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Measuring Competition using the Boone Relative Profit Difference Indicator: an application to Banking Systems in Emerging Economies

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Measuring Competition using the Boone Relative Profit Difference Indicator: an application to Banking Systems in Emerging Economies

Abstract

This paper suggests an operational method for implementing the theoretical relative profit difference test for intensity of competition due to Boone (2008). We use polynomial quantile regressions for which integral areas and their standard errors can easily be computed and compared using Wald tests. An empirical example is presented which applies the test to a panel data sample of banks in different emerging economies. The results indicate that the trend towards more intense competition amongst emerging economy banks continued during the period of the financial upheaval in 2005-2008, and that India and China among others were leading this process.
1 Introduction

There is considerable interest in measuring the strength of competition in different industries and much theoretical and empirical work has been devoted to this. One particular strand has emphasised that the intensity of competition alters the relationship between the profitability of different firms in a multi-firm oligopoly equilibrium. For example, Vickers (1995) argued that after new entry competition becomes harder for the inefficient firms. The essential argument is that output is reallocated towards more efficient firms when the intensity of competition increases. Boone (2008) has developed the idea of the output reallocation effect into a theoretical test of the intensity of competition based on the relationship of profitability and efficiency. This paper suggests an easy operational procedure for implementing this test. Subsequently the paper applies the suggested procedure to a panel data sample of banks in different emerging economies. The example is interesting in itself because of the way that efficiency and profitability are measured in the sample and because the results throw some light on the role of major emerging economy banking systems such as those of Brazil, China and India.

2 Theory

Boone (2008) has suggested a new approach to measuring competition. The context is an industry where firms can enter and compete and where firms may differ in efficiency. Initially the firms decide whether or not to enter the market and then, knowing which firms entered in the first stage, all firms choose strategically to maximise their after entry profits. A sub-game perfect equilibrium is identified in which the firm’s profits are related to the firm’s efficiency, and are conditional on a measure of the aggressiveness of the firms’ conduct in the market. Competition is intensified
by a change in conduct. Adapting the notation in Boone’s paper, let $\pi(E)$ denote the variable profit level of a firm with efficiency level $E$. Consider three firms with different efficiency levels and labelled as: $\text{max}(E) \geq E' \geq \text{min}(E)$. Calculate the following variable referred to as the inverse relative profit difference (RPD), symbolised here as $\rho$, i.e. the ratio of the difference between the profit of the typical firm and the profit of the least efficient firm relative to the difference between the profit of the most efficient and the profit of the least efficient firm:

$$\rho = \frac{[\pi(E') - \pi(\text{min}E)]}{[\pi(\text{max}E) - \pi(\text{min}E)]}$$

[1]

Then Boone (2008, p1246) argues that more intense competition (brought about by, for example, lower entry costs, market liberalization or more aggressive interaction among existing firms) lowers this variable for a broad set of models. The term $\rho$, the relative profit difference, falls as the intensity of competition increases. Boone’s comment is:

*The intuition for the relative profits measure is that in a more competitive industry, firms are punished more harshly for being inefficient.*

In this case the firm in the numerator of the inverse relative profit difference with profit: $\pi(E')$ has less of an efficiency advantage over the least efficient firm, with profit $\pi(\text{min}E)$, than does the firm in the denominator with profit: $\pi(\text{max}E)$; consequently as competition becomes stronger the numerator term is expected to fall proportionately more than the denominator. How can we proceed to use this measure? Two steps are implied in the Boone (2008) treatment:

**Step 1**: verify that in the sample in question, profits are positively related to efficiency of performance: $\pi'(E) > 0$. This is a critical assumption in the analysis.

**Step 2**: is to compute the expression $\frac{[\pi(E') - \pi(\text{min}E)]}{[\pi(\text{max}E) - \pi(\text{min}E)]}$ in order to determine how it
varies across competitive or regulatory environments and over time in order to measure which set of circumstances most closely resemble a competitive environment.

Given the validity of the basic assumption $\pi'(E) > 0$, Boone sketches a relationship between the relative profit difference, $\rho$ which he calls normalised profits and the corresponding normalised efficiency, symbolised here as $\eta$:

$$\eta = \frac{[E' - \text{min}E]}{[\text{max}E - \text{min}E]}$$

[2]

This relationship $\rho(\eta)$ must shift down for all values of the efficiency difference when competition becomes more intense. The test of competition is then straightforward Boone (2008, p1253):

> Once variable profits and efficiency or productivity . . . have been identified for firms in year $t$ in a certain industry, one can calculate normalised profits and efficiency. Plot normalised profits against normalised efficiency. For year $t+1$ a similar plot can be made. If the area under the curve is smaller in $t+1$ than it is in $t$, we say that competition has become more intense in year $t+1$

Boone uses a diagram like Figure 1 to illustrate the idea. Therefore, Boone represents an increase in competition intensity as a lower value for the integral under the curve of the plot: $\rho(\eta)$, i.e.: $\int_0^1 \rho(\eta)d\eta$ . Boone’s suggested test is therefore a visual or sign criterion; in an analytical model the visual comparison of the areas under the relative profit difference plots, or the sign of their difference is sufficient to determine the relative intensity of competition.

**INSERT FIGURE 1 HERE**

In principle therefore the test is straightforward except that we require a means of comparing the areas under sample scatters of points, i.e. empirical distributions
rather than theoretical curves. It is also the case that the discriminating index amongst different competitive regimes need not exclusively be related to time, \( t \); it could just as easily refer to different countries or regions, or industrial sectors. For example in an industry panel data case study we could write \( E_{it} \) as the measured cost efficiency of firm \( i \) at time \( t \). Following Boone (2008) we rank the efficiency scores for a related group of firms from highest \( maxE_{it} \) to lowest: \( minE_{it} \) and normalising the efficiency scores, we construct the following sample points.

\[
\eta_{it} = \frac{[E_{it}' - minE_{it}]}{[maxE_{it} - minE_{it}]} \quad i = 1 \ldots N, \ t = 1 \ldots T
\]  

This variable measures for each firm observation, the relative cost efficiency compared to the least efficient firm and normalised by the range of efficiency scores. Associated with each of these relative efficiency scores will be a relative profit difference observation:

\[
\rho_{it} = \frac{[\pi(E_{it}') - \pi(minE_{it})]}{[\pi(maxE_{it}) - \pi(minE_{it})]} \quad i = 1 \ldots N, \ t = 1 \ldots T
\]  

The visual or sign version of the test suggested by Boone therefore is given by the sign of the difference in the definite integrals computed for two different competition regimes, A and B:

\[
\hat{\Delta} = \int_{0}^{1} \hat{\rho}_{it}^A (\eta_{it}) \, d\eta - \int_{0}^{1} \hat{\rho}_{it}^B (\eta_{it}) \, d\eta = 0
\]  

### 3 Sample procedure

The issue now is how to proceed in a sample context. The underlying efficiency scores could be computed by stochastic frontier analysis of the firms’ cost function (Kumbhakar and Lovell, 2003). The profit data could be the reported return on cap-
ital of each firm, or, for example, the shadow return on capital estimated from the short run cost function as suggested by Braeutigam and Daughety (1983). Whatever method is used, the basic data are firm observations on a measure of efficiency, $E$ and a measure of profitability, $\pi$. Compute the plot for our sample for all $(\eta_{lt}, \rho_{lt})$ observations pooled together. The problem is how to unbundle from this pooled sample the relationship corresponding to different competition regimes. We note as well that, although in the theoretical model both of the terms will lie in the unit interval by definition, in the sample data it is only $\eta_{lt}$ that is constructed to lie in the unit interval; there is no definitional constraint on the sample values for $\rho_{lt}$. In particular, individual firm profitability measures may be negative, thereby causing individual $\rho_{lt}$ observations to lie outside the unit interval. This is why it is important to complete the check in step 1, i.e. that measured profitability is positively related to efficiency, $\pi'(E) > 0$. How can we find a sample procedure for implementing the theoretical Boone (2008) test of competition? Several procedures could be possible with the aim of separating out circumstances where the paired observations under one competition regime lie mostly or entirely below the observations for a different competition regime. A desirable feature of the sampling procedure is that it should not be seriously affected by outliers. This suggests an approach based on least absolute deviations rather than least squared residuals. Consequently we suggest that an effective way of implementing the Boone (2008) test is the use of polynomial quantile regression analysis. Since a quantile regression is an empirical integral, it is appropriate to use it to estimate a theoretical integral concept.

A quantile regression is based on the parameter: $q$, which is the researcher’s chosen probability level for isolating the proportion of the sample lying on or below the quantile regression line. The choice is a compromise between inclusivity of sample points and avoidance of undue outlier impact. Fitting a quantile regression
at the third quartile for a given selection of sample points for example ensures that 75 percent of those sample points lie on or below the fitted line. We need to choose an appropriate functional form to represent the quantile regression and we have suggested a polynomial to approximate the theoretical relationship between the inverse relative profit difference and the normalised cost efficiency.

For example, if \( q = 0.75 \), and \( M = 2 \), then we isolate each competition regime by fitting the quadratic quantile regression at the third quartile. The polynomial functional form has a useful property relating to the objective of the Boone (2008) test since the polynomial quantile regression produces an integral which is a linear function of the quantile regression coefficients. This makes it easy to measure the part of the pooled sample that lies below the theoretical relationship between \( \rho_{it} \) and the horizontal axis \( \eta \). In other words we are interested in computing an integral over the unit interval representing:

\[
\int_0^1 \left[ \sum_{m=1}^M \alpha_m (\eta_{it})^{m-1} \right] d\eta = \sum_{m=1}^M \left( \frac{\hat{\alpha}_m}{m} \right) = h' \hat{\alpha}
\]

Here the \( \hat{\alpha}_m \) terms are the estimated coefficients from the quantile regression. In this expression, the vector \( h' \) is given by: \( (1, \frac{1}{2}, \ldots, \frac{1}{M}) \).

If the size of this integral differs for different clusters of sample points, then we say that the competition regime differs in intensity between those sample points. The integral of the polynomial quantile regression over the unit interval therefore has a simple form to calculate, and since we know the variance matrix of the estimated coefficients: \( \hat{\alpha}_m \), we can also compute the standard error of this integral:
\[ SE\left( \int_0^1 \left[ \sum_{m=1}^M \alpha_m(\eta_{it})^{m-1} \right] d\eta \right) = \left( h' \text{var}(\hat{\alpha}) h \right)^{1/2} \]  

So far we have established a simple procedure for implementing the Boone measures and their standard errors. Ideally we would like to evaluate the Boone measure by testing for two different competition regimes (B: before or benchmark and A: after or alternative). If we impose the same degree of polynomial on the A and B competition regimes then the hypotheses are:

\[ H_0 : \Delta = \int_0^1 \left[ \sum_{m=1}^M \alpha_m^A(\eta_{it})^{m-1} \right] d\eta - \int_0^1 \left[ \sum_{m=1}^M \alpha_m^B(\eta_{it})^{m-1} \right] d\eta = 0 \]  

\[ H_1 : \Delta \neq 0 \]  

This can be tested simply by the use of intercept and slope dummy variables applied to the pooled sample. Create:

\[ D_{it} = \begin{cases} 
0 : & i, t \in B \Rightarrow \alpha^B = \alpha \\
1 : & i, t \in A \Rightarrow \alpha^A = \beta + \alpha 
\end{cases} \]  

The polynomial quantile regression with these dummy variables is:

\[ Pr\left( \rho_{it} \leq \sum_{m=1}^M \alpha_m(\eta_{it})^{m-1} + \sum_{m=1}^M \beta_m (\eta_{it})^{m-1} \times D_{it} \right) = q \]  

Then, for the benchmark and the alternative regimes, we test: \( H_0 : \Delta = h'\beta = 0 \) against: \( H_1 : \Delta \neq 0 \).

This is tested by a classical linear restriction on the regression coefficients: \( \hat{\beta}_m \).
We compute the following Wald statistic from the pooled sample regression with the dummy variable representing the alternative regime:

\[
W = \left( h' \hat{\beta} \right) \left[ \left( h \left( \text{var} \left( \hat{\beta} \right) \right) h' \right) \right]^{-1} \left( h' \hat{\beta} \right)
\]  

[12]

Then under the null hypothesis, where \( r \) is the number of restrictions, (one in this case):

\[
\left( \frac{1}{r} \right) W \sim F \left( r, NT - K \right)
\]  

[13]

The researcher may choose the values of \( q \) and \( M \) to generate the probability criterion for the quantiles and the degree of the fitted polynomial by finding the combination which best fits the sample.

4 Illustrative example: banks in emerging economies

We illustrate the operational test procedure with an example that is of policy interest in itself: the performance of banking systems in different emerging economies over the period 2005-2008. This is a period of both financial upheaval and changing circumstances of competition as the major emerging economies developed the international links in their banking systems. We work with a sample of 485 banks in 34 emerging economies over the period 2005-2008; the banks chosen are the largest in each country and passed a basic filter test that deposits exceeded loans in order to focus on the commercial banks in the sample. The sample was collated from the Bankscope database. Table 1 reports the coverage of the data, in the first three columns (the fourth and fifth columns are considered later); the data have all been converted to constant price (year 2000) values by deflating the $US denominated data converted at market exchange rates by the US GDP deflator. 

INSERT TABLE 1 HERE
Using the variables: bank costs, \( C \), bank outputs, \( y \), i.e. loans, securities and off-balance sheet income, input prices, \( w \), i.e. price of funds, labour and fixed assets, bank equity capital \( e \), and time \( t \), we computed a stochastic frontier analysis efficiency measure by estimating the short run total cost function \( c^s \). This short run cost function combines fixed and variable costs, treating bank capital as a non-discretionary input with unobserved price of equity capital, \( w_0 \), so that:

\[
c^s(y, w, e_0, t) = w_0e_0 + c^{v}(y, w, e_0, t)
\]

\[
\ln C_{it} = \ln c^s(y, w, e_0, t)_{it} + \nu_{it} + \mu_{it}
\]  

[14]

The error component model includes idiosyncratic error \( \nu_{it} \) and inefficiency component \( \mu_{it} \), see Kumbhakar and Lovell (2003) for further details on these models. In our example of a panel of banks in different emerging countries we have derived cost efficiency measures for each bank \( i \) in each country at time \( t \), and we have done this for a range of different efficiency measurement methodologies and measures of profitability, such as net interest margin, return on assets, return on equity and shadow return on equity capital estimated from the cost function. Using the analysis in Braeutigam and Daughety (1983) the shadow price of equity capital is:

\[
-\frac{\partial c^v(y, w, e_0, t)}{\partial e} = w_0,
\]

since the envelope theorem requires that \( \frac{\partial C}{\partial e} = 0 \) in the neighbourhood of the tangency of short run cost function and the long run cost function. From the fitted short run cost function, therefore we interpret the elasticity of cost with respect to equity capital as the shadow return on equity. There is a strong argument for using this measure of profitability in the case of competing banks since it reflects the banks’ attitude to the riskiness of their loan portfolios. They will be expected to hold more equity the more risky is the loan portfolio. The weak disposability property of the translog cost function allows the estimated shadow return on equity to turn negative when a bank is constrained to hold equity capital well in
excess of the cost minimizing level indicated by the long run expansion path.

We used four different measures of profitability in the sample of emerging economy banks used here: net interest margin (NIM) return on assets (ROA), return on equity (ROE) and shadow return on equity (SROE) estimated from the short run cost function. We experimented with a number of different stochastic frontier analysis models as described in Kumbhakar and Lovell (2003) with relatively consistent results across a wide range of specifications. The measured efficiency results used in the competition test reported here were generated by the specifications:

\[ \nu_{it} \sim N\left(0, \sigma^2_{\nu}\right), \mu_{it} \sim N\left(0, \sigma^2_{\mu_{it}}\right), \sigma^2_{\mu_{it}} = z_{it}' \gamma, \]  

where \( z_{it}' \) includes time \( t \), and banking system and macroeconomic variables corresponding to each emerging economy. The cost efficiency measure is:

\[ E_{it} = \exp\left(-E[\mu_{it}|\tilde{e}_{it}]\right) \]  

which is conditional on the maximum likelihood residuals, \( \tilde{e}_{it} \).

Therefore for step 1 of the procedure, we tested the basic assumption \( \pi'(E) > 0 \) with a reduced form regression applied to a single pooled sample that includes all of the different possible competition and regulatory regimes. In each case a pooled regression suggested a significant positive relationship from efficiency to profitability as required by the Boone argument.

\[ \pi_{it} = a + bE_{it} + Z_{it}'c + \epsilon_{it} \]  

[15]

The dependent variable is one of the profitability measures, the term \( E_{it} \) is a measure of cost efficiency derived from the inefficiency component of the random error in the stochastic frontier analysis of the short run cost function . The \( Z_{it}' \) variables for the reduced form profit regression comprise a range of banking system and macroeconomic variables for the country in question, as shown in Table 2. The
The basic assumption is tested by: \( H_0 : b = 0 \) against \( H_1 : b > 0 \). The sample for this test is pooled because the proposition that higher efficiency raises profitability is assumed to be true whatever competitive or regulatory regime is in place. All four profitability measures showed a positive relationship with measured efficiency, with the shadow return on equity showing the strongest significant result. Table 2 reports the results for step 1 of the analysis, and confirms that for four different profitability measures a positive relationship exits with efficiency, although it is not statistically significant in one of these cases.

### INSERT TABLE 2 HERE

We then proceeded to step 2 by sorting and normalising the data on measured profitability, \( \pi \) and measured efficiency, \( E \), in order to calculate the normalised efficiency and the relative profit differences for the sample: \( (\eta_{it}, \rho_{it}) \), as shown in equations [3] and [4] allowing us to calculate the difference in integrals in equation [5]. Any of the profitability measures used here will suffice in principle, but we illustrate our results with the shadow return on capital measure, which Table 2 suggests bears the closest relationship to efficiency\(^1\). We then estimated the quantile regressions and carried out the Wald test shown in equations [11] and [12]. The results are summarised by presenting the probability values corresponding to the Wald test on the hypotheses shown in equation [9]:

Table 3 presents the result\(^2\) for the test suggested in the equation from Boone (2008, p1253): a time-wise comparison of the first half of the sample period with the second half. The results indicate in our sample that the second period exhibited greater intensity of competition in the banking industries of emerging economies than the earlier period. After experimenting with different values for \( M \), i.e. the

\(^1\)Since the shadow return on equity capital can be negative, it is vulnerable to the existence of measured relative profit difference figures that lie outside the unit interval.

\(^2\)All estimations and graphs have been implemented with the STATA software application.
degree of the polynomial quantile regression and choosing a quantile values of 0.75 to compromise between inclusivity and avoidance of outliers, we find statistically significant fits for both of the quadratic quantile regressions. The null of $H_0: \Delta = 0$ is rejected with a $p$-value of 0.0001. In Figure 2, we illustrate these quantile regressions at the third quartile showing clearly the different integral areas identified in the Boone test. In each case the curve is the upper bound on 75 percent of the sample points in the corresponding category: 2005-6 (lighter curve) or 2007-8 (darker curve).

The effectiveness of the test in distinguishing different periods of competition intensity suggests applying it to the differences among the competition regimes in different countries in the sample. Accordingly, returning to Table 1, we present in the fourth column the outcome of the visual or sign version of the Boone test, i.e. the sign of $\hat{\Delta}$ for each country in the sample in a comparison of its competition intensity versus the remaining emerging economies from the pooled data over all years. Again we fitted quadratic quantile regressions at the third quartile for each country in turn and compared these with the quadratic quantile regression for the remaining emerging economies. If $\hat{\Delta}$ is negative then the country in the comparison has a computed relative profit difference integral that is lower in value than that for the whole sample of emerging economies and therefore displays a greater intensity of competition in its banking industry. The reverse is the case if $\hat{\Delta}$ positive. In the last column of Table 1 we present the Wald test for the hypothesis that the difference in integrals is zero.

For example, taking the 2.5 percent tail on the F-distribution as the cut-off, we find that the countries where the banking system is more intensely competitive
than the remaining emerging economies are: Bolivia, China, Croatia, Czech Republic, Slovenia, Greece, Hong Kong, India, Indonesia, Philippines and Turkey. On the other hand, countries which are significantly less intensely competitive than the emerging economies as a whole are Argentina and Latvia. The group of 11 countries with relatively more intense competition than the other emerging economies include three emerging economies in the European Union and the European single currency, together with two candidate countries. Despite the crisis of sovereign debt, banks in the European Union operate in an environment of the single market cross-border competition, although Latvia appears to be the exception. Turkey, a candidate country, had, moreover, by the beginning of this sample period already been subject to intense banking reform under IMF guidance, together with interbank mergers and consolidation with the purpose of eradicating the insolvent fringe banks.

Only one country from South America, i.e. Bolivia, is present in the group while Brazil, although it passes the sign test of more intense competition, is excluded in this period from the group of relatively intensely competitive countries on the basis of the Wald test. The case of Bolivia is perhaps surprising since during the sample period there was considerable re-nationalization of its energy industries, but nevertheless the banking system appears to have been relatively more competitive compared with other emerging countries. No countries from the Middle-East or Africa are included in the list of countries with relatively more intensely competitive banking sector compared to other emerging economies. The remaining group of five countries that are also present are the strong emerging economies of Asia, notably China, Hong Kong and India. China is known to have significantly recapitalized and

\[3\text{If the 1 percent tail of the F-distribution is used as a criterion, India, Indonesia and Turkey leave the list of the more intensely competitive banking systems and Latvia leaves the less intensely competitive list.}\]
reformed its banking system in the lead up to joining the WTO, while India has followed a reform programme for a number of years as Casu et al. (2012) indicates.

In figures 3 and 4 we illustrate the Boone integral plots for two key emerging economy banking systems: Brazil and Hong Kong; these demonstrate the visual aspect of the Boone sign test. In each case the country in the comparison is shown as the darker curve and the rest of the sample of emerging economies is shown as the lighter curve. In the case of Brazil, the plotted curves overlap and although the sign test, $\hat{\Delta} < 0$, indicates relatively more intense competition than the average, the Wald test fails to reject the null hypothesis of no difference in the integrals. In the case of Hong Kong, the integrals are clearly different in area and this is reinforced by the Wald test.

These outcomes indicate therefore the viability of using the quantile regression procedure to calculate the theoretical relative profit difference integrals suggested by Boone (2008) as a basis for measuring the intensity of competition. The quantile regression approach facilitates both Boone’s visual sign test and a Wald test of no difference in the integrals.

5 Conclusion

Boone (2008) suggests a new test for measuring the intensity of competition from firm level data on relative profitability and relative efficiency. The test requires the comparison of integrals based on sample data. The first half of this paper demonstrates a quantile regression procedure for implementing the Boone test of whether the computed relative profit difference integrals for two different competition regimes
differ significantly. Subsequently, the second half of the paper applies the suggested test procedure to a panel data sample of banking systems in a group of emerging economies over the period 2005 to 2008, where the efficiency measures are based on stochastic frontier analysis of a capital constrained cost function fitted to this sample. Boone’s relative profit difference measures and normalised efficiency measure are calculated from the empirical results and then quantile regressions of relative profit difference against normalised efficiency are calculated. These quantile regressions, which correspond to probability integrals, are used to measure the theoretical integrals required for the Boone test. Two broad conclusions are found: intensity of competition in this sample of emerging economies increased during the period, and a group of emerging economies were identified as leading this trend towards more intense competition. The group included countries in the European Union and the strongly developing Asian economies, notably Hong Kong, China and India.
References


Figure 1: The theoretical relationship between normalised profit (relative profit difference) and normalised efficiency, based on Boone (2008) figure 2, p. 1252
Figure 2: All sample
Figure 3: Brazil v emerging economies
Figure 4: Hong Kong v emerging economies
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<td>LITHUANIA</td>
<td>24</td>
<td>$-$</td>
<td>0.5571</td>
</tr>
<tr>
<td>22</td>
<td>PERU</td>
<td>36</td>
<td>$+$</td>
<td>0.3168</td>
</tr>
<tr>
<td>23</td>
<td>PHILIPPINES</td>
<td>80</td>
<td>$-$</td>
<td>0.0000**</td>
</tr>
<tr>
<td>24</td>
<td>POLAND</td>
<td>68</td>
<td>$-$</td>
<td>0.0289</td>
</tr>
<tr>
<td>25</td>
<td>ROMANIA</td>
<td>68</td>
<td>$-$</td>
<td>0.3216</td>
</tr>
<tr>
<td>26</td>
<td>SLOVAKIA</td>
<td>40</td>
<td>$+$</td>
<td>0.38</td>
</tr>
<tr>
<td>27</td>
<td>SLOVENIA</td>
<td>48</td>
<td>$-$</td>
<td>0.0000**</td>
</tr>
<tr>
<td>28</td>
<td>SOUTH AFRICA</td>
<td>32</td>
<td>$+$</td>
<td>0.141</td>
</tr>
<tr>
<td>29</td>
<td>TAIWAN</td>
<td>52</td>
<td>$+$</td>
<td>0.0609</td>
</tr>
<tr>
<td>30</td>
<td>THAILAND</td>
<td>64</td>
<td>$-$</td>
<td>0.0755</td>
</tr>
<tr>
<td>31</td>
<td>TURKEY</td>
<td>48</td>
<td>$-$</td>
<td>0.0110**</td>
</tr>
<tr>
<td>32</td>
<td>UKRAINE</td>
<td>104</td>
<td>$-$</td>
<td>0.6587</td>
</tr>
<tr>
<td>33</td>
<td>UNITED ARAB EMIRATES</td>
<td>44</td>
<td>$-$</td>
<td>0.0467</td>
</tr>
<tr>
<td>34</td>
<td>VENEZUELA</td>
<td>64</td>
<td>$+$</td>
<td>0.3385</td>
</tr>
<tr>
<td></td>
<td>** Total</td>
<td>1940</td>
<td></td>
<td>** $p$-value &lt; 0.025</td>
</tr>
</tbody>
</table>

Table 1: emerging economies and the test of the relative intensity of competition $\hat{\Delta} = \int_0^1 \hat{\rho}^A_{it} (\eta_t) \, d\eta - \int_0^1 \hat{\rho}^B_{it} (\eta_t) \, d\eta = 0$ A: country in comparison; B: emerging economies.
### Step 1: Reduced form profit regressions with robust standard errors: pooled sample, NT=1786

<table>
<thead>
<tr>
<th>Variable</th>
<th>NIM</th>
<th>ROA</th>
<th>ROE</th>
<th>%ROE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost Efficiency</td>
<td>2.83243**</td>
<td>1.28909*</td>
<td>8.70308</td>
<td>0.13772***</td>
</tr>
<tr>
<td>Loans/assets</td>
<td>-0.02410*</td>
<td>-0.02363***</td>
<td>-0.20024</td>
<td>0.00067**</td>
</tr>
<tr>
<td>Loans/deposits</td>
<td>0.00284</td>
<td>0.00801***</td>
<td>0.03664*</td>
<td>-0.00098***</td>
</tr>
<tr>
<td>Liquid-assets/ST funding</td>
<td>0.01228*</td>
<td>0.00966***</td>
<td>-0.00117</td>
<td>-0.00043***</td>
</tr>
<tr>
<td>Reserves/non-performing loans</td>
<td>-0.00022***</td>
<td>-0.00003</td>
<td>0.00002</td>
<td>0.00002***</td>
</tr>
<tr>
<td>non-interest expenses</td>
<td>-0.05141***</td>
<td>0.00522</td>
<td>0.18795</td>
<td>0.00081***</td>
</tr>
<tr>
<td>Non-performing loans</td>
<td>0.01928</td>
<td>-0.01205*</td>
<td>-0.33101***</td>
<td>-0.00024</td>
</tr>
<tr>
<td>Non-performing loans relative to country average</td>
<td>0.04207**</td>
<td>-0.04400***</td>
<td>-0.48230***</td>
<td>0.00049</td>
</tr>
<tr>
<td>Capital assets relative to country average</td>
<td>0.29810***</td>
<td>0.04499**</td>
<td>-0.67187***</td>
<td>-0.00172**</td>
</tr>
<tr>
<td>Per-Capita-GDP growth constant</td>
<td>0.02589</td>
<td>0.03318**</td>
<td>0.52325***</td>
<td>0.00320***</td>
</tr>
<tr>
<td>R2 (adj. df)</td>
<td>1.57498*</td>
<td>0.23407</td>
<td>15.31148*</td>
<td>-0.13500***</td>
</tr>
<tr>
<td>F value</td>
<td>36.13985***</td>
<td>12.07434***</td>
<td>8.5422***</td>
<td>44.88935***</td>
</tr>
</tbody>
</table>

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 2: The relationship between profitability measures and cost efficiency
relative profit difference (RPD), $\rho$, quadratic quantile regression at the third quartile

<table>
<thead>
<tr>
<th>Estimates</th>
<th>2005-6</th>
<th>2007-8</th>
</tr>
</thead>
<tbody>
<tr>
<td>constant</td>
<td>3.222***</td>
<td>2.034***</td>
</tr>
<tr>
<td>Normalised efficiency, $\eta$</td>
<td>4.415***</td>
<td>6.972***</td>
</tr>
<tr>
<td>Normalised efficiency squared, $\eta^2$</td>
<td>-2.413**</td>
<td>-4.562***</td>
</tr>
<tr>
<td>Boone relative profit difference integral</td>
<td>4.625</td>
<td>3.9996</td>
</tr>
<tr>
<td>SE(Boone integral)</td>
<td>0.1051</td>
<td>0.1222</td>
</tr>
<tr>
<td>Estimated difference of 2007-8 integral and 2005-6, $\hat{\Delta} : 0.6254$, $p$-value $H_0 : \Delta = 0$, 0.0001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>889</td>
<td>897</td>
</tr>
</tbody>
</table>

Table 3: Boone (2008) test applied to different time periods