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# Credit Guarantee Optimization of State-owned Enterprises

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## ABSTRACT

The objective of this paper is to estimate the credit risk of state-owned enterprises (SOEs) in the form of probability of default (PD) and then use it to analyze credit guarantee optimization. Estimation of the probability of default by the Hybrid Model found that the estimated PD for both financial and non-financial SOEs are ranked by credit rating grade (the rank ordering property), except for the 3rd rating grade PD of non-financial SOEs. Analysis of the optimal credit guarantee for each SOE by Linear Programming model found that the results of maximizing the net benefit and the results of minimizing the net expected loss from credit guarantee are similar. Moreover, the value of expected loss implies that the magnitude of credit risk must be mitigated and managed with appropriate tools by the Ministry of Finance.

**Keywords:** Government credit guarantee, Credit risk, State-owned enterprises

**JEL Classification:** C61, H63

# 1. Introduction

## *1.1. Government credit guarantees*

Government credit guarantees are a fiscal instrument of government financial support for infrastructure and public goods investment in cases where the government is the best organization to anticipate risk, control risk exposure, and minimize the cost of risk (IMF, 2005).

In Thailand, the Public Debt Management Office (PDMO) of the Ministry of Finance has guaranteed credit (loan and bond) to some state-owned enterprises (SOEs) since 2005[1]. Its goals are to give SOEs access to finance at a lower financial cost (loan interest rate) and to get a greater amount of credit from financial institutions with a favorable borrowing term because they can benefit from the government's high credit standing. In addition, the government's support for SOEs also support economic growth and social development, such as infrastructure development projects[2] and supporting farmers.[3]

## *1.2. Fiscal risk from government credit guarantee*

Government credit guarantees create a contingent liability or government obligation for the Ministry of Finance. The Ministry of Finance must repay the outstanding guaranteed loans of state-owned enterprises if those state-owned enterprises default on the loans. It is the uncertainty as to whether the government will have to pay, and if so the timing

[1] Under the Thailand's Public Debt Management Act of 2005 (B.E. 2548)
[2] E.g. High-speed train project by the State Railway of Thailand (SRT)
[3] E.g. Rice pledging scheme and agricultural credit for rural development project by Bank for Agriculture and Agricultural Cooperatives (BAAC)

and amount of spending that is complicated for estimation of fiscal risk management (IMF, 2005).

The fiscal risk from government credit guarantees are classified as endogenous risks that are generated from government activities or where the probability of the event can be influenced by government actions (IMF, 2016).

Table 1. Government Credit Guarantee Fee Rate

| | **Credit rating grade** | **Guarantee Fee Rate (Percentage of outstanding guaranteed loan)** | | | |
|---|---|---|---|---|---|
| | | <1 year of loan period | 1-5 years of loan period | >5 years but <10 years of loan period | >10 years of loan period |
| **Government agency** | - | 0.01 | 0.05 | 0.10 | 0.15 |
| **SOE** | 1 | 0.01 | 0.05 | 0.10 | 0.15 |
| | 2 | 0.05 | 0.10 | 0.15 | 0.20 |
| | 3 | 0.10 | 0.15 | 0.20 | 0.25 |
| | 4 | 0.15 | 0.20 | 0.25 | 0.30 |
| | 5 | 0.20 | 0.25 | 0.30 | 0.35 |
| | 6 | 0.25 | 0.30 | 0.35 | 0.40 |
| | 7 | 0.30 | 0.35 | 0.40 | 0.45 |
| | 8 | 0.35 | 0.40 | 0.45 | 0.50 |

Source: The Guarantee Fee Rate and Condition Ministerial Regulation of 2008 (B.E. 2551)

Currently, the Ministry of Finance of Thailand partially manages this fiscal risk by charging a fee for credit guarantees from state-owned enterprises. The fee pricing is around 0.01-0.5 %, depending on the credit rating grade[4] and the loan

[4] The credit rating grade has 8 levels from grade 1 (the lowest risk) to grade 8 (the highest risk) that is evaluated by the PDMO every fiscal year.

period, which reflects the level of credit risk of each state-owned enterprise. Nevertheless, the Ministry of Finance can use the SOEs credit rating grade to evaluate fiscal risk exposure from credit guarantee each fiscal year to take advantage of the value of such contingent liabilities and to determine the optimal value of credit guarantee for each SOE which the Ministry of Finance has the highest net benefit from credit guarantees, and the least risk from credit guarantees for the SOE in each fiscal year.

## 2. Credit Risk of State-owned Enterprises

### *2.1. Credit risk from government credit guarantee*

A financial instrument that is similar to government credit guarantees are bank loans. The credit risk of bank loans consists of three components, Exposure at default (EAD), Loss given default (LGD), and Probability of default (PD). Then, the magnitude of credit risk from credit guarantees is a multiplied result of EAD, LGD, and PD (Naksakul, 2006; Public Debt Management Office, 2014).

In the case of government credit guarantees, EADs are the risk of disbursement that can be estimated from the value of guaranteed loans outstanding, while LGDs are risk in collateral value that can be estimated from a proportion of loss value after recovery from collateral that is equal to one since no collateral is required in this case. So, the variable that must be estimated is the probability of default or default risk.

### *2.2. Simulated default for state-owned enterprises*

Default events are important data for estimating the probability of default. Standard & Poor's Global Rating (2017)

and the Bank of Thailand (2016) define "default event" in the general case as the event in which "the debtor or the counter-party cannot pay back the loan principal or interest on the due date contained in the original terms of a debt issue". However, in practice, when referring to sovereign debt, including government, state-owned enterprises, and other government agency debt, both in the form of loan and bond, default events never occur when considering the definition of default in the general case. Especially in the case of Thailand if the state-owned enterprise fails to pay the loan principal or interest on the due date, the Ministry of Finance will give assistance such as finding a new source of funds to repay original debts, according to financial market conditions and financial status of state-owned enterprises at that time.

Because of the special characteristics of SOE debt, it is necessary to define a new default event as applied to SOEs to calculated their PD. Default events for state-owned enterprises are defined in this article according to Public Debt Management Office (2014) which defined SOEs default events as "when their liabilities greater than their assets in a year, when they have EBITDA[5] negative for three consecutive years, when they received a credit rating grade as 8 in a year, or when they received a credit rating grade as 7 for three consecutive years." Those conditions of the Public Debt Management Office (2014) apply only to the non-financial state-owned enterprise[6]; none of the financial state-owned enterprise have performance that meet these conditions.

[5] EBITDA is Earnings before Interest, Taxes, Depreciation and Amortization that calculated in the following manner: EBITDA = Operating Profit + Depreciation Expense + Amortization Expense.

[6] The total number of state-owned enterprises that are given credit rating by the Public Debt Management Office in each fiscal year is 20 SOEs, including 16 non-financial institutions and 4 financial institutions.

Therefore, the Public Debt Management Office (2014) can estimate default probabilities only for non-financial SOEs.

To resolve that limitation to estimate all types of SOE's default probabilities, consider the characteristics of sovereign debt. The Standard & Poor's Global Rating (2017) defines a default for sovereign debt as "when they fail to pay scheduled debt service on the due date or tenders an exchange offer of new debt with less favorable terms than the original issue, or when their notes or bonds are converted into a new currency of less than the equivalent face value." The default definition of Standard & Poor's Global Rating (2017) focuses on the characteristic of the loan agreement, not the SOE's performance like the default definition of the Public Debt Management Office (2014). Thus, focusing on the characteristics of a loan agreement is more appropriate to define SOE's default event.

Therefore, to properly define default events for Thailand's SOEs, consider S&P Global Rating's default condition with a framework for public debt management of the Ministry of Finance of Thailand, in the case of state-owned enterprises. A framework for public debt management found that the type of SOE's debt management, which meets the S&P Global Rating's default condition, is debt management with rollover method[7]. Thus, this article defined a new definition of default for SOE (Simulated default) as "when the SOE either issues new bonds to repay original bond with less-favorable terms than the original bond or negotiates with the bank creditors a rescheduling of principal or interest at less-favorable terms than in the original loan."

However, with limited access to SOE insights data, i.e., we did not have more details about the payment terms of the pair of loan, which rollover or issue new bonds to repay

[7] The SOE issue new bonds to repay original bond

original bonds. So, this article will use default condition as "when the SOE manages its debt with rollover" to be a proxy for our default condition as defined above.

Debt data on SOEs during the fiscal years 2009-2014 were used in this study; it was found that this period has data on 110 SOEs where their credit was rated by Thailand's public debt management office. Among them, it was found that there were 4,087 contracts for loans and bonds that were outstanding, and restructured debt as rollover totaled 355 contracts that presented in Table 2.[8]

Table 2. Number of SOE's loan and bond that restructure debt as rollover during the years 2009-2014

| **Fiscal year** | **The number of state-owned enterprises that PDMO's credit rated** | **The number of loan and bond outstanding** | **The number of loan and bond that restructure debt as a rollover** |
|---|---|---|---|
| - | Enterprises | contracts | contracts |
| 2009 | 19 | 658 | 47 |
| 2010 | 17 | 705 | 54 |
| 2011 | 16 | 672 | 5 |
| 2012 | 18 | 683 | 95 |
| 2013 | 20 | 690 | 85 |
| 2014 | 20 | 679 | 69 |
| **Total** | **110** | **4,087** | **355** |

[8] In practice, the public debt management office did not collect data about payment structure between pairs of loan or bond that restructure debt as rollover and their original issue, so this study uses the loan and bond that restructure debt as rollover every case as a simulated default event instead of the new definition of default for SOE which mentioned above. As a result, this estimation will give a conservative probability of default.

Note: This data, includes both non-financial institutions and financial institutions, and their debt, including all currencies.

### *2.3. Probability of default for state-owned enterprises*

The nature of SOE debt is low default portfolios, which limits default events and thus general estimation models cannot estimate PD in the case of no default events occurring and may yield an underestimation of credit risk. So, the estimation of probability of default for SOE in this study will use the model that is appropriate for SOE debt characteristics, which is the Hybrid model of Roengpitya (2012). The Hybrid model was based on two existing estimation approaches, including the most prudent estimation of Pluto and Tasche (2006) and the maximum likelihood of Forrest (2005). In this study, we use the Hybrid model with forward method to estimate PD and assume that there is no asset correlation between SOEs. The PD estimates are split between SOEs that are non-financial institutions and SOEs that are financial institutions.

First of all, let the general likelihood function of N rating grade be defined as $\mathcal{L}(p_{1,\dots,}p_N) = \prod_{i=1}^{N} \mathcal{L}(p_i)$, where $p_{1,\dots,}p_N$ are the PD estimates for each rating grade. Let $i$ =1 be the lowest risk grade and $i = N$ be the highest risk grade. In the non-financial institutions case, $i$ =1, 2, 3, … , 7[9], while financial institutions rank from, $i$ =3, 4, 5, 6.[10] Then, using the concept of the most prudent to collapse the rating grade – assuming that the N rating grade satisfy the rank order

[9] Total of PDMO's credit rating grade is eight grades, but this estimation ignores grade 8 because this grade never rated to any state-owned enterprise.

[10] During the fiscal year 2009-2014, state-owned financial institutions received a PDMO's credit rating in grade 3-6 out of the total grade (8 grades).

requirement, then we must have $p_1 \leq p_2 \leq p_3 \leq \cdots \leq p_N$. And to find the upper bound of $p_1$, the most prudent implies that the condition is $p_1 = p_2 = p_3 = \cdots = p_N = p$ –in the general likelihood function, and we get the new likelihood function:

$$\mathcal{L}(\vec{p}_i) = p^{\sum_{j=i}^{N} k_j}(1-p)^{\sum_{j=i}^{N}(n_j - k_j)} \quad (1)$$

Next, let $\bar{\mathcal{L}} = e^{\left(-0.5 \cdot \chi^2(\propto, N)\right)} \cdot \mathcal{L}(MLE)$ where $\mathcal{L}(MLE) = \prod_{i=1}^{N} \mathcal{L}\left(p_{MLE}^{i}\right)$ is the maximum likelihood value that is evaluated at the estimated PD from the maximum likelihood method and set confident level is 0.95 and degree of freedom is N.[11] The hybrid forward method begins with solving for the best grade PD first so $p_1$ solves

$$(p_1)^{\sum_{j=1}^{N} k_j}(1 - p_1)^{\sum_{j=1}^{N}(n_j - k_j)} = \bar{\mathcal{L}} \quad (2)$$

The PD estimates for other rating grades will be solved through the following iterative process. The estimated PD for grade $i = 2, \ldots, N$ is $p_i$ that solves

$$\mathcal{L}(\vec{p}_i) = (p_i)^{\sum_{j=i}^{N} k_j}(1 - p_i)^{\sum_{j=i}^{N}(n_j - k_j)} = \frac{\bar{\mathcal{L}}}{\prod_{l=1}^{i-1} \mathcal{L}\left(p_{MLE}^{l}\right)} \quad (3)$$

This model can estimate the probability of default for both financial and non-financial institution presented in Table 3 and Table 4. This study can resolve previous limitations in studies that only estimated PD for non-financial institutions because of the new definition of simulated default for state-owned

[11] The degree of freedom in case of non-financial institution and financial institution is 7 and 4 respectively, according to the results of the credit rating grade of the Public Debt Management Office in the past fiscal year 2009-2014.

enterprise and new model that is more appropriate with low default portfolio than the earlier model.

Table 3. The estimated PD for Non-financial state-owned enterprises (Percentage)

| **Model** | **Hybrid forward** | **MLE** | **The most prudent** |
|---|---|---|---|
| **Rating grade (i)** | $p_i^{NB}$ | $p_{MLE}^{i}$ | $p_{MP}^{i}$ |
| 1 | 1.8202 | 2.0548 | 8.3220 |
| 2 | 2.1529 | **1.2987** | 8.6504 |
| 3 | **2.0951** | 3.8462 | 9.0805 |
| 4 | 10.4135 | 7.0485 | 10.7972 |
| 5 | 14.6874 | 12.6984 | 11.9110 |
| 6 | 15.2261 | **10.6816** | **11.7999** |
| 7 | 22.8343 | 14.8876 | 14.8876 |

In addition, this study found that the estimated PD for both financial and non-financial are ranked by credit rating grade (the rank ordering property), except the 3rd rating grade PD of non-financial. However, the Hybrid forward PD ($p_i^{NB}$) has failed to rank order condition less than the maximum likelihood PD ($p_{MLE}^{i}$).

In case of financial institutions, estimation of PD found that all the Hybrid forward PD are ranked by credit rating grade and the Hybrid forward model can estimate PD in rating grade 6. The maximum likelihood model and the most prudent model cannot estimate this because there is no default event occurring at this rating grade. This is to be expected as it is characteristic of Low default portfolios, hence the Hybrid

forward model can solve this characteristic of Low default portfolios.

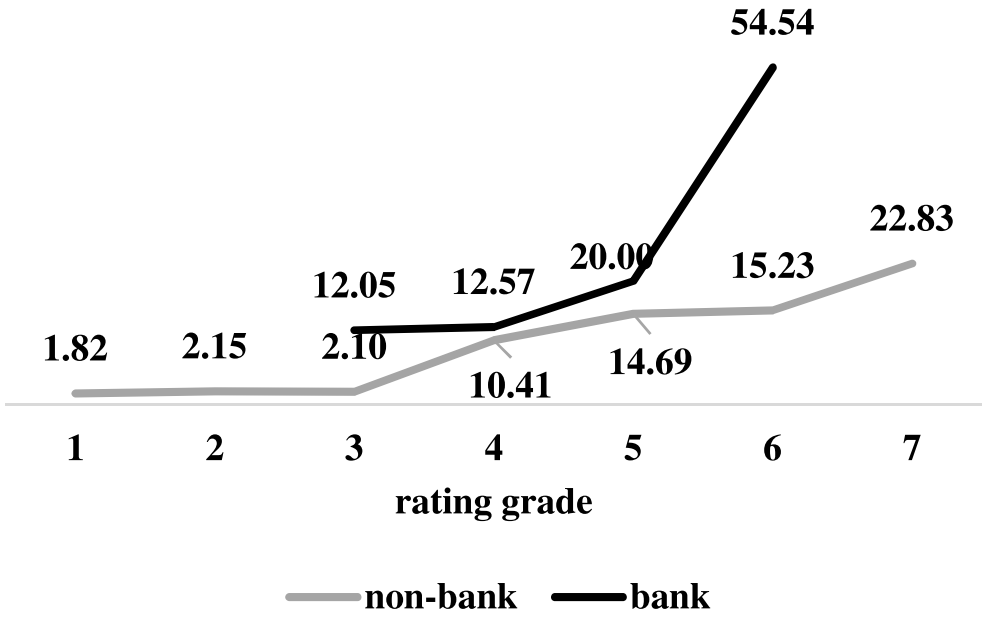
Table 4. The estimated PD for Financial state-owned enterprises (Percentage)

| **Model** | **Hybrid forward** | **MLE** | **The most prudent** |
|---|---|---|---|
| **Rating grade (i)** | $p_i^B$ | $p_{MLE}^i$ | $p_{MP}^i$ |
| 3 | 12.0480 | 5.3571 | 12.0301 |
| 4 | 12.5684 | 7.4510 | 12.5337 |
| 5 | 19.9955 | 15.3846 | 15.1951 |
| 6 | 54.5415 | n.a. | n.a. |

Note: During the fiscal year 2009-2014, state-owned financial institutions received a PDMO's credit rating in grade 3-6 out of the total grade (8 grades).

It should be noted that when we compare the estimated PD for financial and non-financial SOEs at the same credit rating grade, it was found that the financial institutions were more likely to default on debt than the non-financial institutions (see Figure 1), in spite of the fact that financial institutions should have a lower default. That result may be due to the data used during 2009 and 2014 which experienced many changes in government policies and interventions, such as intervention in the Bank for Agriculture and Agricultural Cooperatives and Government Housing Bank. Even these policies have ended, the liabilities and obligations from implementing these policies remain with these banks since the majority of loans and bonds that rollover debts restructure are from these banks and these debts was from government projects.

Figure 1. The estimated PD of financial and non-financial state-owned enterprise




Thus, these estimated PD reflect the magnitude of the credit risk of each state-owned enterprise which are important data to risk management process of the Ministry of Finance in the next section.

## 3. Credit Guarantee Optimization

### *3.1. The objectives of government credit guarantees and risk exposure*

Government credit guarantees to state-owned enterprises create both benefits and fiscal risk for the Ministry of Finance. Government credit guarantees were used as a fiscal tool for financially supporting SOE investment in the production of public goods and services and infrastructure investment.

Meanwhile, this government transaction creates a fiscal risk and obligation to the Ministry of Finance as the guarantor.

The Public Debt Management Office (PDMO), the main player in public debt management, should manage the fiscal risk from government guarantees. Risk management may be within the design of the guarantee system, including the optimal credit guarantees, which the PDMO stands to have a maximum benefit from while fulfilling the goals of the government credit guarantee, while also experiencing minimum fiscal risk, under the relevant legal framework.

Based on portfolio selection theory, the expected utility of the investor is a function that depends on the expected return and risk of investing. However, the PDMO is a government agency that is not intended for profit, but it has the primary purpose of managing public debt of the country. So, the net benefit from credit guarantees of PDMO depends on achieving the goals of government credit guarantees to SOEs against the fiscal risk of this operation, which can be characterized as

$$net\ benefit = achieving\ the\ objectives - \ fiscal\ risk \quad (4)$$

Consider the goals of government credit guarantees in Thailand: one is to provide SOEs with access to finance at a lower financial cost (loan interest rate) and another one is to support those that have high credit risk to get access to finance because they can benefit from the government's high credit standing. The fiscal risk from government credit guarantees is the credit risk of SOEs that can be estimated in the form of the value of the net expected loss from credit guarantees. Thus, the net benefit from credit guarantees of PDMO is as the following equation:

$$B(X_j) = \{[\sum_{j=1}^{20}(R_j^{NG} - R_j^G)X_j] + \sum_{j=1}^{20} X_j\} - \{\sum_{j=1}^{20} PD_j X_j - \sum_{j=1}^{20} r_j X_j\} \quad (5)$$

Where $X_j$ is guaranteed loan of state-owned enterprise $j$; $j$ =1, 2, 3,…, 20. Achieving the goals of government credit guarantees to SOEs is (i) to provide state-owned enterprises with access to finance at a lower financial cost that is evaluated by the spread of interest rate between non-government guaranteed loan and government guaranteed loan $(R_j^{NG} - R_j^G)$ and (ii) to support those that have high credit risk to get access to finance that is evaluated by the amount of guaranteed loan of each state-owned enterprise ($\sum_{j=1}^{20} X_j$). The net expected loss from credit guarantees is the value of expected loss after recovery by the total value of guarantee fee. The expected loss from credit guarantees is the sum of multiple of the probability of default ($PD_j$)[12] by guaranteed loan ($X_j$) of state-owned enterprise $j$. Income from government guarantee fees is a multiple of the fee rate ($r_j$)[13] by guaranteed loan ($X_j$) of the state-owned enterprise $j$.

### *3.2. Laws and regulations*

Considering the optimal guaranteed loan of each state-owned enterprise ($X_j^*$), the value of guaranteed loan at which the Public Debt Management Office receives a maximum the net benefit from credit guarantees is subject to the relevant laws and regulations. The relevant laws and regulations are as follows:

[12] Use the estimated PD from the previous section.
[13] The fee rate is set by the Guarantee Fee Rate and Condition Ministerial Regulation of 2008 (B.E. 2551), that fee rate varies by the credit rating grade and loan period for each state-owned enterprise.

(i) A quasi-budget constraint: in each fiscal year the Ministry of Finance can guarantee no more than 20% of the annual budget that is in force at that time[14]. This can be expressed as $\sum_{j=1}^{20} X_j \leq 0.2A$ where $A$ is the annual budget that is in force at fiscal year 2014.

(ii) Fiscal Sustainability Framework: in each fiscal year the government can generate public debt outstanding no more than 60% of GDP. This can be expressed as $\sum_{j=1}^{20} X_j + B \leq 0.6\,GDP$ where $B$ public debt is outstanding at the end of fiscal year 2013 and the forecast of other public debt in fiscal year 2014.

(iii) Exchange rate risk requirement: in each fiscal year, the proportion of foreign debt to export income must not be more than 9%[15]. This can be expressed as $\sum_{j=1}^{20} X_j^f + C \leq 0.09\,EXP$ where $X_j^f$ is the value of guaranteed loan in foreign currency of state-owned enterprise $j$ and $C$ is another foreign currency debt outstanding of the government at the end of the fiscal year 2013.

(iv) Leverage ratio: the Ministry of Finance can provide credit guarantees to each state-owned enterprise an amount ($X_j$) that, after summing with that SOE's other debt ($D_j$), does not exceed three times the capital of the SOE ($E_j$). In the case where the SOE is a Public Limited Company ($j$ = 9) the amount must not exceed six times the capital of the SOE, and similarly for SOEs which are

[14] Section 28 of Public Debt Management Act of 2005 (B.E. 2548)
[15] The Regulation of the Ministry of Finance on Public Debt Management of 2006 (B.E. 2549)

financial institutions ( $j = 17, 18, 19, 20$). This can be expressed as $D_j + X_j \leq 3E_j$; $j = 9$ and $D_j + X_j \leq 6E_j$; and $j = 17, 18, 19, 20$ respectively.

Furthermore, the optimal guaranteed loan also considers the demand for loan of each state-owned enterprise in a fiscal year that can be expressed as $X_j \leq Ld_j$ where $Ld_j$ is the demand for loan of state-owned enterprise $j$ in fiscal year 2014.

*3.3. Optimization for government credit guarantees*

The study of the optimization of credit guarantees of state-owned enterprise using linear programming models is divided into two groups: maximizing the net benefit from credit guarantee, and minimizing the net expected loss from credit guarantee. This optimization found that (i) subject to all the relevant laws and regulations, and demand for fund of each state-owned enterprise in that time, the results from maximizing the net benefit and the results from minimizing the net expected loss from credit guarantee are similar in terms of optimal guaranteed loan distribution, the value of the net benefit, and the value of the net expected loss from credit guarantees (models 1.1 and 2.1). In addition, (ii) adding the total value of guaranteed loan, which happened in fiscal year 2014 as constraints of the optimization, it was found that high risk enterprises have been reduced to a guaranteed amount, if considered with a focus on the net benefit of PDMO, while some enterprises are not guaranteed, if considered with a focus on the net expected loss value (models 1.2 and 2.2).

Table 5. The optimal values from credit guarantee optimization

| **Model** | **Model 1.1** | **Model 1.2** | **Model 2.1** | **Model 2.2** |
|---|---|---|---|---|
| **Method** | Maximize | Maximize | Minimize | Minimize |
| **Objective function** | Net Benefit | Net Benefit | Net Expected loss | Net Expected loss |
| **Constraints** | ≤ | ≤ | = | = |
| 1. Budget constraints I | √ | √ | √ | √ |
| 2. Budget constraints II | √ | √ | √ | √ |
| 3. Exchange rate risk constraints | √ | √ | √ | √ |
| 4. Leverage constraints | √ | √ | √ | √ |
| 5. Demand for loan | √ | √ | √ | √ |
| 6. Total of credit guarantee | - | √ | - | √ |
| **Optimal values (Million Baht)** | | | | |
| **Guaranteed loan** | SOE1 = 751.45 | SOE1 = 751.45 | SOE1 = 751.45 | SOE1 = 751.45 |
| | SOE5 = 8,810.00 | SOE5 = 8,810.00 | SOE5 = 8,810.00 | SOE5 = 8,810.00 |
| | SOE7 = 30,033.13 | SOE7 = 15,790.15 | SOE7 = 30,033.13 | SOE7 = 30,033.13 |
| | SOE8 = 20,539.94 | SOE8 = 20,539.94 | SOE8 = 20,539.94 | SOE8 = 20,539.94 |
| | SOE10 = 3,000.00 | SOE10 = 3,000.00 | SOE10 = 3,000.00 | SOE10 = 3,000.00 |
| | SOE11 = 10,532.99 | SOE11 = 10,532.99 | SOE11 = 10,532.99 | SOE11 = 290.00 |

Table 5. (Continued)

| Model | Model 1.1 | Model 1.2 | Model 2.1 | Model 2.2 |
|---|---|---|---|---|
| **Optimal values (Million Baht(** | | | | |
| **Guaranteed loan** | SOE13 = 3,000.00 | SOE13 = 3,000.00 | SOE13 = 3,000.00 | - |
| | SOE16 = 1,000.00 | SOE16 = 1,000.00 | SOE16 = 1,000.00 | - |
| | SOE17 = 285,360.90 | SOE17 = 285,360.90 | SOE17 = 285,360.90 | SOE17 = 285,360.90 |
| **Total of credit guarantee** | **363,028.41** | **348,785.42** | **363,028.41** | **348,785.42** |
| **Net benefit** | **320,228.76** | **309,046.31** | **320,228.76** | **306,578.97** |
| **Net expected loss** | **45,765.10** | **42,576.90** | **45,765.10** | **45,115.41** |

## 4. Conclusion and Implication

Estimation of default probability with the Hybrid Model found that the estimated PD for both financial and non-financial SOE is ranked by credit rating grade (the rank ordering property), except the 3rd rating grade PD of non-financial SOE. It should be noted that financial SOEs have a higher estimated PD than non-financial SOEs at the same rating grade despite the fact that financial institutions should perhaps have a lower default risk than non-financial institutions. However, data limitations must be acknowledged as the estimation of PD in this study used data over a period of six years, even if it is under the requirements specific for PD Estimation of the Bank of Thailand (2012) that require use of data of at least five years. In the future, a longer time series data of SOE debts may be used, and thus the estimated PD may be more consistent with financial theory, including satisfying the rank order condition and the financial institution PD less than the non-financial institution PD.

Moreover, estimated PD in this article represents the size of the credit risk of each SOE's credit rating grade that

increases by each rating grade exponentially, while the guarantee fee rate increases by each rating grade linearly. This is so despite the fact that, in financial theory, the guarantor should charge a guarantee fee equal to the default probability of each borrower to mitigate their risk exposure. This implies that the Public Debt Management Office just manages partial risk from a guarantee. However, in the case of SOEs, the Public Debt Management Office cannot charge a guarantee fee more than as prescribed in the Guarantee Fee Rate and Condition Ministerial Regulation of 2008 (B.E. 2551) and increasing the fee contradicts the goal of credit guarantee to SOE, which helps SOE to reach the financial source with a lower cost.

Nevertheless, the Public Debt Management Office can use this estimated default probability to recognize size of credit risk from their credit guarantees to better manage risk, for example counter-guarantees funds. Moreover, estimated default probability can be used to enhance the efficiency of guarantee allocations by using PD as a criterion in the decision about the optimal value of guaranteed loans for each state-owned enterprise.

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