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Abstract

To investigate the association between return to scale (RTS) and profitability in the United Kingdom banking sector, we adopted logistic regression analysis, using sample sizes of 135, 140, and 121 banks for the years 2016, 2015, and 2014, respectively. Our findings indicate a positive and statistically significant association between profits as measured by return on assets (ROA) and increasing RTS during the three years of the sample period. We also investigated the relationship between bank size as represented by the log of total deposits and RTS. Our findings also indicate that bigger banks show increasing RTS, but with decreasing rate, as represented by the negative coefficient of the square of the log of deposits. To investigate further the link between bank size and operating cost with ROA, we employed panel data regression, covering the sample period (2011-2016) for the largest 25 banks. Our results show that there is a positive and significant association between ROA and the total assets of the largest banks, but the operating expenses impact negatively on the ROA. More specifically, 1% increase in total assets increase ROA by 2, and 1% increase in the operating expenses reduce ROA by 1.7%. These results imply that bigger banks in the United Kingdom's banking sector are able to gain competitive edge in attracting deposits as they operate along the downward sloping portion of average operating cost curve.

Keywords: Competitive advantage; Banks; United Kingdom.

1. INTRODUCTION

The dominance of bigger banks in the banking industry is due to increasing return to scale (RTS) that gives bigger banks competitive advantage in cost minimization compared to their smaller counterparts. The competitive edge of bigger banks over smaller banks is because bigger banks can finance large projects of higher risk for the sake of higher profits (Tianxi, 2015). On the other hand, smaller banks are restrained by their financial capacity to finance bigger projects of higher profits potential.

The most factor that helps in increasing RTS in the banking sector is the expertise gained by bigger banks in screening profitable investment projects as well as reducing default loans. Once such screening expertise is obtained, then the bigger the bank, the higher its lending capacity and higher the gains obtained.

Another feature enhancing profitability of bigger banks is the homogeneity of banks financing products that enable them to benefit from the competitive environment in the banking sector. This is because on the banks' balance sheet side, a borrower business firm prefers funding by a bigger bank with better expertise to enhance the quality of its investment project in the market. On the liability side, bigger banks compete better for public funding because they are more trustworthy to investors as they can better diversify their portfolio investments and reduce risks.

As a result, small banks, with a low level of expertise, are disadvantaged in competition, as eventually they would be taken over by big banks or leave the business altogether. Consequently, the number of banks remaining in business declines continuously, but those that remain in business grow continuously bigger. As a result, the banking industry becomes dominated by a few big and highly leveraged banks.

There is a profound practical implication of the assertion that there is a significant association between banks' size and RTS. As commercial banks, by their nature, sell loans to investors, the competitive advantage of cost minimization of big banks can be advantageous to economic growth as it implies lower cost of financing investment projects.

The remaining parts of this paper are structured as follows. Section 2 highlights the literature review. Section 3 gives a brief review of the methodology of the research. Section 4 includes the empirical analysis, and the final section concludes the study.

2. LITERATURE REVIEW

This section summarizes a recent debate on the association of banks' size with RTS. For better illustration, we divide these studies into two categories. The first category includes those studies that find that larger banks are more efficient in cost minimization and thereby exhibit increasing RTS, whereas the second category sees that bigger banks may not necessarily be more efficient in cost minimization than smaller ones.

Wheelock and Wilson (2012) estimate a fully nonparametric cost function using data from 1984 to 2006, and they employ two separate samples with over 850,000 observations each. They find a positive association between a bank's size and increasing RTS, implying that large banks have a cost advantage over smaller ones. Hughes and Mester (2013) estimate a risk-adjusted, almost ideal demand system with cross-sectional data from 2003, 2007, and 2010. Their finding revealed that if risk preferences of managers are unaccounted-for, there is little evidence of the association between banks' size and RTS. However, if risk preferences of managers are included, then there is a significant association between banks' size and RTS. They conclude that any study that fails to account for risk-taking behavior of managers may be misleading to indicate significant association of banks' size with RTS. They go on to add that large banks enjoyed superior diversification benefits and cost savings from large information systems. Although their work was robust to the inclusion and exclusion of various bank sizes, one must be cautious about introducing additional variables in an effort to estimate RTS.

Kumar (2013) suggests that failing to account for market power will result in RTS estimates that are biased upward, and that could lead to the misleading conclusion of a positive correlation between profitability and bank size. Hughes and Mester (2013) estimate a static model using data from 2003, 2007, and 2011 and find a positive association between bank size and increasing RTS. In a more recent study, Babihuga and Spaltro (2014) find evidence that large financial institutions enjoyed considerable cost advantages. A research paper from Clearing House (2011) finds that larger banks generate larger RTS, returns to scope, and innovate faster than smaller banks. Beccalli *et al*. (2015) studied 103 European banks from 2000 to 2011 using stochastic frontier analysis and translog cost function. They find that there are increasing RTS for banks with higher liquidity, equity capital, and too-big-to-fail (TBTF) status. Boot (2016) suggests that implicit or explicit government guarantees, such as TBTF, may give artificial advantages to size when competing against single business line competitors and smaller banks. Elsas *et al*. (2010) studied international banks from 1996 to 2008—they find evidence for economies of scope through revenue diversification. Feng and Serletis (2010) and Feng and Zhang (2012) find increasing RTS using a Bayesian output-oriented distance function. However, this method requires that inputs remain exogenous while outputs are endogenous. Restrepo-Tobón and Kumbhakar (2015) observe that this method violates the standard assumption in the literature that inputs are endogenous and outputs are exogenous.

On the other hand, there are a number of studies [Koetter and North (2013); Restrepo *et al*. (2013); Sarin and Summer (2016); Berger *et al*. (2009); and Boot (2016)] indicating that larger banks may not necessarily be more efficient than smaller banks. Feng and Zhang (2014) estimate a random stochastic output distance function that allows for heterogeneous technology. They find that from 1997 to 2010, technology was independent of bank assets—a large bank did not necessarily have better technology than a smaller bank.

Restrepo-Tobón and Kumbhakar (2015) estimate a nonparametric input distance function that requires the assumptions that outputs are exogenous and inputs are endogenous. They find evidence that small banks exhibit increasing RTS and others operated at constant or even decreasing RTS. According to their estimates, a reduction in the size of banks would have little detrimental impact on cost efficiency. Davies and Tracey (2014) studied large international banks using a translog cost function. Without adjustment, they find increasing RTS; however, they then adjust the interest expense for TBTF. This is done using corporate bond ratings. Once this TBTF implicit subsidy is accounted and using a sample of large international banks from 2001 to 2010, they find that RTS was constant. Miles and Sapci (2017) use a panel data model to estimate a translog and Fourier cost function for 198 commercial banks during the period from 1992 to 2014. They find that as bank size increases, RTS decreases.

3. METHOD(S)

A decision-making unit may be scale inefficient if it exceeds the most productive scale size (thus, experiencing decreasing RTS) or if it is smaller than the most productive scale size (thus, failing to take full advantage of increasing RTS). Fare *et al.* (1985) show that the source of scale inefficiency (increasing or decreasing RTS) may be found for each DMU by comparing the measures of technical efficiency found under the assumptions of constant RTS and variable RTS models indicated in the following input-oriented model:

$$Min\left\{\pi-\varepsilon\left(\sum_{i=1}^{m}S_i^{-}+\sum_{i=1}^{s}S_r^{+}\right)\right\} \tag{1}$$

subject to:

$$\sum_{j=1}^{n}\mu_j X_{ij}+S_j^{-}=\pi X_{io} \qquad i=1,2,..m \tag{2}$$

$$\sum_{j=1}^{n}\mu_j y_{rj}-S_r^{+}=y_{ro} \quad r=1,2,..s, \quad j=1,2,..n \tag{3}$$

$$\mu_j\geq 0 \quad \text{(VRT)} \tag{4}$$

$$\sum_{j=1}^{n}\mu_j=1 \quad (CRS) \tag{5}$$

$$\sum_{j=1}^{n}\mu_j\leq 1 \quad (NIRS) \tag{6}$$

$$\sum_{j=1}^{n}\mu_j\geq 1 \quad (NDRS) \tag{7}$$

where S_i^{-} and S_r^{+} are slack variables indicating, respectively, the inputs and the output restrictions.

The objective function in Equation (1) minimizes the input combination taking into account the constraints in Equations (2)-(7). The constraints in (2) stipulate that there is always a minimum set of input combination, which constitutes the benchmark for the inputs set. Equation (3) restricts that there is a maximum set of output combination, which represents the output frontier that no output of all decision-making units can exceed. Equations (4) to (7) stipulate respectively conditions of variable, constant, and decreasing returns to scale.

To assess the association between RTS and bank size in this paper, we employed logit regression that links the binary values estimated from Equations (1)-(7) with bank size variables in the logistic function[1]:

$$P(Y=1|X\beta)=\frac{\exp(X\beta)}{1+\exp(X\beta)}$$

where

$Y\ ddl =$ 1 at increasing RTS

$=$ 0 at decreasing RTS

$X =$ bank size indicators.

4. RESULTS AND DISCUSSION

The results in Table 1 indicate even though the difference between the mean profits of the big and small banks is not noticeable during the 3 years of the sample period but bigger banks show higher volatility

Table 1. Descriptive Statistics.

2016	X_1	X_2	X_3	**2016**	X_1	X_2	X_3
Largest 20 banks				**Smallest 20 banks**			
Mean	14.8	18.8	19.7	Mean	15.3	12	12.6
Std. dev.	3.26	1.62	1.19	Std. dev.	0.001	1.28	0.38
Min Max	1.26 16.25	13.9 20.9	17.9 21.5	Min Max	15.3 15.3	8.26 13	11.85 13.24
2015				**2015**			
Largest 20 banks				**Smallest 20 banks**			
Mean	15.3	18.4	20.2	Mean	15.4	11.9	12.7
Std. dev.	0.81	3.19	0.99	Std. dev.	0.007	1.5	0.43
Min Max	13.4 16.9	6.8 20.8	18.1 21.5	Min Max	15.4 15.4	7.8 13.2	11.8 13.4
2014				**2014**			
Largest 20 banks				**Smallest 20 banks**			
Mean	15.4	18.6	19.8	Mean	15.2	11.7	12.8
Std. dev.	6.2	1.8	1.1	Std. dev.	0.001	1.8	0.41
Min Max	13.7 16.7	13.9 20.8	17.9 21.4	Min Max	15.2 15.2	7.9 13.3	12.1 13.4

Note: X_1 = log (profit); X_2 = log(total deposits); X_3 = log(total assets).

1 The binary numbers generated by setting the number 1 for each of the DMUs exhibiting increasing return to scale and 0 for decreasing return to scale.

of profits compared to its smaller counterparts. This result is counterintuitive as bigger banks expected to have higher return on average and higher risk of earnings, given that earning volatility is appropriate measure of risk. Table 2 shows positive and statistically significant association between profitability as measured by return on assets (ROA) indicator and increasing RTS during the 3 years of the sample period (2014-2016). This result implies banks with higher profitability to exhibit increasing RTS or declining average cost. As a result they are able to gain competitive edge in attracting deposits compared to smaller banks which face higher average cost. In Table 3, we investigate the link between size, as represented by the log of total deposits of each bank and RTS. The relationship between bank size and increasing RTS reported in Table 3, indicate bigger banks show increasing RTS but with decreasing rate. In other words, as bank size increases, RTS increases, but with a decreasing rate, as indicated by the negative coefficients of the square of size indicator. The earlier mentioned results are based on logistic regression analysis on yearly basis. However, it is very important to take into account bank-specific factors when assessing the association between bank size and profit. To do so in Table (4)., we estimated the relationship between profits before tax of the largest 25 banks (in assets) and total deposits, and operating expenses, using panel data regression under fixed and random effects. As indicated in Table 3, given that the correlation between the explanatory variables and the bank-specific term (u) is zero, then the random effect specification becomes more appropriate. Results in Table 4 reveals that there is a significant positive association between profit and total deposits of the largest banks, but the operating expenses negatively impact on the profits of banks.

Table 2. Return to Scale and Profitability.

Variable	Coefficient	*t*-Ratio	Marginal effect
2016			
ROA	0.44	4.22	0.10
Constant	−1.09	−4.17	–
Log likelihood function (LLF)	−70.3	–	–
Estrella *R* sq Sample size = 135	0.33	–	–
2015			
ROA	0.098	3.1	0.02
Constant	−1.06	−4.7	–
LLF	−84.2	–	–
Estrella *R* sq Sample size = 140	0.08	–	–
2014			
ROA	0.31	3.68	0.07
Constant	−0.86	−3.48	–
LLF	−70.68	–	–
Estrella *R* sq Sample size = 121	0.21	–	–

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Table 3. Return to Scale and Bank Size.

Variable	Coefficient	t-Ratio	Marginal effect
2016			
S_1	5.85	3.85	1.04
S_2	−0.24	−4.23	−0.04
Constant	−33.56	−3.22	–
LLF	−52.82	–	–-
Estrella R sq Sample size =135	0.55	–	–
2015			
S_1	1.74	2.28	0.32
S_2	−0.078	−2.68	−0.014
Constant	−9.21	−1.84	–
LLF	−74	–	–
Estrella R sq Sample size = 140	0.21	–	–
2014			
S_1	1.16	1.21	0.27
S_2	−0.06	−1.74	−0.01
Constant	−3.94	−0.59	–
LLF	−63.81	–	–
Estrella R sq Sample size = 121	0.31	–	–

Note: S_1 = log of total deposits; S_2 = square of S_1

5. CONCLUSION

To investigate the association between RTS and profitability, we adopted logistic regression analysis, using sample sizes of 135, 140, and 121 banks for the years 2016, 2015, and 2014, respectively. Our findings indicate a positive and statistically significant association between profit as measured by ROA and increasing RTS during the 3 years of the sample period (2014-2016). This result implies that banks with higher profits exhibit increasing RTS. To check if bank size is associated with RTS, we investigated the link between size, as represented by the log of total deposits of each bank and RTS. Our results indicate a positive relationship between bank size and increasing RTS, implying that bigger banks show increasing RTS but with decreasing rate, as represented by the negative coefficient of the square of log of deposits. These findings imply that bigger banks are able to gain competitive edge in attracting deposits as they operate along the downward sloping portion of average cost curve.

To investigate further the link between bank size and operating cost with RTS, we adopted panel data regression under fixed and random effects, during the sample period (2011-2016) for the largest 25 banks, in total asset sizes. Here, we estimated the relationship between ROA and logs of total assets, and operating

Table 4. Profit and Bank Size (Panel Data Regression).

Fixed effect model				Random effect (ML regression		
Independent variables	Coefficients β_i	t	$p > \|t\|$	Coefficients β_i	z	$p > z$
X_{1i},	0.021 *	2.13	0.03	0.022 *	2.22	0.02
X_{2i},	−0.016	−1.54	0.12	−0.017 **	−1.67	0.10
α	−0.077 *	−3.01	0.00	−0.079 *	−3.11	0.00
No. of observations	143			143		
Corr(u_i, X)	0.04			Log likelihood	348	
F(2,134) $p > F$	4.20 0.01 –			LR Chi^2 (2) Prob > Chi^2	8.78 0.01	

*Significant at 5% sig level. **Significant at 10% sig level.
Y_{it} = Return on assets (dependent variable).
$X_{1i,t}$ = log total assets.
$X_{2i,t}$ = log operating expenses.

expenses. As the correlation between the explanatory variables and the bank-specific term (u) is turned out to be zero, then the random effect model has been chosen as more appropriate specification. As a result, our finding indicates that there is a significant positive association between profitability of banks and the log of total assets of the largest banks, but the operating expenses impact significantly and negatively on the profits. More specifically, 1% increase in the assets increases profits by 2, and 1% increase in the operating expenses decreases profits by 1.7%.

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Author Contributions
IAO was responsible for writing, estimation, analyzing results, and the final editing and reviewing of the manuscript. AA collected and organized the data. MMA reviewed the final draft of the manuscript.

Conflict of Interest
None.

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