7	3.1	3.0	2.3
Highway/Toll Facilities	4.3	3.4	4.6	4.9
Mass Transit	2.3	3.8	2.9	3.1
Others	0.8	0.4	0.8	0.9
Education	16.9	21.9	24.9	26.2
Health Care	12.2	12.8	8.8	12.1
Water and Sewage System	10.0	8.3	8.1	7.6

* Excluded the bond less than 13 months of maturity.
The author extracted from Thomson Financial SDC Platinum database(Oct., 2009).

Secondly, transport infrastructures such as airport and roads are of a large scale and involve huge and lumpy investments, which have large risks. Thus attitudes toward risk might differ depending on the size of the project. It might be expected that a PPP firm would be more risk averse than the one in joint ownership.

We compare the case when attitudes toward risk differ. The expected social welfare is as follows:

$$W_{PPP} - W_{PO} = \frac{(-\alpha)\tilde{\alpha}y^2}{k} - \frac{1}{2}(+\lambda)\tilde{y}^2\left\{\alpha^2\gamma_{PPP}\sigma^2 - \gamma_{PO}\sigma^2 + \frac{1}{k}(-\alpha^2)\right\} \qquad (5)$$

γ_{PPP} and r_{PO} denote the degree of risk aversion of a PPP firm and public ownership, respectively. If γ_{PPP} is large enough and γ_{PO} is low, joint ownership would be preferable. For example, that holds if $\alpha \cong 1$.

There are the following implications: In the case that a PPP firm is highly risk averse, the firm would require high rent. As a result, the cost of introducing harsh competition would override the benefit. In fact, such an argument seems to be applicable because it appears that the larger scale the project becomes, the more risk averse the PPP firm would be. In this case, joint ownership or public provision might be preferable.

Thirdly, we represent the case that bond rate differs between PPP firms and PO firm: that is

$$W_{PPP} - W_{PO} = \frac{(-\alpha)p^2}{k} - \frac{1}{2}(+\lambda)p^2\left(\gamma\sigma^2 - \frac{1}{k}\right)(\alpha^2 - 1) - (1+\lambda)(r_{PPP} - r_{PO})K \quad (6)$$

where r_{PPP} is bond rate of PPP and r_{PO} bond rate of PPP and *K* denote level of capital assets. If $r_{PO} > r_{PPP}$ and K is large enough, then $W_{PPP} - W_{PO} < 0$. In other words if the bond rating of PO is high and the levels of investment is huge enough, then the public ownership is preferred.

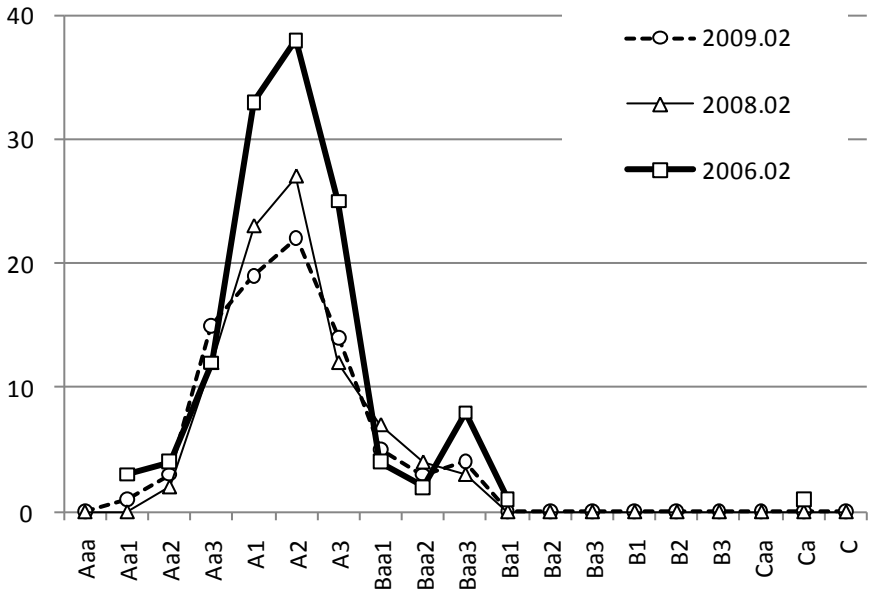


Fig. 2 Moody's Credit Rating of Airport Bonds

Source: Moody's(2006,2008,2009), *U.S. Airport Sector Outlook*.

With regards to airport bond ratings in US, most of them are around A2, and there are no airports that have below Ba2 as seen in Figure 2. These high ratings of airports might give us the reason that public ownership preferred.

Table 4 Indicators of Moody's Rating

Airport Management
Enplanements(2005, 1,000), **Growth over Prior Year's Enplanements(+)**, **Enplanement Five Year Average Growth Rate(+)**, **Primary Carrier Market Share(%・-)**, O&D Enplanements (%), Population of Metropolitan Area (1,000), **Utilization Ratio(%・+)**
Airport Scale Index related assets
Gross Fixed Assets(Million $), Net Fixed Assets(Million $), Long Term Debt(Million $), Net Funded Debt(Million $)
Airport Scale Index related Management
Operating Revenues ($1,000/+), Non-Operating Revenues($ 1,000), Gross Revenue and Income($1,000), Operating Expenditures($1,000), Net Income($1,000), Airport Revenue Debt Service ($1,000)
Index related to Financial Ratio
Debt Ratio, Debt per Enplaned Passenger, Days cash on hand(days), Airline Payments per Enplanement, Operating Revenue per Enplaned Passenger, Operating Expenses per Enplaned Passenger, Airline Payments/Operating Revenues, Operating Ratio(%), Net Take-Down(%), Debt Service Safety Margin (%), **Debt Service Coverage by Net Income (+)**

*Parameters in Gothic were statistically significant for explaining public rating (Saegusa, Kato and Kurosawa(2009)).

In addition, Table 4 shows the indicators of Moody's Rating from Saegusa, Kato and Kurosawa (2009). The table denotes how public rating could be determined. The factors such as airport scale index, or index related financial ratio could be related parameters of r_{PO} and K in (6). However, more detailed interpretation is left for our future research.

5. CONCLUSIONS

This paper analyzes the effect of airport ownership structure on management efficiency as reflected through their credit ratings. A game-theoretical model is proposed to examine the role of credit ratings in mitigating the moral hazard problem of public-owned airports. The analytical results derived from the model are then supplemented with a case observed in the US airport industry. The research found that t public-owned airports have some advantages, despite the fact that the less competitive environment of a public-owned entity might bring some welfare loss because of credit ratings.

Some avenues remain for future research. In this research, we have provided a model that compares the PPP and public ownership schemes. A meaningful extension of the model will involve a development that is capable of examining the effect of credit rating directly. Also, the consideration of determinant of credit rating will be useful. . In view of the potential theoretical contributions and many practical applications, we conclude that there is much potential for further developments of our model.

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