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Privatization, intermediation and performance: global evidence

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Abstract This study compares the performances of privatized banks from 43 countries during 1992–2007 by using two matching theories, Nearest-Neighbor Matching and Mahalanobis Metric Matching. The evidence demonstrates the following: first, the privatized banks outperform non-privatized banks in terms of return on equity, net interest margin and non-performance loan but are tied in terms of return on asset; second, in most cases, full privatization is more effective than partial privatization in improving bank performance; third, the results demonstrate that privatization through asset sales yield a better performance.

Keywords Matching theories · Privatization · Full and partial privatization · Asset sales · Share issue privatization

JEL Classification C21 · G21 · G28

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1 Introduction

This study examines whether the privatization of state-owned banks improves performance. Roughly speaking, over 300 commercial banks have been fully or partially privatized by the governments of 60 countries, either privately through asset sales (AS), or publicly through public share offerings (Megginson 2005). Despite this large number of privatized banks, empirical studies on bank privatization are relatively scarce, and the literature on this area is still being established. Researchers are particularly interested in whether privatized banks are more efficient than non-privatized banks.[1]

In addition to the privatization effect, two additional issues are often raised in the nascent literature. The first issue considers whether the full privatization outperforms the partial privatization. Clarke et al. (2005) argued that performance improves less following privatization when the government retains partial ownership of the privatized bank. We conjecture that this reduced improvement may be due to the fact that continued state-ownership allows politicians to exploit banks for their own purposes. Next, the type of privatization may affect the performance. Clarke et al. (2005) suggested that the approach of share issue privatization (SIP) results in dispersed ownership, while AS privatization displays more concentrated ownership. They suggest concentrated ownership is better than dispersed ownership, implying that the AS privatization outperforms that SIP. This is probably because that concentrated ownership creates larger incentives than the dispersed ownership to monitor managers and correspondingly minimizes the information asymmetries.

While the number of studies addressing these issues is increasing, previous studies frequently confronted two challenges in methodology. First, the privatization may be endogenous. If high quality state-owned banks are especially prone to privatization, it would not be surprising to find superior performance after privatization. Therefore, studies assuming that privatization is exogenous may suffer a self-selection bias. We adopt Heckman's (1979) two-step method to overcome this problem. Second, comparisons between privatized banks and non-privatized banks should share similar characteristics to avoid the effects of contamination by other factors. That is, a privatized bank that has certain characteristics, such as large asset sizes and low loan to deposit ratio, should be compared with a non-privatized bank with equivalent characteristics. These two challenges indicate that privatization should be a random process to avoid endogenous problems and problems relating to different bank characteristics.[2]

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[1] See Beck et al. (2005), Boubakri et al. (2005), Weintraub and Nakane (2005), Otchere (2005), Choi and Hasan (2011) and Clarke et al. (2009).

[2] Moreover, Stuart and Rubin (2007) argued that matching methods and regression-based model adjustments should also not be seen as competing methods, but rather as complementary, which is a decades-old message. In fact, as discussed earlier, much research over a period of decades (Rosenbaum and Rubin 1983, 1985; Rubin and Thomas 1992; Ho et al. 2007) has shown that the best approach is to combine the two methods by, for example, performing regression adjustment on matched samples. Selecting matched samples reduces bias due to covariate differences, and regression analysis on those matched samples can adjust for small remaining differences and increase efficiency of estimates. This study follows their suggestion to conduct matching method.

The aim of this study is to investigate the above three issues—the simple privatization effect, full versus partial privatization effect, and AS versus SIP privatization effect—by using both matching method and Heckman two-step estimation. The matching theory reestablishes the conditions of a randomized experiment where the randomization mimics a *treatment*. Thus, privatized and non-privatized banks are also termed treated and controlled banks, respectively. The basic concept of matching theory is that when making a comparison, the treatment sample (i.e., privatized bank) should have similar characteristics to the controlled sample (i.e., non-privatized banks). Provided the samples share similar characteristics, they can be considered to be randomly sampled, with the resulting difference between two matched observations representing the treatment effect (see Rubin (1973) for details).

In addition to using matching theory, our study differs from the earlier ones in the following aspect. Past studies typically select a limited number of countries to examine their issues, which may create the sample selection problem. To ensure that the four privatization effects found in different countries is not due to the sample selection, we collect worldwide 110 privatized banks headquartered in 43 countries for the longest sample period 1993–2007. To the best of our knowledge, our study is the most comprehensive collection of privatized banks. This provides a systematic and more reliable investigation for this issue. Earlier studies use only a subsample of developing countries: Bonin et al. (2005) use eight countries and 29 privatized state-owned banks, and Boubakri et al. (2005) study the post-privatization performance of 81 privatized state-owned banks in 22 developing countries. The use of the more comprehensive data set and matching theory provide more robust results.

Employing the comprehensive data and matching theory, our results confirm the existence of the privatization effect, on average. Also, our results find that the AS privatization is not always defeated against SIP privatization. This conclusion also applies to the full versus partial privatization. While some of our results are largely similar to those using case studies, the systematic study provides more reliable and robust results.

The remainder of this paper is organized as follows. Section 2 then discusses the implication of our three hypotheses. Section 3 then discusses the matching methodology and its application. Subsequently Sect. 4 presents the empirical results. Section 5 then concludes the paper.

2 Hypotheses

2.1 Privatization effect

Theoretically, state-owned banks are inefficient because they are frequently manipulated to address political and social objectives, rather than being left to pursue profit and efficiency maximization goals. Empirical studies largely support the theoretical prediction. Boubakri et al. (2005) found that only part of performance proxies improved after privatization using data from 81 privatizations in 22 low- and middle-income countries. They also observed that higher

improvements in performance are achieved in richer countries. Weintraub and Nakane (2005) examined the privatization experience of Brazilian banks, and found that bank size and ownership significantly influence productivity. They also found that state-owned banks are considerably less productive than private banks, and that privatization significantly increases productivity. Additionally, Clarke et al. (2009) found that the performance of commercial banks in Uganda improved after they sold 80 % of their shares to a private commercial bank.[3] Thus, our first hypothesis is:

H1 Privatized banks outperform non-privatized state-owned banks.

2.2 Full and partial privatization

Clarke et al. (2005) argued that full privatization should outperform partial privatization. This is because continued state-ownership in partial privatization allows politicians to continue to exploit banks for their own purposes and negatively impact their performance. In addition, Bonin and Wachtel (2000, 2003) and Hasan and Marton (2003) also found that, privatizations were less successful when governments maintained large ownership rather than small ownership in the Czech Republic and Poland. Otchere (2005) also found that continued government ownership is associated with substantial under-performance.

Because a 100 % relinquishing of shares is rare, this study uses 50 % of the total shares to distinguish full from partial privatization. Full privatization is considered to occur if 50 % or more of the shares are relinquished, whereas partial privations denote the releases of shares less than 50 %. Thus, our second hypothesis is:

H2 Full privatization outperforms partial privatization.

2.3 Privatization through AS and SIP

The privatization type also influences performance. Clarke et al. (2005) argued that the approach of SIP results in dispersed ownership, while AS privatization displays more concentrated ownership. Since managers may focus exclusively on personal interests because of agency problems (Shleifer and Vishny 1997), monitoring becomes important for reducing information asymmetries between managers and shareholders. Concentrated ownership creates larger incentives than the dispersed ownership to monitor managers and then to minimize the information asymmetries (Burkart et al. 1997; Shleifer and Vishny 1997; Maug 1998).[4] Thus, our third hypothesis is:

H3 Banks privatized through ASs outperform those by SIP.

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[3] Beck et al. (2005) demonstrated that the performance improved in nine privatized banks but failed to surpass that of existing private banks in a set of data on Nigerian banks.

[4] Furthermore, Otchere (2005) also argued that minimal performance gains have been achieved following SIP since the new owners lack full control over privatized banks. Similarly, Boubakri et al. (2005) found lower economic efficiency when banks are privatized through SIP, although return on equity is also higher.

3 Matching theory

While the original concept of matching theory is simple, its implementation is not easy because matching two or more firms with identical multi-dimensional characteristics is difficult, particularly in situations involving large dimensions. Rosenbaum and Rubin (1983) proposed Propensity score matching (PSM) to resolve this problem, since PSM can reduce multi-dimensional matching problems to single-dimensional ones. Rubin and Thomas (1992) further demonstrated that the use of PSM could overcome the selection bias problem.

3.1 Propensity score matching

The PSM estimates the probability of privatization using characteristic variables as the explanatory variables. PSM helps project these multi-dimensional characteristics into one-dimensional probability while still fulfilling the requirement that all other things should be equal.[5] Then for each firm in the treatment sample, banks in the control samples are selected as matched samples based on the closeness of the above estimated probabilities. The propensity scores can be estimated using the Logit model as follows:

$$P(D = 1) = F(\beta' X),$$

where $F(\cdot)$ denotes the cumulative probability density function of the logistic distribution, β represents a vector of marginal impact coefficients, and X is the vector of characteristic variable, which contains ASSET (assets), EQUITY (equities), LOAN (loans), DEPOSIT (deposits), and ROA_{t-1} (return on bank assets).[6] All characteristic variables are the calculated by the average of 3 years before privatization. Table 1 lists detailed definitions of each variable.

Vega and Winkelried (2005a) pointed out that the estimation requires a set of conditioning variables X that is not influenced by the treatment effect. Consequently, X measures firm attributes before treatment. The first four characteristic variables, including ASSET, EQUITY, LOAN, and DEPOSIT, are not influenced by the privatization (the treatment).The fifth characteristic variable, ROA_{t-1}, is designed to control the past performance in two groups.

Then, after obtaining the estimated propensity score $Pr(D_i = 1|X_i)$ for privatized and non-privatized state-owned banks, denoted as P_i and P_j, respectively, the next step is to identify non-privatized banks whose propensity scores are "sufficiently" close to those of the privatized banks.

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[5] Applications of PSM to investigate the treatment effect, as well as to remove the selection bias problem in economics and finances, are increasing. See Heckman et al. (1998a, b), Persson (2001), Hutchison (2004), Elston, Hofler and Lee (2004), Dehejia and Wahba (2002), Li and Zhao (2006), Glick et al. (2006), Vega and Winkelried (2005b) and Ham et al. (2011) for detail.

[6] In this paper, we adopt these five characteristic variables. However, we also use other characteristic variables, as the robustness check and the results are similar.

Table 1 Definition of characteristic, performance, and other variables

Variable	Definition	Expected sign after the privatization
$D_{Privatized}$	A dummy variable which is equal to one if the bank is privatized and zero otherwise	
D_{full_P}	A dummy variable which is equal to one if the bank is privatized more than 50 % and zero otherwise	
$D_{partial\_P}$	A dummy variable which is equal to one if the bank is privatized less than 50 % and zero otherwise	
D_{AS}	A dummy variable which is equal to one if the bank is privatized with asset sales and zero otherwise	
D_{SIP}	A dummy variable which is equal to one if the bank is privatized with share issue privatization and zero otherwise	
D_{SR}	A dummy variable which is equal to one if the privatization timeis the year of privatization ($t = 0$) to the second year after privatization ($t = 0$–2)	
D_{LR}	A dummy variable which is equal to one if the privatization time is the third year to the fifth year after privatization ($t = 3$–5)	
Characteristic variables		
ASSET	Total asset	
EQUITY	Total equity	
LOAN	Total loan	
DEPOSIT	Total deposit	
ROA_{t-1}	Net income in previous period to total asset in previous period	
Performance variables		
ROA	Net income to total assets	+
ROE	Net income to total equity	+
NIM	Net interest income to total assets	+
NPL	Impaired loans to gross loans	−

3.2 Matching criteria

Two criteria are employed to identify the matched control groups.[7]Among the criteria employed, Nearest-Neighbor Matching is based on PSM, and Mahalanobis Metric Matching is based on characteristic variables to examine the robustness. For simplicity, the later method is referred to as characteristic variables matching (CVM).

The first criterion is the Nearest-Neighbor Matching with Replacement (Nearest hereafter), which matches each treatment sample to the control sample so as to minimize the difference between the two. That is,

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[7] We also use other choices of matching criteria, such as Kernal matching, caliper matching, and Mahalanobis Metric Matching with Caliper, to do the same framework. The results still confirm our hypothesis.

$$\text{Nearest Method}: C(P_i) = \min_j |P_i - P_j|,$$

where $C(P_i)$ denotes a set of control units matched with the treated unit i, i.e., samples that have a propensity score closely approaching that of privatized banks i.

The second criterion is to minimize Mahalanobis Metric Matching, which is referred to as) Mahalanobis Metric Matching (Mahala).That is,

$$\text{Mahala Method}: \min d(i,j) = (X_i - X_j)'V^{-1}(X_i - X_j),$$

where $d(i, j)$ denotes the Mahalanobis distance between treated firm i and control firm j, and X_i and X_j are the respective $k \times 1$ vectors of the observed characteristic variables, where k denotes the number of characteristic variables and V represents the $k \times k$ variance–covariance matrix of the observed characteristics. For any given treated firm i, we choose the control firm j which gives the smallest d.[8]

3.3 Estimate the treatment effects

This section examines four issues: first, whether privatizations can improve local performance; second, whether partial and full privatizations have the same effects; third, whether different types of privatizations have the same effects.

The regression model using the matched sample as follows:

$$\text{PERFORM} = \alpha_1 + \alpha_2 \times D_{\text{Privatized}} + \beta\, Z + \varepsilon, \tag{1}$$

$$\text{PERFORM} = \alpha_1 + \alpha_3 \times D_{\text{full\_P}} + \alpha_4 \times D_{\text{partial\_P}} + \beta\, Z + \varepsilon, \tag{2}$$

$$\text{PERFORM} = \alpha_1 + \alpha_5 \times D_{\text{AS}} + \alpha_6 \times D_{\text{SIP}} + \beta\, Z + \varepsilon, \tag{3}$$

where PERFORM denotes the performance variables, including return on asset (ROA), return on equity (ROE), net interest margin (NIM) and Nonperforming Loan (NPL).[9] TermZ represents the control variables, including ASSET (assets), DEBT (debts), LOAN (loans) and DEPOSIT (deposits), Inverse Mills ratio, and year and country dummies. Inverse Mills ratio is also used to avoid the endogenous problem which is the bank privatization is decided by banks their own.[10] The ratio is obtained from the Heckman's first step of estimating a determinant equation by using the logit model. The selection of the performance and control variables follows Iannotta et al. (2007), Micco et al. (2007), Fang and Lelyveld (2014) and Shaffer (2012a, b).[11]

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[8] For example, if there are 10 treated firms and 20 control firms, we have to compute 200 Mahalanobis Distance.

[9] NPL is the impaired loans to gross loans taken from BANKSCOPE.

[10] The Heckman two-step estimation proceeds as follows. The first step is to estimate a logit model by using ASSET, EQUITY, LOAN, DEPOSIT, and ROA_{t-1} as our dependent variables, which yields the Inverse Mills ratio. Next, the performance regression is implemented by regressing our performance against the explanation variables and the inverse Mills ratio.

[11] We skip the explanation of control variables, but they can be found in the reference cited therein.

The seven dummy variables are used to answer our three hypotheses. Dummy variable $D_{Privatized}$ is equal to 1 if a bank is privatized and zero otherwise; dummy variables, D_{full_P} and $D_{partial\_P}$, denote full and partial privatizations, respectively, where the former is equal to unity when the government banks release more than 50 % shares to the private sector, and zero otherwise; and the latter is equal to unity when the released shares are less than 50 % and zero otherwise. Similarly, dummy variables, D_{AS} and D_{SIP}, are equal to unity if the types of privatization are ASs and share issue privatization, respectively, and zero otherwise.

Equation (1) examines the influence of privatization on financial performances. The positive α_2 suggests the existence of the privatization effect. Since the samples after matching are experimented as randomly drawing, selection bias is eliminated. A similar argument applies for Eq. (2). The positive α_3 suggests that full privatization is effective, and positive α_4 suggests that partial privatization is effective. Similarly, the argument is also applied to Eq. (3). Positive α_5 suggests that AS privatization is effective and positive α_6 suggests that SIP privatization is effective.

4 Empirical results

The matching theory employed in this study is applied as follows. First, we search over a comprehensive set of privatized banks covering 43 countries over the period 1992–2005. Next, using the date of privatization for each bank as the event date, 3-year basic characteristics of privatized banks are collected before the event day.[12] The rule of selecting similar state-owned banks is based on the matching theory. The paired sample thus may have equivalent sizes and 1-year earlier performances before privatization. Finally, employing the same data set, the performance is compared again during the post-privatization year. This study examines whether the performance of the various sample banks changes after privatization.

4.1 Variable description and sources

The sample of privatized banks covers the period 1992–2005, where privatized banks before 2003 are taken from Megginson (2005), who provides a list of privatized banks from 1987 to 2003. Because bank financial data are not available in Bankscope data bank before 1992, the starting period is 1992. For the post 2003 period, data is obtained from the World Bank, representing a total of 13 years. The total sample includes 110 privatized banks from 43 countries,[13] making it more complete than any other study of which we are aware.

Among the 110 banks, a mix of 70 and 40 are fully and partially privatized, respectively. Also, 47 and 49banks are privatized, with the privatization conducted

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[12] The basic characteristics include assets, liabilities, loans, deposits and earnings over the previous year. Simultaneously, state-owned banks with similar basic characteristics to privatized banks but which are not themselves privatized are selected.

[13] We also exclude the sample which is privatized with M&A in our study.

via SIP and ASs, respectively.[14] The privatization type for the remaining 14 banks is unclear due to missing records. After identifying the privatized banks, we search the Fitch-IBCA Bankscope data to identify their financial ratios. Besides the 110 treated sample banks, we also collect control sample banks,[15] including bank holding companies, commercial banks, and savings banks in the same countries. Finally, yearly bank observations are excluded during 1992–2007 if they do not have complete data of characteristic variable. The final sample contains 297 banks from 43 countries.

Table 2 lists the number of bank privatizations for each country during each year. For most countries the number of bank privatizations during the survey period is just one or two. Poland has the largest number of bank privatizations during the sample period (with eight), followed by India and Indonesia (each with six). The largest number of privatizations occurs red during 1997–1999, and coincided with the Asian crisis.

Table 3 presents the correlation coefficient Matrix of variables. With the exception of the high correlation coefficient between NIM and DEPOSIT, the correlations between other pairs are below 0.85, creating little multicollinearity problem.

4.2 Descriptive statistics before matching

Table 4 lists the descriptive statistics for the characteristic and performance variables using the entire sample of privatized and non-privatized banks. Notably, all the characteristic variables of privatized banks are markedly smaller than those of non-privatized banks. That is, the privatized banks have smaller ASSET, EQUITY, LOAN, and DEPOSIT than the non-privatized banks, implying smaller state-owned banks are more likely to be privatized than big state-owned banks. Particularly, the ASSET of privatized banks is only around half that of non-privatized banks, and their difference is highly statistically significant.

4.3 Descriptive statistics after matching

The average of the characteristic variables for the past 3 years is employed for matching. The 110 banks were successfully matched using the Nearest and Mahala methods. To ensure the validity of the comparisons of performance variables, we examine the matching effectiveness by testing the differences of characteristic variables between the treated and control sample. Following Li and Zhao (2006), we conduct the paired t and joint F-tests using the sample after the matching, where the paired t test investigates the mean difference of each characteristic variable between the privatized and non-privatized banks, and the joint F-test examines the joint distribution of characteristic variables between them.

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[14] Primary and secondary issues have not had the same impact on firms' performance (Sun et al. 2002). Therefore, in this study, we only focus on the primary issue case.

[15] Control sample banks are the banks with more than 20 % state-owned shares.

Table 2 Number of privatizations across countries during 1992–2004

	Country	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Sum	full_P	partial_P	SIP	AS	Amount of Offer (US $ million)
1	Albania									1					1	1	0	0	0	10
2	Argentina							1							1	1	0	0	1	57.3
3	Australia				1				1						2	1	1	1	1	758.7
4	Austria					1		1							2	1	1	0	2	158.9
5	Brazil							1		1					2	2	0	0	2	4094
6	Bulgaria						1	1	1	1					5	4	1	0	5	812
7	China										1	2	1		3	1	2	1	2	2929
8	Colombia					2									2	1	1	0	2	599
9	Croatia					1				1		2			4	2	2	1	0	579
10	Czech Rep.				1	1		1	1			1			5	3	2	1	2	1974
11	Egypt	1				2	1		1						5	1	4	4	1	299.6
12	France	1	1		1			1	1						5	5	0	2	3	16,788
13	Germany										1				1	1	0	0	1	3234
14	Ghana					1									1	1	0	0	1	26
15	Guyana						1								1	0	1	0	1	20
16	Hungary				1		2								3	1	2	2	1	320.9
17	Iceland							1							1	0	1	1	0	24.5
18	India				1	1	4								6	3	3	6	0	1683
19	Indonesia					1						1	1	3	6	4	2	1	1	2209
20	Israel		2	1											3	0	3	2	1	502
21	Japan									1					1	1	0	0	1	932
22	Kenya			1		1									2	0	2	2	0	21
23	Korea								1			1			2	2	0	0	2	1665

Table 2 continued

	Country	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Sum	full_P	partial_P	SIP	AS	Amount of Offer (US $ million)
24	Kuwait					1	3								4	4	0	1	3	503.3
25	Latvia					1									1	0	1	0	1	10
26	Malta								1						1	1	0	0	1	250
27	Mexico											1			1	0	1	0	1	865
28	Morocco				1	1									2	2	0	2	0	219
29	Mozambique						1								1	1	0	0	1	21
30	Norway		1		1	1									3	2	1	3	0	926
31	Pakistan						1				1	3			5	4	1	0	2	249.5
32	Peru				1										1	1	0	0	1	256
33	Poland			1	1	1		1	2	1					8	4	4	6	2	2825
34	Portugal	2													2	2	0	2	0	340
35	Romania							1							1	0	1	0	1	200
36	Russia											1			1	0	1	0	1	300
37	Singapore		1												1	1	0	1	0	235
38	Slovakia									2	1	1			4	4	0	0	3	1276
39	Sri Lanka						1								1	1	0	1	0	75
40	Sweden				1										1	1	0	1	0	893
41	Taiwan					1	1	2	1						5	3	2	5	0	2914
42	Uganda					1	1								2	2	0	0	2	8.8
43	Zimbabwe						1								1	1	0	1	0	43.7
	Sum	2	6	3	11	17	18	12	10	8	5	13	2	3	110	70	40	47	49	52107.2

full_P: full privatization; partial_P: partial privatization

AS asset sales, SIP share issue privatization

Table 3 Correlation coefficient matrix of the variables

	D$_{Privatized}$	ASSET	EQUITY	LOAN	DEPOSIT	ROA	ROE	NIM	NPL
D$_{Privatized}$	1.0000								
ASSET	−0.0110	1.0000							
EQUITY	−0.0062	0.2368***	1.0000						
LOAN	−0.0096	0.4143***	−0.0118	1.0000					
DEPOSIT	−0.0101	0.2164***	0.6227***	−0.0104	1.0000				
ROA	−0.0146	−0.0179	−0.0054	0.0210	0.0018	1.0000			
ROE	−0.0346	−0.0247	−0.0090	−0.0069	0.8262***	0.1697***	1.0000		
NIM	−0.0050	−0.0173	−0.0049	−0.0169	0.9038***	−0.0156	0.5806***	1.0000	
NPL	−0.0071	−0.0214	−0.0054	−0.0228	−0.0056	0.7219***	−0.0020	0.1887***	1.0000

Superscripts *, **, and *** denote the significance at the 10, 5, and 1 % levels, respectively

Table 4 Basic statistics of privatized-banks and Non-privatized banks

	Privatized banks Average	Non-privatized banks Average	Differ Average	P value	full_P Average	partial_P Average	Differ Average	P value	AS Average	SIP Average	Differ Average	P value
Characteristic variable (US $ million)												
ASSET	1859	3124	−1265**	(0.039)	2633	1238	1395**	(0.023)	1124	2956	−1832***	(0.000)
EQUITY	91	232	−142**	(0.014)	146	77	69**	(0.047)	72	161	−89***	(0.000)
LOAN	949	1141	−192	(0.473)	1262	738	524*	(0.067)	550	1476	−926***	(0.000)
DEPOSIT	1500	1880	−380	(0.371)	2087	1014	1073**	(0.039)	847	2422	−1575***	(0.000)
Performance measure (%)												
ROA	1.0030	0.5837	0.4193*	(0.058)	1.2868	1.112	0.1748	(0.175)	1.3292	1.1804	0.1488	(0.119)
ROE	11.8648	8.4097	3.4551	(0.472)	15.1301	13.8203	1.3098	(0.311)	15.6973	14.6762	1.0211	(0.241)
NIM	4.6291	3.6305	0.9986**	(0.019)	4.3508	4.5182	−0.1674	(0.607)	4.9415	3.9304	1.0111***	(0.000)
NPL	14.402	14.5217	−0.1196	(0.967)	8.3343	12.2879	−3.9536***	(0.000)	9.066	9.3477	−0.2817	(0.632)

full_P: full privatization; partial_P: partial privatization

AS asset sales, SIP share issue privatization

Differ: difference between the respective two groups

Superscripts *, **, and *** denote the significance at the 10, 5, and 1 % levels, respectively

Table 5 Characteristic variables comparisons between privatized- and non-privatized banks: after-matching samples

Characteristic variable	Nearest				Mahala			
	Privatized banks	Non-privatized banks	Differ	Paire t tests P value	Privatized banks	Non-privatized banks	Differ	Paired t tests P value
Matching algorithms								
ASSET	1859	2630	−771	(0.327)	1859	2221	−362	(0.620)
EQUITY	91	192	−102**	(0.049)	91	211	−120*	(0.055)
LOAN	949	997	−48	(0.905)	949	827	122	(0.739)
DEPOSIT	1500	1555	−55	(0.930)	1500	1305	194	(0.749)
ROA_{t-1} (%)	1.0333	1.0550	−0.0217	(0.948)	1.0333	1.2815	−0.2482	(0.446)
P value of joint F−test				(0.127)				(0.114)

The numbers presented denote the average of variables

Differ denotes the performance differences between the two groups

Paired t tests are used to investigate the mean difference of individual firm characteristics between privatized and non−privatized banks

Joint F−tests are used to examine the joint distribution of firm characteristics between privatized and non−privatized banks

Superscripts *, ** and *** denote the significance at the 10, 5, and 1 % levels, respectively

Panels A and B of Table 5 present the matching effectiveness using privatized banks as the treated sample, respectively. Employing the individual paired t test, each differences of characteristic variable between the privatized and non-privatized banks are insignificant regardless of the matching methods, except for EQUITY. Employing the joint F-test, the differences regarding four characteristic variables are jointly insignificant. Therefore, our matching passes the requirement, making the treated sample (privatized banks) and controlled sample (non-privatized banks) similar.

Furthermore, we also compare the similarity of the characteristic variables of private banks before and after matching. The differences are significant, indicating that using the private banks without matching may reach misleading results.[16]

4.3.1 Privatization effect

Table 6 presents the results of matching performance variables between the two groups during the post-privatization period. We investigate the privatization effect in the short-term, covering the period from the year of privatization to the second year after privatization ($t = 0$–2), and in the long-term, from the third through to the fifth years after privatization ($t = 3$–5). The results are highlighted as follows.

First, recall that when using the pre-matching sample, the difference in ROA between the two groups of banks is 0.419, and moreover is statistically significant for the post privatization periods (see Table 3). Using the post-matching sample, the performance of ROAs is roughly tied. For example, privatized banks do not outperform non-privatized banks except for the period $t = 4$ when Nearest is used. Next, the differences of ROEs between two types of banks using the post-matching sample significantly exceed those before matching. Using the sample before matching, the average difference is 3.45 (Table 3). Using the sample after matching, the differences are all significantly positive regardless of methods and time horizons. For example, the average differences are approximately 4.36 and 4.52 when using the two matching methods, respectively. Thus, after the matching, the profit improvement is even larger in terms of ROEs than ROAs.

Third, NIM improves significantly, but its size varies with the matching method used. Using the pre-matching sample, the average difference is 0.99, but becomes 1.36 and 1.19 for the two matching methods, respectively. The long-term improvement seems to outweigh the short-term improvement. Finally, the improvements in asset quality (NPL) are insignificant when using the Nearest method. However, when using the Mahala method asset quality was significantly improved, especially in the short-term.

Thus, basic statistical comparisons reveal that privatized banks outperform non-privatized banks in ROE, NIM, and NPL, thus confirming the first hypothesis. It is interesting to note that throughout the paper, we find that when using ROE as the profit measure, privatized banks tend to outperform non-privatized banks in ROE.

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[16] Accordingly, the 110 privatized banks are successfully matched with the non-privatized banks, fulfilling the prerequisite of the comparisons. Given that the matched and unmatched control samples are substantially different, the comparison would have been misleading (too many biased) if we simply use the pre-matching non-privatized banks.

Table 6 Performance comparison after matching: short- and long-term effects

Performance measure (%)	Matching algorithms				
	Nearest			Mahala	
	Privatized banks	Non-privatized banks	Differ	Non-privatized banks	Differ
$ROA_{t=0}$	1.2096	1.1886	0.0210	1.6038	−0.3942
$ROA_{t=1}$	1.2013	1.0250	0.1763	1.3357	−0.1344
$ROA_{t=2}$	1.1179	1.1236	−0.0056	1.2633	−0.1454
$ROA_{t=3}$	1.2461	0.9446	0.3015	1.1414	0.1047
$ROA_{t=4}$	1.2706	0.6241	0.6465**	0.9627	0.3079
$ROA_{t=5}$	1.4079	1.1728	0.2351	1.5264	−0.1186
$ROE_{t=0}$	15.3708	10.4269	4.9439**	11.0265	4.3443**
$ROE_{t=1}$	14.5132	10.1835	4.3296**	9.9998	4.5133***
$ROE_{t=2}$	13.9439	10.347	3.5968**	9.2052	4.7387***
$ROE_{t=3}$	15.5018	11.7817	3.7200*	10.5494	4.9523**
$ROE_{t=4}$	14.5113	10.4355	4.0757*	10.0200	4.4912**
$ROE_{t=5}$	15.8171	10.2793	5.5377***	11.6836	4.1335***
$NIM_{t=0}$	4.6201	3.2537	1.3663***	3.4220	1.1980**
$NIM_{t=1}$	4.4329	3.2403	1.1925**	3.3323	1.1006**
$NIM_{t=2}$	4.3088	2.9504	1.3584**	3.1346	1.1742**
$NIM_{t=3}$	4.1453	2.7305	1.4147***	2.8112	1.3340**
$NIM_{t=4}$	4.2789	2.4863	1.7926***	2.7815	1.4974**
$NIM_{t=5}$	4.4819	2.3232	2.1587***	2.5849	1.8971
$NPL_{t=0}$	10.2675	14.6521	−4.3846	26.0643	−15.7968*
$NPL_{t=1}$	9.6614	11.6093	−1.9478	22.3471	−12.6856*
$NPL_{t=2}$	8.7229	8.6060	0.1169	42.3465	−33.6235*
$NPL_{t=3}$	8.2337	8.9123	−0.6786	21.8808	−13.6471
$NPL_{t=4}$	9.5865	8.4273	1.1591	11.2742	−1.6877
$NPL_{t=5}$	9.7031	7.8504	1.8528	8.7822	0.9209**

The numbers presented denote the average of variables

Differ denotes the performance differences between the two groups

Paired t tests are used to investigate the mean difference of individual firm characteristics between privatized and non-privatized banks

Joint $F-$tests are used to examine the joint distribution of firm characteristics between privatized and non−privatized banks

Superscripts *, ** and *** denote the significance at the 10, 5, and 1 % levels, respectively

When using ROA, results tend to show no privatization effect. Regarding usage of NIM and NPL, results are prone to be consistent with that of ROE.

4.3.2 Full versus partial privatization

Table 7 lists the results of full privatization versus partial privatization based on the Mahala method alone. To save space, we do not report the results of Nearest method

Table 7 Performance comparison: full versus partial privatizations

Performance measure (%)	Privatization percentages					
	Full privatization (full_P)			Partial privatization (partial_P)		
	Privatized banks	Non-privatized banks	Differ	Privatized banks	Non-privatized banks	Differ
$ROA_{t=0}$	1.1152	1.6262	−0.5110	1.4729	1.5361	−0.0633
$ROA_{t=1}$	1.2324	1.2728	−0.0404	1.1417	1.5030	−0.3613
$ROA_{t=2}$	1.1051	1.1291	−0.0241	1.1661	1.5979	−0.4318
$ROA_{t=3}$	1.3383	1.2316	0.1067	1.0229	1.0314	−0.0085
$ROA_{t=4}$	1.4757	1.1318	0.3439	0.8175	0.6326	0.1849
$ROA_{t=5}$	1.5976	1.6089	−0.0113	0.9562	1.3171	−0.3610
$ROE_{t=0}$	14.9077	12.2841	2.6236	16.7021	7.1663	9.5359***
$ROE_{t=1}$	13.0738	11.0260	2.0478	15.4618	6.9836	8.4781***
$ROE_{t=2}$	13.8894	9.7843	4.1052**	13.9204	8.2865	5.6338**
$ROE_{t=3}$	16.4662	11.1357	5.3305**	12.8788	10.9122	1.9666
$ROE_{t=4}$	16.1409	10.3600	5.7809***	10.9083	10.3657	0.5427
$ROE_{t=5}$	17.4608	12.1941	5.2667**	12.0600	9.8563	2.2037
$NIM_{t=0}$	4.3641	3.7335	0.6306	5.3739	2.7446	2.6293**
$NIM_{t=1}$	4.3031	3.8423	0.4608	4.8390	2.0088	2.8301***
$NIM_{t=2}$	4.3690	3.7465	0.6225	4.2238	1.7026	2.5212*
$NIM_{t=3}$	4.1724	3.5972	0.5752	4.1468	1.0911	3.0557***
$NIM_{t=4}$	4.3591	3.6162	0.7429	4.1716	1.0408	3.1308***
$NIM_{t=5}$	4.5998	3.3004	1.2994	4.1957	0.9338	3.2619***
$NPL_{t=0}$	9.8138	27.7524	−17.9386***	11.9564	11.4700	0.4864
$NPL_{t=1}$	9.3143	24.6830	−15.3687***	10.8961	7.4033	3.4928
$NPL_{t=2}$	8.0810	48.4945	−40.4135***	10.9676	5.1780	5.7896*
$NPL_{t=3}$	8.5191	25.6105	−17.0913**	7.7427	4.1883	3.5543*
$NPL_{t=4}$	7.6260	11.279	−3.6530	14.2600	8.8667	5.3933
$NPL_{t=5}$	6.4859	8.3560	−1.8701	18.2057	10.1725	8.0332

The numbers presented denote the average of variables

Differ denotes the performance differences between the two groups

$t = 0$ denotes the year of privatization and $t = 1, 2,...,5$ denote the number of years post the privatization

Superscripts *, ** and *** denote the significance at the 10, 5, and 1 % levels, respectively

now and later.[17] Four results are obtained as follows. First, no improvement occurs when profitability in measured by ROA for both privatizations. Next, regarding ROE, full privatization exhibits strong improvement in the long-term but partial privatization in the short-term. Third, partial privatization displays strong improvement in NIM for the whole period but full privatization has no effect at

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[17] The estimated results of Nearest method are similar to those of Mahala method and they are available upon request.

all. Finally, full privatization displays strong asset quality (NPL) improvement in the short-term, but partial privatization has no effect on NPL in either the short- or long-term. Thus, full privatization outperforms partial privatization to a larger degree for ROE in the long-term and NPL in the short-term. In contrast, partial privatization outperforms its full privatization in ROE in the short-term and NIM always. Therefore, the full privatization tends to have influence

Therefore, once we consider the dynamic effect, the results are mixed and it is difficult to draw a clear cut conclusion. On average over the time horizons, we find that the full privatization outperforms the partial privatization when using ROE, NIM, and NPL as performance measure, but is tied when using ROA. To add the dynamic effect analysis, we find that using ROE, full privatization is effective in the long-term and the partial privatization is in the short-term. Using NPL, the effect is transient for full privatization but no short- and long-term effects for partial one.

4.3.3 Privatization of asset sales and securities issue privatization

Table 8 lists the results of ASs and securities issue privatization using the Mahala method. Again, once we consider the dynamic effect, it is uneasy to draw the clear cut conclusion. With respect to AS, the privatization effect is larger in for ROE and NIM in the long-term than in the short-term, but not found in ROA and NPL. In addition, the SIP privatization is stronger in the short-term than in the long-term for ROE and NIM but not found in ROA and NPL. Thus, the third hypothesis that AS is superior to SIP is also only partially correct.

Arguably, the above basic statistical comparisons may be subject to criticisms that variables are missing. Thus, the next section employs regression analysis to examine the robustness of the results.

4.4 Regression analysis

Table 9 presents the estimated results using panel regression analysis with only the Nearest and Mahala methods. Regarding the first hypothesis, the concerned coefficient of $D_{Privatized}$ is overwhelmingly significantly positive, positive and negative when ROE, NIM and NPL are employed as the performance measure, respectively. Consequently, our first hypothesis is supported. However, when performance is measured using ROA, the concerned coefficient is insignificant. Thus, our results support the Hypothesis one when ROE, NIM and NPL are used but not for ROA. This conclusion also holds for the remaining sensitive tests to some extent.

Next, when using the Mahala method, the coefficients of D_{full_P} are significantly positive for ROE and NIM, negative for NPL, and are insignificant for ROA. When the Nearest method is used, the concerned coefficients become much weaker, and some even reduce to insignificance, for example the coefficients on the NIM and NPL become insignificant. The coefficients of $D_{partial\_P}$ exhibit similar results to those of D_{full_P}, but exhibit two different aspects. Restated, it gives the insignificant negative coefficients of ROA and NIM when using the respective Mahala and

Table 8 Performance comparison: asset sales and share issue privatization

| Performance measure (%) | Privatization type | | | | | |
| | Asset sales (AS) | | | Share issue privatization (SIP) | | |
	Privatized banks	Non-privatized banks	Differ	Privatized banks	Non-privatized banks	Differ
$ROA_{t=0}$	1.0668	1.7920	−0.7252	1.3634	1.5986	−0.2352
$ROA_{t=1}$	1.0483	1.2958	−0.2475	1.3434	1.3865	−0.0431
$ROA_{t=2}$	1.0755	1.2534	−0.1779	1.0858	1.6944	−0.6086
$ROA_{t=3}$	1.5556	1.2970	0.2586	0.7618	1.1794	−0.4176
$ROA_{t=4}$	1.5074	1.1460	0.3614	0.8984	0.6494	0.2490
$ROA_{t=5}$	1.6679	1.6031	0.0648	1.1000	1.9233	−0.8233
$ROE_{t=0}$	13.7679	10.318	3.4499	16.1432	12.1253	4.0179*
$ROE_{t=1}$	13.6571	9.6854	3.9717	15.3239	11.1019	4.2220**
$ROE_{t=2}$	14.0541	9.6878	4.3663	12.5808	12.2613	0.3195
$ROE_{t=3}$	18.9178	11.213	7.7048***	11.0676	12.3927	−1.325
$ROE_{t=4}$	15.4211	9.5503	5.8708**	12.0178	13.925	−1.9072
$ROE_{t=5}$	15.6169	10.3243	5.2926**	14.2631	12.4924	1.7707
$NIM_{t=0}$	4.9263	4.0993	0.8271	4.1642	2.2464	1.9178**
$NIM_{t=1}$	4.6343	3.5595	1.0748	3.8616	2.8662	0.9954
$NIM_{t=2}$	4.8843	3.9114	0.9729	3.2046	2.1291	1.0755
$NIM_{t=3}$	4.7298	3.3279	1.4019*	3.1408	1.9144	1.2264
$NIM_{t=4}$	4.7305	3.0308	1.6997**	3.7676	2.4273	1.3403
$NIM_{t=5}$	5.8076	3.0935	2.7141**	3.1119	2.0200	1.0919
$NPL_{t=0}$	10.5593	34.4609	−23.9016*	10.0288	24.112	−14.0832
$NPL_{t=1}$	10.5700	29.9225	−19.3525	8.4661	19.6786	−11.2125
$NPL_{t=2}$	9.0849	48.7323	−39.6474	8.756	38.4413	−29.6853
$NPL_{t=3}$	9.0867	27.0213	−17.9346	7.4167	14.5429	−7.1262
$NPL_{t=4}$	8.0603	11.9082	−3.8479	12.3004	10.4918	1.8086
$NPL_{t=5}$	7.8225	9.1600	−1.3375	12.6664	8.2033	4.4631

The numbers presented denote the average of variables

Differ denotes the performance differences between the two groups

$t = 0$ denotes the year of privatization and $t = 1, 2,…,5$ denote the number of years post the privatization

Superscripts *, ** and *** denote the significance at the 10, 5, and 1 % levels, respectively

Nearest methods. Next, the coefficients of D_{full_P} generally exceed those of $D_{partial\_P}$. Thus, fully privatized banks significantly outperform non-privatized banks when the Mahala method is used but the outperformance becomes much weak when the Nearest method is used. Nevertheless, the fully privatized banks significantly outperform partially privatized banks, which generally outperform non-privatized banks. The Hypothesis two is thus also supported.

Finally, the coefficients of D_{AS} again show expected signs when ROE, NIM, and NPL are the performance measures but not ROA when the Nearest and Mahala

Table 9 Privatization effect with four performance measures

Variable		ROA						ROE					
		Nearest			Mahala			Nearest			Mahala		
MODEL		1	2	3	1	2	3	1	2	3	1	2	3
$D_{\text{Privatized}}$	α_2	0.183			−0.077			4.146***			4.112***		
$D_{\text{full\_P}}$	α_3		0.316**			−0.027			4.873***			4.463***	
$D_{\text{partial\_P}}$	α_4		0.074			−0.200			2.373*			3.288***	
D_{AS}	α_5			−0.189			0.053			1.933**			4.401***
D_{SIP}	α_6			0.168			−0.152			0.060			2.400***
Adj–R^2		0.318	0.318	0.320	0.365	0.365	0.365	0.510	0.508	0.508	0.522	0.522	0.525

Variable		NIM						NPL					
		Nearest			Mahala			Nearest			Mahala		
$D_{\text{Privatized}}$	α_2	1.496***			1.339***			−2.280*			−14.568***		
$D_{\text{full\_P}}$	α_3		0.809***			1.217***			−1.592			−15.149***	
$D_{\text{partial\_P}}$	α_4		0.819***			1.632***			0.277			−12.897***	
D_{AS}	α_5			0.098			1.515***			−0.909			−10.178***
D_{SIP}	α_6			−0.060			0.260			−0.418			−8.307***
Adj–R^2		0.581	0.562	0.560	0.604	0.605	0.609	0.520	0.517	0.516	0.281	0.282	0.276

Control variable including Constant, ASSET, EQUITY, LOAN, DEPOSITS, Inverse Mills' ratio, year and country dummies. We do not report them for brevity. Results are available upon request

The sample covers the privatization periods $t = 0$ to $t = 5$ of privatized and non-privatized banks. The number of samples is 1186

Superscripts *, **, and *** denote the significance at the 10, 5, and 1 % levels, respectively

methods are used. The coefficients of D_{SIP} are much weaker, or even become insignificant. Additionally, these coefficients of D_{AS} exceed those of D_{SIP}. Thus, privatization through ASs exhibits strong improvement than through share issues, supporting hypothesis three, that privatized-banks that adopt ASs achieve significantly greater performance improvements than those that adopt SIP is also supported.

5 Conclusion

This study compares the performance of privatized banks, using a sample of privatized banks from 43 countries over the period 1992–2007. Two matching theories, Nearest-Neighbor Matching (Nearest) and Mahalanobis Metric Matching (Mahala), area dopted to seek controlled banks sharing similar characteristic variables located in the same countries.

We investigate three issues. The first hypothesis deals with bank performance following privatization. Privatized banks are found to outperform non-privatized banks in terms of ROE, NIM, and NPL, but not ROA. This finding is consistent with the literature, which frequently suggests that privatized banks outperform or at least equal the performance of non-privatized banks. However, the results presented here are clearer than those presented in the remainder of the literature because the privatization effect is clearly identified given the matched samples. Restated, privatized banks have superior profitability (in terms of ROE) and asset quality (in terms of NPL) to non-privatized banks but exhibit no superiority in ROA.

The second hypothesis compares performance between fully and partially privatized banks. Our conclusion is that fully privatized banks outperform partially privatized banks, except for the results in ROA, which therefore support the hypothesis that performance is substantially improved following privatization when the government fully releases ownership. The third hypothesis compares the relative performance between banks undergoing privatization by the share issue privatization and AS processes. The analytical results indicate that banks privatized using ASs outperform those privatized using share issue privatization. Thus, the agency problem, that banks with concentrated ownership have greater incentive to monitor managers than those with dispersed ownership, is supported. Once again, banks privatized via ASs exhibit superior performance when compared via ROE, NIM, and NPL, but not ROA.

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