Chapter 5

Empirical Results

I. Descriptive statistics

The key environmental factors for Thai commercial banks are shown in Table 5.1. It can be seen from Table 5.1 and Figure 5.1 that the average exchange rate was stable at about 25 Baht/US$ during the pre-crisis period. Then it tended to be stable at about 40 Baht/US$ towards the end of the post-crisis period. Figure 5.2 shows the difference between volumes of the current gross domestic product (GDP) and the real GDP. The increasing difference justifies the inflation adjustment of the data in this study. Figure 5.3 graphs the annual real GDP growth and inflation. It shows that the average annual real GDP growth is negative (-0.67 percent) during the financial crisis period and the lowest rate is -10.51 percent in year 1998. The growth rate of the post-crisis period (about 5.03 percent per year) is lower than that of the pre-crisis period (about 8.60 percent per year). The annual inflation rate has the similar pattern that the post-crisis period annual inflation (about 2.48 percent) is lower than the pre-crisis period annual inflation rate (about 4.87 percent). The highest and lowest inflation rates are also in the financial crisis period, the highest is 9.24 percent in 1998 (when the real GDP growth has the lowest rate: negative 10.51 percent) and the lowest is -4.02 percent in 1999.

Table 5.1

Environmental factors for Thai commercial banks

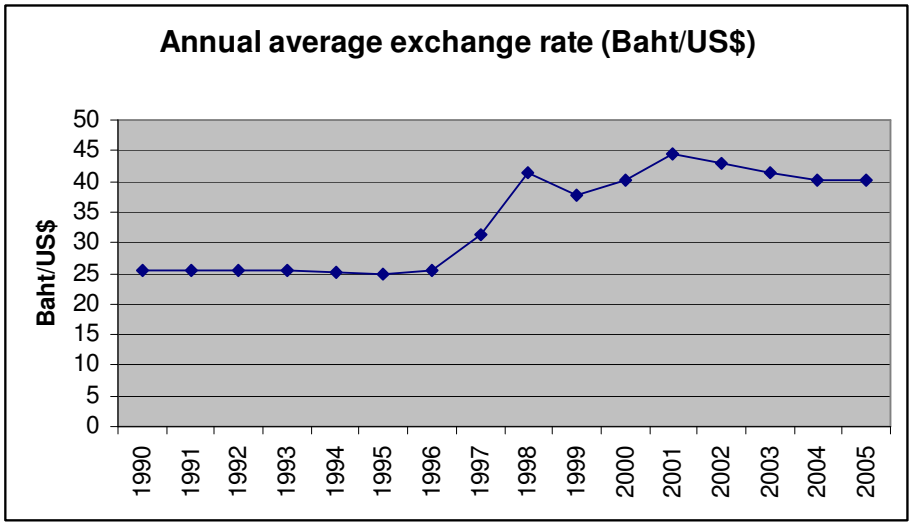
Year	Average exchange rate (Baht/US$)	GDP (Billions of Baht)	GDP Volume in 1988 prices (Billions of Baht)	Real GDP growth (%)	Inflation (%)
Pre-crisis period					
1990	25.59	2183.5	1945.4	11.17	5.77
1991	25.52	2506.6	2111.9	8.56	5.75
1992	25.40	2830.9	2282.6	8.08	4.49
1993	25.32	3165.2	2470.9	8.25	3.29
1994	25.15	3629.3	2693.0	8.99	5.21
1995	24.92	4186.2	2941.7	9.24	5.59
1996	25.34	4611.0	3115.3	5.90	4.01
Average				**8.60**	**4.87**
Crisis period					
1997	31.36	4732.6	3072.6	-1.37	4.06
1998	41.36	4626.4	2749.7	-10.51	9.24
1999	37.81	4637.1	2871.5	4.43	-4.02
2000	40.11	4922.7	3008.4	4.77	1.33
Average				**-0.67**	**2.65**
Post-crisis period					
2001	44.43	5133.5	3073.6	2.17	2.07
2002	42.96	5450.6	3237.0	5.32	0.82
2003	41.49	5929.0	3464.7	7.03	1.63
2004	40.22	6503.5	3678.5	6.17	3.31
2005	40.22	7103.0	3842.5	4.46	4.56
Average				**5.03**	**2.48**

Source: International Monetary Fund (1999; 2003; 2006)

Note:
1. Real GDP growth rates are calculated from the GDP volume in 1988 prices.
2. Inflation is computed from GDP deflator.

Figure 5.1

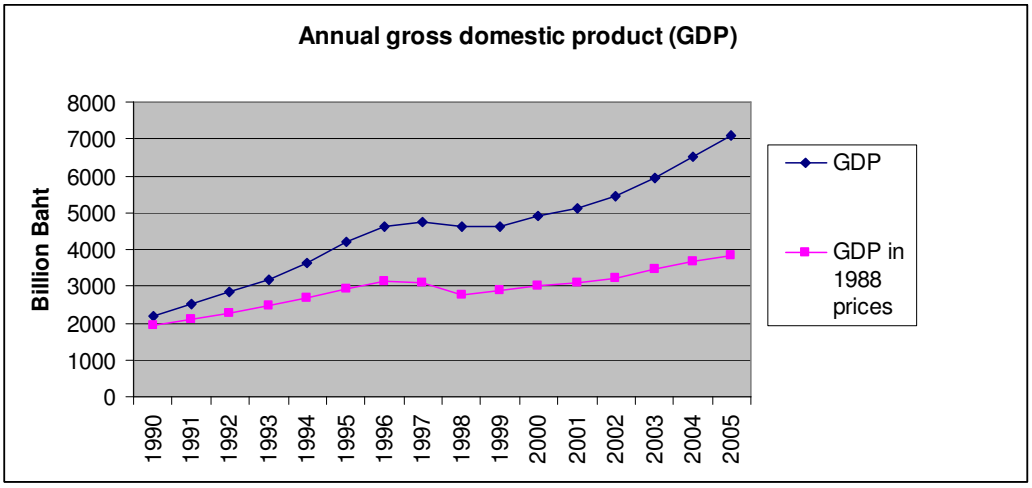
Annual average exchange rate (Baht/US$)



Source: International Monetary Fund (1999; 2003; 2006)

Figure 5.2

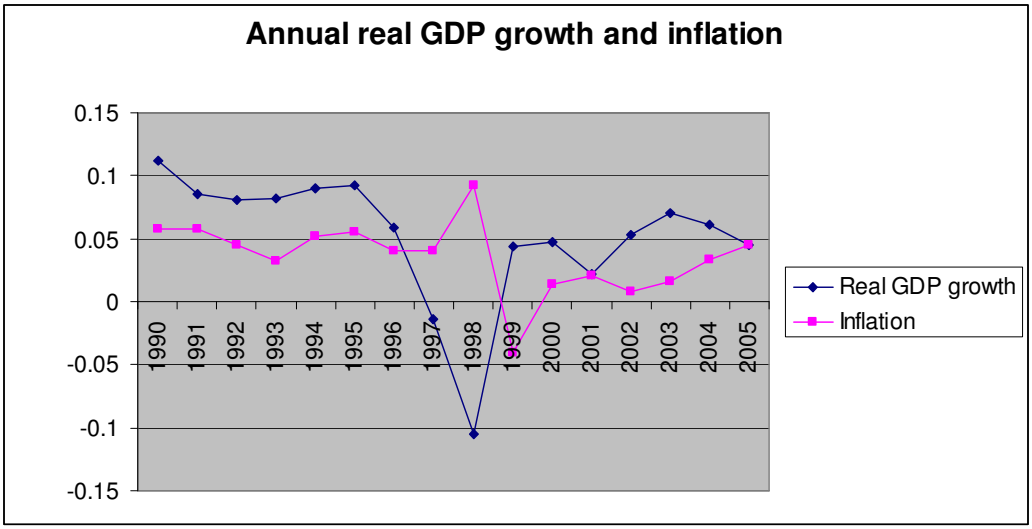
Annual gross domestic product (GDP) of Thailand



Source: International Monetary Fund (1999; 2003; 2006)

Figure 5.3

Annual real GDP growth and inflation



The descriptive statistics for the variables used to measure the bank's cost and profit inefficiency with stochastic frontier approach are compared in Table 5.2. The table provides the information for both of the full sample and three sub-samples. The information shows that the statistics for different periods are quite different. The mean profit is about negative 8,000 million Baht per bank observation in the crisis period. The mean profits of both pre-crisis and post-crisis samples are nearly the same as above 2,000 million Baht. However, the standard deviation of the post-crisis sample is much higher than that of the pre-crisis sample. The total variable cost is the lowest in the post-crisis period with only a little more than half of that of the pre-crisis level. The price of borrowed funds measured as the ratio of total interest expenses to total liabilities is decreasing throughout three periods, from 8.5 percent in the pre-crisis period to 2.1 percent in the post-crisis period. On the other hand, the price of the labor

is increasing throughout three periods, from 166 thousand Baht per employee in the pre-crisis period to 279 thousand Baht per employee in the post-crisis period. The surprising observation is that the total loans net of allowances for doubtful accounts is also increasing steadily from period to period even with the introduction of the NPL concept, from 123 billion Baht in the pre-crisis period to 173 billion Baht in the post-crisis period. The other earning assets and the physical capital have the highest level in the crisis period, and the equity is always increasing and the highest level is in the post-crisis period.

Table 5.3 summarizes descriptive statistics of the variables used to study the correlation between them and the bank's efficiency or inefficiency score. The mean foreign ownership is increasing period by period from 25 percent in the pre-crisis period to 47.4 percent in the post-crisis period. The mean age is decreasing period by period which indicates that the number of new banks is increasing. The mean ratio of non-interest income to interest income has the highest level in the post-crisis period and lowest level in the crisis period, which could be the result of that the banks were taking less market risk during the crisis period and taking more market risk during the post-crisis period. The ratios of provision to loan have the highest level in the crisis period, which is consistent with the high level of non performing loans in Thai commercial banks during the crisis period. The ratios of loan to deposit and equity to total assets have the highest level in the pre-crisis period and the lowest level in the crisis period, which could indicate that banks are more cautious in providing loans than before and the equity level is recovering slowly.

Table 5.2

Descriptive statisticsof the variables used to measure the bank's cost and profit inefficiencies with stochastic frontier approach (SFA)

		Mean	Median	Standard Deviation	Minimum	Maximum
Full sample	π (million Baht)	70	520	9,257	-56,363	46,605
	C (million Baht)	12,193	7,716	12,364	553	67,427
	w_1 (percent)	6.4	7.3	3.6	0.8	30.6
	w_2 (million Baht per employee)	0.212	0.195	0.077	0.069	0.535
	y_1 (million Baht)	140,716	84,646	133,316	3,538	583,681
	y_2 (million Baht)	33,367	13,137	55,251	421	374,100
	z_1 (million Baht)	4,802	2,335	4,904	34	19,359
	z_2 (million Baht)	14,453	8,055	15,320	140	68,757
Pre-crisis sample	π (million Baht)	2,296	931	3,221	36	18,482
	C (million Baht)	12,675	7,898	12,196	553	57,511
	w_1 (percent)	8.5	8.5	1.4	5.7	12.7
	w_2 (million Baht per employee)	0.166	0.159	0.039	0.101	0.286
	y_1 (million Baht)	122,663	74,463	127,333	4,239	583,681
	y_2 (million Baht)	9,716	6,812	9,521	489	48,863
	z_1 (million Baht)	3,264	1,444	3,780	74	17,265
	z_2 (million Baht)	11,223	6,576	12,747	713	67,753
Crisis sample	π (million Baht)	-8,132	-4,576	15,093	-56,363	46,605
	C (million Baht)	17,895	12,112	15,807	1,454	67,427
	w_1 (percent)	7.4	5.6	4.4	3.1	30.6
	w_2 (million Baht per employee)	0.223	0.218	0.071	0.069	0.535
	y_1 (million Baht)	138,724	89,661	127,809	3,538	497,057
	y_2 (million Baht)	72,946	39,395	88,295	421	374,100
	z_1 (million Baht)	6,499	3,443	5,469	655	19,359
	z_2 (million Baht)	17,082	8,973	17,272	878	68,440
Post-crisis sample	π (million Baht)	2,819	820	5,802	-8,213	29,707
	C (million Baht)	6,876	5,826	5,770	663	27,011
	w_1 (percent)	2.1	2.1	0.9	0.8	6.0
	w_2 (million Baht per employee)	0.279	0.268	0.079	0.121	0.492
	y_1 (million Baht)	172,574	162,994	143,283	8,733	507,365
	y_2 (million Baht)	41,759	26,888	46,243	810	196,906
	z_1 (million Baht)	6,040	4,588	5,369	34	19,185
	z_2 (million Baht)	17,793	10,745	16,722	140	68,757

Note:

1. Full sample is from year 1990 to 2005 with 215 observations; the pre-crisis sample is from 1990 to 1996 with 104 observations; the crisis sample is from year 1997 to 2000 with 49 observations; and the post-crisis sample is from year 2001 to 2005 with 62 observations.

2. π is net profit; C is total variable cost (total interest expenses and personnel expenses); w_1 is equal to total interest expenses divided by total liabilities; w_2 is equal to personnel expenses divided by number of employees; y_1 is total loans net of allowances for doubtful accounts; y_2 is total other earning assets; z_1 is physical capital; and z_2 is equity.

Table 5.3

Descriptive statistics of correlated factors

	Full sample		Pre-crisis sample		Crisis sample		Post-crisis sample	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
RGDPG	0.0551	0.0480	0.0862	0.0144	-0.0050	0.0602	0.0503	0.0171
inflation	0.0364	0.0270	0.0488	0.0090	0.0258	0.0470	0.0240	0.0130
foreign ownership	0.3403	0.1946	0.2500	0.0000	0.3629	0.2109	0.4740	0.2557
ln_age	3.6998	0.8907	3.8942	0.2480	3.6698	1.0413	3.3975	1.2915
loanpower	0.6463	0.0221	0.6414	0.0159	0.6648	0.0333	0.6398	0.0081
nonintinc/intinc	0.1839	0.0124	0.1021	0.0036	0.1415	0.0227	0.3547	0.0286
provision/loan	0.0222	0.0946	0.0053	0.0032	0.0746	0.1896	0.0092	0.0152
loan/deposit	0.8805	0.2114	1.0410	0.0844	0.6763	0.1943	0.7725	0.1606
e/ta	0.0685	0.0247	0.0711	0.0144	0.0659	0.0330	0.0663	0.0303
depo/tl	0.8319	0.0699	0.8220	0.0555	0.8084	0.0861	0.8671	0.0650

Note: Full sample is from year 1990 to 2005 with 215 observations; the pre-crisis sample is from 1990 to 1996 with 104 observations; the crisis sample is from year 1997 to 2000 with 49 observations; and the post-crisis sample is from year 2001 to 2005 with 62 observations. RGDPG is the annual real gross domestic product (GDP) growth rate; inflation is the annual inflation rate; ln_age is the natural log of the age of the bank; foreignownership is the limit set by the bank that the highest percentage of the bank's shares can be owned by the foreigners; loanpower: it is equal to the total loans of the four large banks divided by the total loans of all Thai commercial banks; e_ta is equal to equity divided by total assets; depo_tl is equal to deposit divided by total liabilities; nonintinc_intinc is equal to the non-interest income divided by the interest income; provision_loan is equal to the provisions for the bad debts divided by the loans; loan_deposit is equal to the loans divided by the deposits.

Table 5.4

Correlation coefficients of correlated variables

	foreign ownership	ln_age	RGDPG	inflation	nonintinc_ intinc	provision_ loan	loan_ deposit	e_ta	depo_tl	loanpower
foreignownership	1									
ln_age	-0.16	1								
RGDPG	-0.13	0.06	1							
inflation	-0.29	0.11	-0.14	1						
nonintinc_intinc	0.32	-0.20	0.01	-0.33	1					
provision_loan	-0.11	-0.02	-0.42	0.21	-0.06	1				
loan_deposit	-0.19	0.20	**0.69**	0.10	-0.31	-0.12	1			
e_ta	0.08	-0.35	0.08	0.06	0.03	-0.17	0.06	1		
depo_tl	0.16	0.03	0.16	-0.25	0.22	-0.17	-0.19	0.11	1	
loanpower	0.10	-0.08	-0.36	-0.03	-0.08	0.17	-0.22	-0.05	0.17	1

Note: RGDPG is the annual real gross domestic product (GDP) growth rate; inflation is the annual inflation rate ; ln_age is the natural log of the age of the bank; foreignownership is the limit set by the bank that the highest percentage of the bank's shares can be owned by the foreigners; loanpower is equal to the total loans of the four large banks divided by the total loans of all Thai commercial banks; e_ta is equal to equity divided by total assets; depo_tl is equal to deposit divided by total liabilities; nonintinc_intinc is equal to the non-interest income divided by the interest income; provision_loan is equal to the provisions for the bad debts divided by the loans; loan_deposit is equal to the loans divided by the deposits.

Table 5.5

Descriptive statistics of inputs and outputs used to measure efficiency with non-parametric frontier approach (Million Baht)

	Variables	Mean	Standard Deviation	Minimum	Maximum
Full sample	Inputs:				
	1. Total interest expenses	10,548.88	11,104.04	313.69	61,874.31
	2. Personnel expenses	1,643.67	1,591.01	57.56	6,840.23
	3. Physical capital expenses	764.02	702.44	20.76	2,941.62
	Outputs:				
	1. Loans	140,716.37	133,315.63	3,537.82	583,680.95
	2. Other earning assets	33,367.14	55,251.42	421.10	374,100.05
Pre-crisis sample	Inputs:				
	1. Total interest expenses	11,289.89	10,748.19	495.82	50,689.30
	2. Personnel expenses	1,385.07	1,508.22	57.56	6,822.14
	3. Physical capital expenses	532.34	516.50	20.76	1,914.95
	Outputs:				
	1. Loans	122,663.21	127,333.06	4,239.16	583,680.95
	2. Other earning assets	9,716.17	9,520.90	489.43	48,862.78
Crisis sample	Inputs:				
	1. Total interest expenses	16,009.02	14,321.32	1,175.50	61,874.31
	2. Personnel expenses	1,886.11	1,706.90	229.23	6,840.23
	3. Physical capital expenses	949.03	739.88	150.35	2,263.42
	Outputs:				
	1. Loans	138,724.13	127,808.72	3,537.82	497,057.26
	2. Other earning assets	72,946.25	88,294.57	421.10	374,100.05
Post-crisis sample	Inputs:				
	1. Total interest expenses	4,990.62	4,451.91	313.69	21,960.71
	2. Personnel expenses	1,885.83	1,589.34	71.65	5,317.10
	3. Physical capital expenses	1,006.44	819.19	36.36	2,941.62
	Outputs:				
	1. Loans	172,573.59	143,282.76	8,732.53	507,364.61
	2. Other earning assets	41,759.47	46,242.56	809.79	196,905.58

Note: Full sample is from year 1990 to 2005 with 215 observations; the pre-crisis sample is from 1990 to 1996 with 104 observations; the crisis sample is from year 1997 to 2000 with 49 observations; and the post-crisis sample is from year 2001 to 2005 with 62 observations.

The correlation coefficients among the 10 variables are shown in Table 5.4. As can be seen, the correlation coefficients are not high as there is only 1 coefficient above 0.5: RGDPG and loan_deposit. This pair of highly correlated variables will be taken into account when the correlation analysis is conducted. The low correlations of other variables imply that those variables can be grouped together to run the regression analysis.

Table 5.5 shows the descriptive statistics of the inputs and outputs used to measure efficiency with the non-parametric frontier approach. Three inputs are total interest expenses, personnel expenses, and physical capital expenses. Two outputs are loans and other earning assets. Again, the full sample statistics are compared with three sub-samples' descriptive statistics. Figure 5.4 to 5.8 graph the differences of each variable. Figure 5.4 indicates that the mean total interest expenses are increased from the pre-crisis period level of 11,000 million Baht to the crisis period level of 16,000 million Baht, then dropped to the lowest level of about 5,000 million Baht in the post-crisis period. This could be consistent with exchange rate and interest rate changes over time, where the exchange rate is the highest for the crisis period and the interest rate is the lowest for the post-crisis period. Figure 5.5 points out that the mean total personnel expenses have the lowest level in the pre-crisis period, then level off at about the same level for the crisis and post-crisis periods. It can be seen from Figure 5.6 and 5.7 that the mean physical capital expenses and loans are increasing from period to period and reach the highest level in the post-crisis period. The mean other earning assets (see Figure 5.8) increased dramatically from the pre-crisis level of around 10,000 million Baht to the crisis level of above 70,000 million Baht, and to the

post-crisis period level of above 40,000 million Baht, which indicates that the banks are taking more market risk after the financial crisis.

Figure 5.4

Annual mean total interest expenses of Thai commercial banks

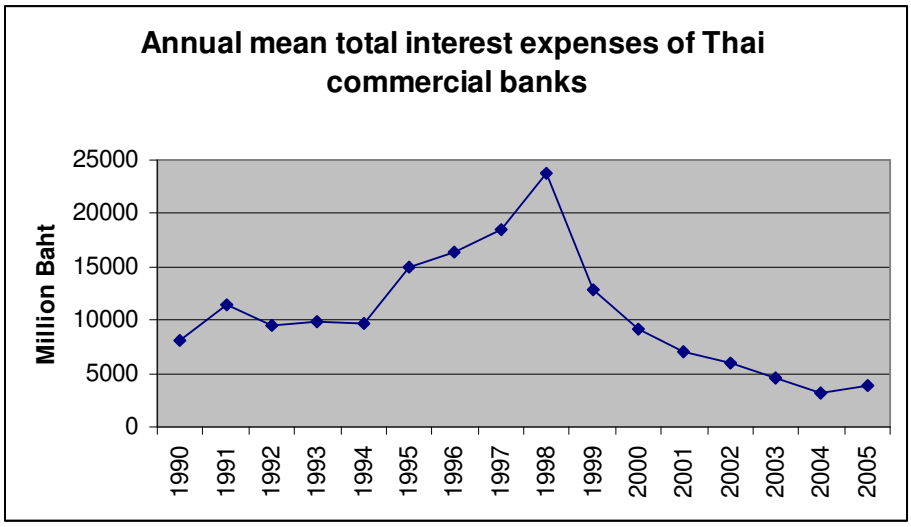


Figure 5.5

Annual mean personnel expenses of Thai commercial banks

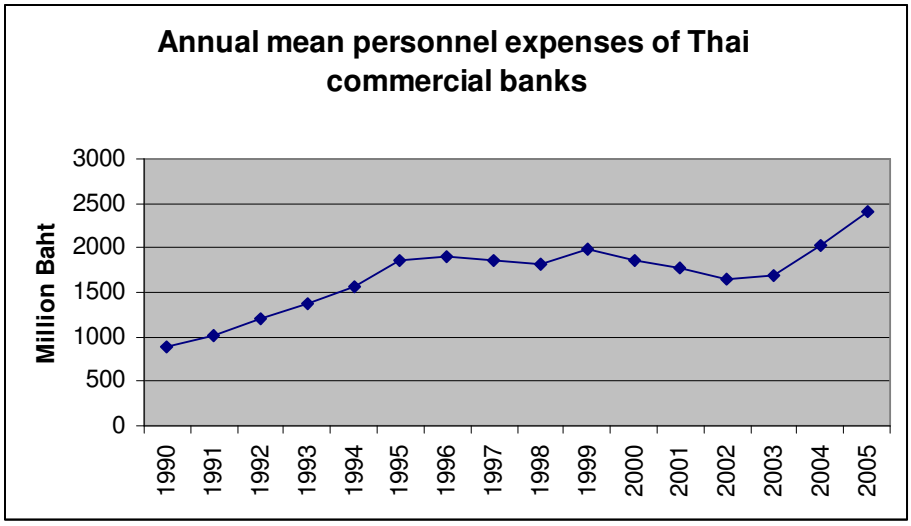


Figure 5.6

Annual mean physical capital expenses of Thai commercial banks

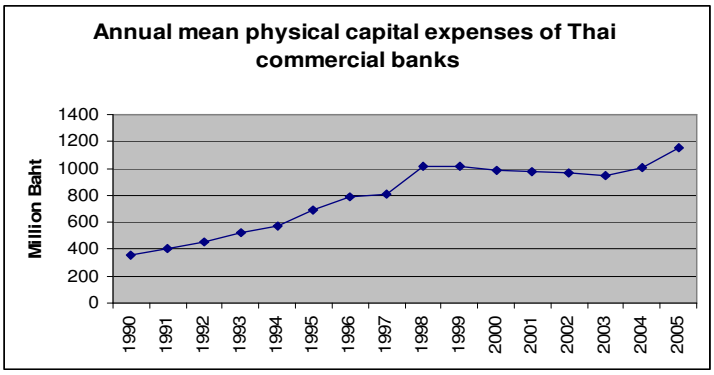


Figure 5.7

Annual mean loans of Thai commercial banks

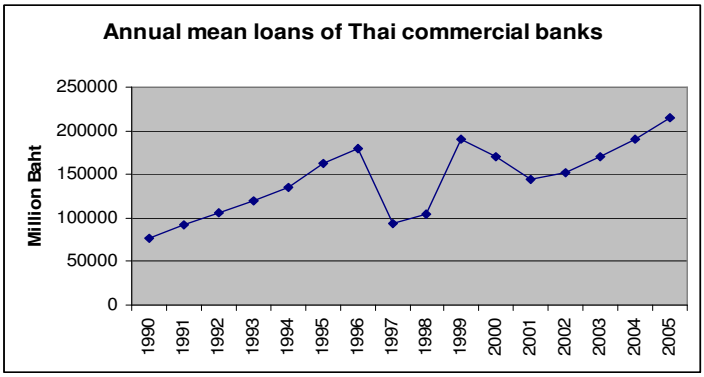
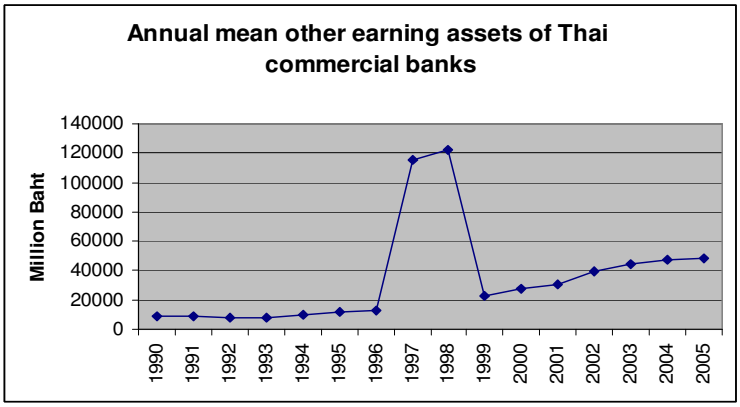


Figure 5.8

Annual mean other earning assets of Thai commercial banks



II. Inefficiency/efficiency scores

Inefficiency scores generated from the parametric approach (Stochastic Frontier Approach)

Maximum likelihood method is used in stochastic frontier approach. Cost and profit inefficiency scores are generated by using the full sample. After inefficiency scores are generated for each bank year observation, then the average inefficiencies of all banks are computed for each year. The results are in panel A of Table 5.6.

It is shown obviously that the results for cost inefficiency and profit inefficiency are not quite the same from the magnitude point of view. However, it can be concluded that the profit and cost inefficiencies of Thai commercial banks are changing overtime, and the inefficiency scores for the post-crisis period are higher than those of the pre-crisis period.

For the case of profit inefficiency, the expected profit inefficiency is the lowest for the pre-crisis period, 14.59 percent, and highest for the crisis period, 29.29 percent, which is about doubled during this period. This can be explained by the Thai commercial banks' huge loss during the financial crisis period. This result is consistent with the previous paper of Williams and Intarachote (2002). After the crisis period, the profit inefficiency is decreasing; Thai commercial banks start to have positive profit. The average profit inefficiency during the post-crisis period is 20.91 percent, which is better than the crisis period, but it is surely worse than the pre-crisis period.

Table 5.6

Annual average cost and profit inefficiencies of Thai commercial banks generated by Stochastic Frontier Approach (SFA) and the t-test

	Year	Annual average Eup	Annual average Eucv
Panel A: inefficiency scores			
Pre-crisis period	1990	0.1246	0.0794
	1991	0.1092	0.0489
	1992	0.1486	0.1014
	1993	0.1554	0.1232
	1994	0.1664	0.1196
	1995	0.1500	0.0773
	1996	0.1669	0.0646
	Mean	**0.1459**	**0.0878**
Crisis period	1997	0.3875	0.0756
	1998	0.2206	0.0992
	1999	0.1636	0.0758
	2000	0.3999	0.1314
	Mean	**0.2929**	**0.0955**
Post-crisis period	2001	0.2551	0.2242
	2002	0.2884	0.1459
	2003	0.2239	0.1005
	2004	0.1359	0.1628
	2005	0.1422	0.1729
	Mean	**0.2091**	**0.1613**
Panel B: t-test of equal means			
Pre-crisis vs. crisis period		-2.453**	-0.456
		(0.046)	(0.331)
Crisis vs. post-crisis period		1.256	-2.744**
		(0.132)	(0.014)
Pre-crisis vs. post-crisis period		-2.011**	-3.247***
		(0.050)	(0.009)

Note: The inefficiency scores are generated by using the full sample from year 1990 to 2005 with 215 observations; Eup is expected profit inefficiency score; and Eucv is the expected cost inefficiency score where the cost is total variable costs. Panel B lists the t-statistics of each t-test of two equal means, and the p-values are in the parentheses. *, **, and *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

Table 5.7

Annual average cost and profit inefficiencies (generated by Stochastic Frontier Approach) computed by bank size

		Annual average Eup			Annual average EuCv		
	Year	Large	Medium	Small	Large	Medium	Small
Panel A: inefficiency scores							
Pre-crisis period	1990	0.0952	0.1175	0.1455	0.0925	0.0514	0.0880
	1991	0.1086	0.1059	0.1115	0.0619	0.0317	0.0512
	1992	0.1611	0.1426	0.1448	0.1141	0.0851	0.1035
	1993	0.1766	0.1439	0.1499	0.1188	0.1098	0.1334
	1994	0.1804	0.1758	0.1530	0.0953	0.1263	0.1297
	1995	0.1624	0.1779	0.1270	0.0730	0.0920	0.0715
	1996	0.1849	0.1768	0.1482	0.0497	0.0797	0.0644
	Mean	**0.1527**	**0.1486**	**0.1400**	**0.0865**	**0.0823**	**0.0917**
Crisis period	1997	0.1865	0.1594	0.6737	0.1170	0.0814	0.0442
	1998	0.2371	0.1964	0.2224	0.1367	0.0935	0.0658
	1999	0.1283	0.1537	0.1979	0.0710	0.0399	0.1013
	2000	0.1210	0.6673	0.4114	0.1791	0.0726	0.1424
	Mean	**0.1682**	**0.2942**	**0.3763**	**0.1259**	**0.0719**	**0.0884**
Post-crisis period	2001	0.2917	0.2608	0.2213	0.2257	0.1920	0.2487
	2002	0.2459	0.3145	0.3015	0.1515	0.1772	0.1165
	2003	0.1972	0.2608	0.2159	0.0676	0.1282	0.1048
	2004	0.1271	0.1761	0.1044	0.0685	0.1534	0.2665
	2005	0.1188	0.1518	0.1607	0.0383	0.1346	0.4036
	Mean	**0.1961**	**0.2328**	**0.2008**	**0.1103**	**0.1571**	**0.2280**
Panel B: t-test of equal means							
Pre-crisis vs. crisis period		-0.5078	-1.1624	-2.1457*	-1.6104*	0.6202	0.1318
		(0.3166)	(0.1646)	(0.0606)	(0.0913)	(0.2762)	(0.4501)
Crisis vs. post-crisis period		-0.6475	0.4788	1.5291	0.3798	-5.0860***	-2.3663**
		(0.2690)	(0.3324)	(0.1005)	(0.3577)	(0.0007)	(0.0321)
Pre-crisis vs. post-crisis period		-1.2020	-2.6272**	-1.8182*	-0.6649	-4.3247***	-2.4242**
		(0.1416)	(0.0233)	(0.0716)	(0.2678)	(0.0008)	(0.0362)

Note: The inefficiency scores are generated by using the full sample from year 1990 to 2005 with 215 observations; Eup is expected profit inefficiency score; and Eucv is the expected cost inefficiency score where the cost is total variable costs. Panel B lists the t-statistics of each t-test of two equal means, and the p-values are in the parentheses. *, **, and *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

On the other hand, it can be seen that the average cost inefficiency is increasing period by period, from 8.78 percent of the pre-crisis period to 9.55 and 16.13 percent of the crisis and post-crisis periods respectively. The reason for this increase could be that the cost efficiency gap between the observed bank and the ideal bank was increasing overtime, and the banks were using more variable costs than before. For instance, after the financial crisis banks are hiring more capable employees to screen and construct loan portfolios to manage the credit risk, or to manage the market risk; therefore, they are paying more for the expertise. It can be seen from Table 5.2 that the average annual personnel expense is increased dramatically from 0.166 million Baht per employee during the pre-crisis period to 0.223 and 0.279 million Baht per employee during the crisis and post-crisis periods respectively.

Hence, both profit and cost inefficiencies of the post-crisis period are higher than those of the pre-crisis period. To find out whether the differences of the mean inefficiency scores for the three periods are significant, the t-tests are conducted. Panel B of Table 5.6 presents the t-statistics and the p-values. The differences between the pre-crisis and post-crisis periods are found to be significant at the 1 percent or 5 percent significance level. Therefore, it can be concluded that the post-crisis period has higher cost and profit inefficiency levels than the pre-crisis period does.

Table 5.7 shows the details of average cost and profit inefficiency scores of large, medium, and small banks (Each bank's Eup and Eucv scores are generated by using the full sample with 215 observations.) The scores indicate that the post-crisis inefficiency level is higher than the pre-crisis inefficiency level in all cases. For the post-crisis period, the large banks have the lowest cost and profit inefficiency scores

whereas the medium banks have the highest profit inefficiency scores and the small banks have the highest cost inefficiency scores. Panel B of Table 5.7 shows the results of t-test of equal mean inefficiency scores. The results indicate that although all of large, medium, and small banks have the higher inefficiency levels in the post-crisis period than that in the pre-crisis period, which is consistent with the results in Table 5.6, the differences are significant only for the medium and small banks.

Efficiency scores generated from the non-parametric approach (Data Envelopment Analysis and Free Disposal Hull)

This part of empirical results will show the efficiency score of Thai commercial banks from two different dimensions: horizontal and vertical. Horizontal dimension means that the bank is compared with other banks, whereas the vertical dimension compares the bank with itself across time.

1. Horizontal measurement

Horizontal measurement lets the bank compare with the best-practice bank during the year. The average CCR, BCC, and FDH efficiency scores are computed annually after the efficiency scores for each bank are obtained. The annual averages and period averages are shown in panel A of Table 5.8. It can also be seen graphically from Figure 5.9. The mean efficiency level is the highest for the pre-crisis period (average CCR of 92.6%, average BCC of 97.2%, and average FDH of 99.98%), and lowest for the crisis period (average CCR of 76.89%, average BCC of 91.92%, and average FDH of 98.73%). Panel B of Table 5.8 lists the t-statistics of each t-test of two equal means. Although the difference is not significant, the conclusion still can be

drawn is that the efficiency level of the post-crisis period (average CCR of 91.74%, average BCC of 96.41%, and average FDH of 99.92%) is lower than that of the pre-crisis period. This conclusion is consistent with the result of previous section when using the parametric approach. Also, the result is consistent with the paper of Chunhachinda and Srisawat (2007).

Figure 5.9

Annual average efficiency scores of Thai commercial banks (generated by the non-parametric approach)

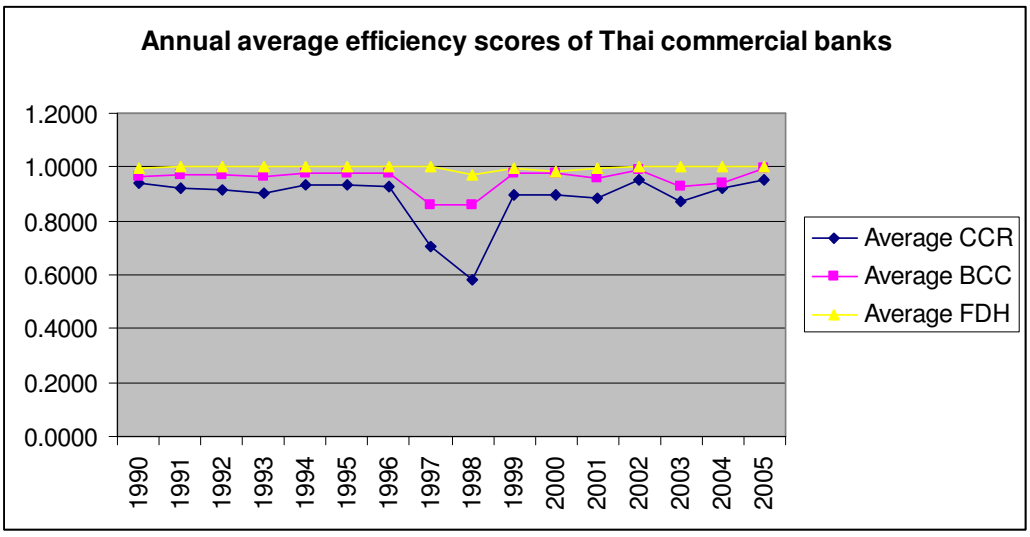


Table 5.8

Annual average efficiency scores by the non-parametric approach (Data Envelopment Analysis (CCR and BCC) and Free Disposal Hull)

	Year	Average CCR	Average BCC	Average FDH
Panel A: efficiency scores				
Pre-crisis period	1990	0.9431	0.9678	0.9986
	1991	0.9242	0.9713	1
	1992	0.9149	0.9727	1
	1993	0.9041	0.9638	1
	1994	0.9363	0.9770	1
	1995	0.9342	0.9760	1
	1996	0.9249	0.9774	1
	Mean	**0.9260**	**0.9723**	**0.9998**
Crisis period	1997	0.7030	0.8626	0.9999
	1998	0.5819	0.8610	0.9686
	1999	0.8945	0.9744	0.9949
	2000	0.8961	0.9789	0.9857
	Mean	**0.7689**	**0.9192**	**0.9873**
Post-crisis period	2001	0.8843	0.9598	0.9960
	2002	0.9527	0.9912	1
	2003	0.8739	0.9296	1
	2004	0.9214	0.9426	1
	2005	0.9548	0.9971	1
	Mean	**0.9174**	**0.9641**	**0.9992**
Panel B: t-test of equal means				
Pre-crisis vs. crisis period		2.0344*	1.5969	1.8204*
		(0.0674)	(0.1043)	(0.0831)
Crisis vs. post-crisis period		-1.8836*	-1.2552	-1.7223*
		(0.0781)	(0.1389)	(0.0917)
Pre-crisis vs. post-crisis period		0.4869	0.6162	0.7323
		(0.3235)	(0.2856)	(0.2523)

Note: The efficiency scores are generated year by year using CCR, BCC, and FDH approaches. Panel B lists the t-statistics of each t-test of two equal means, and the p-values are in the parentheses. *, **, and *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

2. Vertical measurement

The vertical measurement allows the bank to compare with itself across years. Different year observations of the same bank are pooled together to generate the CCR, BCC, and FDH efficiency scores. The average efficiencies for each period for each bank are computed after efficiency scores of each year are obtained. The conclusion is not easy to draw from the vertical measurement, since the results are not consistent among banks. The results can be seen from Table 5.9. The banks can be divided into two groups based on the changes of efficiency scores. One group's BCC efficiency level of the post-crisis period is higher than that of the pre-crisis period, which indicats that the bank's BCC efficiency is improving. The reason for the increased efficiency is either the bank is utilizing less inputs with the given output level or producing more outputs with the given input level than before. There are five banks (2 large, 1 medium, and 2 small banks) in this group. The other group's BCC efficiency level is decreased from the pre-crisis period to the post-crisis period, which indicates that the bank's BCC efficiency is getting worse or not improving. The reason for this could be that the bank uses more inputs with the given level of output or produces less output with the given level of input than before.

Inefficiency scores generated from the combination approach (Stochastic Frontier Approach and Data Envelopment Analysis)

The expected inefficiency scores are recorded in panel A of Table 5.10. The results are similar to previous inefficiency scores generated by the parametric approach. The average cost and profit inefficiency levels of the post-crisis period are

Table 5.9

Average efficiency for each period (generated by non-parametric approaches)

Category	Bank	Period	Average CCR	Average BCC	Average FDH
The post-crisis period BCC score is lower than that of the pre-crisis period	BBL	Pre-crisis period	0.974	1	1
		Crisis period	0.987	0.990	1
		Post-crisis period	0.958	0.977	0.998
	KBANK	Pre-crisis period	0.966	0.988	1
		Crisis period	0.913	0.915	0.975
		Post-crisis period	0.946	0.948	0.980
	TMB	Pre-crisis period	0.930	0.956	1
		Crisis period	0.859	0.973	1
		Post-crisis period	0.924	0.952	1
	LTB/RSB/UOBR[1]	Pre-crisis period	0.902	0.928	1
		Crisis period	0.564	0.626	0.898
		Post-crisis period	0.776	0.809	0.996
	BOA/UOBT[1]	Pre-crisis period	0.858	0.994	1
		Crisis period	0.980	0.985	1
		Post-crisis period	0.962	0.980	1
The post-crisis period BCC score is higher than that of the pre-crisis period	BAY	Pre-crisis period	0.927	0.942	1
		Crisis period	0.928	0.930	0.983
		Post-crisis period	0.964	0.980	0.998
	UB/BT[1]	Pre-crisis period	0.600	0.940	1
		Crisis period	0.966	1	1
		Post-crisis period	0.994	1	1
	TDB/DTDB[1]	Pre-crisis period	0.936	0.952	1
		Crisis period	0.990	1	1
		Post-crisis period	1	1	1
	KTB	Pre-crisis period	0.750	0.913	1
		Crisis period	0.886	0.909	0.964
		Post-crisis period	0.864	0.995	1
	NTB/SCNB[1]	Pre-crisis period	0.996	0.999	1
		Crisis period	0.963	0.978	1
		Post-crisis period	0.999	1.000	1
	SCB	Pre-crisis period	0.932	0.952	0.983
		Crisis period	0.917	0.931	1
		Post-crisis period	0.996	0.999	1
	SCIB	Pre-crisis period	0.840	0.850	1
		Crisis period	0.904	0.957	1
		Post-crisis period	0.901	0.948	0.994
	BMB[2]	Pre-crisis period	0.950	0.985	1
		Crisis period	1	1	1
		Post-crisis period	1	1	1

Note: 1. "/" indicates that the bank name was changed due to the merger or foreign acquisition.
2. Some year observations are deleted due to the negative equity. Thus, there is only 1 observation for both the crisis period (1997) and post-crisis period (2001).

Table 5.10

Average inefficiency scores generated by the combination approach (Stochastic Frontier Approach and Data Envelopment Analysis)

	Year	Average EupCCR	Average EupBCC	Average EucvCCR	Average EucvBCC
Panel A: inefficiency scores					
Pre-crisis period	1990	0.1248	0.1273	0.0847	0.0799
	1991	0.1091	0.1049	0.0563	0.0536
	1992	0.1484	0.1488	0.0895	0.0918
	1993	0.1555	0.1587	0.0999	0.1095
	1994	0.1666	0.1686	0.0963	0.1091
	1995	0.1498	0.1495	0.0678	0.0712
	1996	0.1668	0.1666	0.0446	0.0569
	Mean	**0.1459**	**0.1463**	**0.0770**	**0.0817**
Crisis period	1997	0.3873	0.3828	0.0634	0.0735
	1998	0.2205	0.2128	0.1043	0.1100
	1999	0.1637	0.1623	0.0855	0.0602
	2000	0.3997	0.3996	0.1344	0.1096
	Mean	**0.2928**	**0.2894**	**0.0969**	**0.0883**
Post-crisis period	2001	0.2555	0.2587	0.2275	0.2297
	2002	0.2888	0.2888	0.1438	0.1534
	2003	0.2247	0.2360	0.0811	0.0900
	2004	0.1360	0.1389	0.1421	0.1569
	2005	0.1421	0.1405	0.1606	0.1738
	Mean	**0.2094**	**0.2126**	**0.1510**	**0.1608**
Panel B: t-test of equal means					
Pre-crisis vs. crisis period		-2.4531*	-2.3680**	-1.1690	-0.4285
		(0.0457)	(0.0493)	(0.1475)	(0.3416)
Crisis vs. post-crisis period		1.2497	1.1408	-1.9441**	-2.8170**
		(0.1334)	(0.1528)	(0.0465)	(0.0152)
Pre-crisis vs. post-crisis period		-2.0144**	-2.0635**	-2.9916**	-3.2962**
		(0.0500)	(0.0470)	(0.0152)	(0.0108)

Note: The sample is from year 1990 to 2005 with 215 observations; EupCCR and EupBCC are expected profit inefficiency scores generated with CCR dummy and BCC dummy respectively; and EucvCCR and EucvBCC are the expected cost inefficiency scores generated with the CCR dummy and BCC dummy respectively where the cost is total variable costs. t-statistics of each t-test of two equal means are listed in the table, and the p-values are in the parentheses. *, **, and *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

higher than those of the pre-crisis period. And the t-test results in panel B of Table 5.10 show that the post-crisis inefficiency level is significantly (at the 5 percent significance level) higher than the pre-crisis inefficiency level. The average EupCCR and EupBCC are nearly the same: about 15 percent for the pre-crisis period and about 21 percent for the post-crisis period. The average EucvCCR and EucvBCC are around 8 percent for the pre-crisis period and 15 percent for the post-crisis period.

Comparison of efficiency/inefficiency scores generated from three approaches (parametric, non-parametric and the combination approaches)

After the cost and profit inefficiency scores are converted into cost and profit efficiency scores, the efficiency scores generated by parametric approach, non-parametric approach, and the combination approach are pooled together in panel A of Table 5.11. The result is consistent with the literature that the efficiency scores are sensitive to the methodology applied, and the profit efficiency score is lower than the other measurements.

The profit efficiency is around 22 to 24 percent for the pre-crisis period and 9.9 to 12 percent for the post-crisis period, which is about only half of the pre-crisis level. Therefore, the post-crisis profit efficiency level is lower than the pre-crisis level. The crisis period has the lowest profit efficiency which turns out to be negative, which means that the banks were losing more than the maximum potential profits.

The cost efficiency scores are quite robust no matter which it is converted from. The cost efficiency is about 94 percent during the pre-crisis period and 87 percent during the post-crisis period. Thus, the post-crisis cost efficiency level is

lower than the pre-crisis cost efficiency level. The crisis period efficiency is about 91 percent, which is lower than the pre-crisis level but higher than the post-crisis level. This could suggest that the Thai commercial banks still have problems dealing with the high cost.

For the pre-crisis period, the highest profit efficiency was about 43% in year 1992, and then dropped to about 14% in year 1995 and 1996; the highest cost efficiency was about 95% in year 1991, and then decreased slightly thereafter. This result is weakly consistent with Narongtanupon's (2000) result which showed that the efficiency after the deregulation was diminishing, although the deregulation did improve the efficiency during the earlier years. Possible sources of diminishing efficiency might be increased personnel and physical capital expenses, other operating costs, and less prudent aggressive lending (Narongtanupon, 2000). For the post-crisis period, the profit and cost efficiencies were improving year by year and reached the highest level in year 2003, then decreasing year by year again. This trend mirrors exactly the annual real GDP growth trend (see Table 5.1). This can be the evidence that macroeconomic situation has the positive correlation with the commercial banks' efficiency.

The DEA efficiency scores are not quite the same among CCR, BCC, and FDH methods. However, the patterns are the same that the lowest efficiency level is during the crisis period and the highest efficiency level is in the pre-crisis period. Therefore, the post-crisis DEA efficiency level is lower than the pre-crisis level.

To sum up, from the magnitude point of view, it is easy to make the conclusion that the efficiency level of Thai commercial banks of the post-crisis period is lower than that of the pre-crisis period, no matter which method is utilized:

parametric approach, non-parameter approach, or the combination approach. Another conclusion can be drawn is that the financial crisis has an adverse impact on commercial banks' efficiency. To test the significance of the difference of efficiency scores among three periods, t-tests are conducted for each pair of mean efficiency scores for each two periods. Panel B of Table 5.11 presents the resulting t statistics and p-values. For the profit and cost efficiencies (converted from inefficiency scores generated by either the parametric approach or the combination approach), the post-crisis levels are significantly lower than the pre-crisis levels at the 5 or 1 percent significance level. However, the non-parametric approach DEA efficiency level of the post-crisis period is not significantly lower than that of the pre-crisis period.

Table 5.11

Efficiency scores generated from parametric, non-parametric, and the combination approaches

		Profit efficiency[1], converted from			Cost efficiency, converted from			DEA or FDH effiicency		
	Year	Eup[2]	EupCCR	EupBCC	Eucv	EucvCCR	EucvBCC	CCR	BCC	FDH
Panel A: efficiency scores										
Pre-crisis period	1990	0.1799	0.1802	0.1947	0.9249	0.9407	0.9417	0.9431	0.9678	0.9986
	1991	0.1734	0.1737	0.1676	0.9531	0.9462	0.9490	0.9242	0.9713	1
	1992	0.4369	0.4328	0.4263	0.9437	0.9333	0.9287	0.9149	0.9727	1
	1993	0.3143	0.3135	0.3336	0.9163	0.9115	0.9105	0.9041	0.9638	1
	1994	0.2892	0.2887	0.2096	0.9286	0.9174	0.9129	0.9363	0.9770	1
	1995	0.1442	0.1415	0.0691	0.9425	0.9430	0.9477	0.9342	0.9760	1
	1996	0.1442	0.1442	0.1364	0.9383	0.9570	0.9457	0.9249	0.9774	1
	Mean	**0.2403**	**0.2392**	**0.2196**	**0.9353**	**0.9356**	**0.9337**	**0.9260**	**0.9723**	**0.9998**
Crisis period	1997	-0.3636	-0.3490	-0.2167	0.9284	0.9393	0.9299	0.7030	0.8626	0.9999
	1998	-4.4435	-4.2017	-1.1724	0.9081	0.9215	0.8976	0.5819	0.8610	0.9686
	1999	-3.2010	-135.0926	-22.3565	0.9282	0.9202	0.9430	0.8945	0.9744	0.9949
	2000	-0.5987	-0.6117	-0.7223	0.8811	0.8772	0.8990	0.8961	0.9789	0.9857
	Mean	**-2.1517**	**-35.0638**	**-6.1170**	**0.9114**	**0.9146**	**0.9174**	**0.7689**	**0.9192**	**0.9873**
Post-crisis period	2001	0.1131	0.1139	0.1384	0.8134	0.8145	0.8076	0.8843	0.9598	0.9960
	2002	0.1337	0.1315	0.1357	0.8721	0.8804	0.8677	0.9527	0.9912	1
	2003	0.1470	0.1495	0.2217	0.9111	0.9273	0.9198	0.8739	0.9296	1
	2004	0.1267	0.1297	0.1398	0.8588	0.8966	0.8899	0.9214	0.9426	1
	2005	0.0794	0.0739	-0.1404	0.8576	0.8668	0.8568	0.9548	0.9971	1
	Mean	**0.1200**	**0.1197**	**0.0990**	**0.8626**	**0.8771**	**0.8683**	**0.9174**	**0.9641**	**0.9992**

Table 5.11 (continued)

Efficiency scores generated from parametric, non-parametric, and the combination approaches

Year	Profit efficiency[1], converted from			Cost efficiency, converted from			DEA or FDH effiicency		
	Eup[2]	EupCCR	EupBCC	Eucv	EucvCCR	EucvBCC	CCR	BCC	FDH
Panel B: t-test of equal means									
Pre-crisis period vs. crisis period	2.394** (0.048)[3]	1.058 (0.184)	1.170 (0.163)	1.964* (0.061)	1.447 (0.111)	1.263 (0.131)	2.034* (0.067)	1.597 (0.104)	1.820* (0.083)
Crisis period vs. post-crisis period	-2.275* (0.054)	-1.055 (0.184)	-1.147 (0.167)	2.537** (0.019)	1.641* (0.072)	2.249** (0.033)	-1.884* (0.078)	-1.255 (0.139)	-1.722* (0.092)
Pre-crisis period vs. post-crisis period	2.780** (0.014)	2.763** (0.014)	1.562* (0.078)	4.442*** (0.003)	2.984** (0.015)	3.329*** (0.010)	0.487 (0.323)	0.616 (0.286)	0.732 (0.252)

Note:

1. The bank observations for the profit efficiency is less than 215 in total. Some bank observations are deleted since they have the negative maximum potential profit which makes the profit efficiency ratio meaningless.

2. Eup is the expected profit inefficiency score; and Eucv is the expected cost inefficiency score where the cost is total variable costs. EupCCR and EupBCC are expected profit inefficiency scores generated with CCR dummy and BCC dummy respectively; and EucvCCR and EucvBCC are the expected cost inefficiency scores generated with the CCR dummy and BCC dummy respectively where the cost is total variable costs.

3. p-values are in parentheses; *, **, and *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

III. Correlated factors

The correlation between inefficiency/efficiency scores and other factors are studied first by the OLS regression with White heteroskedasticity-consistent standard errors and covariance. However, the Durbin-Watson statistics are not all around 2 since the sample is paneled from year 1990 to 2005. The range of Durbin-Watson statistics of all regressions is from 1.10 to 2.19. Therefore, to correct the serial correlation or autocorrelation problem, the correlation is studied again by the generalized least squares (GLS) regression with White heteroskedasticity-consistent standard errors and covariance. The GLS is estimated by the AR(1) method which simply treats "AR(1)" as an independent variable (Studenmund, 2001). Although the significant variables are not exactly the same for the OLS and GLS estimates, this paper reports only the GLS results.

Inefficiency scores from the parametric frontier approach

The correlation between the inefficiency score generated from the parametric frontier approach and other factors are studied through the GLS regression. Tables 5.12 and Table 5.13 describe the results.

There are three regressions conducted. The first regression investigates the relationship between inefficiency scores and macroeconomic factors, banking industry level economic factors, and bank general characteristics. The second regression studies only the bank specific financial characteristics. Further, all

variables except the macroeconomic factors are pooled together to test the correlation effects in regression 3.

1. Eup (expected profit inefficiency generated by SFA) as the dependent variable

Table 5.12 describes the estimates when the dependent variable is the expected profit inefficiency based on the pool of the full sample. Only two variables are significant in the 1st regression. RGDPG is negatively related to the profit inefficiency at the 10 percent significance level, the better the economic situation is, the more profit efficient the banks are. This result is consistent with Narongtanupon (2000) that the banks tend to have higher efficiency level during the economic prosperity. Inflation is negatively related to the inefficiency and it is significant at the 5 percent significance level. The higher the inflation, the lower the profit inefficiency is. This can be explained by the fact that the inflation trend normally has the similar pattern with the economic trend. The special case of the Thai financial crisis does not affect the general relationship between the inflation and the efficiency.

There are no significant variables in the 2nd and 3rd regressions after the macroeconomic variables are excluded. This can lead to the conclusion that the Thai commercial banks' profit efficiency is mainly related to macroeconomic conditions.

Loanpower is negatively related to the profit inefficiency although the coefficient is not significant. The higher the concentration of the loan market share is, the lower the profit inefficiency is. Provision_loan, which is the proxy for credit risk, is positively related to the profit inefficiency though the relationship is not significant. The higher the proportion of the loan becomes doubtful, the higher the level of the profit inefficiency is. That is, the bank with higher credit risk will have higher profit inefficiency.

2. Eucv (expected cost inefficiency generated by SFA where the cost is the total variable costs) as the dependent variable

Table 5.13 lists the GLS estimates of Eucv (based on the full sample) on other factors. When the dependent variable is Eucv instead of Eup, more variables become significant at different significance levels. When macroeconomic factors are included in the regression, private dummy is significantly negatively related to the cost inefficiency, which indicates that private-owned banks have the lower inefficiency level whereas government-owned banks have the higher cost inefficiency level. This may be explained by the rescue role of the Thai government-owned banks.

The negative sign of LN_AGE variable indicates that the banks are learning from the experience, the older the bank, the lower the cost inefficiency is. This is consistent with Mester's (1996) "learning by doing" and the result of Berger and Mester (1997). The sign of E_TA variable is also negative; banks with higher equity ratio will have lower cost inefficiency level. This result is supported by the moral hazard theory (Mester, 1996; Berger and Mester, 1997). NONINTINC_INTINC is positively related to the cost inefficiency. This variable is a proxy for the market risk. The higher the market risk is, the higher the cost inefficiency is. Thai commercial banks possibly spent more cost to generate the non-interest income. Also the unfavorable market movement may cause more costs consequently.

DEPOSITE_TL is negatively related to cost inefficiency, which makes sense that the bank using more of the cheapest input (deposit) will have the higher cost efficiency. LOAN_DEPOSIT is also negatively related to the cost inefficiency. Higher liquidity risk is correlated with lower cost inefficiency, or the aggressive lending is correlated with the cost efficiency in screening and monitoring.

Table 5.12

GLS estimates of Eup (generated by the full sample of 215 observations) on other factors

Variable	Regression 1	Regression 2	Regression 3
C	1.387	0.790	1.538
	(0.138)	(0.173)	(0.161)
RGDPG	-1.313*		
	(0.086)		
INFLATION	-1.330**		
	(0.019)		
LARGE	-0.051		-0.009
	(0.341)		(0.780)
MEDIUM	-0.006		0.015
	(0.910)		(0.698)
PRIVATE	0.008		0.033
	(0.912)		(0.578)
FOREIGN_OWNERSHIP	-0.020		0.101
	(0.865)		(0.124)
LN_AGE	0.002		-0.011
	(0.928)		(0.483)
LOANPOWER	-1.635		-1.296
	(0.214)		(0.183)
E_TA		-1.227	-1.546
		(0.396)	(0.295)
DEPO_TL		-0.540	-0.393
		(0.364)	(0.444)
NONINTINC_INTINC		0.141	0.069
		(0.234)	(0.510)
PROVISION_LOAN		0.476	0.574
		(0.132)	(0.127)
LOAN_DEPOSIT		-0.137	-0.108
		(0.266)	(0.248)
Adjusted R-squared	0.022	0.110	0.128

Note: The regression is generalized least squares (GLS) with White heteroskedasticity-consistent standard errors and covariance. Eup is expected profit inefficiency score; RGDPG is the annual real gross domestic product (GDP) growth rate; inflation is the annual inflation rate; large equals 1 if the bank is one of the large banks, 0 otherwise; medium equals 1 if the bank is one of the medium-sized banks, 0 otherwise; private equals 1 if the bank is private-owned and 0 if the bank is government-owned; ln_age is the natural log of the age of the bank; foreignownership is the limit set by the bank that the highest percentage of the bank's shares can be owned by the foreigners; loanpower equals the total loans of the four large banks divided by the total loans of all Thai commercial banks; e_ta equals equity divided by total assets; depo_tl equals deposit divided by total liabilities; nonintinc_intinc equals the non-interest income divided by the interest income; provision_loan equals the provisions for the bad debts divided by the loans; loan_deposit is the loans divided by the deposits. p-values are in parentheses; *, **, and *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

Table 5.13

GLS estimates of Eucv (generated by the full sample of 215 observations) on other factors

Variable	Regression 1	Regression 2	Regression 3
C	0.602**	0.987***	1.136**
	(0.033)	(0.000)	(0.012)
RGDPG	-0.122		
	(0.509)		
INFLATION	-0.061		
	(0.830)		
LARGE	0.002		-0.021
	(0.895)		(0.326)
MEDIUM	-0.003		-0.017
	(0.877)		(0.442)
PRIVATE	-0.056**		-0.014
	(0.049)		(0.465)
FOREIGN_OWNERSHIP	0.054		-0.008
	(0.345)		(0.856)
LN_AGE	-0.032**		-0.011
	(0.044)		(0.278)
LOANPOWER	-0.517		-0.396
	(0.193)		(0.523)
E_TA		-0.433*	-0.599**
		(0.051)	(0.039)
DEPO_TL		-0.489***	-0.362***
		(0.000)	(0.001)
NONINTINC_INTINC		0.033	0.064*
		(0.345)	(0.095)
PROVISION_LOAN		0.047	-0.002
		(0.382)	(0.969)
LOAN_DEPOSIT		-0.508***	-0.422***
		(0.000)	(0.000)
Adjusted R-squared	0.216	0.467	0.482

Note: The regression is generalized least squares (GLS) with White heteroskedasticity-consistent standard errors and covariance. Eucv is expected cost inefficiency where the cost is total variable costs; RGDPG is the annual real gross domestic product (GDP) growth rate; inflation is the annual inflation rate; large equals 1 if the bank is one of the large banks, 0 otherwise; medium equals 1 if the bank is one of the medium-sized banks, 0 otherwise; private equals 1 if the bank is private-owned and 0 if the bank is government-owned; ln_age is the natural log of the age of the bank; foreignownership is the limit set by the bank that the highest percentage of the bank's shares can be owned by the foreigners; loanpower equals the total loans of the four large banks divided by the total loans of all Thai commercial banks; e_ta equals equity divided by total assets; depo_tl equals deposit divided by total liabilities; nonintinc_intinc equals the non-interest income divided by the interest income; provision_loan equals the provisions for the bad debts divided by the loans; loan_deposit is the loans divided by the deposits. p-values are in parentheses; *, **, and *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

Efficiency scores from the non-parametric approach

Since 97.21 percent (see Table 5.14) of the banks have the efficiency score of 1 for the FDH method, the correlation regression of FDH efficiency scores on other factors will be meaningless. Thus, the correlation analysis is only conducted for the CCR and BCC efficiency scores. Table 5.15 and 5.16 show the estimates.

There are 4 regressions conducted when the dependent variable is efficiency scores generated from the non-parametric approach. One more regression is added besides the previous three regressions. The fourth regression includes the crisis and post-crisis dummies since the efficiency scores are generated year by year in this non-parametric case. Thus, these two dummies may have the correlation with the efficiency score. The loan_deposit and rgdpg variables are excluded in the fourth regression because they are highly correlated with the crisis dummy.

Table 5.14

Number of efficient/inefficient banks by different non-parametric approaches

	CCR	BCC	FDH
Number of inefficient banks[1]	133	85	6
Number of efficient banks[2]	82	130	209
Total	215	215	215
Number of efficient banks/Total	0.3814	0.6047	0.9721

Note: 1. “Inefficient bank” means that the bank’s efficiency score is lower than 1.
2. “Efficient bank” means that the bank’s efficiency score is equal to 1.

Table 5.15

GLS estimates of BCC (non-parametric approach) efficiency scores on other factors

Variable	Regression 1	Regression 2	Regression 3	Regression 4
C	0.908***	0.682***	0.682***	0.824***
	(0.000)	(0.000)	(0.004)	(0.004)
RGDPG	0.577***			
	(0.004)			
INFLATION	-0.302			-0.950***
	(0.208)			(0.008)
CRISIS				-0.086***
				(0.002)
POSTCRISIS				-0.023
				(0.246)
LARGE	0.029**		0.022*	0.026**
	(0.022)		(0.077)	(0.047)
MEDIUM	-0.023		-0.024*	-0.021
	(0.141)		(0.091)	(0.179)
PRIVATE	0.014		-0.017	-0.007
	(0.475)		(0.413)	(0.768)
FOREIGN_OWNERSHIP	-0.027		-0.028	-0.030
	(0.434)		(0.429)	(0.491)
LN_AGE	-0.011*		-0.008	0.003
	(0.073)		(0.359)	(0.784)
LOANPOWER	0.102		0.120	0.440
	(0.775)		(0.732)	(0.350)
E_TA		0.577***	0.474*	0.761***
		(0.002)	(0.083)	(0.009)
DEPO_TL		0.100	0.059	-0.175
		(0.285)	(0.579)	(0.151)
NONINTINC_INTINC		0.102***	0.104***	0.038
		(0.004)	(0.004)	(0.234)
PROVISION_LOAN		-0.048	-0.069	0.030
		(0.373)	(0.240)	(0.687)
LOAN_DEPOSIT		0.153***	0.172***	
		(0.000)	(0.000)	
Adjusted R-squared	0.165	0.230	0.283	0.245

Note: The regression is generalized least squares (GLS) with White heteroskedasticity-consistent standard errors and covariance. RGDPG is the annual real gross domestic product (GDP) growth rate; inflation is the annual inflation rate; crisis equals 1 if the bank observation is in the crisis period, 0 otherwise; postcrisis equals 1 if the bank observation is in the post crisis period, 0 otherwise; large equals 1 if the bank is one of the large banks, 0 otherwise; medium equals 1 if the bank is one of the medium-sized banks, 0 otherwise; private equals 1 if the bank is private-owned and 0 if the bank is government-owned; ln_age is the natural log of the age of the bank; foreignownership is the limit set by the bank that the highest percentage of the bank's shares can be owned by the foreigners; loanpower equals the total loans of the four large banks divided by the total loans of all Thai commercial banks; e_ta equals equity divided by total assets; depo_tl equals deposit divided by total liabilities; nonintinc_intinc equals the non-interest income divided by theinterest income; provision_loan equals the provisions for the bad debts divided by the loans; loan_deposit is the loans divided by the deposits. p-values are in parentheses; *, **, and *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

Table 5.16

GLS estimates of CCR (non-parametric approach) efficiency scores on other factors

Variable	Regression 1	Regression 2	Regression 3	Regression 4
C	0.759	0.126	0.412	0.677
	(0.569)	(0.466)	(0.177)	(0.101)
RGDPG	1.636***			
	(0.000)			
INFLATION	-0.730***			-2.802***
	(0.000)			(0.000)
CRISIS				-0.234***
				(0.000)
POSTCRISIS				0.024
				(0.565)
LARGE	0.100***		0.111***	0.123***
	(0.000)		(0.000)	(0.000)
MEDIUM	0.074***		0.076***	0.056**
	(0.000)		(0.000)	(0.020)
PRIVATE	-0.010		-0.057**	-0.001
	(0.125)		(0.028)	(0.964)
FOREIGN_OWNERSHIP	-0.018*		0.007	-0.109
	(0.084)		(0.901)	(0.160)
LN_AGE	0.033		0.018	0.056***
	(0.107)		(0.331)	(0.005)
LOANPOWER	-0.144**		-0.335	0.843
	(0.025)		(0.442)	(0.226)
E_TA		-0.926	-0.232	0.753
		(0.142)	(0.657)	(0.137)
DEPO_TL		0.435**	0.186	-0.535***
		(0.012)	(0.240)	(0.007)
NONINTINC_INTINC		0.171***	0.167***	-0.100
		(0.005)	(0.002)	(0.298)
PROVISION_LOAN		-0.149	-0.135	0.164
		(0.527)	(0.422)	(0.231)
LOAN_DEPOSIT		0.494***	0.512***	
		(0.000)	(0.000)	
Adjusted R-squared	0.405	0.440	0.562	0.468

Note: The regression is generalized least squares (GLS) with White heteroskedasticity-consistent standard errors and covariance. RGDPG is the annual real gross domestic product (GDP) growth rate; inflation is the annual inflation rate; crisis equals 1 if the bank observation is in the crisis period, 0 otherwise; postcrisis equals 1 if the bank observation is in the post crisis period, 0 otherwise; large equals 1 if the bank is one of the large banks, 0 otherwise; medium equals 1 if the bank is one of the medium-sized banks, 0 otherwise; private equals 1 if the bank is private-owned and 0 if the bank is government-owned; ln_age is the natural log of the age of the bank; foreignownership is the limit set by the bank that the highest percentage of the bank's shares can be owned by the foreigners; loanpower equals the total loans of the four large banks divided by the total loans of all Thai commercial banks; e_ta equals equity divided by total assets; depo_tl equals deposit divided by total liabilities; nonintinc_intinc equals the non-interest income divided by theinterest income; provision_loan equals the provisions for the bad debts divided by the loans; loan_deposit is the loans divided by the deposits. p-values are in parentheses; *, **, and *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

From Table 5.15 where the dependent variable is BCC efficiency score, it can be seen that 9 variables are significant in different regressions. And there are 12 variables significant in Table 5.16 where the dependent variable is CCR efficiency score. The RGDPG is positively related to both CCR and BCC efficiency scores. The better economic environment goes hand in hand with the bank efficiency. This is the same as the Eup case that banks tend to have the higher efficiency scores in the good economic conditions. The crisis dummy and inflation variable are negatively related to both CCR and BCC efficiency scores. This is consistent with the result that the banks have the lowest efficiency scores in the crisis period. The crisis and high inflation may deteriorate the output and explode the input cost. The dummy variables large, NONINTINC_INTINC and LOAN_DEPOSIT are positively related to both of the BCC and CCR scores. Large banks tend to have the higher efficiency level. Banks with higher non-interest income ratio and aggressive lending policy tend to have the higher efficiency scores. This can be explained by the high level of outputs and low level of inputs. The variable E/TA is only positively correlated to the BCC efficiency score. Banks with the higher E/TA ratio tend to have less moral hazard, hence higher efficiency scores. LN_AGE and MEDIUM are only positively related to CCR efficiency score. Older banks have the higher efficiency due to their experience learning. Medium-sized banks have higher CCR efficiency ratio than the small-sized banks do. Private-owned banks have the lower CCR efficiency than the government-owned banks do. This may be explained by the possible high output level (loans) of the government-owned banks, which may be the result of the order from the authority. Foreign ownership is negatively related to the CCR efficiency because the bank's efficiency is already very low before the increase of the foreign ownership. It will

take some time to increase the bank's efficiency if the foreign ownership has the better management skills. William and Nguyen (2005) did show that the foreign acquisition led to the improved profit efficiency in the long-term rather than the short-term. Loanpower is negatively related to the CCR efficiency. The monopoly will generally decrease the CCR efficiency. Narongtanupon (2000) also found the negative relationship between the concentration of competition and the efficiency. This implies that the increase in competition or decrease of large bank's monopoly may increase the overall efficiency level of Thai commercial banks.

Inefficiency scores from the combination approach

The correlation analysis is done for the EupBCC (expected profit inefficiency scores generated by SFA with the BCC dummy) and EucvBCC (expected cost inefficiency scores generated by SFA with BCC dummy where the cost is the total variable costs) inefficiency scores. The dependent variable is EupBCC or EucvBCC. The independent variables are chosen as previous 15 variables. The GLS estimates of the same three regressions as the previous parametric approach section are displayed in Table 5.17 and 5.18. The estimates are similar to the results of the parametric approach case (comparing with Table 5.12 and 5.13).

Table 5.17 shows the estimates when the dependent variable is EupBCC. There are only two variables significant in the 1st regression. RGDPG, and inflation are significantly negatively related to the EupBCC at different significance levels. These two variables tell that the macroeconomic environment and the bank profit efficiency have the positive correlation. The better economic situation goes together

with the higher bank efficiency. The explanations are the same as the previous section when the dependent variable is Eup.

Table 5.18 presents the estimates of EucvBCC (expected cost inefficiency generated by SFA with BCC dummy where the cost is total variable costs) on other factors. Variables private, ln_age, depo-tl, loan-deposit, and e_ta are negatively related to EucvBCC at different significance levels. Nonintinc_intinc is positively related to EucvBCC. Explanations are the same as the previous section when the dependent variable is Eucv. The newly significant variables in this section are large and medium dummies. Large and medium are negatively related to the EucvBCC where the large dummy has the larger magnitude. Large banks have the highest cost efficiency and small banks have the lowest cost efficiency. Scale of economies could be one reason for this result.

No conclusion can be drawn about the correlation between foreignownership and EucvBCC, or provision_loan and EucvBCC.

IV. Robustness test

Two types of robustness tests are conducted in this section to study the sensitivity of the SFA approach. Firstly, the dependent variable is changed to generate a different set of expected cost inefficiency scores. Secondly, the sample is changed from the full sample to three sub-samples to generate different sets of expected profit and cost inefficiency scores.

1. Change of dependent variable

The robustness test is conducted through replacing the variable cost (total interest expenses plus personnel expenses) with the total cost (total interest expenses plus personnel expenses plus physical capital expenses) to generate the expected cost inefficiency Euc. The resulting averages of Euc generated (from year 1990 to 2005 with 215 observations) are displayed in panel A of Table 5.19. The average cost inefficiency is the lowest for the crisis period, 9.16 percent, which is just slightly lower than the pre-crisis level of 9.59 percent. This can be explained by that Thai commercial banks strived against the loss by cutting total cost during the crisis period. However, the cost inefficiency increased to the highest level of 16.62 percent during the post-crisis period, which is much higher than the pre-crisis level. The possible reason is that the total costs for the post-crisis period is much higher than necessary. This leads to the conclusion that the average cost inefficiency of the post-crisis period is significantly higher than that of the pre-crisis period (see panel B of Table 5.19). This conclusion is robust when it is compared with the results from the previous section when using the variable cost to generate the expected cost inefficiency Eucv. The slight difference is that the average cost inefficiency of the crisis period generated by variable cost is higher than that generated by the total cost while the other two periods show the opposite.

The correlation analysis is also performed as the previous section. Table 5.20 reports the estimates of three regressions. The dependent variable in Table 5.20 is Euc (expected cost inefficiency generated by SFA). The signs and the significance of the estimates are comparable to the previous part (see Table 5.13 where the dependent variable is Eucv). The results are robust. Variables significantly negatively related to

Euc are private, ln_age, e_ta, depo-tl, and loan-deposit. Private-owned banks have the higher total cost efficiency than the government-owned banks do. Older banks have the higher total cost efficiency because of learning by doing. Banks with higher capital ratio tend to have higher total cost efficiency which is consistent with the moral hazard theory. Banks using more cheap input (deposit) will surely have the higher total cost efficiency. Higher lending correlates with higher total cost efficiency which is possibly resulted from the aggressive lending coupled with less spending in screening and monitoring.

2. Change of sample

The robustness test is also conducted through replacing the full sample with the three sub-period samples. Then the expected profit and cost inefficiency scores for each bank observation are generated period by period. The specification of the SFA model is modified by deleting the crisis and post-crisis dummies. After the inefficiency scores are generated, the correlation analysis is conducted. The results indicate that the SFA approach is sensitive to the sample selection. The details of this section can be found in appendix.

Table 5.17

GLS estimates of EupBCC (generated by the full sample of 215 observations) on other factors

Variable	Regression 1	Regression 2	Regression 3
C	1.394	0.770	1.559
	(0.138)	(0.187)	(0.157)
RGDPG	-1.266*		
	(0.099)		
INFLATION	-1.351**		
	(0.018)		
LARGE	-0.050		-0.010
	(0.351)		(0.762)
MEDIUM	0.000		0.019
	(0.998)		(0.620)
PRIVATE	0.007		0.037
	(0.921)		(0.523)
FOREIGN_OWNERSHIP	-0.009		0.105
	(0.935)		(0.112)
LN_AGE	0.003		-0.013
	(0.902)		(0.442)
LOANPOWER	-1.659		-1.373
	(0.209)		(0.158)
E_TA		-1.344	-1.688
		(0.352)	(0.252)
DEPO_TL		-0.508	-0.347
		(0.397)	(0.502)
NONINTINC_INTINC		0.144	0.069
		(0.225)	(0.514)
PROVISION_LOAN		0.556	0.631
		(0.145)	(0.136)
LOAN_DEPOSIT		-0.106	-0.132
		(0.274)	(0.247)
Adjusted R-squared	0.021	0.107	0.128

Note: The regression is generalized least squares (GLS) with White heteroskedasticity-consistent standard errors and covariance. EupBCC is expected profit inefficiency score generated by the SFA with BCC dummy; RGDPG is the annual real gross domestic product (GDP) growth rate; inflation is the annual inflation rate; large equals 1 if the bank is one of the large banks, 0 otherwise; medium equals 1 if the bank is one of the medium-sized banks, 0 otherwise; private equals 1 if the bank is private-owned and 0 if the bank is government-owned; ln_age is the natural log of the age of the bank; foreignownership is the limit set by the bank that the highest percentage of the bank's shares can be owned by the foreigners; loanpower equals the total loans of the four large banks divided by the total loans of all Thai commercial banks; e_ta equals equity divided by total assets; depo_tl equals deposit divided by total liabilities; nonintinc_intinc equals the non-interest income divided by the interest income; provision_loan equals the provisions for the bad debts divided by the loans; loan_deposit is the loans divided by the deposits. p-values are in parentheses; *, **, and *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

Table 5.18

GLS estimates of EucvBCC (generated by the full sample of 215 observations) on other factors

Variable	Regression 1	Regression 2	Regression 3
C	0.411	0.614***	0.593**
	(0.112)	(0.000)	(0.023)
RGDPG	-0.164		
	(0.306)		
INFLATION	-0.211		
	(0.382)		
LARGE	-0.031*		-0.050***
	(0.066)		(0.008)
MEDIUM	-0.027		-0.044**
	(0.116)		(0.015)
PRIVATE	-0.053*		-0.019
	(0.074)		(0.494)
FOREIGN_OWNERSHIP	0.009		-0.051
	(0.850)		(0.242)
LN_AGE	-0.042***		-0.041***
	(0.005)		(0.002)
LOANPOWER	-0.094		-0.141
	(0.784)		(0.671)
E_TA		-0.006	-0.707**
		(0.984)	(0.048)
DEPO_TL		-0.269***	0.008
		(0.020)	(0.936)
NONINTINC_INTINC		0.056	0.091*
		(0.206)	(0.057)
PROVISION_LOAN		0.062	-0.040
		(0.277)	(0.448)
LOAN_DEPOSIT		-0.322***	-0.167***
		(0.000)	(0.001)
Adjusted R-squared	0.241	0.263	0.389

Note: The regression is generalized least squares (GLS) with White heteroskedasticity-consistent standard errors and covariance. EucvBCC is expected cost inefficiency score generated by SFA with BCC dummy where the cost is total variable costs; RGDPG is the annual real gross domestic product (GDP) growth rate; inflation is the annual inflation rate; large equals 1 if the bank is one of the large banks, 0 otherwise; medium equals 1 if the bank is one of the medium-sized banks, 0 otherwise; private equals 1 if the bank is private-owned and 0 if the bank is government-owned; ln_age is the natural log of the age of the bank; foreignownership is the limit set by the bank that the highest percentage of the bank's shares can be owned by the foreigners; loanpower equals the total loans of the four large banks divided by the total loans of all Thai commercial banks; e_ta equals equity divided by total assets; depo_tl equals deposit divided by total liabilities; nonintinc_intinc equals the non-interest income divided by the interest income; provision_loan equals the provisions for the bad debts divided by the loans; loan_deposit is the loans divided by the deposits. p-values are in parentheses; *, **, and *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

Table 5.19

Annual average Euc (generated by Stochastic Frontier Approach where the cost is the total cost)

	Year	Annual average Euc
Panel A: inefficiency scores		
Pre-crisis period	1990	0.0949
	1991	0.0538
	1992	0.1156
	1993	0.1360
	1994	0.1289
	1995	0.0783
	1996	0.0637
	Mean	**0.0959**
Crisis period	1997	0.0644
	1998	0.1049
	1999	0.0744
	2000	0.1225
	Mean	**0.0916**
Post-crisis period	2001	0.2082
	2002	0.1491
	2003	0.1151
	2004	0.1784
	2005	0.1804
	Mean	**0.1662**
Panel B: t-test of equal means		
Pre-crisis vs. crisis period		0.236
		(0.410)
Crisis vs. post-crisis period		-3.593***
		(0.004)
Pre-crisis vs. post-crisis period		-3.523***
		(0.004)

Note: Euc is expected cost inefficiency score where the cost is total costs; Euc is generated by using the full sample of 215 observations. Panel B lists the t-statistics of each t-test of two equal means, and the p-values are in the parentheses. *, **, and *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

Table 5.20

GLS estimates of Euc (generated by the full sample of 215 observations) on other factors

Variable	Regression 1	Regression 2	Regression 3
C	0.444*	0.738***	0.942**
	(0.091)	(0.000)	(0.019)
RGDPG	0.008		
	(0.962)		
INFLATION	0.107		
	(0.685)		
LARGE	-0.010		-0.030
	(0.544)		(0.141)
MEDIUM	-0.006		-0.025
	(0.741)		(0.252)
PRIVATE	-0.054**		-0.010
	(0.038)		(0.601)
FOREIGN_OWNERSHIP	0.081		0.017
	(0.125)		(0.694)
LN_AGE	-0.028**		-0.020*
	(0.047)		(0.063)
LOANPOWER	-0.323		-0.493
	(0.385)		(0.253)
E_TA		-0.497**	-0.827***
		(0.041)	(0.008)
DEPO_TL		-0.309***	-0.155
		(0.004)	(0.128)
NONINTINC_INTINC		0.017	0.054
		(0.627)	(0.195)
PROVISION_LOAN		0.015	-0.048
		(0.727)	(0.425)
LOAN_DEPOSIT		-0.380***	-0.272***
		(0.000)	(0.000)
Adjusted R-squared	0.233	0.399	0.432

Note: The regression is generalized least squares (GLS) with White heteroskedasticity-consistent standard errors and covariance. Euc is expected cost inefficiency score where the cost is total costs; RGDPG is the annual real gross domestic product (GDP) growth rate; inflation is the annual inflation rate; large equals 1 if the bank is one of the large banks, 0 otherwise; medium equals 1 if the bank is one of the medium-sized banks, 0 otherwise; private equals 1 if the bank is private-owned and 0 if the bank is government-owned; ln_age is the natural log of the age of the bank; foreignownership is the limit set by the bank that the highest percentage of the bank's shares can be owned by the foreigners; loanpower equals the total loans of the four large banks divided by the total loans of all Thai commercial banks; e_ta equals equity divided by total assets; depo_tl equals deposit divided by total liabilities; nonintinc_intinc equals the non-interest income divided by the interest income; provision_loan equals the provisions for the bad debts divided by the loans; loan_deposit is the loans divided by the deposits. p-values are in parentheses; *, **, and *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.