

BANKING EFFICIENCY AND PRODUCTIVITY IN TRINIDAD AND TOBAGO

Panel Data Estimation of Technical
Input Efficiency

Outline

- ◉ Introduction and Rationale
- ◉ Efficiency - Definitions and Measurement
- ◉ Theoretical Construct - Panzar-Rosse
- ◉ Econometric Specification
- ◉ Results and Analysis
- ◉ Conclusion

Stated Purpose

- To augment existing research in the area
 - CBTT Research
 - Research in the Region
- To deepen the perspective on “best” and “worst” banking practices
- To inform policy

Structure of the T&T Banking System

- ◉ 8 banks
 - 6 banks foreign-owned (private)
 - 1 bank locally owned (private)
 - 1 bank government owned (public)
- ◉ Since financial liberalization:
 - Bank mergers have taken place
 - Ownership has changed hands
 - Banks have expanded their reach into the region
 - New banks have been established

COMMERCIAL BANKS: SUMMARY DATA

	2004	2005	2006	2007	2008 ^P
NUMBER OF BANKS	6	6	6	8	8
NUMBER OF BRANCHES	120	119	123	125	120
TOTAL NUMBERS EMPLOYED	7,142	7,414	7,661	7,840	7,968
of which:					
(i) Head Office	727	785	884	883	929
(ii) Branches	6,415	6,629	6,777	6,926	7,039
Managerial (including Branch Managers)	816	850	919	981	1,031
Administrative/Supervisory	1,546	1,600	1,655	1,704	1,776
Data Processing	307	316	306	293	355
Clerical/Secretarial/Manipulative	4,475	4,648	4,781	4,831	4,806
NUMBER OF DEPOSIT ACCOUNTS	1,293,062	1,294,524	1,423,689	1,444,502	1,591,280
Demand	83,599	91,299	99,460	105,889	118,052
Savings	1,115,823	1,118,501	1,246,321	1,254,507	1,390,042
Time	93,640	84,724	77,908	84,106	83,186
NUMBER OF LOAN ACCOUNTS	433,345	426,458	457,580	487,603	533,608
Overdraft	39,336	37,979	39,378	39,835	47,629
Installment	164,458	156,865	163,811	137,123	126,838
Bridging Finance	236	356	444	436	390
Demand	30,817	31,501	46,259	83,127	102,215
Real Estate Mortgage	18,699	20,737	17,814	15,422	16,976
Credit Cards	178,624	177,855	189,100	209,791	236,317
Other	1,175	1,165	774	1,869	3,243
NET PROFIT AFTER TAX (\$000)	1,706,238	1,308,018	1,758,436	1,926,720	2,258,627
AVERAGE TOTAL ASSETS (\$Mn)	45,812	53,640	60,913	70,789	82,240
AVERAGE TOTAL LOANS - NET (\$Mn)	18,699	24,974	30,239	36,629	42,886
AVERAGE TOTAL DEPOSITS (\$Mn)	25,920	31,432	37,401	44,512	52,155

Efficiency - Definitions

⦿ Input Efficiency

- Ability to produce a given level of output at minimum expense

⦿ Allocative Input Efficiency

- Ability to optimally combine inputs to produce a given level of output

⦿ Technical Input Efficiency

- Ability to “fully” employ inputs to produce at the production possibility frontier

Efficiency - Definitions

⦿ Output Efficiency

- Ability to price and achieve maximum levels of output

⦿ Allocative Output Efficiency

- Ability to maximize revenue by pricing output at its marginal cost

⦿ Technical Output Efficiency

- Ability to reap economies of scale and scope

Main Focus of this Study

TECHNICAL INPUT EFFICIENCY

- ◉ Institution employs inputs at or close to “best practice” (operates at its existing PPF)
- ◉ Directly related to the level of competition among the institutions
- ◉ The degree of competition is a proxy for technical input efficiency

Efficiency - Measurement

- ⦿ Operational Ratio Method
- ⦿ Efficiency Frontier Approaches
- ⦿ “Proxy” Approaches

Operational Ratio Method

- Traditionally used in the Caribbean region
- Input efficiency:
 - Operating costs / Income
 - Operating costs / Average assets
- Output efficiency - “profitability ratios”
 - Income / Average assets
 - Net Profit / Total Deposits
 - Net Profit / Equity

COMMERCIAL BANKS: EFFICIENCY RATIOS

	2004	2005	2006	2007	2008 ^P
PERCENTAGE OF OPERATING INCOME					
(i) Interest Expense	25.2	28.5	31.0	30.8	30.0
(ii) Salaries & Employee Benefits	18.2	18.0	16.6	15.2	15.1
(iii) Professional Services	1.0	1.2	1.1	1.0	0.7
(iv) Occupancy Expenses	1.9	1.8	1.8	1.8	2.0
(v) Depreciation	1.4	2.9	2.5	2.5	2.3
(vi) Additions/(Releases) to Provisions	1.0	0.7	0.1	1.0	1.4
(vii) Loans Written-Off	0.0	0.4	0.3	(0.1)	0.2
(viii) Other Operating Expenses	19.7	20.7	16.6	16.1	15.9
(ix) Total Operating Expenses	67.0	71.3	67.6	65.7	65.3
PERCENT OF AVERAGE TOTAL ASSETS					
(i) Interest Expenses	2.3	2.5	2.8	3.0	2.8
(ii) Non-Interest Expenses	4.6	4.8	4.7	4.9	4.8
of which:					
Salaries & Employee Benefits	1.7	1.6	1.5	1.5	1.4
Professional Services	0.1	0.1	0.1	0.1	0.1
Occupancy Expenses	0.2	0.2	0.2	0.2	0.2
Depreciation	0.2	0.3	0.2	0.2	0.2
Additions/(Releases) to Provisions	0.1	0.1	0.0	0.1	0.1
Loans Written-Off	0.0	0.0	0.0	0.0	0.0
Other Operating Expenses	1.9	1.9	1.5	1.6	1.5
Total Operating Expenses	6.3	6.4	6.2	6.3	6.2

COMMERCIAL BANKS: PROFITABILITY RATIOS

	2004	2005	2006	2007	2008 ^P
PERCENT OF AVERAGE TOTAL ASSETS					
(i) Total Operating Income	9.5	9.0	9.1	9.6	9.5
(ii) Interest Income	6.0	6.3	6.9	7.2	7.2
(iii) Non-Interest Income	3.5	2.7	2.3	2.4	2.3
(iv) Net Interest Margin	3.6	3.8	4.0	4.3	4.4
(v) Net Profit Before Tax	4.2	3.1	3.4	3.4	3.5
(vi) Net Profit After Tax	3.7	2.5	2.8	2.7	2.7
PERCENT OF AVERAGE TOTAL DEPOSITS					
(i) Net Profit Before Tax	7.5	5.3	5.6	5.4	5.5
(ii) Net Profit After Tax	6.5	4.3	4.6	4.3	4.3
PERCENT OF AVERAGE TOTAL EQUITY					
(i) Net Profit After Tax	27.6	20.2	22.3	22.0	20.6

Ratio Method - Pros and Cons

◎ Advantages

- Ease of computation and comparison

◎ Disadvantages - examples

- Cost / Income ratios can mask the presence of oligopolistic rents
- Cost/Assets ratios can be:
 - Influenced by structural shifts in bank business
 - Distorted by acquisitions/mergers

Efficiency Frontier Approaches

- Efficiency = level of cost (revenue) relative to efficient cost (revenue) frontier
- Frontiers estimated using:
 - **Parametric Techniques**
 - Stochastic Frontier Approach
 - Distribution Free Approach
 - Thick Frontier Approach
 - **Non-parametric Technique**
 - Data Envelopment Analysis

"Proxy" Method - Panzar-Rosse Model

○ General Assumptions

- Banks are operating in (long-run) equilibrium
- Bank performance is influenced by other participants' actions
- Homogeneous cost structure
- Standard Cobb-Douglas function with constant returns to scale
- Price elasticity of demand is greater than unity

"Proxy" Method - Panzar-Rosse Model

- ◎ Assumptions specific to this study:
 - Banks behave as single-product firms
 - Banks use labour, capital and deposit funds as inputs

"Proxy" Method - Panzar-Rosse Model

⊙ Consider, for firm i :

- $R_i = R_i (y_i, z_i)$ Revenue
- $C_i = C_i (y_i, p_i, x_i)$ Cost

Where:

y = output level

z = exogenous revenue-shifting variables

p = exogenous input prices

x = exogenous variables cost-shifting variables

"Proxy" Method - Panzar-Rosse Model

⊙ Profit Maximizing (equilibrium*) Output:

$$\blacksquare y^*_i = y^*_i(z_i, p_i, x_i)$$

⊙ Substitute y^*_i into R_i

$$\blacksquare R^*_i = R^*_i(y^*_i(z_i, p_i, x_i), z_i) = R^*_i(p_i, z_i)$$

This is the reduced-form Revenue function

Market power is measured by the extent to which input price changes affect equilibrium revenue

"Proxy" Method - Panzar-Rosse Model

- ◉ Measure of Competition - **H Statistic**

- ◉ $H = \sum_i \frac{\partial R_i^*}{\partial p_i} \frac{p_i}{R_i}$

- ◉ H is the sum of revenue-elasticities with respect to input prices
- ◉ $H < 0$ under monopoly/oligopoly
- ◉ $0 < H < 1$ under monopolistic competition
- ◉ $H = 1$ under perfect competition

Panzar-Rosse Empirical Specification

$$\text{Log}R_i = \lambda + \sum_{j=1}^J \mu_j \log P_i^j + \rho \log Y_i + \sum_{k=1}^k \sigma_k \log Z_i^k + \varepsilon_i$$

Where:

- i represents the firm
- j represents the input
- P_i^j is the price of the j th input
- Y_i is a scale variable
- Z_i^k is a vector of k exogenous and bank-specific variables that may shift the revenue schedule
- λ is a constant term
- ε_i is a stochastic error term

Variables - Definition

The variables are all in natural logs

◉ Dependent Variables

- TOTINC = Total Bank Income
- INTINC = Bank Interest Income

Variables - Definition

The variables are all in natural logs

◉ Independent Variables

- Factor Prices - Labour, Capital, Deposit Funds

$$\circ \text{LPRICE} = \frac{\textit{Personnel Expenses}}{\textit{Total Loans \& Deposits}}$$

$$\circ \text{FPRICE} = \frac{\textit{Interest Expenses}}{\textit{Total Deposits}}$$

$$\circ \text{CPRICE} = \frac{\textit{Other Expenses}}{\textit{Fixed Assets}}$$

Variables - Definition

◎ Scale Variable

- TOTASS = Total Assets

◎ Revenue-Shifting Variables

- RISK1 =
$$\frac{\textit{Past Due Loans}}{\textit{Total Loans}}$$
- RISK2 =
$$\frac{\textit{Total Loans}}{\textit{Total Assets}}$$
- TBILL = Nominal Treasury Bill Rate

DATA DESCRIPTION

- Balance sheet data (CB20 and CB40) was collected for
 - 5 of the 8 T&T Banks
 - Period - 1995 - 2009
 - Frequency - Semiannual
- 3 banks were omitted to allow a balanced panel
- The data were de-seasonalized

ECONOMETRIC METHODOLOGY

- ◉ The study features a balanced panel model with fixed cross-section effects and no period effects
- ◉ All data are in natural logarithms, to allow direct computation of the H Statistic
- ◉ Software package - Eviews 6.0

CHOICE OF MODEL - RATIONALE

◎ The Panzar Rosse Model - Advantages

- Econometric Application
 - Allows analysis of factors affecting efficiency
- H Statistic can be compared with those computed for other countries / regions

◎ The Panel Model - Advantages

- Greater degrees of freedom
- Ability to run unbalanced panels

Initial Estimation Results - INTINC

- ◉ Dependent Variable: INTINC
- ◉ Sample: 1995S1 2009S1
- ◉ Cross-sections included: 5
- ◉ Total panel (balanced) observations: 145

	Coeff	Std. Error	t-Statistic	Prob.
◉ C	-1.270106	0.449721	-2.824209	0.0055
◉ LPRICE	0.194105	0.056981	3.406503	0.0009
◉ KPRICE	0.110019	0.034870	3.155113	0.0020
◉ FPRICE	0.226936	0.037030	6.128410	0.0000
◉ TOTASS	0.972436	0.038805	25.05954	0.0000
◉ RISK1	-0.006856	0.007117	-0.963277	0.3372
◉ RISK2	0.142108	0.052426	2.710610	0.0076
◉ TBILL	0.154288	0.043894	3.515046	0.0006

Initial Estimation Results - INTINC

- Effects Specification

Cross-section fixed (dummy variables)

○ R-squared	0.978816	Mean dependent var	12.442060
○ Adjusted R ²	0.977064	S.D. dependent var	0.735360
○ S.E. of reg	0.111367	Akaike info criterion	-1.472846
○ SSR	1.649535	Schwarz criterion	-1.226495
○ L/likelihood	118.7813	Durbin Watson Statistic	1.590851
○ F-statistic	558.6771	Prob (F-Statistic)	0.000000

Wald Restriction Test - H0: H Statistic = 1

Test Statistic	Value	df	Probability
F-statistic	75.10898	(1, 137)	0.0000
Chi-square	75.10898	1	0.0000

Initial Estimation Results - TOTINC

- Dependent Variable: TOTINC
-
- Sample: 1995S1 2009S1
- Cross-sections included: 5
- Total panel (balanced) observations: 145

	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.308915	0.484039	-0.638203	0.5244
LPRICE	0.251281	0.061329	4.097281	0.0001
KPRICE	0.129173	0.037531	3.441761	0.0008
FPRICE	0.216319	0.039856	5.427537	0.0000
TOTASS	0.972500	0.041766	23.28440	0.0000
RISK1	0.008829	0.007660	1.152612	0.2511
RISK2	0.217197	0.056427	3.849161	0.0002
TBILL	0.014203	0.047243	0.300631	0.7642

Initial Estimation Results - TOTINC

- Effects Specification
- Cross-section fixed (dummy variables)

○ R-squared	0.975911	Mean dependent var	12.714760
○ Adjusted R ²	0.973918	S.D. dependent var	0.742203
○ S.E. of reg	0.119865	Akaike info criterion	-1.325772
○ SSR	1.910887	Schwarz criterion	-1.079422
○ L/likelihood	108.1185	Durbin Watson Statisti	1.487809
○ F-statistic	489.8259	Prob (F Statistic)	0.000000

Wald Restriction Test - H0: H Statistic = 1

Test Statistic	Value	df	Probability
F-statistic	47.93834	(1, 137)	0.0000
Chi-square	47.93834	1	0.0000

Diagnostic Testing

- ⦿ Multicollinearity
 - No evidence in either model
- ⦿ Heteroskedasticity - Koenecker
 - Evidence in both models

Diagnostic Testing

- ⦿ Autocorrelation - Durbin-Watson ($\alpha=1\%$)
 - Positive autocorrelation in TOTINC
 - Inconclusive result in INTINC

- ⦿ Normal Residuals - Jarques-Bera
 - Evidence in both models

Fixed Effects Test

- ⦿ H0: The fixed effects are redundant
- ⦿ Result: H0 rejected at $\alpha=1\%$ for both models

Redundant Variable Test

- ⦿ H0: Risk1 is redundant
- ⦿ Result: H0 not rejected at $\alpha=1\%$ for both models
- ⦿ Risk1 retained in both specifications due to its perceived importance
- ⦿ Further research with more observations may highlight its significance in the model

Omitted Variable Test

- ◉ H0: Inf (the inflation rate) is irrelevant
- ◉ Result: H0 not rejected at $\alpha=1\%$ for both models
- ◉ Inf omitted from the model specification in this initial stage of the research

Final Estimation Results - INTINC

Dependent Variable: INTINC

Method: Panel EGLS (Cross-section SUR)

Sample: 1995S1 2009S1

Periods included: 29

Cross-sections included: 5

White cross-section standard errors & covariance (d.f. corrected)

	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.782133	0.324345	-2.411424	0.0173
LPRICE	0.206219	0.046667	4.418922	0.0000
KPRICE	0.103606	0.025477	4.066707	0.0001
FPRICE	0.219846	0.030920	7.110253	0.0000
TOTASS	0.950854	0.030516	31.15873	0.0000
RISK1	-0.001171	0.008044	-0.145533	0.8845
RISK2	0.226888	0.043565	5.207975	0.0000
TBILL	0.148316	0.039305	3.773441	0.0002

Final Estimation Results - INTINC

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.977527	Mean dependent var	129.5311
Adjusted R-squared	0.975669	S.D. dependent var	45.12861
S.E. of regression	1.022160	Sum squared resid	138.9598
F-statistic	525.9357	Durbin-Watson stat	1.398731
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.999725	Mean dependent var	12.44206
Sum squared resid	1.703227	Durbin-Watson stat	1.576924

Final Estimation Results - TOTINC

Dependent Variable: TOTINC

Method: Panel EGLS (Cross-section SUR)

Sample: 1995S1 2009S1

Periods included: 29

Cross-sections included: 5

White cross-section standard errors & covariance (d.f. corrected)

	Coefficient	Std. Error	t-Statistic	Prob.
C	0.036683	0.321826	0.113983	0.9094
LPRICE	0.209086	0.052209	4.004751	0.0001
KPRICE	0.140790	0.029988	4.694850	0.0000
FPRICE	0.193469	0.033888	5.709107	0.0000
TOTASS	0.928521	0.035821	25.92130	0.0000
RISK1	0.008501	0.008612	0.987136	0.3254
RISK2	0.217665	0.042277	5.148491	0.0000
TBILL	0.046878	0.035278	1.328799	0.1862

Final Estimation Results - TOTINC

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.976563	Mean dependent var	139.8953
Adjusted R-squared	0.974624	S.D. dependent var	78.80680
S.E. of regression	1.027009	Sum squared resid	140.2813
F-statistic	503.7906	Durbin-Watson stat	1.621863
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.999675	Mean dependent var	12.71476
Sum squared resid	1.946973	Durbin-Watson stat	1.499128

Banking Sector Market Structure: Selected Countries

**T&T Average H Statistic:
0.537**

Country	Period	Hstatistic	#Banks	#obs
Ghana	1998-2003	0.56	13	65
Kenya	1994-2001	0.58	34	106
Nigeria	1994-2001	0.67	42	186
South Africa	1994-2001	0.85	45	186
North America*	1994-2001	0.67	3 countries	
South America*	1994-2001	0.73	12 countries	
East Asia*	1994-2001	0.67	6 countries	
South Asia*	1994-2001	0.53	3 countries	
Western Europe*	1994-2001	0.67	14 countries	
Eastern Europe*	1994-2001	0.68	7 countries	

Source: Buchs and Mathisen (2005)

*median