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Off-Balance Sheet Activities and Profit Efficiency of Indian Banks: An Empirical Investigation

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Abstract
This paper investigates the relevance of the inclusion of off-balance activities in the specification of banks' output on the profit efficiency of Indian banks. The results indicate that the exclusion of off-balance activities not only understates the profit efficiency of individual banks but also affects the ranking of ownership groups in the industry. In particular, when a proxy for off-balance activities is accounted for in the output specification, the foreign banks appear to be more efficient than public and private sector banks. Overall, the results reinforce the prevailing view in the extant literature that the exclusion of off-balance activities causes misspecification of banks' output, and may distort the efficiency estimates.

***Keywords*:** off-balance sheet activities, data envelopment analysis, profit efficiency, Indian banks.

1. Introduction

The objective of present study is to investigate the influence of off-balance sheet (OBS) activities on the profit efficiency of Indian banks. For this, we estimate and compare profit (in)efficiency with or without OBS outputs of Indian banks during the period, 1992/93 through 2007/08. In recent years, heightened competition, emergence of deregulatory forces, new financial market innovations, decreasing margins from traditional financial intermediation functions(i.e., collecting deposits and purchasing funds to be subsequently intermediated into loans and other assets), and rapid growth and diffusion of new technologies induced the Indian banks to move into new areas of off-balance sheet (OBS) banking. Consequently, there has been a significant shift in the sources of income of the Indian commercial banks. The relative share of income from traditional banking activities has decreased and that of non-interest income originating from off-balance sheet activities (OBS)- like loan commitments; future and forward contracts; standby letters of credit; options arrangement; swaps; and loan sales (securitization) - has increased significantly. It is worth noting here that banks are resorting to off-balance activities not only as a potent source of income but with the purpose to retaining and expanding their customer base and for reducing their on-balance sheet risks.

In the light of growth of OBS activities in the banking industry, it is well recognized in the contemporary literature on banking efficiency that estimating efficiency without incorporating these activities may not be accurate or meaningful, and the omission of these activities could seriously understate actual bank output. Thus, focusing only on the on-balance sheet activities of banks leads to significant mismeasurement of bank output. Traditionally, loans and investments are used to measure outputs in estimating the efficiency of Indian banks. The majority of research on efficiency of Indian banks does not include off-balance sheet activities when measuring outputs. Further, the rapid expansion of OBS activities has prompted some researchers to include 'non-interest income' in the output

vector as a proxy for these activities. However, to best of our knowledge, none of these studies have investigated the impact of inclusion or exclusion of these activities on the profit efficiency estimates. Thus, a clear void exists in available literature since no study has been conducted to analyze how the entire distribution of efficiency scores differs when these activities are not considered. In particular, our focus is on the two main questions: First, does the exclusion of a proxy for OBS activities in the output vector affect the profit efficiency of Indian banks? Second, does the omission of OBS activities in the output specification change the rankings of individual banks and ownership groups?

The contribution of present study is empirical in nature, as we have employed three distinct DEA models to estimate standard and alternative profit efficiency scores for individual banks with and without the inclusion of OBS activities, and compared the differences among them. As OBS outputs are inserted, the frontier is probably different, and the individual bank profit efficiency score may change. For instance, a bank that is expert at OBS business relative to traditional output will yield a higher efficiency score than one in the traditional model. On the other hand, if a bank is not expert at OBS business relative to traditional output, then its efficiency score will be smaller in the model with OBS items. We assert that banks with the inclusion of OBS activities enjoy a higher profit efficiency than those without OBS output.

The empirical results highlight that the exclusion of non-interest income as a proxy for OBS activities in the output specification understates the profit efficiency of Indian banks. Moreover, the omission of this proxy in the definition of bank output not only affects the relative ranking of individual banks but changes the relative rankings of ownership groups, especially in the most recent years of the study period under evaluation. Overall, the empirical findings reinforce the prevalent view in the recent literature and support the inclusion of OBS activities, as proxied by non-interest income, to analyze the efficiency of Indian banks more accurately.

The rest of the paper is structured as follows. Section 2 provides the detailed account on the trends of OBS activities in Indian banking industry. Section 3 provides a relevant literature review on the subject matter. Section 4 outlines the conceptual framework for measuring the profit efficiency scores using DEA approach. The sources of data and the specification of input and output variables are reported in the Section 5. Section 6 presents the empirical results and discussion. The relevant conclusions and directions for future research are provided in the final section.

2. Off-balance sheet activities in Indian banking industry

Since the advent of banking reforms programme in 1992, Indian commercial banks have undergone a huge transformation. One of the most important strategic developments in post-reforms years is the decline in traditional banking activities and consequent increase in fee-producing nontraditional activities. In fact, Indian banks have heavily diversified their product lines and earnings by leveraging their OBS activities. Traditionally, the core business of the Indian banks has been deposit taking and lending or the interest payments. But with the financial deregulation during the 1990s, coupled with revolutionary advances in the ICT-based technology, the very nature of the activities of Indian banks has changed. Indian banks are now deriving an ever-increasing percentage of income from sources other than interest from merchant banking operations such as, trading in securities, commission, exchange & brokerage, portfolio management services, underwriting, and providing back up

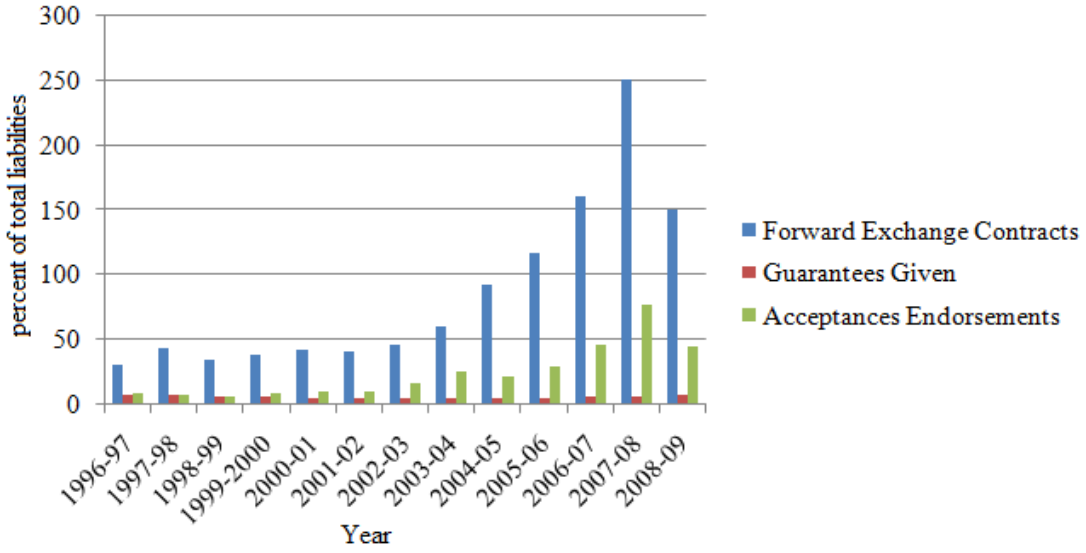
liquidity. Thus, banks in India witnessed a significant shift from traditional banking activities to a more universal banking character with financial market activities such as brokerage and portfolio management growing in importance.

In recent years, an exposure of Indian banks to off-balance sheet operations which include forward exchange contracts, guarantees, acceptances, endorsements etc., had increased manifold in the recent years (see Figure 1). Banks have responded to OBS activities imaginatively and vigorously in an effort both to retain their traditional customer base and to boost fee income from sources which are largely or wholly free from capital requirements. These activities act as the vehicles of information and risk sharing services; and contribute to an overall diversification of a bank's output and lead to an increase in its productivity levels.

Table 1 provides the trend in OBS activities in India commercial banking industry during the period spanning from 1996-97 to 2008-09. It is clear that OBS activities showed a significant growth over the period of reforms, reflecting the impact of deregulation, risk management operations, diversification of income and new business opportunities thrown up by advances in information technology. Total off-balance sheet exposure of SCBs has increased from Rs. 318398.59 crore in 1996-97 to Rs. 14498587.00 crore in 2007-08. This increase in OBS activities is primarily propelled by rise in forward exchange contracts. Further, leveraged positions in derivatives as a means of diversifying income, improvements in technology (trading and information services) and increasing use of derivatives as tools for risk mitigation appear to have contributed to the growth in OBS exposures. The sharp growth in off-balance sheet exposure reflected the banks' attempt to diversify their sources of income.

Among bank groups, foreign banks constituted the largest share in OBS activities since 1996-97, followed by new private banks, old private sector banks, and public sector banks, respectively. The level of OBS activities in the foreign banks rises from Rs. 149259.21 crores in 1996-97 to 10210744.00 in 2007-08. Apart from the foreign banks, new private banks have shown uplift in their OBS exposure by Rs. 2309881 crore in 2007-08 as compared to Rs. 13720.20 crore in 1996-97. However, the same has increased from Rs. 9562.96 crore in 1996-97 to 1111137 crores in old private sector banks, and Rs. 145856.22 crores in 1996-97 to Rs. 1866824 crores in 2007-08 in public sector banks. These figures reveal that public sector banks followed closely by old private sector banks are still generating more of their income from traditional activities rather than relying more on OBS activities.

Figure 2.1: Components of Off-balance Sheet Items for Scheduled Commercial Banks



It is worth noting here that, the year 2008-09, marked an exception to this trend with the SCBs reducing their OBS exposures to Rs. 10671961.00 crore as compared to Rs. 14498587.00 crore in 2007-08, i.e., by 26.4%. This partly reflected the strengthening of prudential regulations effected by the Reserve Bank on OBS exposures. Further, the decline in OBS was especially evident in the case of foreign banks (i.e., 1570.10% vs. 2804.40%). Apart from the foreign banks, the new private sector banks, old private banks and public sector banks have also witnessed a decline in their OBS in 2008-09. The statistics for the financial year 2009 reveal that the foreign banks continued to have largest share of off-balance sheet exposures of the SCBs (65.8%), followed by public sector banks (17.9%) and new private sector banks (15.2%).

Table 1: Off-balance sheet activities of Indian commercial banks since 1996/97													
Year	**1996/97**	**1997/98**	**1998/99**	**1999/00**	**2000/01**	**2001/02**	**2002/03**	**2003/04**	**2004/05**	**2005/06**	**2006/07**	**2007/08**	**2008/09**
All SCBs													
Forward Exchange Contracts	209280.55 (31.10)	351151.89 (44.14)	334759.00 (35.21)	424315.12 (38.38)	553596.46 (42.75)	635095.44 (41.36)	792479.78 (46.64)	1182865.71 (59.92)	2196948.67 (93.27)	3280178.87 (117.66)	5585256.11 (161.25)	10876228.00 (251.40)	7915211.00 (151.00)
Guarantees Given	52352.89 (7.78)	58774.01 (7.39)	62814.70 (6.61)	67023.01 (6.06)	71449.38 (5.52)	84254.97 (5.49)	90341.17 (5.32)	101848.33 (5.16)	123476.69 (5.24)	161451.32 (5.79)	219617.22 (6.34)	295506.00 (6.80)	417064.00 (8.00)
Acceptances Endorsements	56765.15 (8.43)	57119.16 (7.18)	60518.10 (6.37)	92950.14 (8.41)	127930.09 (9.88)	166000.25 (10.81)	282757.55 (16.64)	508574.02 (25.76)	512082.67 (21.74)	807911.08 (28.98)	1626840.77 (46.97)	3326853.00 (76.90)	2339686.00 (44.60)
Total Contingent Liabilities	318398.59 (47.31)	467045.06 (58.71)	458092.00 (48.18)	584288.27 (52.85)	752975.93 (58.15)	885350.66 (57.66)	1165578.50 (68.6)	1793288.06 (90.84)	2832508.03 (120.25)	4249541.72 (152.43)	7431714.10 (214.58)	14498587.00 (335.10)	10671961.00 (203.60)
Public Sector Banks													
Forward Exchange Contracts	68632.02 (12.34)	109069.97 (16.80)	107180.41 (13.92)	142195.00 (15.97)	199565.35 (19.38)	209240.62 (18.00)	264186.60 (20.55)	313184.99 (21.29)	416427.29 (23.47)	505315.30 (25.08)	612935.74 (25.12)	994109.00 (33.90)	1040139.00 (27.60)
Guarantees Given	37039.64 (6.66)	40540.70 (6.24)	41991.56 (5.45)	42837.62 (4.81)	43993.22 (4.27)	48150.67 (4.17)	53555.74 (4.17)	62845.32 (4.27)	79497.12 (4.48)	103838.99 (5.15)	137715.20 (5.64)	175078.00 (5.80)	255918.00 (6.80)
Acceptances Endorsements	40184.56 (7.22)	39145.75 (6.03)	40275.26 (5.23)	49062.76 (5.51)	55176.56 (5.36)	71886.86 (6.22)	88848.55 (6.91)	110366.63 (7.50)	187972.48 (10.60)	233052.69 (11.57)	300626.56 (12.32)	697637.00 (23.10)	613366.00 (16.30)
Total Contingent Liabilities	145856.22 (26.22)	188756.42 (29.08)	189447.23 (24.60)	234095.38 (26.29)	298735.13 (29.01)	329278.15 (28.49)	406590.89 (31.63)	486396.94 (33.06)	683896.89 (38.55)	842206.98 (41.80)	1051277.50 (43.09)	1866824.00 (61.80)	1909422.00 (50.70)
New Private Sector Banks													
Forward Exchange Contracts	8409.24 (52.04)	15594.36 (60.31)	23663.41 (61.41)	34377.90 (58.34)	40888.84 (51.91)	47697.38 (27.34)	72662.83 (37.81)	153266.20 (62.16)	278124.65 (94.46)	428420.21 (101.60)	700301.18 (119.74)	1217367.00 (163.30)	919698.00 (115.60)
Guarantees Given	1906.87 (11.80)	3148.91 (12.18)	4116.02 (10.68)	5741.21 (9.74)	7087.08 (9.00)	14503.54 (8.31)	15638.70 (8.14)	17397.12 (7.06)	20139.36 (6.84)	27083.86 (6.42)	42009.59 (7.18)	65571.00 (8.80)	93420.00 (11.70)
Acceptances Endorsements	3404.09 (21.07)	3644.08 (14.09)	4223.39 (10.96)	6606.45 (11.21)	9806.00 (12.45)	23979.72 (13.75)	77658.22 (40.41)	182970.87 (74.20)	199743.84 (67.84)	334638.06 (79.36)	515828.30 (88.20)	1026943.00 (137.70)	611920.00 (76.90)
Total Contingent Liabilities	13720.20 (84.90)	22387.35 (86.59)	32002.82 (83.06)	46725.56 (79.29)	57781.92 (73.35)	86180.64 (49.40)	165959.75 (86.36)	353634.19 (143.42)	498007.85 (169.15)	790142.13 (187.39)	1258139.07 (215.12)	2309881.00 (309.80)	1625037.00 (204.30)
Old Private Sector Banks													
Forward Exchange Contracts	6271.24 (14.11)	13890.46 (25.16)	11270.35 (17.21)	14807.98 (20.25)	18451.56 (21.81)	17390.79 (18.65)	21656.62 (20.63)	23885.38 (19.79)	41807.53 (31.32)	41534.74 (27.74)	50491.66 (31.45)	85454.00 (43.90)	96661.00 (41.70)
Guarantees Given	1864.78 (4.19)	2035.27 (3.69)	2540.44 (3.88)	2566.27 (3.51)	2954.36 (3.49)	3302.63 (3.54)	3798.94 (3.62)	4031.26 (3.34)	4645.15 (3.82)	5715.88 (3.82)	6613.16 (4.12)	9272.00 (4.80)	10486.00 (4.50)
Acceptances Endorsements	1426.94 (3.21)	1555.77 (2.82)	2062.78 (3.15)	2741.06 (3.75)	3246.43 (3.84)	3295.87 (3.54)	4605.08 (4.39)	8257.43 (6.84)	13514.58 (10.13)	15776.62 (10.54)	14848.87 (9.25)	16411.00 (8.40)	9686.00 (4.20)
Total Contingent Liabilities	9562.96 (21.51)	17481.50 (31.67)	15873.57 (24.24)	20115.31 (27.51)	24652.35 (29.14)	23989.29 (25.73)	30060.64 (28.64)	36174.07 (29.96)	59967.26 (44.93)	63027.24 (42.09)	71953.69 (44.81)	111137.00 (57.10)	116834.00 (50.40)
Foreign Banks													
Forward Exchange Contracts	125968.05 (224.69)	212597.10 (325.63)	192645.03 (251.60)	232934.24 (281.29)	294690.71 (289.41)	360766.65 (321.84)	433973.73 (372.00)	692529.14 (510.56)	1460589.19 (950.68)	2304908.63 (1143.39)	4221527.54 (1518.45)	8579297.00 (2356.30)	5858713.00 (1310.20)
Guarantees Given	11541.60 (20.59)	13049.13 (19.99)	14166.63 (18.50)	15877.91 (19.17)	17414.72 (17.10)	18298.13 (16.32)	17347.79 (14.87)	17574.63 (12.96)	19195.07 (12.49)	24812.58 (12.31)	33279.27 (11.97)	45584.00 (12.50)	57241.00 (12.80)
Acceptances Endorsements	11749.56 (20.96)	12773.56 (19.57)	13956.68 (18.23)	34539.87 (41.71)	59701.10 (58.63)	66837.80 (59.63)	111645.70 (95.7)	206979.09 (152.59)	110851.77 (72.15)	224443.71 (111.34)	795537.04 (286.15)	1585863.00 (435.60)	1104714.00 (247.10)
Total Contingent Liabilities	149259.21 (266.24)	238419.79 (365.18)	220768.34 (288.33)	283352.02 (342.17)	371806.53 (365.15)	445902.58 (397.78)	562967.22 (482.57)	917082.86 (676.11)	1590636.03 (1035.33)	2554164.92 (1267.04)	5050343.85 (1816.56)	10210744.00 (2804.40)	7020667.00 (1570.10)
Source: Report of Trend and Progress of Banking in India (various issues)													

3. Relevant Literature Review

It is well established in literature that non-traditional activities captured by off-balance sheet items should be included in the model because these are often an effective substitute for directly issued loans, requiring similar information-gathering costs of origination (Berger and Mester, 1997). The studies which examined the impact of non-traditional activities on the efficiency of US banks include Jagtiani et al. (1995), Siems and Clark (1997), Rogers (1998), Stiroh (2000), and Clark and Siems (2002), among others. The non-US studies on the subject matter comprise Isik and Hassan (2003) on Turkish banks, Tortosa-Ausina (2003) on Spanish banks, Rime and Stiroh (2003) on Swiss banks, Casu and Girardone (2005) on European banks, Sufian and Ibrahim (2005) on Malaysian banks, Lieu et al. (2005) and Huang and Chen (2006) on Taiwanese banks, Pasiouras (2008) on Greece banks, Sufian (2009) and Sufian and Habibullah (2009) on Chinese banks, Budd (2009) on UAE banks, and Lozano-Vivas and Pasiouras (2010) on banks belonging to 87 different countries (see Table 2 for empirical findings of these studies).

In the aforementioned studies, the researchers have included either off-balance sheet (OBS) items or net non-interest income or any disaggregated component of OBS items as a proxy for non-traditional activities in the different model specifications. Except Jagtiani et al. (1995), Pasiouras (2008) and Chortareas et al. (2009), the overwhelming conclusion of these studies is that the exclusion of a proxy for non-traditional activities items might considerably understate the efficiency measures of the banks that actively engaged in these types of activities. In particular, the neglect of non-traditional activities understates the bank efficiency and changes the ranking of individual banks. Thus, the prevalent view in the existing literature is that the failure to incorporate these activities would lead to biased conclusions.

Recognizing the growing importance of the non-traditional activities in the recent years, the most researchers in India have incorporated the non-interest income as a proxy for these activities in the output vector. The significant studies in this context are Mukherjee et al. (2002), Sathye (2003), Ram Mohan and Ray (2004), Shanmugam and Das (2004), Chakrabarti and Chawla (2005), Das et al. (2005), Ataullah and Le (2006), Das and Ghosh (2006), Debasish (2006), Dash and Bhole (2007), Zhao et al. (2008), Das and Ghosh (2009), Dash and Charles (2009), Ray and Das (2010), and Zhao et al. (2010). However, to best of our knowledge, the issue of the effects of inclusion or exclusion of non-traditional items in the output vector on the efficiency of banks is still unexplored for Indian banking sector. Thus, in this paper, we focus on the issue of relevance of non-interest income as a proxy for non-traditional activities in the output specification and try to analyze to what extent the efficiency of individual banks and ownership groups are affected by the inclusion or exclusion of this important output variable.

Table 2: Impact of nontraditional activities on the banking efficiency: A survey international studies			
Author (Year)	**Country (sample period)**	**Methodology (Efficiency Measures)**	**Major findings**
Jagtiani et al. (1995)	US (Quarterly data 1988-1990)	Translog cost function (CE)	Off-balance sheet (OBS) products have little or no significant effect on the scale economies. Further, no evidence of cost complementarities in the production process with the inclusion of OBS products has been noted.
Siems and Clark (1997)	US (cross-sectional data for the year 1995)	TFA (PE)	Exclusion of OBS activities as an output in the profit function has not been supported statistically, and may distort profit efficiency computations.
Rogers (1998)	US (1991-1995)	DFA (CE, RE, PE)	Omission of nontraditional activities proxied by net non-interest income understates the banks' cost and profit efficiency.
Stiroh (2000)	US (1991-1997)	SFA (CE, APE)	The efficiency estimates of US bank holding companies are sensitive to output specification and failure to account for OBS items understates the level of profit efficiency.
Clark and Siems (2002)	US (1992-1997)	SFA and DFA (CE, PE)	Cost and production X-efficiency estimates increase with the inclusion of the OBS measure, while profit X-efficiency estimates are unaffected.
Isik and Hassan (2003)	Turkey (1981-1990)	DEA based Malmquist Productivity Index (TE, PTE, SE, TECHCH, EFFCH, PECH,SECH, TFPCH)	Exclusion of OBS items significantly deteriorates the average efficiency and productivity scores of the Turkish banking industry.
Tortosa-Ausina (2003)	Spain (1986-1997)	DEA (CE)	Average cost efficiency of Spanish banks has enhanced when fee-generating income as a proxy for nontraditional activities is accounted in the output vector.
Rime and Stiroh (2003)	Switzerland (1996-1999)	DFA (CE, APE)	Failure to account for OBS items leads cost and profit efficiency to be dramatically understated.
Casu and Girardone (2005)	European Banks (1994-2000)	DEA based Malmquist Productivity Index (EFFCH, TECHCH, TFPCH)	Inclusion of OBS items results in an increase in the estimated productivity levels of the European countries (France, Germany, Italy, Spain, and UK) under study. Further, the impact seems to be bigger on technological change rather than efficiency change.
Lieu et al. (2005)	Taiwan (1998-2001)	SFA (CE)	Exclusion of OBS items as output lead to underestimation of cost efficiency of Taiwanese banks by 5 percent. The banks with higher OBS output gain higher cost efficiency.
Sufian and Ibrahim (2005)	Malaysia (2001-2003)	DEA based Malmquist Productivity Index (TECHCH, EFFCH, PECH,SECH,	Inclusion of OBS items results in an increase in productivity of Malaysian banks. Moreover, it has more effect on technological change rather than efficiency change.

		TFPCH)	
Huang and Chen (2006)	Taiwan (1992-2004)	DEA (CE)	Inclusion of non-interest income has positive impact on the cost efficiency of Taiwanese banks.
Pasiouras (2008)	Greece (2000-2004)	DEA (TE, PTE, SE)	Inclusion of off-balance sheet items in the output vector does not have an impact on the efficiency scores of Greek banks, while inclusion of loan loss provisions in the input vector contribute to highest efficiency scores.
Lyroudi and Angelidis (2009)	1995-2002	DEA based Malmquist Productivity Index (EFFCH, TECHCH, TFPCH)	
Budd (2009)	UAE (2001-2005)	DEA based Malmquist Productivity Index (TE, AE, CE, PTE, SE, EFFCH, TECHCH, PECH, SECH, TFPCH)	The inclusion of OBS items increases efficiency scores and estimated productivity levels of UAE banks.
Chortareas et al. (2009)	1998-2003	DEA based Malmquist Productivity Index (CE, APE, EFFCH, TECHCH, PECH, SECH, TFPCH)	The inclusion of OBS items seems to have no significant impact on the efficiency and productivity of Greek banking system.
Sufian (2009)	China (2000-2005)	DEA based Malmquist Productivity Index (EFFCH, TECHCH, PECH, SECH, TFPCH)	Inclusion of OBS items has positive impact on the efficiency change; while it has negative impact on total factor productivity of the China's banking industry.
Sufian and Habibullah (2009)	China (2000-2005)	DEA (TE, PTE, SE)	Inclusion of OBS items improves the technical, pure technical and scale efficiencies of Chinese banks.
Lozano-Vivas and Pasiouras (2010)	87 countries (1999-2006)	SFA (CE, APE)	There is an increase in the average cost efficiency of banks when off-balance sheet or non-interest income is accounted for in the output vector. However, the inclusion of OBS does not have any significant impact on profit efficiency.
Notes: (i) DEA, SFA, DFA and TFA are the acronyms for Data Envelopment Analysis, Stochastic Frontier Analysis, Distribution Free Approach, and Thick Frontier Analysis, respectively; (ii) TE, CE, RE, PE, APE, SPE, PTE, and SE stands for Technical, Cost, Revenue, Profit, Alternative Profit, Standard Profit, Pure Technical and Scale Efficiencies, respectively; (iii) EFFCH, TECHCH, PECH, SECH and TFPCH stands for Efficiency Change, Technological Change, Pure Technical Efficiency Change, Scale Efficiency Change and Total Factor Productivity Change (growth), respectively.			
Source: Authors' compilation			

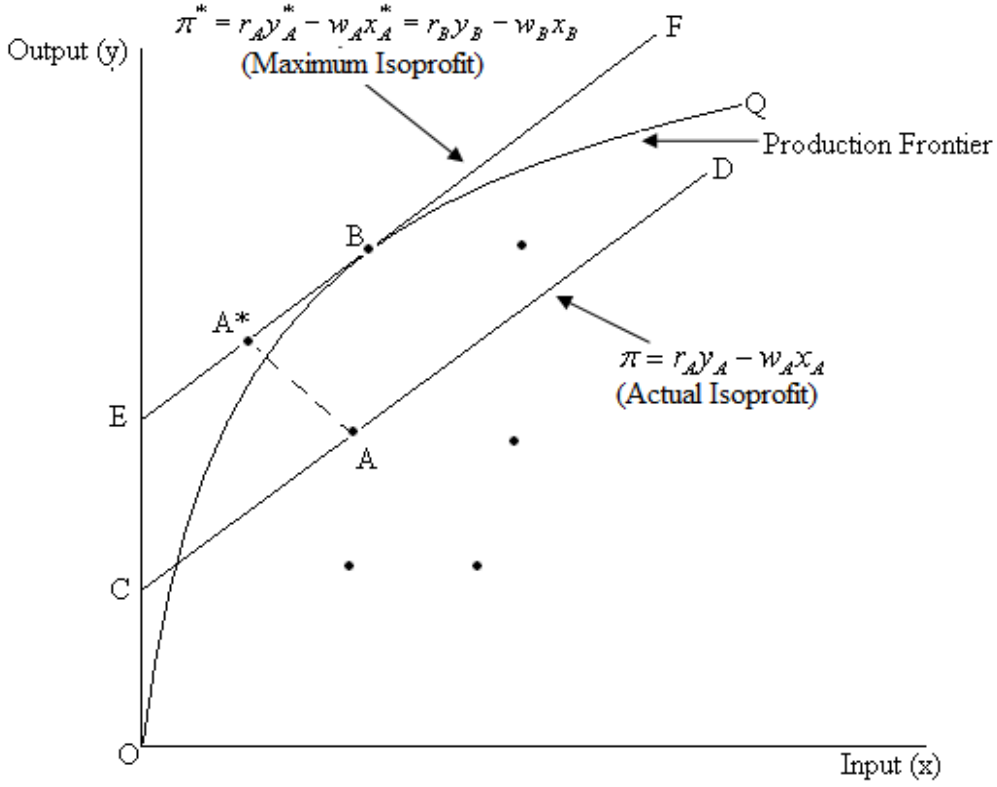
4. Methodological framework

4.1 Concepts of Profit efficiency

In the frontier efficiency measurement framework, a measure of profit efficiency assesses how close a bank comes to generating the maximum possible profit given the levels of input and output prices (quantities) and other exogenous conditions. In other words, profit efficiency improvements occur when a bank moves closer to the profit of a best-practice bank under the

given conditions. It is provided by the ratio of actual profit to maximum profit. The idea of measuring profit efficiency is conceptualized in the Figure 5.3. In the figure, the curve OQ shows the production frontier. The actual input-output combination of the Bank A is (x_A, y_A) shown by the point A. Therefore, the profit earned by Bank A is $\pi = q_A y_A - w_A x_A$. The set of all (x, y) through A which yield normalized profit π is shown by the line CD. The objective of the Bank A is to reach highest isoprofit line parallel to CD that can be attained at any point on or below the curve OQ. The highest such isoprofit line is reached at the point B representing the tangency of the isoprofit line EF with the production frontier. Let the optimal input-output bundle for Bank B is (x^*, y^*). The intercept of this line *OE* equals the maximum normalized profit π^*. The Bank A achieves maximum profit when it is projected on the isoprofit curve EF (say at A^*), where maximum profits equals that of Bank B i.e., $\pi^* = q_A y_A^* - w_A x_A^* = q_B y_B - w_B x_B$. Thus, profit efficiency for Bank A would be given by the ratio of actual to maximum profits i.e., $PE_A = \pi / \pi^*$. Regarding the decomposition of profit efficiency, Kumbhakar and Lovell (2005) states: "*A decomposition of profit efficiency into its constituent parts is somewhat arbitrary, depending on whether an input-oriented or an output-oriented measure of technical efficiency is used*".

Figure 2: Measurement of profit efficiency



In the contemporary literature on banking efficiency, two measures of profit efficiency, namely, standard profit efficiency and alternative profit efficiency, have been used by the researchers (see Berger and Mester, 1997; Färe et al., 2004; Cooper et al., 2007; Maudos and

Pastor, 2003). However, a consensus on the most adequate one was difficult to be achieved. These two measures differ whether or not we consider the existence of market power in the setting of output prices. The estimation of standard profit efficiency is based on the assumptions that i) banks maximize the profits in perfectly competitive input and output markets; ii) the prices of outputs and inputs are determined exogenously. Thus, the standard profit function is specified in term of input prices and output prices i.e., $\pi = f(w,q)$. In fact, standard profit efficiency measures how close a bank is to producing the maximum possible profit given a particular level of input prices and output prices.

In contrast, the alternative profit efficiency (APE) developed by Humphrey and Pulley (1997) assumes the existence of imperfect competition or banks exercise a form of market power in choosing output prices. However, this market power is limited to output markets and banks remain competitive purchasers of inputs. Thus, alternative profit function is defined in terms of input prices and output quantities i.e., $\pi = f(w,y)$. In fact, the alternative profit efficiency measures how close a bank comes to earning maximum profits, given its output levels rather than its market prices. DeYoung and Hassan (1998) listed two advantages of specifying profits as a function of output quantities rather than output prices: (i) it avoids having to measure output prices, which are not available for transactions services and fee-based outputs and can only be imperfectly constructed for loan outputs, and (ii) output quantities tend to vary across banks to a greater degree than do output prices, and as a result explain a larger portion of the variation in profits in regression analysis.

Berger and Mester (1997) noted that alternative profit frontier is preferred over the standard profit frontier when one or more of the following conditions hold: (i) there are substantial unmeasured differences in the quality of banking services; (ii) outputs are not completely variable, so that a bank cannot achieve every output scale and product mix; (iii) output markets are not perfectly competitive, so that banks have some market power over the prices they charge; and (iv) output prices are not accurately measured, so they do not provide accurate guides to opportunities to earn revenues and profits in the standard profit function.

4.2 DEA Models

Most empirical analyses aiming at measuring the technical and cost efficiencies of banking industry applied either parametric or non-parametric frontier efficiency measurement techniques. Common frontier efficiency estimation techniques are Data Envelopment Analysis (DEA), Free Disposal Hull (FDH), Stochastic Frontier Approach (SFA), Thick Frontier Approach (TFA) and Distribution Free Approach (DFA). The first two of these are non-parametric techniques and the latter three are parametric methods. A typical frontier technique provides an overall, objectively determined, numerical efficiency value and ranking of firms that is not other-wise available in traditional financial accounting ratio analysis (Berger and Humphrey, 1997). The basic tenet of frontier methodology is first to construct the efficiency frontier corresponding to a specific technical or behavioural goal and then to compute the bank-specific efficiency scores by working out the deviations from this frontier as inefficiency. Thus, a typical frontier efficiency measurement technique involves a two-step procedure to compute efficiency scores.

Both parametric and non-parametric approaches have a range of advantages and disadvantages, which may influence the choice of methods in a particular application. The principal advantage of parametric frontier analysis is that it allows the test of hypothesis concerning the goodness of fit of the model. However, the major disadvantage is that it requires specification of a particular frontier function (like Cobb-Douglas or Translog), which may be

restrictive in most cases. Furthermore, the major advantage of the non-parametric frontier analysis is that it does not require the specification of a particular functional form for the technology. The main disadvantage is that it is not possible to estimate parameters for the model and hence impossible to test hypothesis concerning the performance of the model. However, no consensus has been reached in the literature about the appropriate and preferred estimation methodology (Iqbal and Molyneux 2005; Staikouras et al. 2008).

As mentioned in the introductory section, this chapter uses data envelopment analysis (DEA) to estimate empirically the efficiency scores for individual banks. Using actual data for the banks under consideration, DEA employs linear programming technique to construct *efficient* or *best-practice frontiers*. In fact, a large number of linear programming DEA models have been proposed in the literature to compute efficiency of individual banks corresponding to different technical or behavioural goals (see, for example, Charnes et al. 1994; Cooper et al. 2007). In practice, the researchers identify three behavioural goals to be pursued by the banks i.e., cost minimization, revenue maximization and profit maximization, and determine the respective frontiers to obtain cost, revenue and profit efficiencies scores. In addition, the technical efficiency frontier correspond to technical goals of producing maximum level of output from given inputs has been constructed to obtain technical efficiency scores.

For the estimation of profit efficiency, a non-oriented DEA model is used which will allow both for increases and decreases in inputs and outputs so as to exploit prevailing prices. Let us suppose that there exist n banks $(j=1,...,n)$ that produce a vector of s outputs $y=(y_1,...,y_s)\in\Re_{s++}$ that they sell at prices $q=(q_1,...,q_s)\in\Re_{s++}$ using a vector of m discretionary inputs $x^D=(x_1^D,...,x_m^D)\in\Re_{m++}$, for which they pay prices $p=(p_1,...,p_m)\in\Re_{m++}$ and l quasi-fixed inputs $x^{QF}=(x_1^{QF},...,x_l^{QF})\in\Re_{l++}$ which do not have any associated input price vector. The profit efficiency measure, as proposed by Färe and Grosskopf (1997), and Färe et al. (1997), for the case of DMU 'o' can be calculated by solving the following problem of linear programming:

$$
\begin{aligned}
&Max \sum_{r=1}^{s} q_r^o \tilde{y}_{ro} - \sum_{i=1}^{m} p_i^o \tilde{x}_{io}^D \\
&\text{Subject to} \\
&\sum_{j=1}^{n} \lambda_j x_{ij}^D \le \tilde{x}_{io}^D, \qquad i=1,...,m \\
&\sum_{j=1}^{n} \lambda_j x_{kj}^{QF} \le x_{ko}^{QF}, \qquad k=1,...,l \qquad (3) \\
&\sum_{j=1}^{n} \lambda_j y_{rj} \ge \tilde{y}_{ro}, \qquad r=1,...,s \\
&x_{io} \ge \tilde{x}_{io}^D \\
&y_{ro} \le \tilde{y}_{ro} \\
&\lambda_j \ge 0, \qquad j=1,...,n
\end{aligned}
$$

From the solution to model (3), we get maximum profits as $Max \sum_{r=1}^{s} q_r^o \tilde{y}_{ro}^* - \sum_{i=1}^{m} p_i^o \tilde{x}_{io}^{D*}$, and the profit efficiency (PE-I) of bank '*o*' is then calculated as follows:

$$PE1_o = \frac{\text{Actual Profit}}{\text{Maximum standard profit}} = \frac{\text{Actual Revenue} - \text{Actual Cost}}{\text{Maximum Revenue} - \text{Minimum Cost}}$$

$$= \frac{\sum_{r=1}^{s} q_r^o y_{ro} - \sum_{i=1}^{m} p_i^o x_{io}^*}{\sum_{r=1}^{s} q_r^o \tilde{y}_{ro}^* - \sum_{i=1}^{m} p_i^o \tilde{x}_{io}^{D*}}$$

Another measure of standard profit efficiency (denoted here as PE2) used in the present study is provided by Cooper , Seiford and Tone (2003) which is described as below:

$$Max \sum_{r=1}^{s} \tilde{\bar{y}}_{ro} - \sum_{i=1}^{m} \tilde{\bar{x}}_{io}^{D}$$

Subject to

$$\sum_{j=1}^{n} \lambda_j \bar{x}_{ij}^{D} \le \tilde{\bar{x}}_{io}^{D}, \qquad i = 1,...,m$$

$$\sum_{j=1}^{n} \lambda_j x_{kj}^{QF} \le x_{ko}^{QF}, \qquad k = 1,...,l \qquad (4)$$

$$\sum_{j=1}^{n} \lambda_j \bar{y}_{rj} \ge \tilde{\bar{y}}_{ro}, \qquad r = 1,...,s$$

$$\bar{x}_{io} \ge \tilde{\bar{x}}_{io}^{D}$$

$$\bar{y}_{ro} \le \tilde{\bar{y}}_{ro}$$

$$\lambda_j \ge 0, \qquad j = 1,...,n$$

From the solution to model (4), we get maximum profits as $Max \sum_{r=1}^{s} \tilde{\bar{y}}_{ro}^* - \sum_{i=1}^{m} \tilde{\bar{x}}_{io}^{D*}$, and the profit efficiency (PE-I) of bank '*o*' is then calculated as follows:

$$PE2_o = \frac{\text{Actual Profit}}{\text{Maximum standard profit}} = \frac{\text{Actual Revenue} - \text{Actual Cost}}{\text{Maximum Revenue} - \text{Minimum Cost}}$$

$$= \frac{\sum_{r=1}^{s} \bar{y}_{ro} - \sum_{i=1}^{m} \bar{x}_{io}^{D}}{\sum_{r=1}^{s} \tilde{\bar{y}}_{ro}^* - \sum_{i=1}^{m} \tilde{\bar{x}}_{io}^{D*}}$$

Finally, the measurement of profit efficiency measure from the linear programming model as developed by Maudos and Pastor (1999) is as follows:

$$Max\ \tilde{R}_{ro} - \sum_{i=1}^{m} p_i^o \tilde{x}_{io}^D$$

Subject to

$$\sum_{j=1}^{n} \lambda_j x_{ij}^D \le \tilde{x}_{io}^D, \qquad i = 1,...,m$$

$$\sum_{j=1}^{n} \lambda_j x_{kj}^{QF} \le x_{ko}^{QF}, \qquad k = 1,...,l$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} \ge \tilde{y}_{ro}, \qquad r = 1,...,s \qquad (5)$$

$$\sum_{j=1}^{n} \lambda_j R_{rj} \ge \tilde{R}_{ro},$$

$$x_{io} \ge \tilde{x}_{io}^D$$

$$y_{ro} \le \tilde{y}_{ro}$$

$$R_{ro} \le \tilde{R}_{ro}$$

$$\lambda_j \ge 0, \qquad j = 1,...,n$$

The solution to above linear programming problem corresponds to the maximum profits as $Max\ \tilde{R}_{ro}^* - \sum_{i=1}^{m} p_i \tilde{x}_{io}^{D*}$, and the profit efficiency (PE3) of bank '*o*' is then calculated as follows:

$$\text{PE3}_o = \frac{\text{Actual Profit}}{\text{Maximum alternative profit}} = \frac{\sum_{r=1}^{s} q_r y_{ro} - \sum_{i=1}^{m} p_i x_{io}^D}{\tilde{R}_{ro}^* - \sum_{i=1}^{m} p_i \tilde{x}_{io}^{D*}}$$

The profit efficiency scores so obtained are bounded above and have a maximum value of 1. It ranges over $(-\infty,1)$ and equals 1 for a best-practice bank within the observed data. Profit efficiency can be negative since banks can throw away more than 100 percent of their potential profits.

5. Data and measurement of input and output variables

In computing the efficiency scores, the most challenging task that an analyst always encounters is to select the relevant inputs and outputs for modeling banks' behaviour. It is worth noting here that there is no consensus on what constitute the inputs and outputs of a bank and how to measure them (Casu and Girardone, 2002; Sathye, 2003). In the literature on banking efficiency, there are mainly two approaches for selecting the inputs and outputs for a bank: i) the *production approach*, also called the *service provision* or *value added approach*; and ii) the *intermediation approach*, also called the *asset approach* (Humphrey, 1985; Hjalmarsson et al., 2000). Both these approaches apply the traditional microeconomic theory of the firm to banking and differ only in the specification of banking activities. The production approach as pioneered

by Benston (1965) treats banks as the providers of services to customers. The output under this approach represents the services provided to the customers and is best measured by the number and type of transactions, documents processed or specialized services provided over a given time period. However, in case of non-availability of detailed transaction flow data, they are substituted by the data on the number of deposits and loan accounts, as a surrogate for the level of services provided. In this approach, input includes physical variables (like labour, material, space or information systems) or their associated cost. This approach focuses only on operating cost and completely ignores interest expenses.

The intermediation approach as proposed by Sealey and Lindley (1977) treats banks as financial intermediaries channeling funds between depositors and creditors. In this approach, banks produce intermediation services through the collection of deposits and other liabilities and their application in interest-earning assets, such as loans, securities, and other investments. This approach is distinguished from production approach by adding deposits to inputs, with consideration of both operating cost and interest cost. Berger and Humphrey (1997) pointed out that neither of these two approaches is perfect because they cannot fully capture the dual role of banks as providers of transactions/document processing services and being financial intermediaries. Nevertheless, they suggested that the intermediation approach is best suited for analyzing bank level efficiency, whereas the production approach is well suited for measuring branch level efficiency. This is because, at the bank level, management will aim to reduce total costs and not just non-interest expenses, while at the branch level a large number of customer services processing take place and bank funding and investment decisions are mostly not under the control of branches. Also, in practice, the availability of flow data required by the production approach is usually exceptional rather than in common.

Elyasiani and Mehdian (1990) gave three distinct advantages of the intermediation approach over other approaches. They argue that (a) it is more inclusive of the total banking cost as it does not exclude interest expense on deposits and other liabilities; (b) it appropriately categorizes the deposits as inputs; and (c) it has an edge over other definitions for data quality considerations. Therefore, as in majority of the empirical literature, we adopted intermediation approach as opposed to the production approach for selecting input and output variables. In the present study, we establish Models A and B, respectively with and without the inclusion of non-interest income as a proxy for non-traditional activities and compare the efficiency differences between them. Table 3 provides the details on input and output variables included in both the model specifications.

Table 3: Input and output variables used in measurement of technical and cost efficiencies

Model A	Model B
Inputs	
1. Physical capital 2. Labour 3. Loanable funds 4. Equity (quasi-fixed)	1. Physical capital 2. Labour 3. Loanable funds 4. Equity (quasi-fixed)
Outputs	
1. Advances 2. Investments 3. Non-interest income	1. Advances 2. Investments
Source: Authors' elaboration	

As seen in Table 3, Models A and B are based on the intermediation approach but different inputs/outputs combinations are examined so as to explore the impact of non-traditional activities on bank efficiency. The two outputs of Model B are advances and investments. Hence, this is a standard specification in the intermediation approach which provides efficiency performance of the banks from the perspective of financial intermediation only and ignores the non-traditional activities which turned out to be a significant source of banks' income in the post-reforms period. In Model A, we introduce non-interest income as a proxy for non-traditional activities as an additional output to account for the fact that in recent years banks are heavily involved in fee-generating activities. In Models A and B, we include four variables in the input vector i.e., i) *physical capital*, ii) *labour,* iii) *loanable funds*, and iv) *equity.*

It is worth noting here that we have taken the equity as quasi-fixed[1] variable without any associated price to account for both risk-based capital requirements and the risk-return trade-off that bank owners face. On commenting the inclusion of equity (so called financial capital) in the input vector, Berger and Mester (1997) stated: "*A bank's insolvency risk depends on its equity (financial capital) available to absorb portfolio losses, as well as on the portfolio risk themselves. Insolvency risk affects bank costs and profits via risk premium the bank has to pay for uninsured debt, and through the intensity of risk management activities the bank undertakes*". Maudos et al. (2002), Ram Mohan and Ray (2004), Das et al. (2005), and Koutsomanoli-Fillippaki et al. (2009) have included the equity variable as one of the inputs while estimating the efficiency performance of banks. The prices of variable inputs are worked out as per unit price of physical capital, per employee wage bill, and cost of loanable funds (see Table 4).

[1] Like Ray and Das (2010), we treat equity as quasi-fixed input because compared to other inputs, the level of equity is much more difficult to alter, especially in the short run.

Table 4: Description of input and output variables		
Variables	**Description in the balance sheet**	**Unit of measurement**
Input variables		
1) Physical Capital (x_1)	Fixed assets	Rupee lac
2) Labour (x_2)	Staff (Number of Employees)	Number
3) Loanable Funds (x_3)	Deposits + Borrowings	Rupee lac
Output variables		
1) Advances (y_1)	Advances in India (= Term loans + Cash credits, overdrafts + Bills purchased and discounted, etc.) + Advances outside India	Rupee lac
2) Investments (y_2)	Investments in India (=Investment in government securities + Other approved securities + Shares, debentures and bonds, etc.) +Investments outside India	Rupee lac
3) Non-interest income (y_3)	Other income (=Commission, exchange, brokerage, etc. + Net profit(loss) on sales of investments + Net profit(loss) on revaluation of investments + Net profit(loss) on sale of land and other assets + Net profit(loss) on exchange transactions + Miscellaneous receipts)	Rupee lac
Quasi-fixed input variable		
4) Equity (x_4)	Capital + Reserve & Surpluses	Rupee lac
Input prices		
1) Price of physical capital (w_1)	(Rent, taxes and lighting + Printing and stationary + Depreciation on bank's property + Repairs and maintenance + Insurance) / Physical capital	
2) Price of labour (w_2)	(Payment to and provisions for employees) / Labour	
3) Price of loanable funds (w_3)	(Interest paid on deposits + Interest paid on borrowings from RBI and other agencies) / Loanable funds	
Output prices		
1) Price of advances (q_1)	(Interest/discount on advances/bills) / Advances	
2) Price of investments (q_2)	Income on investments / Investments	
3) Price of non-interest income (q_3)	1 (taken as constant)	
Source: Authors' elaboration		

The required data on different set of input and output variables have been collected out from the various issues of (i) '*Statistical Tables Relating to Banks in India*', an annual publication of Reserve Bank of India, (ii) '*Performance Highlights of Public Sector Banks*', '*Performance Highlights of Private Banks*', and '*Performance Highlights of Foreign Banks*', annual publications of Indian Banks' Association. Our study is based on the secondary data spanning from the period 1992-93 to 2007-08. Following Barman (2007) and Roland (2008), we bifurcated the entire study period into two distinct sub-periods: i) first sub-period (1992-93 to 1998-99), and ii) second sub-period (1999-2000 to 2007-08). To compute cost, technical and allocative efficiency scores, the analysis has been carried out with real values of the variables (except labour) which have been obtained by deflating the nominal values by the implicit price deflator of gross domestic product at factor cost (base 1999-2000=100). Following Denizer et al. (2007), and Kumar and Gulati (2009), we normalize all the input and output variables by

dividing them by number of branches of individual banks for the given year. The main purpose of using this normalization procedure is that it reduces the effects of random noise due to measurement error in the inputs and outputs.

6. Empirical Results

This section delineates the impact of inclusion or exclusion of non-traditional activities on the profit efficiency in Indian banking industry during the period 1992-93 to 2007-08. For examining the relevance of including non-interest income emanating from non-traditional activities in the output specification to estimate bank efficiency in India, we followed a two-step approach. The first step examines the differences between the magnitude of efficiency estimates obtained from models with and without non-interest income and tests for differences between mean efficiency estimates when the non-interest income is first included and then excluded from the analysis. In the second step, ranking differences are investigated to identify the impact of the inclusion or exclusion of non-traditional activities on the individual banks and across distinct ownership groups.

Instead of constructing a 'grand or inter-temporal frontier'[2] as suggested by Tulkens and van den Eeckaut (1995) and implemented by Bhattacharyya et al. (1997) for estimating the efficiency scores of individual banks, we followed Isik and Hassan (2002), Pasiouras et al. (2007), Kyj and Isik (2008), and estimated separate annual *efficient frontiers* for obtaining year-by-year technical efficiency estimates. Isik and Hassan (2002) pointed out the following two advantages of this approach. First, it is more flexible and thus, more appropriate than estimating a single multi-year frontier for the banks in the sample. Second, it alleviates, at least to some extent, the problems related to the lack of random error in DEA by allowing an efficient bank in one year to be inefficient in another under the assumption that the errors owing to luck or data problems are not consistent over time. In addition, the efficiency estimates obtained from grand frontier are generally over-stated because they are affected by technological progress in the industry. Thus, we believe that our efficiency estimates are more reliable and accurate than what can be obtained from the grand frontier which envelops the pooled input-output data of all banks in all years.

6.1 Impact of OBS activities on the profit efficiency

The focus of this section is to investigate the impact of inclusion or exclusion of a proxy for OBS activities on the profit efficiency of Indian banks during the post-deregulation period. As mentioned in the section on methodological framework, we have estimated three distinct profit efficiency measures, namely PE1, PE2 and PE3 using the three different DEA models as developed by Fare et al. (1997), Cooper et al. (2007), and Maudos and Pastor (1999), respectively. Note here that the PE1 and PE2 are the standard measures of profit efficiency corresponding to the assumption of perfect competition in the markets for inputs and outputs, and PE3 can be described as an alternative profit efficiency measure which is based on the assumption that the banks might have some control over output prices.

Table 5 provides year-wise mean PE1, PE2 and PE3 scores corresponding to Model A (with non-interest income) and Model B (without non-interest income) for Indian banking industry during the post-deregulation period. For the entire study period, the grand means of PE1, PE2 and PE3 scores for Model A are 0.581, 0.640 and 0.568, respectively, whereas the same for Model B are 0.363, 0.463 and 0.376, respectively. Therefore, the levels of mean profit

[2] The 'grand frontier' envelops the pooled input-output data of all banks in all years.

inefficiency[3] corresponding to PE1, PE2 and PE3 measures are 41.9%, 36% and 43.2%, respectively in Model A and 63%, 53.7% and 62.4%, respectively in Model B. Thus, the magnitude of profit inefficiency for an average bank in each year of the sample period is on the order of 40% for the traditional intermediation outputs and above 50% for the output mix including traditional and OBS activities. This indicates that a fairly substantial fraction of potential profits that could be earned by an efficient bank are lost to inefficiency which is emanated due to excessive costs, deficient revenues or both. Apparently, there exists substantial room for significant improvements in potential profits in Indian banking industry. Thus, Indian banks need not only to use and allocate their productive inputs more efficiently but also to sell their product efficiently.

To examine the relevance of OBS activities in estimating profit efficiency of Indian banks, we have made a comparison of the relative sizes of mean profit efficiency scores of Models A and B. From Table 5, we note that barring an exception to one or two years, the mean PE1, PE2 and PE3 scores obtained from the Model A are considerably higher than those estimated from the Model B. Further, the differences in the grand means of PE1, PE2 and PE3 scores between both the models have been found to be 21.8%, 20.4% and 19.2%, respectively, for entire study period. Similar results also appear in the analysis of distinct sub-periods. Like cost efficiency, profit efficiency also rises when a proxy for OBS activities is included in the definition of banks' output. This finding is consistent with Rogers (1998), who finds that the estimates of cost and profit efficiency for U.S. banks increase when OBS activities are accounted for, suggesting that the traditional model understates efficiency. In the light of the empirical results, we can safely comment that Indian banks tend to be producing and selling OBS output better than traditional output. Thus, our results support the importance of including a measure of OBS activities in the profit function. On the whole, for an average Indian bank, the exclusion of non-interest income as a proxy for OBS activities also understates profit efficiency measures.

[3] From the profit efficiency scores, we can work out the extent of profit inefficiency (in percentage) as Profit inefficiency = (1- Profit efficiency) × 100.

Table 5: Mean profit efficiency scores for Indian commercial banking industry: 1992-93 to 2007-08							
Model specifications→		Model A (with non-interest income)			Model B (without non-interest income)		
Year↓	No. of Banks	PE1	PE2	PE3	PE1	PE2	PE3
1992-93	73	0.423	0.385	0.462	0.072	0.265	0.193
1993-94	71	0.534	0.543	0.485	0.289	0.264	0.267
1994-95	75	0.558	0.538	0.511	0.364	0.719	0.316
1995-96	90	0.341	0.600	0.433	0.375	0.338	0.335
1996-97	97	0.552	0.558	0.534	0.469	0.624	0.463
1997-98	98	0.688	0.637	0.654	0.470	0.345	0.485
1998-99	101	0.505	0.481	0.473	0.210	0.212	0.219
1999-2000	100	0.545	0.636	0.522	0.240	0.287	0.311
2000-01	97	0.545	0.599	0.564	0.261	0.283	0.267
2001-02	92	0.558	0.710	0.504	0.215	0.277	0.216
2002-03	88	0.701	0.710	0.637	0.392	0.446	0.369
2003-04	86	0.756	0.830	0.741	0.418	0.469	0.462
2004-05	84	0.667	0.738	0.653	0.537	0.538	0.658
2005-06	83	0.599	0.767	0.615	0.406	0.716	0.414
2006-07	80	0.657	0.737	0.636	0.586	0.546	0.563
2007-08	77	0.660	0.770	0.663	0.499	0.639	0.485
Grand Mean							
Entire Period (1992-93 to 2007-08)		0.581	0.640	0.568	0.363	0.436	0.376
First sub-period (1992-93 to 1998-99)		0.515	0.535	0.507	0.321	0.395	0.325
Second sub-period (1999-2000 to 2007-08)		0.632	0.722	0.615	0.395	0.467	0.416
Source: Authors' calculations							

To assess whether the differences in the mean profit efficiency scores obtained from Models A and B are statistically significant, we again applied paired *t*-test, Sign test and Wilcoxon Signed-ranks test. Table 6 provides the results pertaining to these tests. We note that the null hypothesis is rejected in all the instances. This indicates that the mean profit efficiency scores obtained from Models A are statistically significantly higher than those obtained from Model B. Thus, we can safely infer that profit efficiency estimates increase significantly in magnitude when OBS activities are included in the specification of output vector. Overall, the exclusion of OBS activities from the profit function introduces a systematic bias in the derived estimates of profit efficiency of Indian banks.

Table 6: Hypothesis testing: profit efficiency differences across different model specifications in Indian commercial banking industry			
Efficiency measure	**PE1**	**PE2**	**PE3**
Panel A: Paired *t*-test **H_o: Mean Efficiency of Model A=Mean Efficiency of Model B**			
t-statistics	7.741	5.056	8.506
p-value	<0.0001	0.000	<0.0001
Inference	Reject H_o	Reject H_o	Reject H_o
Panel B: Sign test **H_o: Both efficiency samples are not different**			
No. of positive differences	15	14	15
p-value	0.001	0.004	0.001
Inference	Reject H_o	Reject H_o	Reject H_o
Panel C: Wilcoxon Signed-ranks test **H_o: Both efficiency samples are not different**			
T-statistics	135	129	135
p-value	0.001	0.002	0.001
Inference	Reject H_o	Reject H_o	Reject H_o
Source: Authors' calculations			

6.2 OBS activities and ranking of individual banks on the basis of profit efficiency

For examining the impact of omission of non-interest income originating from the OBS activities on the ranking of individual banks, we again relied on Kendall's rank correlation coefficient. Table 7 provides the year-wise Kendall's tau correlation coefficients between the profit efficiency scores obtained from Models A and B. For PE1 measure, the correlation between the rankings ranges from 0.491 to 0.765. The correlations between rankings based on other measures of profit efficiency are similar to what has been noted in case of PE1. The Kendall's tau value for PE2 (PE3) measures ranged between 0.448(0.469) and 0.777(0.757). From the table, we note that i) in all the years under evaluation, the correlation coefficients take a value less than one, indicating that rankings of the banks under Models A and B are not identical, and (ii) correlation coefficients are statistically significant in all cases, and vary between the range of low and moderately high. On the whole, in all measures, the Kendall's rank correlation coefficient illustrates a linear but not perfect relationship between the rankings of the two alternative models. This suggests that there was some relative movement with regard to the rankings between the two models across the samples. Thus, the results indicate that the inclusion of OBS activities in the output specification has significantly affected the ranking of individual banks, albeit with different extent. In sum, the omission of OBS activities in the definition of bank output not only understates efficiency levels of individual banks, but also affects their relative ranking.

Table 7: Kendall tau correlation coefficients between the profit efficiency scores of Models A and B (H_o: Efficiency Scores of Models A and B are not correlated)			
Year	**PE1**	**PE2**	**PE3**
1992-93	0.660*	0.751*	0.753*
1993-94	0.765*	0.702*	0.757*
1994-95	0.761*	0.754*	0.757*
1995-96	0.681*	0.749*	0.733*
1996-97	0.720*	0.777*	0.722*
1997-98	0.748*	0.686*	0.703*
1998-99	0.561*	0.448*	0.657*
1999-2000	0.699*	0.699*	0.654*
2000-01	0.642*	0.724*	0.682*
2001-02	0.491*	0.508*	0.522*
2002-03	0.555*	0.611*	0.589*
2003-04	0.406*	0.293*	0.469*
2004-05	0.651*	0.636*	0.483*
2005-06	0.592*	0.696*	0.616*
2006-07	0.755*	0.669*	0.622*
2007-08	0.683*	0.731*	0.676*
Note: '*' indicates the significance at 5 percent level.			
Source: Authors' calculations			

6.3 OBS activities and profit efficiency of ownership groups

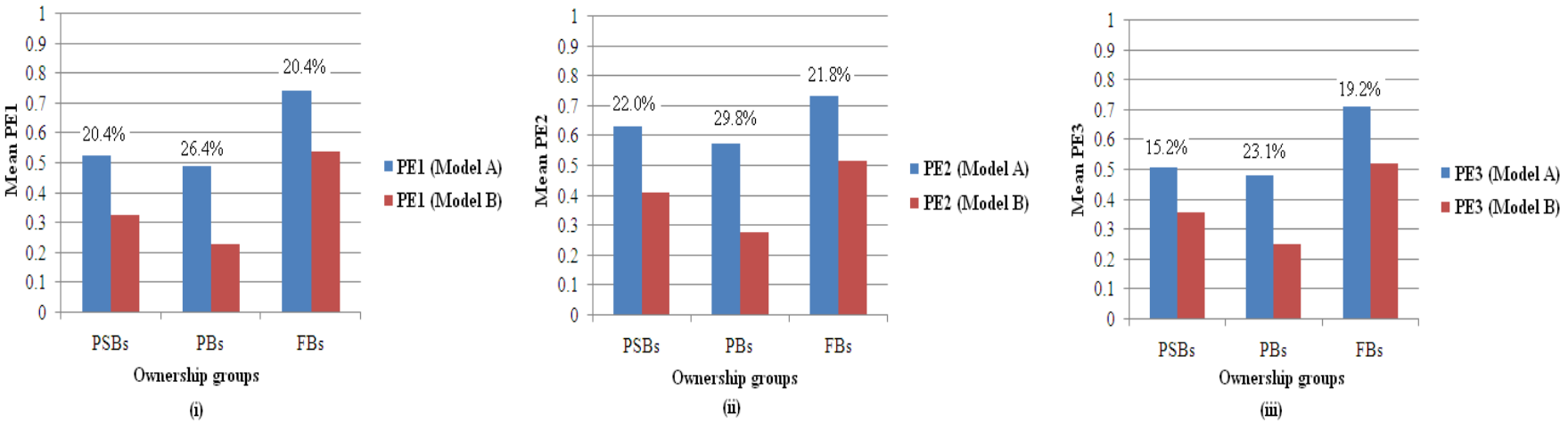
Like cost efficiency, we have also analyzed the impact of inclusion or exclusion of OBS activities on the profit efficiency of distinct ownership groups in Indian commercial banking industry. For this, a comparative analysis has been made between the means of profit efficiency scores from Models A and B. Panel A of Table 8 reports the mean PE1, PE2 and PE3 scores for the public sector banks (PSBs) group in each year of the study period. The results reveal that profit efficiency of PSBs group tends to rise when non-interest income is included in the output vector. This is evident from the fact that the grand means of PE1, PE2 and PE3 for the entire study period have been observed to be 0.527, 0.631 and 0.507, respectively for Model A, and 0.323, 0.411 and 0.355, respectively for Model B. Thus, for an average bank belonging to this group, an ascent in PE1, PE2 and PE3 with inclusion of non-interest income as a proxy for OBS activities is 20.4%, 26.4% and 20.4%, respectively (see also Figure 3). Similar conclusion holds for the analysis of distinct sub-periods. It is noteworthy here that in PSBs group, the effect of insertion of a proxy for OBS activities in the output vector is more pronounced in case of profit efficiency than what has been noted in the case of cost efficiency.

The results for private banks (PBs) and foreign banks (FBs) group are presented in Panels B and C of Table 8. Like their public sector counterparts, the private and foreign banks groups have also exhibited an increase in mean profit efficiency scores when OBS activities have been accounted for in the output vector. This is evident from the fact that for both groups, the grand means of PE1, PE2 and PE3 in Model A are greater than those obtained from Model B for the entire period and distinct sub-periods. In particular, the exclusion of OBS activities in the output specification has underestimated PE1, PE2 and PE3 scores of an average private bank by 26.4%, 29.8% and 23.1%, respectively. Further, the differences in the grand means of PE1, PE2 and PE3 of Models A and B are 20.4%, 21.8% and 19.2%, respectively, for an average foreign bank. Overall, the aforementioned results suggest that the model which omits a proxy for OBS activities in the output vector understates the profit efficiency of banks belonging to all the ownership groups albeit with different magnitudes (see numerical value above each bar in the Figure 3). Further, the magnitude of rise in profit efficiency is higher in case of the private banks

relative to their public and foreign peers when non-interest income is included in the output specification. Thus, the impact of inclusion or exclusion of a proxy for OBS activities on the profit efficiency measure is somewhat more pronounced in case of the private banks.

Table 8: Mean profit efficiency scores across distinct ownership groups: 1992-93 to 2007-08							
Model specifications→		**Model A (with non-interest income)**			**Model B (without non-interest income)**		
Year↓	**No. of Banks**	**PE1**	**PE2**	**PE3**	**PE1**	**PE2**	**PE3**
Panel A: Public sector banks (PSBs)							
1992-93	27	0.112	0.105	0.256	-0.536	0.002	-0.155
1993-94	27	0.345	0.272	0.275	0.046	-0.021	0.018
1994-95	27	0.353	0.477	0.328	0.149	0.354	0.147
1995-96	27	0.463	0.498	0.397	0.237	0.197	0.224
1996-97	27	0.552	0.625	0.523	0.387	0.376	0.385
1997-98	27	0.634	0.552	0.582	0.465	0.272	0.470
1998-99	27	0.376	0.629	0.313	0.078	0.103	0.100
1999-2000	27	0.523	0.658	0.481	0.304	0.235	0.291
2000-01	27	0.431	0.571	0.451	0.114	0.238	0.114
2001-02	27	0.456	0.705	0.440	0.273	0.496	0.261
2002-03	27	0.713	0.805	0.651	0.561	0.661	0.525
2003-04	27	0.752	0.901	0.750	0.537	0.721	0.604
2004-05	27	0.696	0.858	0.680	0.657	0.752	0.895
2005-06	27	0.620	0.842	0.645	0.566	0.795	0.573
2006-07	28	0.689	0.762	0.684	0.697	0.660	0.667
2007-08	28	0.708	0.842	0.655	0.637	0.741	0.566
Entire Period	**Grand Mean→**	0.527	0.631	0.507	0.323	0.411	0.355
First sub-period		0.405	0.451	0.382	0.118	0.183	0.170
Second sub-period		0.621	0.772	0.604	0.483	0.589	0.499
Panel B: Private banks (PBs)							
1992-93	23	0.316	0.193	0.266	0.016	0.007	0.031
1993-94	23	0.412	0.533	0.376	0.116	0.160	0.077
1994-95	23	0.462	0.513	0.456	0.279	0.174	0.271
1995-96	33	0.332	0.600	0.303	0.318	0.286	0.287
1996-97	33	0.456	0.549	0.407	0.330	0.415	0.284
1997-98	34	0.624	0.633	0.563	0.265	0.324	0.317
1998-99	33	0.390	0.358	0.369	0.009	0.103	0.079
1999-2000	32	0.530	0.657	0.527	0.162	0.290	0.243
2000-01	31	0.435	0.617	0.487	0.123	0.262	0.118
2001-02	30	0.534	0.758	0.542	0.061	0.075	0.090
2002-03	30	0.677	0.667	0.637	0.176	0.263	0.203
2003-04	30	0.682	0.809	0.702	0.197	0.332	0.311
2004-05	29	0.456	0.542	0.468	0.381	0.409	0.447
2005-06	28	0.492	0.589	0.508	0.341	0.473	0.284
2006-07	25	0.543	0.610	0.541	0.513	0.476	0.580
2007-08	23	0.502	0.569	0.558	0.337	0.387	0.404
Entire Period	**Grand Mean→**	0.490	0.575	0.482	0.226	0.277	0.251
First sub-period		0.427	0.483	0.391	0.190	0.210	0.192
Second sub-period		0.539	0.646	0.552	0.255	0.330	0.298
Panel C: Foreign Banks (FBs)							
1992-93	23	0.896	0.907	0.899	0.842	0.832	0.762
1993-94	21	0.913	0.903	0.875	0.790	0.745	0.796
1994-95	25	0.866	0.771	0.758	0.676	0.718	0.540
1995-96	30	0.559	0.692	0.609	0.561	0.521	0.487
1996-97	37	0.638	0.517	0.656	0.653	0.380	0.678
1997-98	37	0.787	0.703	0.790	0.663	0.418	0.650
1998-99	41	0.683	0.483	0.662	0.459	0.371	0.409
1999-2000	41	0.572	0.605	0.545	0.259	0.318	0.377
2000-01	39	0.710	0.604	0.705	0.473	0.331	0.490
2001-02	35	0.656	0.674	0.522	0.302	0.281	0.290
2002-03	31	0.715	0.670	0.624	0.453	0.434	0.394
2003-04	29	0.838	0.785	0.774	0.537	0.481	0.485
2004-05	28	0.857	0.826	0.819	0.582	0.465	0.647
2005-06	28	0.686	0.873	0.693	0.316	0.570	0.392
2006-07	27	0.729	0.828	0.676	0.538	0.603	0.439
2007-08	26	0.749	0.869	0.766	0.494	0.751	0.468
Entire Period	**Grand Mean→**	0.741	0.732	0.711	0.537	0.514	0.519
First sub-period		0.763	0.711	0.750	0.663	0.569	0.618
Second sub-period		0.724	0.748	0.680	0.439	0.470	0.442
Source: Author's calculations							

Figure 3: Mean profit efficiency differences across ownership groups



In order to test the statistical significance of differences between profit efficiency scores of Models A and B in distinct ownership groups, we have again relied on paired *t*-test, Sign test and Wilcoxon Signed-ranks test. From the Table 9, we note that the null hypothesis of no differences in the profit efficiency levels is rejected in all the instances, indicating that the estimated mean profit efficiency of banks operating under different ownership patterns is understated when a proxy for OBS activities is not included in the output vector. Overall, the results suggest that the model which omits a proxy for OBS activities understates profit efficiency measures of distinct ownership groups albeit with different magnitudes.

Table 9: Hypothesis testing: profit efficiency differences across different model specifications for distinct ownership groups

	Public sector banks (PSBs)			Private banks (PBs)			Foreign banks (FBs)		
Efficiency measure	**PE1**	**PE2**	**PE3**	**PE1**	**PE2**	**PE3**	**PE1**	**PE2**	**PE3**
Panel A: Paired *t*-test (H_o: Mean Efficiency of Model A=Mean Efficiency of Model B)									
t-statistics	5.345	6.614	4.398	6.558	7.801	6.221	4.310	8.640	8.852
p-value	<0.0001	<0.0001	0.001	<0.0001	<0.0001	<0.0001	0.001	<0.0001	<0.0001
Inference	Reject H_o	Reject H_o	Reject H_o	Reject H_o	Reject H_o	Reject H_o	Reject H_o	Reject H_o	Reject H_o
Panel B: Sign test (H_o: Both efficiency samples are not different)									
No. of positive differences	15	16	15	16	16	15	14	16	15
p-value	<0.0001	<0.0001	0.001	<0.0001	<0.0001	0.001	0.004	<0.0001	0.001
Inference	Reject H_o	Reject H_o	Reject H_o	Reject H_o	Reject H_o	Reject H_o	Reject H_o	Reject H_o	Reject H_o
Panel C: Wilcoxon Signed-ranks test (H_o: Both efficiency samples are not different)									
T-statistics	135	136	123	136	136	133	121	136	135
p-value	0.001	0.000	0.004	0.000	0.000	0.001	0.006	0.000	0.001
Inference	Reject H_o	Reject H_o	Reject H_o	Reject H_o	Reject H_o	Reject H_o	Reject H_o	Reject H_o	Reject H_o

Source: Author's calculations

6.4 OBS activities and ordering of ownership groups on the basis of profit efficiency

In this section, we made a comparison between the rankings of distinct ownership groups on the basis of grand means of profit efficiency scores obtained from Models A and B, and also deliberate the changes in ranking in different phases of reforms. Table 10 provides the relevant results. The empirical results pertaining to the entire study reveals that different profit efficiency measures give identical rankings of ownership groups in Models A and B. Thus, the choice of profit efficiency measures does not affect the ranking of ownership groups obtained from both model specifications.

When OBS activities are accounted for in the output vector, foreign banks maintained higher profit efficiency than their domestic counterparts. This holds for both the distinct sub-periods and entire study period. Further, foreign banks are rated as most efficient in the first sub-period and the entire study period even in Model B. However, in Model B, the ranks are reversed in second sub-period, and PSBs group appeared as most profit efficient group. This restricts us to infer that inclusion or exclusion of OBS activities in the output specification does not seem to affect the ranking of FBs group in terms profit efficiency. Thus, the evidence for most recent years suggests that omission of OBS activities from the output specification understates the profit efficiency of foreign banks, and that changes their relative position in the group ranking.

A closer look at the results shows that the ranking of public sector banks also improved in Model A in the second sub-period, and the overall ranking of ownership groups emerged as FBs>PSBs>PBs in the latter sub-period against FBs>PBs>PSBs in the former sub-period. The observed change in the ranking of PSBs group may be attributed to the fact that after overcoming the initial shock introduced by deregulation, many PSBs took the lead in improving the quality of

their services thereby generating revenues in the second sub-period. Also, during this period, PSBs evolved policies aimed at 'resizing' and 'redeployment' of the surplus staff either by way of retraining them and giving them alternate employment or by introducing a 'voluntary retirement scheme (VRS)' with appropriate incentives. Due to aforementioned revenue enhancing and cost reducing efforts, PSBs group maintained higher profit efficiency than private banks in the second sub-period.

Table 10: Ordering of ownership groups under different model specifications

	PE1		PE2		PE3	
Period	**Model A (with non-interest income)**	**Model B (without non-interest income)**	**Model A (with non-interest income)**	**Model B (without non-interest income)**	**Model A (with non-interest income)**	**Model B (without non-interest income)**
First period	FB>PB>PSB	FB>PB>PSB	FB>PB>PSB	FB>PB>PSB	FB>PB>PSB	FB>PB>PSB
Second period	FB>PSB>PB	PSB>FB>PB	FB>PSB>PB	PSB>FB>PB	FB>PSB>PB	PSB>FB>PB
Entire period	FB>PSB>PB	FB>PSB>PB	FB>PSB>PB	FB>PSB>PB	FB>PSB>PB	FB>PSB>PB

Source: Author's calculations

Overall, the results suggest that in recent years, the efficiency estimates of foreign banks are not only undervalued, but their ranking as a group is also affected if a proxy for OBS activities is not included in the chosen output specification. Moreover, PSBs group appear as more profit efficient than FBs and PBs groups if non-interest income is not included in the output vector. The aforementioned results thus reconcile to some extent the contrasting findings in the empirical literature pertaining to profit efficiency of foreign banks relative to their domestic counterparts.

7. Conclusions and directions for future research

Since the advent of banking reforms in 1992, banks' responses to the changing nature of the operating environment have resulted in changes in the structure of their financial accounts and are mainly reflected in the increase of off-balance sheet activities. Using the nonparametric data envelopment analysis (DEA) methodology, this paper attempts to investigate not only the extent to which the inclusion of a proxy for OBS activities in the output definition of banks affects the estimated cost, technical and allocative efficiency scores, but also examines how the relative ranking of distinct ownership groups varies in the Indian banking industry. The empirical results enable us to draw the following conclusions.

First, the omission of non-interest income as a proxy for OBS activities significantly understates cost, technical and allocative efficiencies of Indian banking industry. Second, the inclusion of OBS activities in the output specification has significantly affected the ranking of the individual banks in each year of the study period. Third, the model which omits OBS activities understates efficiency of distinct ownership groups albeit with different magnitudes. The efficiency of the foreign banks rises to a large extent in comparison of the public and private sector banks when non-interest income is included in the output specification. Fourth, from the analysis of ranking of ownership groups, we conclude that the public sector banks are more efficient than the private and foreign banks if non-interest income as a proxy for OBS activities is not included in the output vector. However, when this proxy is accounted for in the output specification, the foreign banks turn to be more efficient than the public and private sector banks. Thus, the inclusion of OBS activities not only improves the efficiency of foreign banks to a large extent but also changes their relative position in the group ranking.

Summing up, we observe that in contrast to the standard specification of intermediation approach, the efficiency of Indian banks rise significantly when OBS output is included in the

output vector, and there exists significant relative movement of banks and ownership groups with regard to rankings when OBS activities are accounted for. Thus, we can safely infer on the basis of empirical findings that OBS activities are totally relevant in an analysis of the efficiency of Indian banks, and these activities should be included as one of the outputs in the studies on banking efficiency, particularly aiming at the comparison of the performance among distinct ownership type institutions. Overall, the results of this paper reinforce the prevailing view in the extant literature that the exclusion of OBS activities causes misspecification of banks' output, and may distort the efficiency estimates.

The future research could extend our work in various directions which have not been considered in this study. First, the parametric Stochastic Frontier Analysis (SFA) method of estimating the efficiency frontier could be used along with the non-parametric DEA technique that has been used in this paper to test the robustness of the results. Second, one could also investigate the impact of inclusion or exclusion of a proxy for OBS activities in the output specification on the total factor productivity (TFP) growth and its components in Indian banking industry. This could yet be another extension to the paper.

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Appendix A

Kendall's rank correlation test

The Kendall rank correlation coefficient (τ) is a non-parametric rank order which provides a distribution free test of independence i.e., no assumptions related to the distribution. It is used for measuring the degree of correspondence between the rankings of individual units based on two sample observations. Kendall tau represents a probability, that is, it is the difference between the probability that in the observed data the two variables are in the same order versus the probability that the two variables are in different orders. Unlike Spearman's correlation coefficient (*r*) can be thought of as the regular Pearson product moment correlation coefficient, that is, in terms of proportion of variability accounted for, except that *r* is computed from ranks (Siegel and Castellan, 1988)[4]. Thus, Kendall's tau improves upon Spearman's *r* by reflecting the strength of the dependence between two variables. Kendall's correlation test is used for testing the null hypothesis that

$H_o : \tau = 0$ (There is no correlation between the ranked pairs)

$H_1 : \tau <> 0$ (The ranked pairs are correlated)

In order to compute Kendall's τ statistics, consider two samples, *x* and *y*[5], each of size *n*. For each pair of observations, we note whether the observations are ordered in the same way (a concordant pair), ordered in opposite ways (a discordant pair), or equal for one of the variables and so not ordered at all (a tied pair). Let the number of concordant pairs (ordered the say way) are denoted by n_c, the number of discordant pairs (ordered in opposite way) by n_d, and the difference, $n_c - n_d$ by *S*. The total number of possible pairings of *x* with *y* observations is $n(n-2)/2$ pairs altogether. Then, Kendall's tau (τ) correlation coefficient is the proportion of the concordant pairs minus the proportion of discordant pairs and is given by:

$$\tau = \frac{n_c - n_d}{n(n-2)/2} = \frac{S}{n(n-2)/2}$$

The statistical significance of the Kendall's coefficient τ is tests by the *Z*-test, at 5% level of significance. The value of $\tau = 1$ implies that the agreement between two rankings is perfect, $\tau = -1$ implies that one ranking is the reverse of the other, and $\tau = 0$ implies that two rankings are independent.

When there are no ties, $n_c - n_d = n(n-2)/2$. In the presence of ties the statistic τ_b is given as a variant of τ adjusted for ties (Kendall, 1970). We now define τ_b as:

$$\tau_b = \frac{S}{\sqrt{\left(n(n-1)/2 - \sum_{i=1}^{t} t_i(t_i-1)/2\right)\left(n(n-1)/2 - \sum_{i=1}^{u} u_i(u_i-1)/2\right)}}$$

where t_i is the number of observations tied at a particular rank of *x* and u_i is the number of observations tied at a rank of *y*.

[4] Siegel, S. and Castellan Jr, N. J. (1988), Nonparametric statistics for the behavioral sciences, 2nd edition. London: McGraw-Hill.

[5] Two samples of efficiency scores obtained from Model A (with non-interest income) and Model B (without non-interest income).

Note that if there are no ties, $\sum t(t-1)/2 = \sum u(u-1)/2 = 0$, so $\tau_b = \tau$. When the rankings are identical $\tau_b = 1$, no matter how many ties there are.