USING BAYESIAN MODEL AVERAGING (BMA) TO ASSESS THE VIABILITY OF INVESTING IN COMMUNITY BANKING IN A SEEMLY CASHLESS SOCIETY NIGERIA

David Adiele
Department of Statistics,
Michael Okpara University of Agriculture, Umudike,
Anambra State.

Abstract

This paper investigates the viability of investing in community banking in a seemly cashless society using internal and external variables considered to be determinants of bank profitability. The well celebrated Bayesian model averaging is employed, and it reveled that from the fourteen variables considered EQTY, AST, INV, CAR, CRR, BSZ, EXM, LTA, DTA, GDP, IRR, EXR and IR which gave 16384 plausible models generated by MCMC algorithm a sample of 2785 models were sampled. Only EQTY, AST, INV, CAD, CRR, BSZ and EXM showed evidence of strong explanatory power in explaining community Banks viability, with EQTY as the most probable predictor. It is found that the mean recorded number of covariates is seven with a shrinkage statistics 0.9988 meaning that for any community bank to succeed in a seemly cashless society they must give more attention and improve greatly on returns on EQTY, AST, INV, CAD, CRR, BSE and EXM. This finding is in consistent with what is in literature for commercial banks

Key Word: Shrinkage, Posterior Probability. MCMC, Cashless.

The importance of the banking sector in the overall economic development of any nation cannot be overemphasized. In Nigeria, it is the backbone of the Nigeria economy as it plays an important financial mechanization role, therefore its healthy condition is very critical to the health of the economy at large. The Nigerian commercial banks have been faced with a lot of challenges in the last twenty years, thus, there have been a rapid decrease in the number of functional banks in Nigeria from 89 to 23 and this has fostered rapid competitiveness among commercial bank in the country. In the global business and finance system the task of profitability which is a major indicator of performance is becoming a major task daily Adiele [2019]. That is

in order for an organization like banks to operate optimally, it has to be able to measure its profitability with regards to its inputs and outputs.

Therefore, predicting banks profitability and viability is of great importance in any financial circle since this is frontal in the overall development of any economy. For cashless policy to succeed in a developing country, community banks must be a complimentary outlet to commercial banks Jacob [2018].It is then necessary to model profitability and viability, in reality, the true model is not known. Therefore using a single model to evaluate profitability indeed will be misleading. Bayesian Model Averaging (BMA) offers a more coherent mechanism for dealing with model uncertainty, therefore using BMA in modeling commercial bank profitability in Nigeria is of great importance to determine the key drivers of commercial banks profitability in Nigeria.

Several techniques of describing economic relationship are well established in economic literature. BMA offers several advantages, for instance the number of regressors is limited only by the number of variables included in the regression analysis and the resultant effect is that a large number of regressors can be examined jointly. For example, 41 regressors were examined by Fernandez, Ley and Steel [2001], Eicher, Apageerginu, Aftery [2011]. As a result, it decreases the potential omitted variables bias thus, many competing theories can be jointly examined. Bayesian Model Averaging averages over all possible models and estimates model uncertainty Amini [2001]. BMA has been applied in various economic models, stock return predictions and inflating forecasting Chipman, George, McCulloch [2001], Olubusoye [2014], Avramor [2002] their reports improved pseudo-out of sample predictive performance form BMA. Consequently, posterior probability is spread widely among many models, showing the superiority of BMA over many single models.

Theoretical Framework and Methodology

A Systematic modeling of bank profitability which is a proxy for viability is assumed to be predicted with high precision with several indicators as specified. The actual model is not known but various candidate models exist, with a linear regression model as,

$$Y = X\beta + E \quad (1)$$

Where are K potential explanatory variables yields 2^k different combinations of predictor variables indexed by Mj for j=1,2,…2^k. Specification of model is done before looking into the data, infinitely often a uniform prior is employed. Renormalization then yields posterior model probabilities which are used as weights far each coefficient βh in the model space given the data D. The posterior probability of each coefficient is

$$\Pr(\beta h / D) = \sum_{\beta h \varepsilon Mj} \Pr(\beta h / Mj) \Pr(Mj / D) \qquad (2)$$

Posterior model probability $\Pr(Mj / D)$ is the ratio of its marginal likelihood to the sum of marginal likelihood over the entire model space and is given by

$$\Pr(Mj / D = \frac{\Pr(D / Mj) \Pr(Mj)}{\Pr(D)} \qquad (3)$$

$$\Pr(Mj / D) = \frac{\Pr(D / Mj) \Pr(Mj)}{\sum_{i=1}^{2^k} \Pr(D / Mj) \Pr(Mj)} \qquad (4)$$

$$\Pr(Mj / D) = \frac{[\int \Pr(D / B^j .Mj) \Pr(B^{i/Mj) d_j}] \Pr(Mj)}{\sum_{i=1}^{2^k} \Pr(D / Mi) \Pr(Mi)} \qquad (5)$$

Where j $\rightarrow$ the vector parameter from model Mj
$Pr(B^j/Mj) \rightarrow$ prior probability distribution assigned to the parameters of model Mj.
Pr (Mj) $\rightarrow$ prior probability that Mj is the true model. The estimates posterior means and standard deviation $\sigma \hat{\beta}\, j = \hat{\beta}(o\, \hat{\beta}_i \ldots\ldots \hat{\beta}_k)$ are then constructed as

$$E(\hat{\beta}/ D) = \sum_{j=1}^{2^k} \hat{\beta} \Pr(Mj / D) \qquad (6)$$

Table 1: Bayesian Model Averaging Result

	PIP	Post Mean	Post SD	Cond. Pos. Sign	Index
EQTY	1.00000000	$8.553255e^{-02}$	$1.262601e^{-02}$	1.00000000	13
AST	0.98261334	$1.212133e^{-01}$	2.253400e-^{03}	1.00000000	11
INV	0.96678210	$1.300641e^{-13}$	$4.464411e^{-02}$	1.00000000	12
CAD	0.82246970	$-2.441700e^{+12}$	$3.002016e^{-8}$	0.00000000	1
CRR	0.77621311	$4.732461e^{-5}$	$3.966516e^{-12}$	0.77020001	2
BSZ	0.44400021	$3.860672e^{-9}$	$5.504441e^{-05}$	0.89772111	3
EXM	0.39329961	$-1.887041e^{-13}$	$7.323129e^{-12}$	1.00000000	4
LTA	0.11101022	9.914670-e^{-12}	$-6.211120e^{-11}$	1.00000000	5
DTA	0.19125416	$6.240002e^{-02}$	$7.762610e^{-10}$	-0.99116631	6
GDP	0.13312774	$1.606404e^{-02}$	$4.242301e^{-5}$	-0.88610002	7

IRR	0.10455286	$-4.111211e^{-14}$	$1.123499e^{-11}$	-0.92744441	8
EXR	0.04321699	$-5.566062e^{-8}$	$-5.020333e^{-10}$	0.57820110	10
IR	0.04026777	$6.223692e^{-12}$	$-6.926104e^{-10}$	-044980221	9
NII	0.0012345	$-1.0234e^{-12}$	2.4446230	-0.101021	14

where PIP is posterior inclusion probability which refers to the probability that the corresponding predictor should be included. It can be obtained by calculating the proportion of the models drawn by the MC^3algorithim which contains the corresponding explanatory variable. Post mean, refers to the average of all the coefficient of the corresponding predictor in all

$$v(\hat{\beta}/D) = \sum_{j=1}^{2^k} (\text{var}[\beta / D.Mj] + \hat{\beta}^2) \Pr(Mj / D - E[\hat{\beta}/D]^2 \quad (7)$$

Data Description and Empirical Results

Annual data from 2016-2017 obtained from the annual reports Central Bank of Nigeria and Statistical Bulletin. Return on Assets, Equity and investment is used as proxy for community bank profitability. Other series used predictor variables are Capital Adequacy Ration (CAD), Credit Risk Ration (CRR), Business Size Ratio (BSZ), Expenses Management (EXM), Loans/total assets (LTA), Deposit/total assets (DTA), Gross Domestic Product (GDP), Interest Rate Ratio (IRR), Inflation Ratio (IR), Non-interest income (NII) and Exchange Rate Ratio (EXR), Equity (EQTY), Asset (ASS), and Investment (INV). The first ten years was used for estimation while the remaining 2 were used for sample forecasts.

A sample of 2785 models were sampled from 16384 plausible models, generated by the MCMC algorithm EQTY, AST, INV, CAD, CRR, BSZ,, EXM, showed evidence of strong explanatory power in explaining profitability or viability which implies that they must be included in the models. Equity is the most probable predictor appearing in 100% of the total models considered.

Table 2: Covariates of the Nine Top Models and their Corresponding Posterior Model Probabilities

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
CAD	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
CRR	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
BSZ	0.0000000	1.0000000	0.0000000	0.0000000	0.0000000	1.0000000	0.0000000
EXM	0.0000000	0.0000000	0.0000000	1.0000000	0.0000000	1.0000000	0.0000000
LTA	0.0000000	0.0000000	0.0000000	1.0000000	0.0000000	0.0000000	0.0000000
DTA	0.0000000	0.0000000	1.0000000	0.0000000	0.0000000	0.0000000	0.0000000
GDP	0.0000000	0.0000000	0.0000000	0.0000000	1.0000000	0.0000000	0.0000000
IRR	0.0000000	1.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
IR	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
EXR	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
EQTY	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	0.0000000
AST	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
INV	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000

NII	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
PMP(Exact)	0.2672224	0.1429643	0.0762104	0.0666690	0.0455218	0.0330011	0.0301468
PMP (MCMC)	0.2510021	0.1413332	0.0710002	0.0521111	0.0339920	0.0284420	0.02559301

where, PMP (Exact) is actual posterior model probability
PMP (MCMC) is posterior model probability obtained by Markov Chain Monte Carlo model computation and model 1,2,3,4,5,6 and 7 are the top seven models

The other predictors appeared few times in all the models considered with the least being EXR and IR, each appearing in only 4% of the models considered. Meaning that ordinarily these predictors are considered not so important because of small posterior inclusion probabilities. However, not including these predictors will lead to loss of some information. BMA is generous in including such variables because of their minute contributions in order to improve forecast efficiency.

The model comprises on the average seven predictors which have been listed as the important predictors. The mean recommended number of covariates is seven based on result obtained from 2785 model samples considered from 16384 plausible models with shrinkage statistic 0.9988.

Table 2 shows the important predictors covariates of the seven top models and their corresponding posterior model probabilities. The best model comprises EQTY, AST, INV, CAD, CRR, with a model uncertainty of 76% while the second has 84% uncertainty.

Note that selecting the best model (models) as the true model will lead to the loss of about 76% information on profit mode by banks. This means it will not be optimal to use a single model to estimate profitability. However, the top seven model comprising of EQTY, AST, INV,CRR, CAD, BSZ and EXM can only explain 62.3% of bank profitability in Nigeria.

Conclusion

This paper investigated the viability of investing in community banking in a society with cashless policy, using Nigeria banks as a case study, fourteen predictor variables were considered which includes Equity, Asset, Investments, Capital adequacy ratio, Business Size ratio, Expenses management, Loans/total assets, Deposit/total asset, Gross Domestic product, Interest rate ration, Exchange rate, and inflation rate. The Markov Chain Monte Carlo (MCMC) systematic approach of the Bayesian model averaging were critically examined. The posterior inclusion probability which revealed the predictors to be included in the model, which can be obtained by calculating the proportion of the models drawn by the MC^3 algorithm, which contains the corresponding explanatory variable. The (Post mean) average of the coefficients of the corresponding predictors in all the models, the Post Standard deviation and the conditional positive sign index were all examine and the conclusion is that out of the fourteen predictor variables considered resulting to 16384 plausible models generated by MCMC algorithm and the 2785 models sampled, only seven of these predictor

variables, EQTY, AST, INV, CAR, CRR, BSZ and EXM showed evidence of strong explanatory power in explaining viability with EQTY as the most plausible predictor. It therefore implies that for any investor to succeed in community banking attention should be given more to improve returns on EQTY, AST, INV, CAR, CRR, BSZ and EXM

References

Adiele D.F. (2019) Investigating Commercial Bank Profitability in Nigeria, using Bayesian statistical approach,*JNAMP*,Vol.49. January 2019 Issue

Amini S.M., parmeter C.F. (2001) Bayesian Model Averaging in R" *journal of economic and social measurement* 36(4), 253-287.

Avramor.D, (2002), stock return predictability and model uncertainty, *Journal of Financial Economics* 64, 423-458.

Chipman H., George E.I & McCulloch R.E (2001) the practical implementation of Bayesian Model Selection mimes.

Eicher T., P. apageerginu C.R aftery A.E. 2011, Default priors and predictive performance in Bayesian model averaging with application to growth determinant, *Journal of Applied econometrics* 26(1), 30-55.

Fernandez C., Ley E, Steel M. 2001. Benchmark priors for Bayesian model averaging: *journal of Econometrics* 16(5), 563-576.

Jacob K.K (2018). Community banking in Africa An Empirical Insight, *Asian Journal of Economics* Vol. 15, pp.120-128

Olubusoye O.E., Ogbonna A.E., (2014) "Modelling inflation process in Nigeria using Bayesian model Averaging Research gate.