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Estimating a Bayesian stochastic frontier for the Indian banking system

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ABSTRACT

This paper employs a Bayesian stochastic frontier, providing exact inference on both cost and profit efficiencies of the Indian banking sector in the period of 2000–2006. We also test for the inclusion of off-balance sheet data in model specification. The findings suggest that public banks are the most efficient, followed by private and foreign banks. However, the latter largely improved profit efficiency, outperforming domestic banks by the end of the sample. Accounting for off-balance sheet activities significantly improves profit efficiency levels.

1. Introduction

The efficiency of the banking sector has been widely studied and discussed in empirical works, due to the importance of this sector in the growth and stability of the economy. Through the analysis of different countries, it has been found a high degree of inefficiency, particularly in developing economies. The study of Berger et al. (2009), for example, indicates that the Chinese high growth rate in recent years cannot persist without a better financial market and banking reforms. The present study extends previous literature by examining the banking system in India, characterized by the diversity of ownership groups operating in a level playing field, after the deregulation process in the nineties (Sensarma, 2006).

Mostly of the existing literature have estimated efficiency measures using two main approaches: the non-parametric method of Data Envelopment Analysis and the parametric stochastic frontier approach.[1] We will employ a method that is still little explored in banking studies, the Bayesian stochastic frontier approach, based on the work of Griffin and Steel (2007). The stochastic frontier model, developed by Aigner et al. (1977) and Meeusen and van den Broeck (1977), accounts for measurement error and uncontrollable factors influencing the performance of banks. The application of Bayesian methods on this approach was first proposed by van den Broeck et al. (1994), arguing that they allow for easy incorporation of prior ideas, produce exact efficiency estimates and incorporate formal treatment of parameter and model uncertainty.

Previous studies have emphasized the importance of estimating not only cost efficiency measures, but also being concerned with the profit side (Berger et al., 2009; Ariff and Can, 2008; Maudos et al., 2002). In fact, the most important inefficiencies are on the revenue side, as they provide more important information for bank management. Furthermore, an output vector of higher quality might be more costly, but also more profitable. Therefore, we analyze both cost and profit functions to estimate banking efficiency.

Finally, another contribution of this paper is to verify the importance of including off-balance sheet data in cost and profit functions as one of the outputs. Recently researches highlighted the expanding involvement of banks in OBS activities and their impact on efficiency. They argue that not accounting for them as an additional output of the banking service might bias the results.

The model relates inefficiency measures to explanatory variables. The first one is total assets, to account for the size influence over efficiency. The second one is return on assets, which is expected to have a positive sign in the estimation. Banks that have higher profitability are usually preferred by clients, attracting biggest share of deposits and creditworthy borrowing (Sufian, 2009). We also include a variable to measure banks capitalization: the equity over assets ratio. According to Eisenbeis et al. (1999), it captures the degree to which shareholders have

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[1] Lensink et al. (2008) and Staikouras et al. (2008) provide summaries of works with different approaches.

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their own capital at risk in the institution, which may be reflected on their incentives to monitor management and assure that the institution operates efficiently. In agree with the moral hazard theory, the hypothesis is that the higher the equity ratio, the more efficient the institution is likely to be. However, as argued by Berger and Mester (1997), capital used to finance loans may also increase costs, as raising equity usually involves higher costs than raising deposits.

We also include ownership covariates in the inefficiency estimation. According to Das and Ghosh (2006), the reasons why different ownership structures of banks may produce different efficiency levels have support on the public choice theory and the principal agent framework. The argument is that when management is little constrained by capital market discipline, managers pursue their own interests, and are given fewer incentives to be efficient. For Lensink et al. (2008), domestic banks have informational advantages relative to foreign banks. However, foreign banks may benefit from their foreign parents expertise and use of more advanced technologies.

The remainder of the paper is organized as follows. Section 2 provides a review of the relevant literature. Section 3 presents the econometric methodology employed and Section 4 discuss the results. Section 5 concludes.

2. Literature review

Many studies have analyzed banking efficiency and its determinants. We present in this section the main findings that will contribute to prospect and discuss our results. We also review the literature on the Indian banking system.

The efficiency literature that analyzes the influence of different ownership types on banking performance comes to divergent conclusions. The findings of Berger et al. (2009) in China, Sufian (2009) in Malaysia, Sturm and Williams (2004) in Australia and Bonin et al. (2005) in transition countries indicate that foreign banks are the most efficient among their counterparts. On the other hand, Lensink et al. (2008), examining banks from 105 countries, Rao (2005), from the United Arab Emirates and Chang et al. (1998), from the United States, found that domestic banks were more efficient than foreign banks.

Results from studies about the relationship between efficiency and size are also controversial. Ariff and Can (2008) found that in China, medium banks were the most cost and profit efficient, similarly to the findings of Staikouras et al. (2008) in South Eastern European countries. Bonin et al. (2005) and Kwan (2006) found that smaller banks were more efficient, the former in a transition countries study and the later in the Hong Kong case. Hartman and Storbeck (1996) analyzed the efficiency of loan operations in the Swedish banking sector after deregulation. Almost all banks had expanded their assets and lending, which probably led to an increase in risks and thus, in costs. In that way, they reported significant scale inefficiencies, despite the increased interest revenues. Others reported higher efficiency for larger banks, as Bos and Kool (2002) in the Netherlands and Drake et al. (2006) in Hong Kong.

In the investigation of the determinants of efficiency, some works have found a positive effect of the equity to assets ratio,

Table 1
Descriptive statistics of outputs and input prices.

	Mean	SD	Skewness	Kurtosis	JB	Mean[a]	SD[a]	Skewness[a]	Kurtosis[a]	JB[a]
2005										
Loans	6 117 383	11 903 933	5.207	33.309	2482.126	6 224 688	11 981 414	5.174	32.857	2371.443
Investments	3 943 097	7 903 841	5.513	36.596	3021.374	4 006 116	7 959 384	5.473	36.055	2879.617
Investments/loans	6.917	47.377	7.417	56.010	7322.797	0.697	0.383	5.608	38.266	3252.596
Off-balance sheet (OBS)	12 217 096	24 242 442	2.367	7.256	94.551	11 375 986	23 626 837	2.572	8.279	124.498
OBS/loans	1077	8048	7.281	54.018	6568.158	1.909	3.863	3.299	13.190	337.724
Deposits	8 928 760	17 068 629	5.341	35.199	2733.402	9 086 758	17 180 989	5.308	34.723	2611.123
Deposits/loans	2.968	10.839	7.331	54.841	6893.290	1.533	0.439	1.819	17.708	535.624
Cost	783 232	1 653 028	5.539	36.348	2984.241	796 651	1 664 532	5.500	35.816	2845.068
Cost/(loans*PC)	0.368	1.662	6.227	42.053	3990.565	0.291	1.573	7.265	53.865	6529.477
Profit	100 474	186 561	4.619	28.176	1737.971	101 757	187 961	4.579	27.716	1649.938
Profit/(loans*PC)	0.195	1.028	5.751	35.900	2884.839	0.075	0.485	7.272	53.932	6546.415
Price of labor (PL)	0.012	0.005	0.057	3.463	0.540	0.012	0.005	0.089	3.570	0.833
PL/PC	0.008	0.006	2.870	13.483	339.258	0.008	0.007	2.840	13.268	321.315
Price of capital (PC)	2.067	1.133	2.036	11.241	200.665	2.031	1.111	2.192	12.482	254.650
Price of funds (PF)	0.073	0.148	6.547	46.079	4814.812	0.073	0.150	6.492	45.289	4566.207
PF/ PC	0.117	0.483	5.465	32.193	2307.797	0.119	0.488	5.412	31.597	2181.573
2000										
Loans	973 517	952 128	1.564	5.109	27.279	995 099	951 441	1.559	5.071	26.275
Investments	1 030 962	1 025 979	1.364	4.433	18.213	1 052 123	1 027 370	1.346	4.380	17.159
Investments/loans	1.785	4.849	6.471	43.252	3426.418	1.073	0.460	2.250	13.081	228.516
Off-balance sheet (OBS)	869 375	1 658 618	4.625	26.869	1201.344	889 064	1 673 036	4.582	26.366	1128.688
OBS/loans	1.112	1.814	3.145	13.640	280.089	0.910	1.243	2.379	7.539	77.479
Deposits	1 920 500	2 027 504	1.647	5.444	32.259	1 962 382	2 030 191	1.634	5.385	30.700
Deposits/loans	2.261	2.074	5.664	36.493	2396.017	1.970	0.631	0.525	10.122	97.177
Cost	227 792	226 075	1.534	5.103	26.516	232 705	226 133	1.524	5.058	25.351
Cost/(loans*PC)	1.244	6.897	6.555	43.983	3548.667	0.227	0.147	1.121	4.725	14.996
Profit	12 163	18 456	−0.286	6.680	26.582	12 405	18 591	−0.321	6.653	25.791
Profit/(loans*PC)	0.202	1.289	6.554	43.982	3548.493	0.012	0.028	−2.683	18.631	512.131
Price of labor (PL)	0.015	0.008	−0.006	2.141	1.413	0.015	0.008	−0.018	2.099	1.526
PL/ PC	0.016	0.031	5.640	35.950	2324.799	0.012	0.010	1.646	5.394	31.059
Price of capital (PC)	1.534	1.124	1.666	6.061	39.254	1.567	1.115	1.713	6.140	40.507
Price of funds (PF)	0.139	0.357	6.435	42.898	3368.430	0.139	0.361	6.367	41.984	3153.587
PF/PC	0.344	1.505	6.087	39.429	2827.639	0.297	1.489	6.472	42.938	3304.882

[a] Refers to the exclusion of outliers. Values in US$ thousands.