Impact of Credit Guarantee on the Survival of SMEs and Default Prediction for SMEs: Empirical Evidence from Taiwan

by Yeong-Jia Goo and An-Yu Shih

We empirically examine the impact of public credit guarantee on the survival of small and medium-sized enterprises (SMEs) and develop default prediction models for Taiwan SMEs using a 2010-2013 SMEs sample from SME Credit Guarantee Fund of Taiwan (Taiwan SMEG), via logit and multiple discriminant analyses. After utilizing SMEs located area (urban, suburban and rural area) as the dummy variable, we find that Taiwan SMEG's loan guarantee schemes have a significantly more positive impact in urban areas relative to rural areas. We also find that default prediction models with total asset turnover, fixed asset ratio, debt ratio, inventory turnover, and operating revenue growth rate could effectively predict default of guaranteed firms. These results have important implications for Taiwan SMEG in determining the optimal allocation for the budgeted quantity of credit guarantee and developing corporate default prediction models for guaranteed SMEs based upon financial ratios.

Introduction

Importance of small and medium-sized enterprises (SMEs) for economic development and growth is widely known. They play a significant role in almost all economies and are key drivers of innovation. They tend to greatly contribute to the welfare and stability of society by accounting for a large share of employment. According to Small and Medium Enterprise Administration (SMEA), Ministry of Economic Affairs, Taiwan, between 1992 and 2013, SMEs constitute above 97% of all corporations and account for 70~80% of the total employment.

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Although SMEs are critical to economic development, compared with larger firms, SMEs are often denied access to financing, thus impeding their creation, growth and survival. Financial institutions are reluctant to lend to SMEs for market imperfections. The examples of such market failures are insufficient collateral, lack of credit histories, high failure rates, and high administrative costs for financial institutions to engage in small-scale lending.

Therefore, policy-makers throughout the world tend to intervene establishing and enhancing collaboration between financial institutions and SMEs through different sorts of credit enhancement measures. Public credit guarantees are one of many government-sponsored market interventions aimed at enhancing banks' capacity for financing SMEs. The Taiwanese government has also used credit guarantee schemes to assist SMEs to obtain financing from banks. It founded SME Credit Guarantee Fund of Taiwan (Taiwan SMEG) in 1974. Over the past 40 years, the amount of credit guarantee increased rapidly as an important supportive measure.

As Table 1 shows, the number of guaranteed loans grew 325 percent and credit guaranteed amount rose 649 percent during 1998-2013. Credit guarantees covered from 4 percent of bank lending to SMEs in 1998 to 14 percent in 2013 (Figure 1), well above the 5 percent OECD average. Meanwhile, SMEs loans reached a total of New Taiwan Dollar (TWD) 4,776.74 billion (about USD 159 billion), accounted for 51 percent of banks' corporate lending in 2013 (Figure 2). However, the guarantee multiplier (Outstanding Credit Covered by Guarantees / Net Worth) of Taiwan SMEG increased dramatically from about 10 before 2003 to about 20 in 2005 and 2006 (Figure 3), indicating that SMEG undertook overly high financial risk. Although the guarantee multiplier decreased to about 13

in 2013, it was still higher than the level of 8~10 that many researchers consider appropriate. Therefore, Taiwan SMEG might need to actively improve its risk management capability of underwriting loans to support the guarantee balance with its current guarantee capacity.

With credit guarantee, many SMEs are able to overcome financial distress and achieve their transformation into competitive entities. In other words, credit guarantees could relieve the risks of lending to SMEs, as well as provide compensation for low profit margins and produce a significantly larger volume of lending to SMEs (Gudger, 1998). However, it has been criticized that credit guarantees by being favorable to SMEs encourages moral hazard and mitigates the exit of inefficient firms, thereby disturbing the market mechanism (Vogel and Adams, 1997). Therefore, lending based on public guarantees should create a relationship between financial institutions and firms that overcomes the information asymmetry and eliminates the need for such guarantees (OECD, 2014).

For the reason of lack of data, credit guarantee is not a popular research area in Taiwan. It has not been evaluated the effect of credit guarantee on the survival of SMEs and developed a default prediction model with suitable financial ratios for Taiwan SMEG to review the guaranteed firms. Therefore, we propose SMEs financial distress models, via the logit and multiple discriminant analysis, to estimate the impact of credit guarantee on SMEs' survival, and to find which financial ratios are most effective in detecting default. This paper is organized as follows: In the second section, we illustrate issues related with the data set used and the statistical model adopted. In the third section, we apply the proposed model to the empirical data and present the results obtained. Finally, in the last section, we discuss the conclusions and the limitations of this study.

Table 1

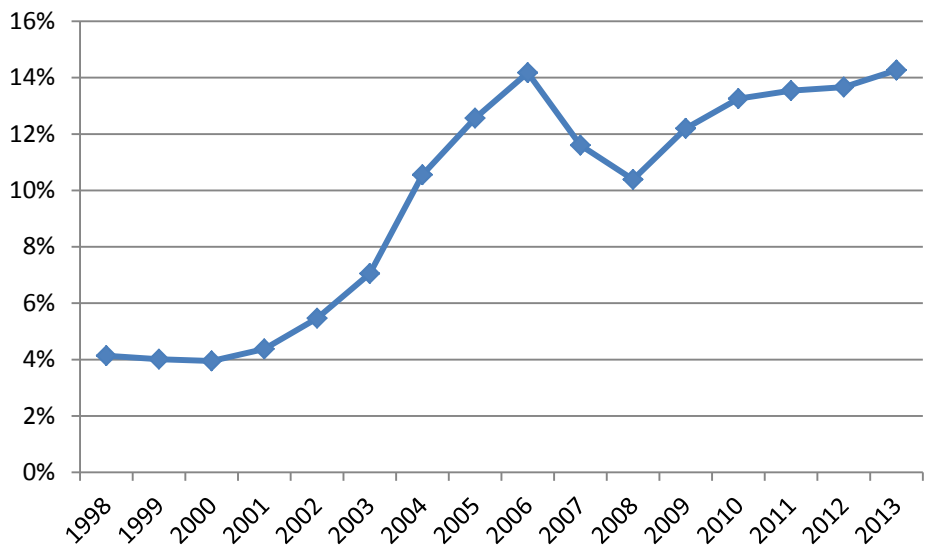
Taiwan SMEG Credit Guarantees to SMEs, 1998-2013

Year	Number of guaranteed loans	Guaranteed amount (TWD million)
1998	92,842	141,045
1999	95,351	135,485
2000	121,858	137,917
2001	149,610	147,804
2002	160,123	151,028
2003	199,783	205,179
2004	265,137	315,449
2005	271,401	333,020
2006	261,824	319,604
2007	238,801	290,611
2008	237,446	330,757
2009	254,807	475,248
2010	312,593	692,598
2011	342,770	808,423
2012	370,144	911,183
2013	394,645	1,056,065

Source: Taiwan SMEG annual reports

Figure 1

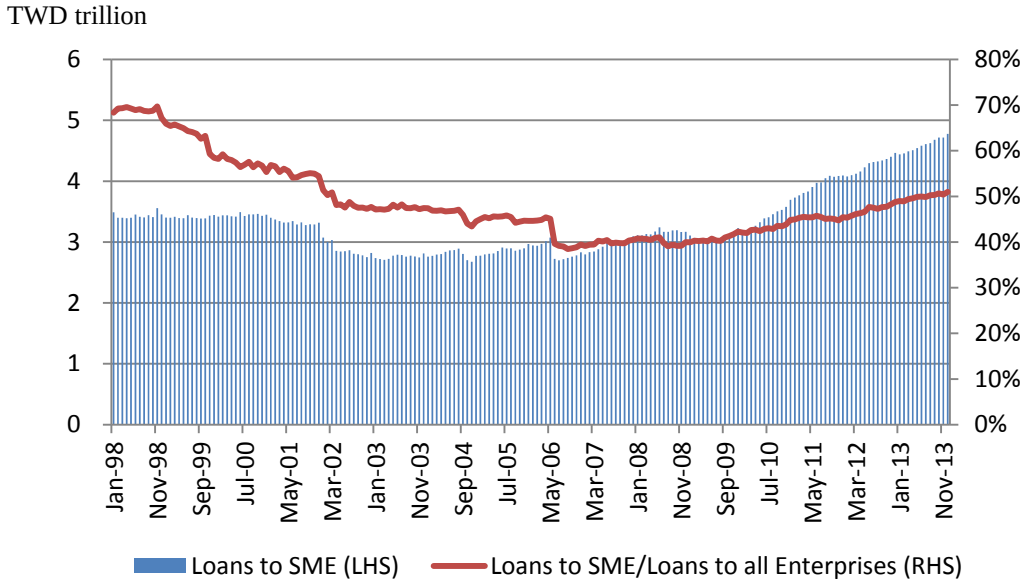
Credit Guarantees Covered Bank Lending to SMEs, 1998-2013



Source: Taiwan SMEG annual reports and Financial Statistics, Banking Bureau, Financial Supervisory Commission

Figure 2

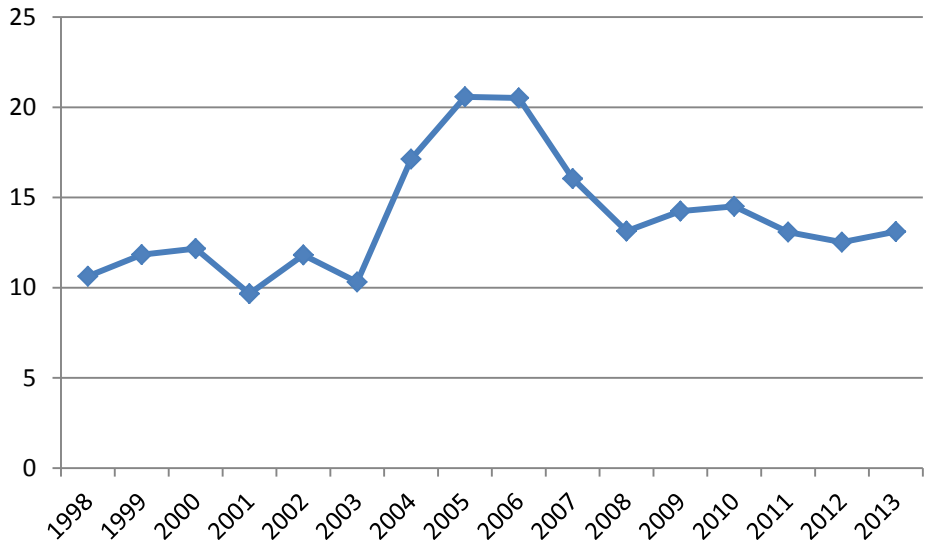
Loans to SMEs and SMEs Loans Account for Banks' Corporate Lending in Taiwan, 1998-2013



Source: Financial Statistics, Banking Bureau, Financial Supervisory Commission

Figure 3

Guarantee Multiplier of Taiwan SMEG, 1998-2013



Source: Taiwan SMEG annual reports

Methodology

In this section, we discuss (1) the data set, (2) the selection of the predictor variables and (3) the statistical models used.

Data set

The statistical analysis utilized a sample containing loan-guaranteed and financial data of 787 SMEs (with non-missing data), gathered from Taiwan SMEG database over the period of 2010-2013. The 787 firms (65 defaults and 722 non-defaults) were randomly selected and all of them were guaranteed firms of Taiwan SMEG.

Selection of Independent Variables

To evaluate the effect of credit guarantee on the survival of SMEs and analyze whether the survival of guaranteed firms would be differentiated from their located area or the number of their employees, we use the logarithm of average credit guarantee amount per company over the period 2010-2013 and classify guaranteed firms into three clusters by either their located area or the numbers of their employees. The distribution of firms by their located area and employee numbers is showed in the Table 2 and 3.

Besides, we consider a number of financial ratios as independent variables, which have been largely used in the default prediction literature. Restricted to the financial data provided by the Taiwan SMEG, we finally choose 21 financial ratios, related to the main aspects of a company's financial profile (profitability, safety, activity, productivity, and growth). All independent variables are presented in Table 4.

Table 2
Distribution of SMEs by Located Area in the Taiwan SMEG Sample

Areas of Taiwan	Number of Non-defaults	Number of Defaults	Total Sample
Urban Area (A_1) (Taipei, New Taipei and Kaohsiung City)	358	34	392
Suburban Area (A_2) (Taoyuan, Taichung and Tainan City)	218	22	240
Rural Area (A_3) (the Others)	146	9	155
Total	722	65	787

Table 3
Distribution of SMEs by Employee Number in the Taiwan SMEG Sample

Employee Numbers	Number of Non-defaults	Number of Defaults	Total Sample
Number of Employees (E_1)$\geqq$200	24	0	24
50$\leqq$Number of Employees (E_2) < 200	285	20	305
Number of Employees (E_3) < 50	413	45	458
Total	722	65	787

Table 4
Candidate Independent Variables

Category	Variable	Definition	
Guarantee	G	Logarithmic Average Credit Guarantee Amount per Company over the Period 2010-2013	
	A_1	Urban Area (Taipei, New Taipei and Kaohsiung City)	
	A_2	Suburban Area (Taoyuan, Taichung and Tainan City)	
	AG_1	$A_1 \times G$	
	AG_2	$A_2 \times G$	
	E_1	Number of Employees$\geqq$200	
	E_2	50$\leqq$Number of Employees< 200	
	EG_1	$E_1 \times G$	
	EG_2	$E_2 \times G$	
Profitability	X_1	Profit Margin	Net Income/Total Operating Revenues
	X_2	Return on Assets	Net Income/Average Total Assets
	X_3	Return on Fixed Assets	Net Income/Average Fixed Assets
	X_4	Return on Capital	Net Income/Average Capital
	X_5	Return on Equity	Net Income/Average Shareholder's Equity
Safety	X_6	Current Ratio	Current Assets/ Current Liabilities
	X_7	Quick Ratio	(Current Assets–Inventories)/Current Liabilities
	X_8	Debt Ratio	Total Debt/Total Assets
	X_9	Long Term Fund Ratio	(Shareholder's Equity+ Long Term Debt)/Fixed Assets
	X_{10}	Fixed Assets Ratio	Fixed Assets/Total Assets
Activity	X_{11}	Receivables Turnover	Total Operating Revenues/Receivables (average)
	X_{12}	Inventory Turnover	Cost of Goods Sold/Inventory(average)
	X_{13}	Inventory Ratio	Inventory/Current Assets
Productivity	X_{14}	Total Asset Turnover	Total Operating Revenues/Total Assets(average)
	X_{15}	Fixed Asset Turnover	Total Operating Revenues/Fixed Assets(average)
	X_{16}	Net Worth Turnover	Total Operating Revenues/Shareholder's Equity(average)
	X_{17}	Merchandise Turnover	Total Operating Revenues/ Inventory(average)
Growth	X_{18}	Operating Revenue Growth Rate	Total Operating Revenues(this year)–Total Operating Revenues(last year)/Total Operating Revenues(last year)×100%
	X_{19}	Net Income Growth Rate	Net Income(this year)–Net Income(last year)/Net Income(last year)×100%
	X_{20}	Net Worth Growth Rate	Net Worth(this year)–Net Worth(last year)/Net Worth (last year)×100%
	X_{21}	Total Asset Growth Rate	Total Assets(this year)–Total Assets(last year)/ Total Assets(last year)×100%

The Logit Analysis

The logit model utilizes the coefficients of the independent variables to predict the probability of occurrence of a dichotomous dependent variable. The technique weights the independent variables and creates a score for every firm in order to classify it as failed or non-failed. The default probability in a logit model is estimated by the following formula:

$$P_{it}(\mathrm{Y}=1)=\frac{1}{1+e^{-Z_{it}}}=\frac{1}{e^{-(\alpha+\beta_1 X_{1,it}+\beta_2 X_{2,it}+\cdots+\beta_n X_{n,it})}}$$

where

$P_{it}(\mathrm{Y}=1)$= probability of default for firm i at the end of year t;

$X_1,\ X_2, \ldots,\ X_n$= independent variables;

$\beta_1,\ \beta_2, \ldots,\ \beta_n$= slope coefficients, which are estimated parameters of the model.

Multiple Discriminant Analysis

Multiple discriminant analysis is a multivariate method in which the phenomena are divided into distinct groups with different qualities. In the context of financial ratio based models for signaling company default, 2 groups are readily identified: failed or non-failed. A company is attributed to a failed or non-failed group according to its achieved score and the maximum similarities.

Classification is done based on optimum shortcut point, identified for multiple discriminant analysis. If the score of a company is lower than shortcut point, it is regarded as a non-failed company. In discriminant analysis, we have tested the validity and significance of models which is taken from stepwise method. Discriminant function can be described as follows:

$$Z=\alpha+\beta_1 X_1+\beta_2 X_2+\cdots+\beta_n X_n$$

where

Z= discriminant score;

X_1, X_2, ... , X_n= independent variables;

β_1, β_2, ... , β_n= discriminant coefficients of independent variables.

Hit ratio

The performance of the above models can be measured in different ways. In this study, we evaluate the performance of our models by calculating their hit ratio (accuracy ratio). The original sample is divided into two subsamples, one used for estimation of the logit or discriminant function (the analysis sample) and another for validation purposes (the holdout sample). This method of validating the function is referred to as the split-sample or cross-validation approach.

Empirical Results

Descriptive Statistics

Table 5 presents descriptive statistics for independent variables. G_1, logarithm of average credit guarantee amount per company over the period 2010-2013, ranges from 17.55 to a low of 12.99, with a mean of 15.20. Many financial-ratio variables display large dispersions. For example, fixed asset turnover (X_{15}) ranges from a high of 22,584.13 percent to a low of 0.08 percent, with a mean of 116.70 percent. Our measure of return on fixed assets (X_3), current ratio (X_6), quick ratio (X_7), long term fund ratio (X_9), receivables turnover (X_{11}), inventory turnover (X_{12}), net worth turnover (X_{16}), operating revenue growth rate (X_{18}), net income growth rate (X_{19}), and net worth growth rate (X_{20}) display wide ranges, too. However, the discrepancy is lower in other financial-ratio variables.

We select among these candidate predictors by means of the logit regression analysis and the stepwise discriminant analysis. The objective of these two analyses is to evaluate the predictive ability of the individual variables.

Logit Analysis

The aims of our logit analysis are to understand the impact of credit guarantee on the survival of SMEs and to evaluate the predictive ability of individual financial ratios. Table 6 and 7 show explanatory variables that were found statistically significant in the logit analysis. Financial explanatory variables of the growth category are not included in Table 6, but added in Table 7. The estimation results in both Table 6 and 7 indicate that the located area of firm exhibits a large, positive, and statistically significant. And the coefficient on AG_1 is negative and significant. This suggests that compared to rural area, SME's default risk is much higher in the urban area. However, with credit guarantee provided by Taiwan SMEG, SME's default risk decreases significantly. Additionally, the insignificant coefficients on employee-number variables (*E* and *EG*) suggest that there is not a significantly different effect of credit guarantee on SMEs with different employee numbers.

With regard to financial-ratio variables, the statistically significant ones are consistent with our expectations and with previous literature. For example, the coefficients on total asset turnover (X_{14}) and fixed asset ratio (X_{10}) are large, negative, and statistically significant at the 1 percent level in both Table 6 and 7. A high value of the total asset turnover (total operating revenues/total assets(average)) indicator means good performances on the market and, therefore, a lower probability of default. The fixed asset ratio (fixed assets/total assets) is a measure of the extent to

which fixed assets are financed with owner's equity (capital). Generally speaking, a high fixed asset ratio, 0.5 or higher, indicates an inefficient use of working capital which reduces the firm's ability to carry accounts receivable and maintain inventory, and usually means a low cash reserve. This will often limit enterprise's ability to respond to increased demand for its products or services. Since the mean and standard deviation of fixed asset ratio in our sample are relatively low showed in Table 5, firm's probability of default still decreases even though the fixed asset ratio increases. The inventory turnover (X_{12}) measures how many times a company's inventory is sold and replaced over a period. The coefficient on inventory turnover is negative and significant at the 5 percent level in Table 6. The higher this ratio, the more healthy should the firm be and, hence the lower is the default probability.

There are also two financial ratios, which are positive, and statistically significant in Table 6 or 7. The coefficient on debt ratio (X_8) is positive and statistically significant at the 1 percent level in Table 6 and the 5 percent level in Table 7. The debt ratio is defined as the ratio of total debt to total assets, which measures the extent of a firm's leverage. The higher this ratio, the more leveraged the firm and the greater its default risk. Operating revenue growth rate (X_{18}) gives a good picture of the rate at which companies have been able to expand their businesses. Firms with higher operating revenue growth rates perform normally better. However, if SMEs expand their business too fast, it may be a dangerous thing. The coefficient on operating revenue growth rate is positive and significant at the 5 percent level in Table 7. This result implies that SMEs with high operating revenue growth rate tend to exhibit a higher default risk.

Multiple Discriminant Analysis

For comparison purposes, we also run a multiple discriminant analysis model using the same sample as we used for the logit analysis. We find that the estimated results of multiple discriminant analysis and logit analysis are quite similar. In Table 8, we present the explanatory variables that are found statistically significant in multiple discriminant analysis. Logarithmic Average Credit Guarantee Amount per Company over the Period 2010-2013 (*G*), debt ratio (X_8), total asset turnover (X_{14}), and fixed asset ratio (X_{10}) are selected. This strongly suggests that credit guarantee schemes indeed enable guaranteed SMEs to overcome financial distress and reduce their probability of default. In addition, debt ratio, total asset turnover, and fixed asset ratio are selected by either multiple discriminant analysis or logit analysis. This may imply that the three financial-ratio variables are good predictors of business failure.

Hit ratio

In order to test the validation performance of our models, we use SMEs in our original sample over the three-year period 2010-2012 as the analysis sample and SMEs in 2013 as the holdout sample. Then, we calculate hit ratio of our logit model and multiple discriminant model.

In Table 9, we summarize the results. Our empirical results reveal that our models constructed by either logit analysis or multiple discriminant analysis have the hit ratios above 92 percent. The hit ratio of our two logit models is 92.43 percent without financial growth variables and 92.35 percent with financial growth variables. Besides, the model constructed by multiple discriminant analysis has whole validity (92.31 percent hit ratio), internal validity (92.08 percent hit ratio) and external validity

(91.54 percent hit ratio) without financial growth variables, and has whole validity (92.53 percent hit ratio), internal validity (92.21 percent hit ratio) and external validity (91.48 percent hit ratio) with financial growth variables. Hence, we can argue that our models are statistically robust and valid.

Table 5
Descriptive Statistics

Name	Variable	Mean	Standard Deviation	Maximum	Minimum
Logged Avg Cr Guar Amt per Co	G_1	15.2042	0.7642	17.5532	12.9862
Urban Area	A_1	0.4897	0.500	1.0000	0.0000
Suburban Area	A_2	0.3118	0.4633	1.0000	0.0000
Number of Employees≧200	E_1	0.0294	0.1689	1.0000	0.0000
50≦Number of Employees< 200	E_2	0.3958	0.4891	1.0000	0.0000
Profit Margin	X_1	0.0088	0.1064	2.0708	-2.4415
Return on Assets	X_2	0.0162	0.0591	0.5843	-1.0296
Return on Fixed Assets	X_3	1.2724	7.0007	155.5000	-23.8312
Return on Capital	X_4	0.1062	0.2709	6.7646	-2.5975
Return on Equity	X_5	0.0537	0.1963	0.9472	-4.4481
Current Ratio	X_6	1.5447	13.3853	655.7662	0.1173
Quick Ratio	X_7	1.1103	13.0155	639.1039	0.0343
Debt Ratio	X_8	0.6851	0.1409	1.3910	0.0014
Long Term Fund Ratio	X_9	18.7237	123.5726	4,211.1200	-0.6819
Fixed Assets Ratio	X_{10}	0.2635	0.2249	0.9389	0.0001
Receivables Turnover	X_{11}	62.5457	40.1663	179.9132	1.2186
Inventory Turnover	X_{12}	72.1628	45.6395	199.2977	10.1015
Inventory Ratio	X_{13}	0.3437	0.1819	0.9469	0.0198
Total Asset Turnover	X_{14}	1.3954	0.9986	13.3926	0.0652
Fixed Asset Turnover	X_{15}	116.7000	699.3536	22,584.1300	0.0793
Net Worth Turnover	X_{16}	5.1339	14.8398	59.2345	-533.6037
Merchandise Turnover	X_{17}	8.4055	7.0059	36.1334	1.8314
Operating Revenue Growth Rate	X_{18}	1.6221	8.4004	291.9413	-0.9893
Net Income Growth Rate	X_{19}	3.2404	55.2036	1,246.0900	-561.6142
Net Worth Growth Rate	X_{20}	1.4853	6.7364	101.8664	-66.6921
Total Asset Growth Rate	X_{21}	1.0670	3.9214	51.8258	-0.9807

Table 6
Results of Logit Analysis without Financial Growth Variables

Name	Variable	Coefficient	Standard Error	Wald Chi-Square	P-value
Urban Area	A_1	21.5754	5.4686	15.5656	< 0.0001**
Suburban Area	A_2	10.7031	5.3110	4.0612	0.0439*
$A_1 \times G$	AG_1	-1.4395	0.3615	15.8562	< 0.0001**
$A_2 \times G$	AG_2	-0.6895	0.3488	3.9081	0.0481*
Total Asset Turnover	X_{14}	-1.0990	0.2525	18.9491	< 0.0001**
Fixed Assets Ratio	X_{10}	-2.0967	0.5846	12.8643	0.0003**
Debt Ratio	X_8	2.2150	0.7185	9.5029	0.0021**
Inventory Turnover	X_{12}	-0.0088	0.0044	3.9109	0.0480*

Note: * and ** denote significance at the 5 percent and 1 percent levels respectively.

Table 7
Results of Logit Analysis with Financial Growth Variables

Name	Variable	Coefficient	Standard Error	Wald Chi-Square	P-value
Urban Area	A_1	22.7889	6.5432	12.1302	0.0005**
$A_1 \times G$	AG_1	-1.5457	0.4346	12.6514	0.0004**
Total Asset Turnover	X_{14}	-1.2769	0.3224	15.6869	< 0.0001**
Fixed Assets Ratio	X_{10}	-2.3489	0.7114	10.9003	0.0010**
Operating Revenue Growth Rate	X_{18}	0.0528	0.0218	5.8759	0.0153*
Debt Ratio	X_8	2.2191	0.9458	5.5055	0.0190*

Note: * and ** denote significance at the 5 percent and 1 percent levels respectively.

Table 8
Results of Multiple Discriminant Analysis without Financial Growth Variables

Name	Variable	Partial R^2	F-statistic	P-value
Logged Avg Cr Guar Amt per Co	G_1	0.0321	80.13	< 0.0001**
Debt Ratio	X_8	0.0029	6.94	0.0085**
Total Asset Turnover	X_{14}	0.0026	6.29	0.0122*
Fixed Assets Ratio	X_{10}	0.0018	4.41	0.0359*

Note: * and ** denote significance at the 5 percent and 1 percent levels respectively.

Table 9
Hit Ratio

	Without Financial Growth Variables				With Financial Growth Variables			
	Multiple Discriminant Analysis			Logit Analysis	Multiple Discriminant Analysis			Logit Analysis
	Whole Validity	Internal Validity	External Validity		Whole Validity	Internal Validity	External Validity	
Hit Ratio	92.31%	92.08%	91.54%	92.43%	92.53%	92.21%	91.48%	92.35%

Summary and Conclusions

The primary objectives of this study are to understand the impact of public credit guarantee on the survival of SMEs and to develop default prediction models for Taiwan SMEs using a 2010-2013 SMEs sample from Taiwan SMEG, via logit analysis and multiple discriminant analysis.

To measure the impact of credit guarantee on the survival of SMEs, we analyze the relationship between credit guarantee and corporate default, and further used dummy variables (firm's located area and employee numbers) to distinguish the effect of credit guarantee on SMEs located in different economic developed areas or with unlike size. The results show that there is a negative relationship between credit guarantee amount and SMEs default. In other words, public credit guarantee enable guaranteed SMEs to overcome financial distress and reduce their probability of default. In addition, the impact of credit guarantee on SMEs for avoiding defaults is more significant in urban areas relative to rural areas. But there is not a significantly different effect of credit guarantee on SMEs with different employee numbers. These results have very significant public policy implications for how Taiwan SMEG's credit guarantees should be directed. SMEs in urban areas may receive a higher priority in the overall credit guarantee schemes.

In this study, we also find that based on logit and multiple discriminant models, the most important variables for default predication among financial ratios are total asset turnover, fixed asset ratio, debt ratio, inventory turnover, and operating revenue growth rate. The results obtained show that the models behave fairly well in our sample and are testified the validity by hit ratio above 90% predictive accuracy.

All results of our study have practical contributions to Taiwan SMEG in determining the optimal allocation for the budgeted quantity of credit guarantee and developing corporate default prediction models for guaranteed SMEs based upon financial ratios. We expect that our research can offer valuable information for the effective operation of credit guarantee schemes.

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