Working Paper

Determinants of Net Interest Margins in Jamaica: An Expanded View

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Abstract

This paper explore the factors determining net interest margins (NIM), an indicator of efficiency within the banking sector, while investigating its influence on non-interest income (NII). To achieve this, a system based dynamic generalized method of moment's approach was used to account for the simultaneous relation between the NIM, deduced from the theoretical construct of a profit maximizing agent subject to a managerial cost function; and the NII, founded in empirics. The assessment considered the influence of bank-specific, macroeconomic as well as institutional and regulatory factors as key determinants. The paper also explored asymmetric patterns associated with commercial bank classification and foreign ownership and provides evidence that a lower NIM is induced by enhanced operating cost efficiencies, improved liquidity conditions, and greater variation in the interest and exchange rates. Furthermore, banks use NII to augment profitability and mitigate the impact of increased tax burden. Key policy recommendations include initiatives to expanded use of technology and agent banking model to lower operating costs as well as enhanced information sharing and communication to increase competition and reduce information asymmetry.

JEL Classification numbers: E43; E44; G21; C23

Keywords: Banks' interest margins; Financial institutions; Panel data estimation.

♣ The views and results expressed in this paper represent those of the authors and not necessarily those of the Bank of Jamaica.

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Introduction:

Mishkin, (2012) characterised the financial system as the brain of the economy as it performs the essential role of channelling funds from economic agents with a surplus to those with a shortage of funds and have access to productive investment opportunities. This intermediation role enables consumption as well as private and public investment, the principal components that constitute aggregate demand and propels economic growth. In order to optimize economic growth, it is therefore imperative to optimize the efficiency of the intermediation process.

The interest margin that accrue to banks for providing credit from their deposit taking activities is generally treated as a metric for intermediation efficiency. This margin accounts for the institutions' cost of operations, risks associated with lending as well as normal profits. As with all efficient markets, financial markets are those that, under competitive conditions, minimize the associated costs of bringing demand and supply together.

The margin that deposit taking institutions require to maintain operational efficiency is generally investigated from either an ex-ante or ex-post perspective. The ex-ante assessment uses spreads by evaluating the difference between average loan rates and average deposit rates. The ex-post approach, however, evaluates the realized margin by comparing the average interest earned to the average interest expenses incurred by the deposit taking institution. The latter, regarded as Net Interest Margin (NIM), when expressed as a proportion of interest earning assets is considered the most useful measure of banking efficiency according to Demirguc-Kunt & Huizinga (1999) since it accounts for high yields and risky credits while better signalling the likelihood of defaults.

However, Nguyen (2012) drew attention to a greater reliance on non-interest income (NII) among banks in the US as customers are provided with higher yielding alternatives that results in a decline of core deposits. He also cited increased pressure for banks to rely more on off-balance sheet services relative to traditional bank lending, resulting in approximately half of commercial bank operating income being accounted for by NII. Jamaican banks have also witnessed a growing trend in NII over the past decade and half and similar to Nguyen (2012), a fulsome review on banks NIM performance must simultaneously account for developments in NII.

This paper seeks to identify the principal factors that influence net interest margin (NIM) in Jamaica and its influence on non-interest income (NII). The NIM is characterised by a modified cost function for an oligopolistic banking sector as introduced by Nassar, Martinez, & Pineda (2014). The linear representation of the models are evaluated using Dynamic Generalized Method of Moments (DGMM) following which the endogenous relationship between the NIM and NII are evaluated within a system. The results indicate that a lower NIM is associated with operating costs efficiencies, improved liquid asset conditions and increase variability in interest and exchange rates. On average, foreign and commercial banks also reflect lower NIMs. The results also show that NII is used to augment profitability and increased taxes. Key policy

recommendations include initiatives to reduce unnecessary regulatory costs, expanded use of technology and agent banking model to lower operating costs as well as enhanced information sharing and communication to increased competition and reduce information asymmetry.

The remainder of the paper is divided into 5 sections. Section 2 provides a review of key developments in both the theoretical and empirical literature. Section 3 reviews the data and associated stylized facts while Section 4 explores the theoretical and empirical methods employed within the paper. Section 5 outlines the empirical assessment and estimated results while Section 6 summarizes and provides recommended policy actions for improved banking sector efficiency.

Literature:

Theoretical Literature:

In a review of the theories of the banking firm, Swank (1996) discussed the influence of key risks, institutional, regulatory and operational costs as well as macroeconomic factors that affect banking behavior. The models assessed included risk management theories, portfolio models, imperfect-market models and real resources. Of fundamental importance are risks faced by the banking agent which includes credit (default) risks, funding (withdrawal) risks, security mismatch (interest rate) risk, as well as price, and exchange rate risks as explored by risk management theories.

Funding risks are largely explained by reserve management models which identify cash reserves and other liquid assets as means of lowering liquidity risks. Consistent with the theoretical frameworks advanced by O'Hara (1983) and Elyasiani (1983) in their portfolio models, Swank (1996) highlighted that access to well-developed money markets and increasing securitization of assets have substantially diminished this risk in modern banking. The theoretical imperfect market model proposed by VanHoose (1985) also lend support to this when accounting for industry regulations that provide fractional cash reserve requirements. Afforded by this regulation, immediate access to a discount window, significantly reduces funding risk. Imperfect market models by Besanko and Thakor (1992) also accounted for the role that deposit insurance play in curtailing funding risks. Aspects of funding risks are also addressed by credit rationing theories which highlight the imbalance between demand and supply of loans. When loanable funds are in shortage, banks may have to offer smaller loans or turn down new loan applicants.

Regarding credit (default) risks, Stiglitz and Weiss (1981) highlighted the impact of asymmetric information on credit rationing decisions and the need to minimize adverse selection that contributes to default risk. Furthermore Thankor and Callaway (1983) also underscore the usefulness of screening loan applicants and collecting information on risk profiles while Swank (1996) highlighted the relevance of appropriate collateral determination and signaling from borrowers who are willing to pay for their own screening. Regarding the pricing of credit risk, Greenbaum et al (1989) and Sharpe (1990) also highlighted concerns about information

asymmetry within imperfect market models. They refer to the information advantage that these banks have on their own clients which provides an incentive to overcharge while still providing a better rate than other banks that have no information on those clients. These authors suggests a tangible relationship between the availability and accurateness of information and the degree of exposure to credit risks within the banking sector.

In a regulatory context, Swank (1996) highlighted that higher equity ratios may be required to diversify credit risk. Issues regarding regulatory efficiencies are also addressed within the confines of portfolio models. Imposing a simple capital asset or gearing ratio, for instance, according to Swank (1996) is more likely to increase than decrease the probability of bank default. This is because balance sheet items among banks are not exposed to the same degree of risk. This challenge is addressed by requiring a risk-weighting sum of the assets as outlined in the Basle agreement on capital adequacy and example provided by Keeton (1989). The general view within the literature is that more stringent capital requirements should deter the build-up of risky assets among banks and even more so as funding costs increase.

While banks may curtail credit risk by gearing equity levels, or adhere to capital adequacy requirements, another potential source of insolvency may arise from capital losses on securities as well as real estate and other assets due to valuation adjustments. Swank (1996) explained that if the bank is risk neutral, it will choose a deposit-capital ratio such that marginal cost of substituting equity for deposits equals the expected marginal cost of insolvency.

Both credit and funding risks are impacted by institutional factors whereby the pricing of loans and deposits are modeled within imperfect market models. These prices are influenced by factors such as firm size and market power. Klein (1971) and Monti (1972) provided a solution to the imperfect market model wherein it was postulated that both loan and deposit rates were informed by a given rate on securities while the allocation of loans and supply of deposits as well as their rates were choices independent of each other. Building on the Klein and Monti framework, Dermine (1986) and Goodman and Santomero (1986) showed that when banks employ insufficient equity to cover bankruptcy risks or do not provide adequate insurance on deposits, depositors require adequate compensation for the risk, thereby narrowing interest rate spreads.

Making the link between interest rate determination and monetary policy, Prisman et al (1986) showed that a price setting bank that has no influence on loan demand but required to maintain minimum reserve requirements may access emergency borrowing from the regulatory institution at a penalty rate. Prisman et al (1986) posits that a higher penalty rate will induce banks to raise both lending and deposit rates. As such, the central bank is able to control bank lending and funding while exercising its role as lender of last resort.

Imperfect market models also address other aspects of monetary policy that impacts decisions within the banking firm. These cases, such as proposed by VanHoose (1985 & 1988) require that the banking sector be treated as a whole and that other macroeconomic variables be incorporated

in the assessment. Analyzing the oligopoly type banking behavior while accounting for competition across the sector, macroeconomic supply and deposit demand, VanHoose (1985 & 1988) explained that, a deregulation of the banking sector which relaxes barriers to entry will impair the effectiveness of reserve requirements on deposits. As such, an increase in competition will induce banks to lower deposit liabilities when reserve requirements increase. This is achieved by lowering deposit rates while the sector attracts additional entrants which exacerbates the exposure to funding risk.

Furthermore, concerns about interest rate risks stem from Gap Management Models due to a mismatch between maturities of assets and liabilities. The intuition is that interest rate risks should be absent when assets and liabilities are completely matched. Swank (1996) noted that this criteria may not hold when there is uncertainty about future rates. Banks will therefore give consideration to interest rate risks in determining credit allocation.

Addressing operating costs, Baltensperger, (1980) highlighted the relevance of transaction and information costs incurred while banks intermediate between borrowers and depositors. The wide range of costs include not just bookkeeping and screening of potential borrowers but also considerable resource costs associated with labour, equipment and office buildings. Considering the significant share of intermediation costs that operating expenses represent, the structure of banking operations will undoubtedly impact the price, scale and diversity of bank services offered. Swank (1996) surmised that "*a complete neglect of real resource costs in a theory of the banking firm is inadvisable*".

The theoretical underpinnings of the banking firm clearly outlines the role that credit, funding, price, exchange and interest rate risks play in the provision of banking services. The review also identifies the pertinence of gathering information to reduce credit risk associated with information asymmetry. The role of regulation is also highlighted with consideration for capital adequacy and sufficient gearing (equity) in minimizing credit (default) and bankruptcy risks. Regulatory factors that affect funding risk in particular, includes requirement for deposit insurance, cash reserves, institutionalizing discount windows and ensuring a well-functioning money market. Imperfect market models show that monetary policy is able to influence loan and deposit rates and underscore the importance of competition and market power in interest rate determination as well as the influence of macroeconomic developments. Finally, but by no means least, operating expenses represent a significant component of intermediation costs and should be accounted for when explaining optimal decisions within the banking firm.

Empirical Literature:

The seminal research on net interest margins was conducted by Ho & Saunders (1981) who sought to identify the determinants of bank interest margins from both a theoretical and empirical approach. A dealership model was used to characterise banks as risk averse dealers. The model explained how takers of deposits deal with supply of loans considering that agents arrive at different times. The paper established that both bank spreads and interest margins would always

exist and that pure spreads depended on the extent of managerial risk aversion; transaction size; market structure; and interest rate variance. Modifications to the Ho & Saunders (1981) model was introduced by Allen (1988) who accounted for variations in the types of credits and deposits while McShane & Sharpe (1962-1985) introduced uncertainty in the money market as an alternative measurement of interest rate risk when considering the determination of credit and deposit rates. Angbanzo (1997) also contributed to the expansion of the dealership model by including measures of credit and interest rate risk.

Additional enhancements to the dealership model was made by Demirguc-Kunt & Huizinga (1999) who included variables for ownership, taxation, financial leverage, as well as legal and other institutional indicators. Evidence from their investigation highlighted that NIM would fall in response to growing bank size, based on asset to GDP ratio's as well as reduced market concentration using the Herfindahl-Hirschman Index (HHI) as proxy. Demirguc-Kunt & Huizinga (1999) however, highlighted that while interest spreads can be treated as a signal for efficiency, there are circumstances where an increase in the NIM may not be characteristic of reduced efficiency. The positive impact on NIM from a reduction in bank taxation or higher loan default rates were identified as two such cases.

Moore & Craigwell (2002) investigated the determinants of high interest rate spreads across Caribbean territories for the post financial liberalization period of the 1990's. They confirmed that high spreads were induced by diseconomies of scale resulting from short-term expansion of loan portfolios. Operating costs, credit risk and fee income, responding to improved economic activity, were also identified as useful determinants in interest rate spreads. To induce a narrowing of spreads, Moore & Craigwell (2002) recommended less restrictive banking sector regulations and strategies to increase competition among Caribbean financial intermediaries. The study cautioned the use of monetary policy as evidence pointed to increased likelihood of wider spreads among banks endowed with some degree of market power.

Maudos & de Guevara (2004) employed a direct measure of market power along with operating costs, market and credit risks, size and regulatory costs to determine the factors explaining net interest margin in the European Union (EU). Using data from 1993 to 2000 within a fixed effects GLS model, (Maudos & de Guevara, 2004) showed that while market concentration increased the NIM, it declined amidst lower operating costs as well as credit and interest rate risks. Furthermore, (Maudos & Solis, 2009) examined the determinants of net interest income for Mexico for the period 1993 to 2005 to account for operating costs as well as measures of diversification and specialization. Using both a dynamic GMM model and a panel fixed effects static model, (Maudos & Solis, 2009) demonstrated that operating cost and market competition base on the Lerner Index were positively related to net interest margins. The paper recommended initiatives to enhance competition, stabilize economic conditions and other strategies aimed at enhancing efficiency in the banking industry.

Horvath (2009) also employed the dealership model introduced by Ho & Saunders (1981) to evaluate the determinants of interest margin in the Czech Republic. Horvath (2009) used measures of market structure, interest rate volatility, opportunity cost of reserves, capital requirements and implicit payments to explain interest margin for the period 2000 to 2006. The assessment confirmed that market structure, bank capitalization and interest rate volatility were key determinants of interest margins.

Furthermore, Hamadi & Awdeh (2012) highlighted the difference in net interest margins between local and foreign held banks. They provided evidence that net interest margins of foreign banks in contrast to domestic banks were less impacted by macroeconomic conditions, industry factors as well as interbank rates and central bank discount rates. Demirguc-Kunt & Huizinga, (1999) provided supporting evidence, highlighting that foreign held banks outperformed local banks with distinctively higher net interest margins and profitability.

Nassar, Martinez, & Pineda (2014) investigated the determinants of Net Interest Margins in Honduras by employing a cost function model developed by Klein (1971) and Monti (1972). The assessment utilized quarterly panel data over the period of 1998 to 2013 and employed an OLS based Panel Corrected Standard Error (PCSE) regression model. The results highlighted rising NIM and higher concentration among banks due to increased competition which contributed favourably to foreign banks. Along with bank-specific factors, the paper found evidence that inflation was a key determinant of bank interest margin. In order to lower NIM, Nassar, Martinez, & Pineda (2014) recommended further structural reforms and consolidation among banks.

Umraugh (2015) investigated the determinants of Banks NIM in Jamaica and found that foreign ownership and operating costs were the most significant factors. Other significant factors included size, liquidity, credit and funding risks. In order to lower NIM and improve efficiency within the banking sector, she recommended strategies aimed at lowering operating costs, expanding market size and increasing competition among banks.

Though significant emphasis has been placed on determination of the NIM, Nguyen (2012) highlighted an increasing reliance on non-traditional off-balance sheet earnings in the context of a declining trend in core deposits among US banks experiencing a falloff in loan yields. He sought to identify the relationship between net interest margin and noninterest income by using a system estimation approach to control for simultaneity between the NIM and Non-Interest Income (NII). Using panel data for banks across 28 financially liberalized countries for the period 1997 to 2004, Nguyen (2012) identified a statistically insignificant association between NIM and NII subsequent to a structural break in 2002. The estimation suggested no apparent benefits from diversifying across traditional and non-traditional banking activities.

Similar to investigations by Craigwell & Maxwell (1986) on Caribbean Commercial Banks and DeYoung & Rice (2004) on US Commercial Banks, Bailey-Taper (2010) explored the inter-

linkages between non-interest income (NII), financial performance and the macroeconomy among commercial banks in Jamaica. Using a system of equations within a seemingly uncorrelated regression (SUR) model, the link between NII, bank profitability with its variance was assessed. Accounting for macroeconomic and bank specific data from 1999 to 2010 which includes ROA as the measure of profitability. Bailey-Taper (2010) showed that NII grew in response to the proliferation of ATMs, deterioration in loan quality and improved bank efficiency as well as an increase consumer loans and investments. While the NII was adversely related to the share of core deposits and loan portfolio growth, a clear influence was observed on profitability and its variation.

Robinson (2002) examined trends in commercial bank interest rate spreads in Jamaica with the objective of identifying the main factors influencing the evolution. The paper recommended use of implicit loan and deposit rates and bank net interest margins in assessing bank behaviour and profitability due to limitations identified when using ex-ante measures. From an examination of operating ratios and estimates of the components of bank interest spreads, the importance of bank specific, macroeconomic and both regulatory and institutional factors were considered crucial in the determination of interest spreads. Robinson (2002) identified low and stable inflation and reduced government debt as key macroeconomic developments to target. He established that reducing required reserves would have only a miniscule effect on banking spreads. However, operating costs were above benchmark levels with significant scope for reduction. Wider use of efficient and appropriate technology was encouraged as well as need for introducing credit reporting to the financial landscape in Jamaica. Along with other regulatory improvements, recommendations for enhanced quality of loan portfolio was encouraged for effective narrowing of interest rate spreads within the sector.

Data:

Data Specification:

Unbalanced panel data was collated for 11 deposit taking institutions in Jamaica for the period 2005Q1 to 2016Q4.[1] These institutions are comprised of six (6) commercial banks, three (3) building societies and two (2) merchant banks. Balance sheet and earnings & expenditure data was obtained from the Bank's data warehouse. Additionally, macroeconomic trends and other bank specific and regulatory information was accessed from the Bank's internal data warehouse and the Statistical Institute of Jamaica (STATIN). Among the bank specific variables evaluated were: net interest margins as the key variable of interest; non-interest income; return on asset; operating costs; measures of liquidity, credit and funding risks; market share and market structure based on asset concentration. Dummy variables were also used to capture the importance of foreign ownership and commercial bank designation.

[1] The panel data was unbalanced due to unavailability of data for building societies prior to 2003. Additionally, one one commercial bank had hand a shorter data span due structural shifts resulting from a change in ownership.

The macroeconomic variables that were evaluated includes annual growth in real gross domestic product (GDP); annual headline inflation; changes in the yield on Government of Jamaica 90-day Treasury bill; money market interest rate and exchange rate volatility, public debt to GDP ratio and a dummy variable to reflect the structural shift around the Global Financial Crisis. Regulatory and institutional information includes required cash reserve, capital adequacy, the asset tax rate, dummy variables for both the Jamaica debt exchange (JDX) and National debt exchange (NDX) as well as usage of credit bureau reports since 2013. A list of the variables are provided in Table 3 of the Appendix with descriptions. The list of variables considered as potential determinants of the NIM was guided by a survey of the key variables employed in previous studies (see Table 1).

Table 1 – Survey of Potential Determinants of Bank Net Interest Margin and Profitability

	Operating Cost	Liquidity Risk – Liquid Asset Ratio	Credit Risk – Loan Loss Provision	Credit Risk – Non performing Loans	Funding Risk – Loan to Deposit Ratio	Interest Risk – Interest Rate Volatility	Capital Adequacy – Risk Wgt. CAR	Managerial Efficiency	Opportunity Cost of Reserves	Market Share – Industry Asset Share	Market Power/ Concentration – HHI	Non Interest Revenue (importance)	Foreign Ownership	Bank Type	Bank System Reform	GDP Growth	Inflation	Interest Rate	Gov. Debt to GDP Ratio	Financial Taxation
(Ho & Saunders, 1981)	⊘					⊘			⊘		⊘							⊘		
(Nassar, Martinez, & Pineda, 2014)					⊘						⊘									
Angbazo (1997)				⊘																
Athanasoglou, et. al. (2006)	⊘	⊘	⊘				⊘			⊘	⊘		⊘		⊘	⊘	⊘			
Brock and Suarez (2000)	⊘	⊘		⊘	⊘	⊘	⊘		⊘							⊘	⊘			
Claeys and Vander Vennet (2008)	⊘						⊘			⊘	⊘				⊘	⊘	⊘			
Dumicic and Ridzak (2013)	⊘	⊘		⊘			⊘		⊘		⊘	⊘				⊘	⊘	⊘	⊘	
Dietrich and Wanzenried (2011)	⊘		⊘							⊘	⊘		⊘			⊘		⊘		⊘
Fungacova (2008)				⊘						⊘										
Kasman et al. (2010)	⊘		⊘				⊘	⊘		⊘	⊘					⊘	⊘			
Lieberg and Schwaiger (2006)	⊘																			
Manurung and Anugrah (2013)		⊘			⊘					⊘										
Mannasoo (2012)		⊘				⊘		⊘			⊘	⊘	⊘							
Maudos and de Guevarra (2004)	⊘		⊘			⊘		⊘	⊘	⊘	⊘					⊘				
McShane and Sharpe (1985)							⊘													
Moore & Craigwell (2002)	⊘		⊘							⊘	⊘	⊘		⊘		⊘				⊘
(Robinson, 2002)	⊘	⊘		⊘			⊘		⊘						⊘		⊘	⊘	⊘	
Saunders and Schumacher (2000)	⊘		⊘			⊘	⊘	⊘	⊘											
Sidabalok and Viverita (2011)	⊘			⊘					⊘	⊘										
Garcia-Herrero, et. al. (2009)						⊘				⊘	⊘		⊘	⊘		⊘	⊘			
Saad and El-Moussawi (2010)	⊘		⊘				⊘		⊘	⊘	⊘					⊘	⊘			
Schwaiger and Liebig (2009)	⊘			⊘		⊘	⊘			⊘	⊘	⊘	⊘					⊘		
Horvath (2009)	⊘						⊘			⊘	⊘	⊘				⊘	⊘			
Hasan & Khan (2010)	⊘										⊘	⊘				⊘		⊘		

Data Definitions:

The following provide descriptions of the variables that are evaluated in this paper.

1. *Net Interest Margin (NIM)* – The NIM is used as an indicator of efficiency among deposit taking institutions. A higher NIM suggests a deterioration in efficiency among banks except for exogenous factors such as lower taxes and higher loan default rates (Demirguc-Kunt & Huizinga, 1999). NIM is calculated as the difference between interest earnings and interest expenses as a proportion of total average interest earning assets. The metric is also used as an indicator of profitability among banks.
2. *Non-Interest Income (NII)* – NII is used to assess the degree of reliance on non-traditional earnings sources among banks. As the banking sectors become more competitive traditional banking becomes less profitable and banks are inclined to diversify their earning sources. An increase in NII is anticipated when NIM becomes depressed. The NII is measured as the ratio of Non-Interest Income as a proportion of Interest Earning Assets.
3. *Return On Asset (ROA)* – ROA is used to signal the banking firm profit motive. A decline in profits is likely to be met by increased diversification of earning sources among banks. The ROA is measured as the ratio of Profits before tax to Total Assets.
4. *Operating Cost (OC)* – OC is used to measure the costs incurred by banks to maintain operations. A higher OC is indicative of increased inefficiencies and should result in a higher NIM. OC is measured as the proportion of operating expenses to total interest earning assets.
5. *Non-Interest Income (NII)* – NII is used as a measure of income substitution between interest earnings activities and other sources of income such as charges and fees. It is postulated that when banks face increase competition within the lending market, they will increase fees and charges to compensate for lower margins on loans. A negative correlation is expected between NIM and NII but the case of inverse causality is highly suspected.
6. *Liquidity Risk (LR)* – LR measures the degree of mismatch between maturing liabilities and new and maturing loans. A higher ratio indicates greater accessibility of loanable funds. Considering that interest rates are likely to fall when banks are more liquid, increased liquidity should negatively affect the NIM. (Hamadi & Awdeh, 2012) also noted that when banks interest rates rise, the resulting increase in liquidity due to reduced lending would trigger a reduction in NIM. LR is calculated as the ratio of liquid assets to total assets.
7. *Funding Risk (FR)* – FR seeks to capture the cost or availability of funds to meet lending needs. A higher FR indicates that banks are better able to accommodate lending thereby inducing a lower NIM due to reduced burden on the business model (Nassar, Martinez, & Pineda, 2014). If capital inflows are used to support lending, then internalizing the foreign currency risk may require higher NIM. Also, if foreign capital flows out, then a higher NIM may be required to induce deposits for lending. In this study, FR is estimated using the credit (loans) to deposit ratio among banks.

8. *Credit Risk (CR)* – CR measures the likelihood that borrowers will default on loans. The higher the CR the higher the NIM will be required to cushion the deterioration in loan portfolio value. Typical measures of CR include provisions for non-performing loans, loan write-offs and portfolio of delinquent loans (Nassar, Martinez, & Pineda, 2014). The authors however, highlighted that these measures are backward looking and suggest using a lag of these variables to capture the anticipated credit risk. This paper evaluates CR using both coincident and single lag of the proportion of "loan loss provisions" to total loans.
9. *Capital Adequacy Ratio (CAR)* – CAR is also intended to measure credit risk exposure. Banks are required to maintain sufficient capital to match a given proportion of interest earning assets should loan portfolio risks materialize. Increased lending or an increase in the risk of asset portfolio may require increased capital funding to meet minimum CAR requirements. Improving the CAR may therefore require higher NIM (Raharjo, Hakim, Manurung, & Maulana, 2014). CAR is measured as the sum of both Tier 1 and Tier2 Capital as a proportion of Risk Weighted Assets.
10. *Market Share (Size)* – Larger banks are able to take advantage of economies of scale to reduce intermediation costs thereby boosting efficiency. Furthermore, larger banks are expected to have a greater concentration of loans and deposits allowing for less competitive pricing strategies. Therefore, larger size banks can sustain higher net margins even while pricing competitively. However, market share objectives may induce larger banks to maintain a lower NIM. Size is measured as the share of bank assets to total industry assets.[2]
11. *Herfindahl-Hirschman Index (HHI)* – HHI is a measure of market concentration that signals the ability of a bank to set monopolistic prices. A lower HHI therefore, reflects increase competition and a tendency for the NIM to be lower. The HHI is measured by squaring the sum of market share ratios across banks. In this case, market share is calculated as the proportion of total industry loans held by banks.
12. *Bank Structure* – The paper includes binary variables to identify the influence of being a commercial bank (D_CBNK) as well as being a foreign bank (D_FBNK). Any significant asymmetric influence of these classifications on the NIM would be useful information in charting policies aimed at improving efficiency in the banking system.
13. *Macroeconomic Variables* – The literature highlights numerous instances where macroeconomic variables prove influential in NIM determination. This assessment includes the standard macroeconomic variables as well as other indicators of economic conditions and outlook. Among the key macroeconomic variables are GDP growth, headline inflation, depreciation and changes in the Treasury bill yields. Other measures of economic conditions includes public debt to GDP ratio as a proxy for crowding out of private sector investment, interest rate and exchange rate volatility to account for the foreign currency risk exposure among banks.
14. *Regulatory Variables* – Structural breaks were included to take account of changes in the financial landscape resulting from the onset of the global financial crisis in 2008

[2] Industry asset is estimated using the aggregate of assets for the eleven (11) banks included in the sample.

(D_GCRISIS); the National Debt Exchange (D_NDX) in the March quarter of 2010 and the Jamaica Debt Exchange (D_JDX) in the March quarter of 2013 as well as the introduction of numerous Credit Bureaus aimed at reducing credit risk exposure within the banking system. *Cash Reserve Ratio (CRESV)* is also treated as a measure of regulatory expense and is expected to induce a higher NIM due to the imposed opportunity cost of lending. CRES is measured as the proportion of local currency deposits held as cash reserves at the central bank. Another Regulatory expense is the *Asset Tax (ASTAX)* faced by Banks in Jamaica.[3] The asset tax is expected to reduce efficiency in the banking system by increasing the NIM.

Stylized Facts:

Overview: *Table 2* shows the operating ratios and component contribution of the implicit loan rate among commercial banks in Jamaica consistent with the method employed by Robinson (2002).[4] The results indicate that commercial bank loan rates averaged approximately 20% between 2001 and 2006 which fell to 10.8% by end 2016. Subsequent to 2006, implicit loan rates began to fall in response to a narrowing of profit margins despite an increase in operating cost ratios. In 2010, the weighted average of the implicit deposit rate fell by approximatley half coinciding with the Jamaica Debt Exchange (JDX), contributing to further reductions in the implicit loan rate. While commercial bank profit margins narrowed following 2010, and deposit rates remained largely subdued, adjustments in the implicit loan rate continued to reflect changes in operating costs. Commercial bank operating ratios show that employee and professional costs are significant contributors to operating costs.[5] Furthermore, the share of commercial bank profits from lending operations fell to 26.1% in 2016 from 54.6% in 2006 while the share of non-interest and non-investment income (other) rose to 57.9% in 2016 from 17.5% in 2006. The assesment indicate that while margins from implied interest rates narrow, operating costs remain elevated with banks relying more on non-interest income to bolster overall profitability.

Table 2 – Commercial Bank Operating Ratios & Profits

Operating Ratios of Banks	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Implicit Loan Rate (wgt.avg)	20.2	20.3	21.0	20.4	20.5	20.7	19.1	17.5	18.2	16.3	14.3	13.0	12.1	13.5	12.1	10.8
Implicit Deposit Rate (wgt.avg)	8.1	7.2	8.5	6.6	5.3	5.2	5.3	5.5	5.6	3.5	2.4	2.1	2.1	2.9	2.2	2.0
Implicit Margin (Spread)	**12.1**	**13.1**	**12.5**	**13.8**	**15.3**	**15.4**	**13.8**	**12.0**	**12.6**	**12.9**	**11.9**	**10.9**	**10.0**	**10.6**	**9.9**	**8.9**
Cash Reserves	0.9	0.7	1.0	0.6	0.5	0.5	0.6	0.6	0.8	0.4	0.3	0.3	0.3	0.3	0.3	0.3
Operating Costs	5.3	5.3	5.8	5.9	6.5	6.1	6.0	7.5	7.2	7.3	7.3	7.5	7.9	8.1	7.2	6.6
Employee Costs	*2.7*	*2.6*	*2.9*	*2.7*	*3.0*	*2.7*	*2.7*	*3.3*	*3.1*	*3.1*	*3.2*	*3.1*	*3.1*	*3.1*	*2.7*	*2.4*
Occupancy Costs	*0.8*	*0.8*	*0.9*	*1.0*	*1.1*	*1.0*	*0.9*	*1.0*	*0.9*	*0.9*	*0.9*	*0.9*	*0.9*	*1.0*	*0.8*	*0.8*
Professional Costs	*0.5*	*0.4*	*0.6*	*0.7*	*0.7*	*0.9*	*0.8*	*1.0*	*0.9*	*1.1*	*1.1*	*1.3*	*1.5*	*1.6*	*1.7*	*1.7*
Loan Losses	*0.1*	*0.1*	*0.1*	*0.3*	*0.3*	*0.4*	*0.4*	*0.6*	*1.0*	*0.8*	*0.8*	*0.7*	*0.6*	*0.7*	*0.5*	*0.4*

[3] The Asset Tax on Jamaican Banks was introduced by the Government of Jamaica (GOJ) in FY2012/16 at a rate of 0.14% of taxable assets. Taxable assets entailed the aggregate of asset value excluding "IFRS and prudential loan loss provisions, withholding tax receivables owned by GOJ and required capital". The rate was further adjusted in FY2014/15 to 0.25% and has since been unchanged. (*The variable ASTAX is measured as 1 plus the rate over the sample period to reflect 1 when the tax was non-existent*).

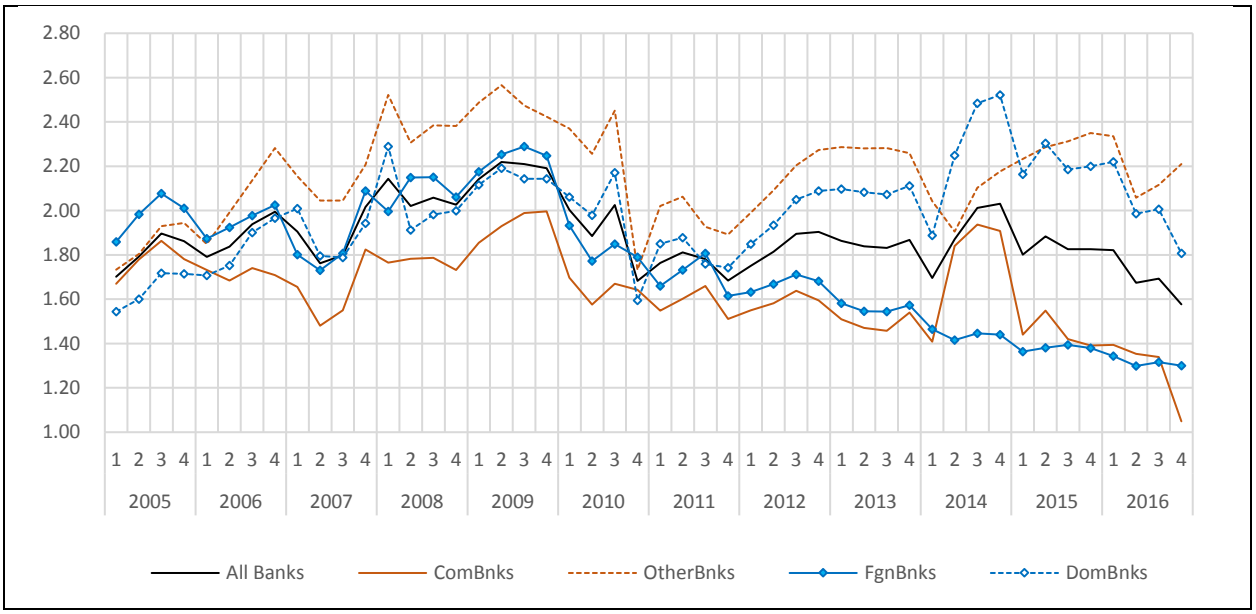
[4] The implicit loan rate was weighted across commercial banks based on industry share of loans and advances while implicit deposit rates was weighted across commercial bank share of demand, savings and time deposits.

[5] Whereas employee costs include all salary related costs, professional costs incorporate legal, advertisement, auditing and other fees related to borrowing.

Other Costs	*1.2*	*1.2*	*1.3*	*1.2*	*1.3*	*1.1*	*1.2*	*1.5*	*1.3*	*1.4*	*1.3*	*1.5*	*1.8*	*1.8*	*1.5*	*1.4*
Profits (Interest)	**5.8**	**7.1**	**5.7**	**7.2**	**8.3**	**8.8**	**7.2**	**3.9**	**4.6**	**5.2**	**4.4**	**3.1**	**1.8**	**2.1**	**2.5**	**2.0**
Investment Income	7.9	6.6	7.3	5.8	4.8	4.5	3.8	5.0	4.5	3.0	2.4	2.1	1.7	1.7	1.4	1.2
Other Income	2.0	2.2	2.8	2.4	3.2	2.8	3.0	3.9	3.0	3.6	6.0	4.3	3.7	4.2	3.7	4.5
Profits (All Income)	**15.7**	**15.9**	**15.9**	**15.5**	**16.2**	**16.2**	**14.0**	**12.8**	**12.1**	**11.8**	**12.7**	**9.5**	**7.2**	**8.0**	**7.6**	**7.8**
Interest Profit (%Share)	*37.3*	*44.9*	*36.2*	*46.8*	*50.9*	*54.6*	*51.2*	*30.5*	*37.6*	*44.2*	*34.4*	*32.2*	*25.5*	*26.5*	*32.7*	*26.1*
Investment Income (%Share)	*50.1*	*41.5*	*46.2*	*37.7*	*29.4*	*27.9*	*27.4*	*38.8*	*37.5*	*25.7*	*18.6*	*22.1*	*23.6*	*21.2*	*18.4*	*16.1*
Other Income (%Share)	*12.6*	*13.6*	*17.5*	*15.5*	*19.7*	*17.5*	*21.4*	*30.7*	*24.9*	*30.1*	*47.1*	*45.7*	*51.0*	*52.3*	*49.0*	*57.9*

Over the 5-year period to 2009, average Net Interest Margins (NIM) for the banking sector reflected a modest upward trend (see Figure 1). However for the four quarters of 2010, NIM reverted to 2005 levels coinciding with the introduction of the Jamaica Debt exchange (JDX). After 2010, the NIM reflected a mild increase to 2014. Subsequently, the industry average NIM featured a general downward trend to end 2016 at the lowest level attained during the sample period. The lower NIM was due to the efficiency gains observed in the foreign and commercial bank segments. Banks classified as foreign banks and banks classified as commercial banks featured trend declines in the NIM since 2009 and continue to outpace the industry average. Following the 2010 structural break, the margin spread between commercial and non-commercial banks as well as foreign and domestic banks have widened considerably, as efficiency in commercial and foreign banks improved.[6]

Figure 1 - Net Interest Margins by Bank Segmentation (quarterly ratios)



2005-2009 Period: The NIM displayed a general upward trend that coincided with strong growth in loan to deposit ratios, used as proxy for funding risk, as well as upward trends in operating

[6] Commercial to non-commercial bank margin spread widened to negative 116 bps at end-2016 from negative 42 bps at end-2009. The margin spread for foreign banks widened to negative 51 bps at end-2016 from negative 11 bps at end-2009.

costs and statutory reserves (see Figure 2 and Figure 3). While the liquid asset ratio, used as a proxy for liquidity risk, displayed periodic changes that coincided positively with the NIM, this relationship broke down over 2007 to early 2008 when international oil prices reached record highs and banks liquid asset positions plummeted. Market concentration, proxied by the Herfindahl-Hirschman Index (HHI) varied marginally over the period to 2009, but displayed a general upward trend in line with the NIM. Until 2010, non-interest income (NII) displayed a fairly stable trend with periodic adjustments reflecting no distinctive correlation with the NIM. Until 2007, the patterns in NIM closely corresponded with developments in GDP growth but broke down thereafter as GDP growth continued to decline over the 2008 period (see Figure 4). Over the period 2005-2009, there was no discernible relationship between trends in annual inflation and the NIM, and while loan loss provisions, as a measure for credit risk, featured positive correlation with the NIM in 2005, there was no distinguishable relation out to 2009.

Figure 2 – Net Interest Margin and Measures of Bank Risk

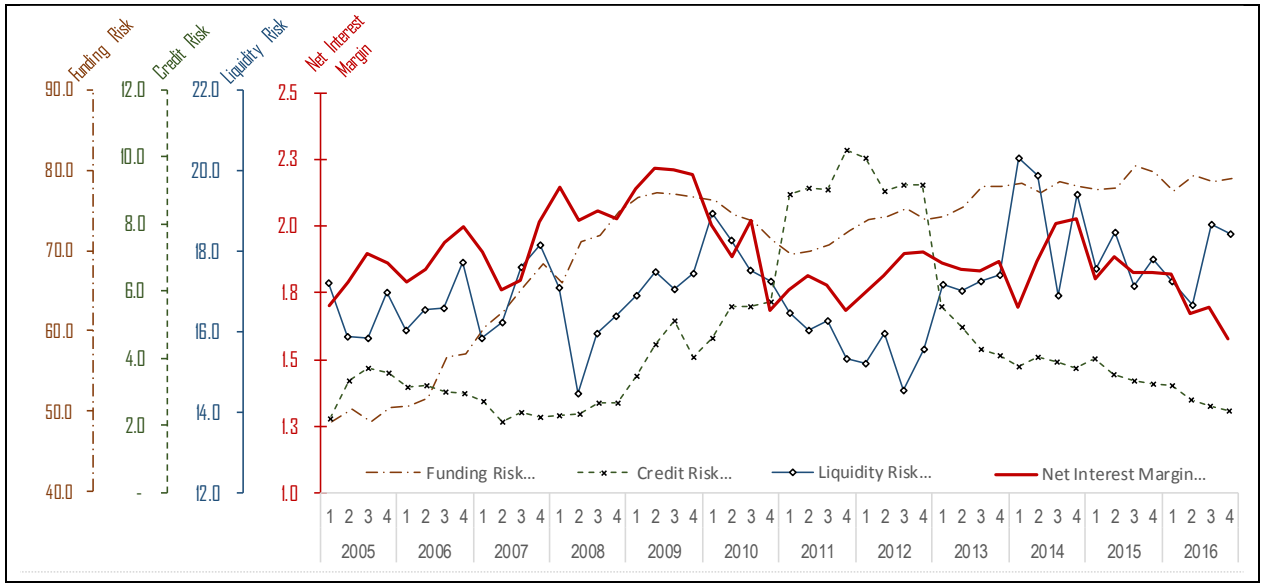
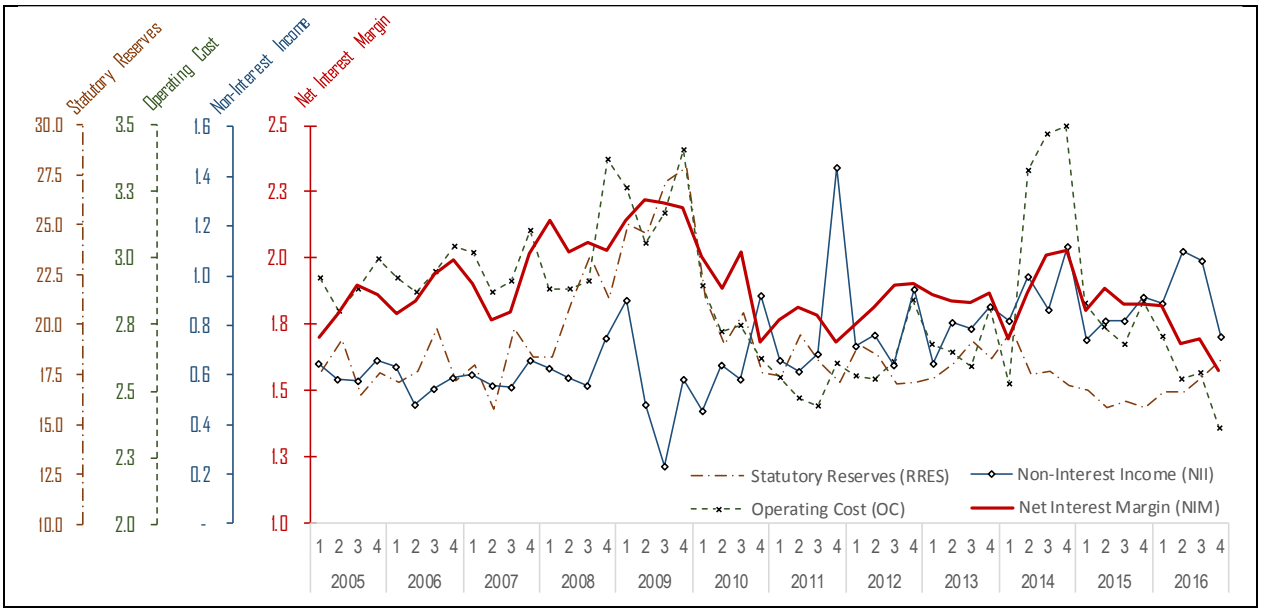
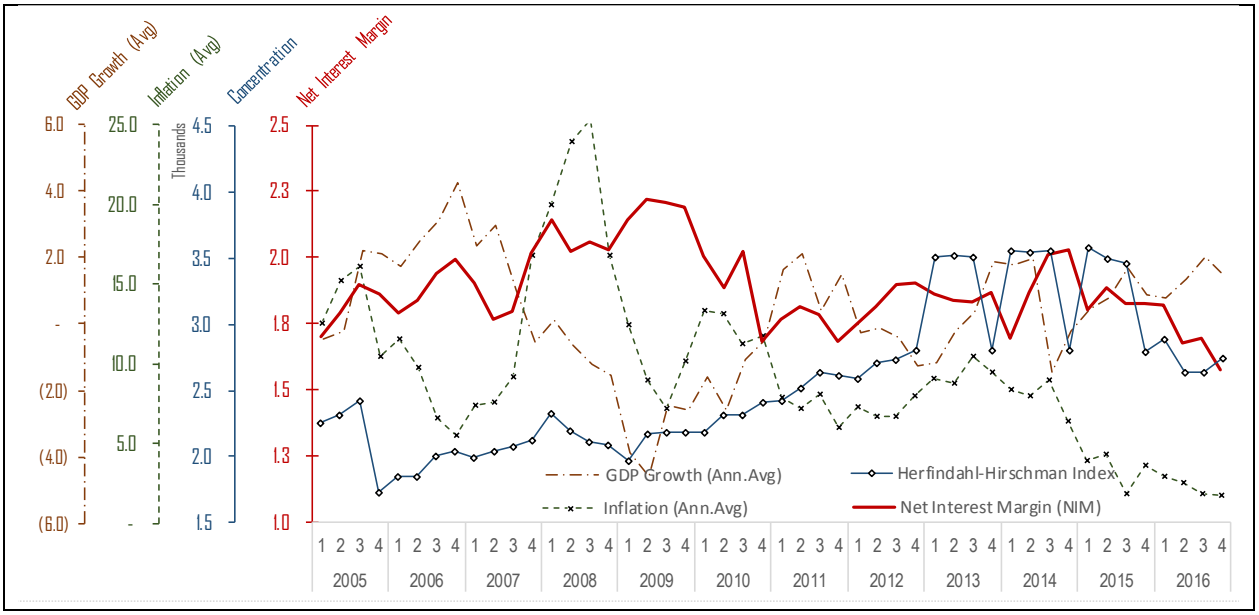


Figure 3 – Net Interest Margin, Non-Interest Income, Operation & Statutory Costs



2010 Period: There was a notable downward shift in the NIM that was featured across all banking segments. This reduction coincided with the Jamaica Debt Exchange (JDX) that was introduced in that year. Among the variables that reflected decline were Operating Cost and Statutory Reserves, as well as both liquid asset ratio (liquidity risk) and loan to deposit ratio (funding risk). Over the year, NII climbed displaying a distinctive negative correlation with the NIM. Market concentration appeared to accelerate slightly while GDP growth rebound. In the last quarter of 2010 there was also a distinctive spike in loan loss provision as proxy for credit risk.

Figure 4 – Net Interest Margin, Market Concentration & Macroeconomic Indicators



2011-2014 Period: Following the reduction after the 2010 JDX, the NIM reverted to a modest upward trend for the four year period to 2014. While operating cost reflected a corresponding mild upward trend, periodic changes displayed some inverse relation with the NIM. This inverse pattern was also observed with statutory reserves which, on average, displayed a fairly stable trend. Funding Risk reflected a consistent upward trend along with market concentration and annual inflation. There was no discernible relationship between the NIM and GDP growth during this period. A break in the patterns of both liquidity risk and credit risk was observed at the beginning of 2013 when the National Debt Exchange (NDX) was introduced and the Government of Jamaica secured an Extended Fund Facility (EFF) with the IMF. In the period to 2013, credit risk (loan loss provision) remained significantly elevated while liquidity risk (liquid asset ratios) continued its steep decline following the JDX in 2010. On initiation of the NDX in 2013, Liquid assets rebounded steadily to all-sample high by early-2014 while loan loss provisions (Credit risk) plummeted to pre-JDX levels. However, the NIM displayed no significant response to these developments.

2015-2016 Period: Following 2014, a distinctive downward turn was observed in the NIM. This coincided with persistent downward trend in operating cost, credit risk, liquidity risk, the measure of market concentration and annual inflation. Among these variables, the NIM displayed strong periodic co-movement with operating cost, liquidity risk, and to a lesser degree, market concentration. During this period, economic growth reflected a favourable trend. While NIM tapered over the two years to 2016, NII reflected a strong incline except for quarter four of 2016 when the measure fell precipitously. Over the period, cash reserve featured a modest upward trend while loan to deposit ratios (FR) continued to reflect a growing trend, though at a slowing pace relative to the 2011-2014 period.

Stationarity Tests:

When non-stationary variables are included in regressions, the results are prone to biased standard errors leading to unreliable estimates for statistical inference. Non-stationary variables are likely to signal significant relationships when there is none. To ensure the reliability of our results, all variables were subject to unit root tests. Table 3 provide results from the unit root tests considered most appropriate for panel data analyses. These include "Levin Lin Chu", "Im Pesaran Shin" and "Fisher Augmented Dickey Fuller" unit root tests. The results and proposed transformations are included in the last four columns of Table 3.

Correlation Assessment:

A correlation analysis was conducted on the range of stationary variables considered in the model. The assessment was aimed at identifying highly correlated explanatory variables and use the most significant among each set in order to minimize inconsistent results stemming from multicollinearity. Among the explanatory variables, there was strong correlation between Funding Risk (FR) and risk weighted Capital Adequacy Ratio (CRAR) as well as FR and Liquidity Risk (LR) (see Table 4). In obtaining parsimonious estimates, the least significant

among these pairs should be first eliminated while conducting the general to specific technique in attaining parsimonious estimates.

Methodology:

Modified Cost Function Model:

This paper adapts a modified version of the cost-function model developed by Klein (1971) and Monti (1972) as introduced by Nassar, Martinez, & Pineda (2014) to explain developments in the NIM. The model assumes that banks are managed based on a cost function which takes into account the value of asset entrusted and other factors of production such as capital and labour (see Eq. 1). Assuming banks are competitive, profit will be maximized using the identity in Eq.2. Profits will be induced from higher loan interest earnings and lower costs associated with borrowings, production, provisions and non-interest expenses.

Eq. 1 $\text{Costs} = \mathrm{C(A; K, L)}$

Eq. 2 $\text{Profits} = (\mathrm{r_A} - \mathrm{r_D}) - \mathrm{C(A; K, L)} - Provisions - NonInterestExpenses$

The profit maximizing identities for competitive, monopolistic and oligopolistic banking industries are given in Eq.3, Eq.4 and Eq.5, respectively.

Eq. 3 $(r_A - r_D) = \frac{\partial C(A;K,L)}{\partial A}$ Competitive Agent

Eq. 4 $(r_A - r_D) = \frac{\partial C(A;K,L)}{\partial A} + \mathrm{D}\frac{\partial r_D}{\partial D} - \mathrm{A}\frac{\partial r_\mathrm{A}}{\partial \mathrm{A}}$

$= \frac{\partial C(A;K,L)}{\partial A} + \frac{1}{\eta_\mathrm{D}} + \frac{1}{\eta_A}$ Monopolistic Agent

Eq. 5 $(r_A - r_D) = \frac{\partial C(A;K,L)}{\partial A} + \frac{1}{\mathrm{N}}\left(\frac{1}{\eta_D} + \frac{1}{\eta_\mathrm{A}}\right)$ Oligopolistic Agent

Where, for competitive banks, the interest spread only equates to the marginal cost of managing assets with all other components of the profit identity being reduced to zero as they represent infra-marginal profits. However, Monopolistic banks account for semi-elasticities of demand deposits $\left[\eta_D = \frac{1}{D}\frac{dD}{dr_D}\right]$ and assets supply$\left[\eta_A = \frac{1}{A}\frac{dA}{dr_A}\right]$ while Oligopolistic banks will relate the interest spread to the number of banks (N) in the system.

Adopting the Oligopolistic representation of profit maximization in Eq. 5, Nassar, Martinez, & Pineda (2014) showed that changes in the degree of concentration in the banking system will influence the interest rate spread achieved through an adjustment to the size of oligopoly profits. Given Eq. 5, a reduction in the number of banks within an Oligopolistic market will rule out

contestable markets and ensure higher spreads and marginal operating costs.[7] Using the Herfindahl-Hirschman index (HHI) as a measure of market concentration and banks operating cost (OC) as the marginal cost of managing assets and production (see Eq. 3), the Oligopolistic cost function in Eq. 5 was reinterpreted as Eq.6

Eq. 6 $$(r_A - r_D) \approx OC + HHI$$

Similar to the inclusion of HHI in Eq. 6, Nassar, Martinez, & Pineda (2014) modified the functional form of the profit maximizing identity to incorporate measures of liquidity, credit and funding risk as well as inflation and real GDP growth as key macroeconomic variables for empirical estimation. The modified cost function model introduced by Nassar, Martinez, & Pineda (2014) is represented in Eq.7.

Eq. 7 $$(r_A - r_D) \approx OC + \mathrm{LR} + \mathrm{CR} + \mathrm{FR} + HHI + \mathrm{RGDP} + \mathrm{INFL}$$

Following in the pattern of Nassar, Martinez, & Pineda (2014), the reduced form modified cost function used to investigate determinants of the NIM in Jamaica is provided in Eq.8.

Eq.8 $$(r_A - r_D) \approx f(firm, institutional, regulatory, macroeconomic\ )$$

Where: $(r_A - r_D) = NIM$ and

$$f(firm) = f(OC, LR, CR, FR, SIZE)$$
$$f(institutional) = f(HHI, CBNK, FBNK)$$
$$f(regulatory) = f(CRESV, CAR, ASTAX, CBUR, NJDX)$$
$$f(macroeconomic) = f(NGDP, CPIJA, XRATE, INTVOL, XRVOL)$$

Where NIM is the Net Interest Margin as a share of interest earning assets, OC is Operating Cost ratio, LR, CR and FR are proxies for Liquidity, Credit (default) and Funding (withdrawal) risks, respectively (see Table 3 for data specifications). Size is based on share of industry assets. HHI is the Herfindahl-Hirschman Index for market concentration, FBNK and CBNK are dummies to account for Foreign and Commercial Bank classification, respectively, CRESV is the ratio of deposits held as reserves, CRAR is the risk weighted Captial Adequacy ratio, ASTAX is the Asset tax rate, CBUR is the number of reports generated by Credit bureau while NJDX are dummies for either the National or Jamaica Debt Exchange. RGDP is real GDP, CPIJA is the Consumer price index, XRATE is the bilateral exchange rate for the US dollar and INTVOL and XRVOL are the daily standard deviation in the interbank rate and exchange rate for each quarter.

[7] *The theory of contestable markets holds that there exist markets served by a small number of firms, which are nevertheless characterized by competitive equilibria (and therefore desirable welfare outcomes), because of the existence of potential short-term entrants.*

Following Nguyen (2012) and Baily-Taper (2010) the specification for Non-interest Income (NII) is represented in Eq.9.

Eq. 9 $$\text{NII} = f(OC, LR, FR, CR, SIZE, ROA, NIM, ATM, PSLOAN, NGDP, CPIJA, XRATE, INTVOL, XRVOL)$$

Where NII is the Non interest income as a share of interest earning assets, ROA represents the Return on Asset using before tax profits, ATM is the count of Automated Teller Machine Transaction as a proxy for use of technology in the industry, PSLOAN is the share of Private Sector Loan to total loans and NGDP is the nominal GDP for economic activity.

Equation 9 indicates that the NIM along with variables that determines its outcome are instrumental in the determination of the NII. (Nguyen, 2012) recommends estimation of the two equations within a system to account for simultaniety bias. To address the problem of serial correlation, Nguyen (2012) employed a Generalized Method of Moements (GMM) technique to estimate the NIM and NII equations for his system of equations.

Model Selection:

To model the NIM and NII simultaneously, a system based approach will be adopted consistent with (Nguyen, 2012). However, the following provide details on the selection criteria for the individual models to be incorporated within the system.

Both the NIM and NII in Eq.8 and Eq.9, respectively, are tested for heterogeneous effects, model misspecification, and the presence of serial correlation in order to decide the most appropriate model to handle the data characteristics. Results from the Breush Pagan (1980) test rejected the null of no heterogeneity across banks for both models (see *Figure 5* in Appendix). Furthermore, the Hausman (1978) misspecification test was used to check for consistency between the parameters of the fixed-effects (FE) and random-effects (RE) models. The results confirmed consistent estimates and so the RE model was chosen to obtain the most efficient estimates. Additionally, the RE model was tested for serial correlation using the Arellano-Bond LM test statistic. The results confirmed the presence of serial correlation.

The presence of serial correlation signal the potential for endogenous relationships that requires the use of an instrumental variables approach to provide more efficient estimates than the standard RE model. The GMM instrumental variables approach was chosen instead of the 2SLS due to prior selection of the RE model.[8] According to Baltagi (2008), lag dependent variables are included in panel data models to account for persistence over time due to both serial correlation and individual heterogeneous effects. It is on this ground that a Dynamic GMM model was employed for this assessment.

[8] The 2SLS instrumental variables approach is generally considered appropriate when the model specification is governed by the simple GLS for a pooled data representation. GMM is able to account for individual effects with the aid of specialized weighting matrices.

The literature features similar instances where panel data among banks provided evidence of serial correlation and potential endogeneity (Dumicic & Ridzak, 2013). The GMM estimator was generally selected due to its ability to handle these data characteristics, Garcia-Herrero, Gavila and Santabarbara (2009), Dietrich and Wanzenried (2011), Horvath (2009) and Dumicic & Ridzak (2013). The Dynamic GMM estimator introduced by Arellano and Bover (1995) was adopted to effectively address the concerns of serial correlation and endogenous relationships within the panel dataset.

Dynamic Generalized Method of Moments DGMM:

The Generalized Method of Moment (GMM) estimation approach uses an orthogonality condition between the residuals of an equation (Eq.10) and the set of the K instruments in Z_t as represented in Eq.11. The method then seeks to identify the parameter β which ensures that the sample of moment conditions $m_T(\beta)$ in (Eq.12) are as close to zero as possible. The distance to be minimized is defined by the quadratic cost function represented in (Eq.13).

Eq.10 $$u_t(\beta) = u(y_t, X_t, \beta)$$

Eq.11 $$E\left(Z_t u_t(\beta)\right) = 0$$

Eq.12 $$m_T(\beta) = \left({}^{1}/_{T}\right) \sum_t Z_t u_t(\beta) = \left({}^{1}/_{T}\right) Z' u(\beta)$$

Eq.13 $$J\left(\beta, \widehat{W}_T\right) = T m_T(\beta)' \widehat{W}_T^{-1} m_T(\beta)$$
$$= \left({}^{1}/_{T}\right) u(\beta)' Z \widehat{W}_T^{-1} Z' u(\beta)$$

Where $u_t(\beta) = u(y_t, X_t, \beta)$ are residuals from the equation, $\widehat{W}_T$ is a symmetric, positive-definate $L \times L$ weighting matrix across the moment conditions, Z_t is a set of K instruments and L is the number of moment conditions.

Model performance is judged based on R-Square value, significance of parameters and appropriateness of sign. Also, the cost function specified by the Sargan test as represented by the J-Statistic (see Eq.4) must be indifferent to zero. This is established when the J-Statistic is very small and the associated p-value shows that the Null Hypothesis of being zero, cannot be rejected at the 5% critical value. The p-value should therefore approach unity.

Empirical Estimation and Results:

Estimation DGMM:

The Dynamic GMM estimation procedure proposed by Arellano and Bover (1995) was used to estimate the expanded reduce form of the bank firm cost function represented in Eq.8 as well as

the identifying relationship for the NII in Eq.9. Also, using the NIM as the indicator of banking sector efficiency, equations were estimated for the overall banking sector and four separate segments which include commercial banks, non-commercial banks, foreign banks and domestic banks (see Table 7 in Appendix). The estimation includes only stationary series to minimize the likelihood of Type I errors. Additionally, a correlation assessment was carried out to minimize the occurrence of multicollinearity while eliminating insignificant variables from model results. Parsimonious estimates were attained by using the general to specific technique with further refinements for robust results achieved from an additive approach for identifying significant variables.

A GMM with a single autoregressive term was used to account for serial correlation and the presence of endogenous and heterogeneous effects. The success of this method was gauged against the Durbin Watson test statistic.[9] The list of instruments selected for consistent results was guided by the method prescribed by Fair (1970) while ensuring the order condition for model identification was met.[10] The Sargan test statistic of over-identifying restriction is premised on the quadratic form of the moment conditions being indifferent to zero (see Eq.4). This test requires a J-Statistic that is close to zero with failure to reject the null hypothesis of being zero, evidenced by a statistically insignificant probability value. This was confirmed for all five (5) of the NIM equations as well as the NII (see Table 7 & 8 in Appendix). Furthermore, the estimation of each equation was guided by achieving a significant R-square value while limiting undue influence from the autoregressive term.

System Estimation:

As precondition for the system of equation, a granger causality test was conducted with both NIM and NII as stationary series (see Table 3). The pairwise granger causality test suggests that the NIM, with weak statistical significance (10%), granger cause NII but the NII does not granger cause NIM. This is consistent with the proposed structural form Eq.8 and Eq.9 whereby the NIM is a contributing factor to NII. However, when using the Dumitrescu Hurlin (2012) panel causality test that averages the pairwise causality across individual effects, there appear to be no causality from the NIM to NII or vice versa. The System of Dynamic GMM was estimated with consideration of a potentially weak causality through the endogenous relationship. Allowing for separate auto regression coefficients, while supplying similar instruments to those obtained in the individual DGMM. The results of the system of equation aggregated across all banks is provided in Table 8.

[9] The Durbin Watson test statistic for a case where there is no serial correlation approaches the value of 2.0.
[10] For the identification of instrumental variable models, Fair (1970) prescribed the use of both lagged LHS and RHS variables as well as those variables that were excluded from the model. Furthermore Fair (1984) and Davidson & MacKinnon (1993) outlined that too many instruments may lead to over identification that would result in computational difficulties. They recommended the addition of instruments only if they improve the model.

Findings:

The final results on determinants of NIM from the system of DGMM equation as well as individual estimates for the industry and subcomponents are represented in Table 7 & 8 of the Appendix. The key findings are featured below:

The NIM and NII system of equation confirms the relationships identified by the individual D-GMM estimates with few exceptions. Variables with weak statistical significance in the individual D-GMM estimates fell out completely within the System of equations. These include Capital Adequacy Ratio (CRAR) and Commercial Bank Classification (D_CBNK) for the NIM and Funding (withdrawal) Risk for the NII (see Table 8 in Appendix). All other determinants maintained strong statistical significance and represent parameters that were largely similar in magnitude along with corresponding signs to the individual D-GMM estimates.

Monetary policy, economic growth, market power and asset tax have immaterial effects on NIM: Among the determinants, no clear influence on the NIM was discerned from cash reserves adjustments (CRESV) and interest rate (T-Bill) as proxies for monetary policy influence on margins. Also, no significant influence on margins were detected from economic growth, market concentration (HHI) or changes in the asset tax rate. Notwithstanding, the NIM model relied on bank size and changes in the T-Bill as necessary instruments for identification. Also, whereas the count of ATM transactions, as a proxy for technology usage within the sector, was not statistically significant in either models, the measure was relied on as a necessary instrument for identification of the NII.

When aggregated across all banks, the system of equations approach show that banking sector efficiency is mainly hampered by high operating costs while lower NIM has been brought about by increased liquid asset conditions, increased holdings of government debt and increased volatility in interest and exchange rates.

Banks rely more on non-interest income to make up for lost profitability and Asset Tax Demands:
The system of equation reveals that non-interest income (NII) was positively influenced by the NIM, reduced profitability (ROA), increased liquid asset conditions, growing bank size and imposition of the asset tax.

Operating cost is the most significant single determinant of NIM: Consistent with inference from the stylized facts, operating costs proved to be the most significant determinant of NIM and mainly so among non-commercial banks (see Table 7). This comes as no surprise considering that foreign and commercial banks reflect the lowest operating costs across the banking sector (see Figure 5 F). All classification of banks reflected a positive relationship between NIM and OC in accordance with a prior expectations.

Foreign Banks competitively reduce NIM when assets are liquid: On average, an increase in liquid assets across banks contributed to a lower NIM and primarily among foreign banks. This

is likely due to competitive type pricing strategies whereby loan rates are lowered when liquid funds increase. Domestic banks, however, reflected a positive and statistically significant increase in net interest margins when liquid assets improved.

Foreign and Commercial Banks maintain lower NIM: A distinctive individual effect was observed for foreign banks which on average maintained a lower NIM than domestic banks. This result coincides with findings from (Demirguc-Kunt & Huizinga, 1999) who identified the inherent efficiency advantage that international banks have, allowing for tighter margins. A similar effect was observed among commercial banks which, though with weaker statistical significance, displayed an even lower average NIM. The upside bias for NIM among domestic banks may reflect a larger share of non-commercial banks being domestically owned.

There is a high degree of persistence in NIM among foreign and commercial banks: Results from individual estimation of the NIM across all banks indicate that approximately 34% of the explanatory power was due to the determinants considered while 63% was accounted for by inertia from the autocorrelation term (see Table 7 in Appendix). The inertia was even stronger within the system of equations. Quite distinctively, the determinants identified in this study were responsible for 9.6% and 51% of the variation in NIM among foreign and domestic banks, respectively. The high degree of persistence in NIMs may be due to structure of the banking sector, and for foreign and commercial banks in particular, a signal of approach to a lower bound threshold.

Funding risks do not constrain Commercial Banks but impacts Domestic Non-Commercial banks: Commercial banks on the average reflect a positive relationship between funding risk and NIM, contrary to a prior expectations. This result potentially reflects liquidity pressures signalling that funding risk is not a significant factor that commercial banks contend with considering stipulated cash reserve requirements along with direct access to the central bank discount window, access to interbank and private money markets as well as deposit insurance coverage. However, the impact of funding risk on NIM among domestic banks was negative as expected suggesting that domestic banks lower margins when a larger share of deposits are held in loans. Domestic non-commercial banks are therefore exposed to a greater degree of funding (withdrawal) risks.

Foreign and Domestic Banks respond differently to changes in CAR: The impact of CAR on NIM was mixed across banks. Foreign banks increased NIM while domestic banks reduced NIM in order to maintain minimum CAR levels. This result suggests that Foreign Banks are more likely to bolster CAR by raising retained earnings or new equity issue while domestic banks are more inclined to dispose of risky assets.

Credit Bureau Reporting has contributed to lower NIM among Non-commercial banks: Credit Bureau Reporting was notable and statistically significant in lowering NIM among non-commercial banks. While the effect was not observed among Commercial banks which already have significant information systems, Non-commercial banks have more to gain due to the significant risk of adverse selection that they face for new clients.

While foreign banks respond weakly to inflation by raising NIM, non-commercial banks appear to absorb this cost, tolerating a narrowing of interest margin.

The NIM gets smaller during uncertain times: On aggregate, banks reduced NIM amidst periods of exchange rate and interest rate volatility. This may signal the outcome of either valuation losses or a tendency for investment lending to slow during uncertain times, necessitating lower margins to maintain business objective. While commercial banks respond to both exchange and interest rate volatility alike, domestic banks responds primarily to exchange rate volatility.

Banks reflect higher NIM following reduction in Government Debt: A lower debt to GDP ratio and reduced share of Government debt in the balance sheet of banks was associated with higher NIM. This was statistically significant among non-commercial banks and to a lesser degree, commercial banks. This relationship contradicts a prior expectations and may be attributed to a shift away from low yield government instruments to a risker asset base among banks. This was also supported by positive influence of National Debt Exchange (NDX) on NIM among domestic non-commercial banks, though with weak statistical significance.

Summary & Recommendation:

Using a system based Dynamic GMM model to identify the determinants of NIM as a gauge for banking sector efficiency, numerous insights were ascertained. Among these: (1) operating cost represents the single most influential determinant of net interest margin among Jamaican banks; (2) NIM among foreign and commercial banks are at sample period lows and feature a high degree of persistence suggesting approach to a lower bound threshold, while displaying evidence of competitive pricing when liquid conditions improve; (3) The banking sector has evolved with increased reliance on revenue from non-traditional banking services (NII) to maintain profit motive and offset growing tax burden; (4) While commercial banks are fortified with client information to minimize risk of loan default, non-commercial banks are able to benefit from enhanced credit reporting facilities to reduce their exposure to credit risks and (5) Interest rates and cash reserves as well as economic growth, market power and asset tax display negligible role in reducing NIM among Jamaican deposit taking institutions.

In order to improve banking sector efficiency in Jamaica, it is recommended that significant focus be given to reducing operating costs among banks. Strategies to lower operating costs must be internally driven. These may include centralization of banking services with greater reliance on technology based banking facilities with emphasis on reducing labour and professional costs. Also, as the banking sector modernize and reduced the need for brick and mortar operations, banks should consider expanding the use of agent banking models to reduce operating costs while meeting client transaction needs.

The BOJ should continue its liquidity expansion programme to maintain downward pressure on domestic lending rates and margins among deposit taking institutions in Jamaica.

Whereas the use of technology in Jamaica was evident in early periods Bailey-Tapper (2010), further expansion of ATM and POS facilities are unlikely to generate significant efficiency gains. Instead, a new wave of technology products such as mobile banking should be strongly promoted and endorsed by the Central Bank and Government for improved banking sector efficiency.

Considering that non-commercial banks have reflected efficiency gains from introduction of credit bureaus in Jamaica. Continued support for credit reporting and other institutional enhancements should be targeted for reduced NIM. This approach to increase access and quality of information should be matched by increased communication on the costs and availability of financial services in order to promote competition within the sector.

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Appendix:

Table 3: Data Specification

Group	Notation	Description	Formula	Mean	Maximum	Minimum	Std.Error	UR Test - (Levin Lin Chu)	UR Test - Im Pesaran Shin	UR Test - Fisher _ADF	Required Adjustment
Bank Specific Indicators	NIM	Net Interest Margin	(Interest Income - Interest Expense) / Interest Earning Assets *100	1.95	6.20	0.35	1.37	I(0)***	I(0) c,***	I(0) c,***	-
	NII	Non-Interest Income	Non-Interest Income / Interest Earning Assets * 100	0.84	3.41	(2.95)	0.83	I(0)***	I(0) c,***	I(0)***	-
	OC	Operating Costs	Operating Cost / Earning Assets * 100	3.20	11.32	0.79	2.22	I(0)***	I(0) c,***	I(0)***	-
	LR	Liquidity Risk	Liquid Assets / Total Assets * 100	18.40	61.66	2.27	13.38	I(0)***	I(0) c,***	I(0) c,***	-
	CR	Credit Risk	Loan Loss Provision / Total Loans * 100	1.49	4.97	-	1.16	I(0)***	I(0) c,***	I(0)***	-
	FR	Funding Risk	Total Loan / Deposit * 100	77.31	237.05	7.12	46.79	I(0) c,***	I(0) c,***	I(0) c,**	-
	CRAR	Capital Adequacy Ratio	Capital Adequacy Ratio (Risk Weighted Assets)	18.91	40.18	10.29	7.78	I(0)***	I(0) c,***	I(0) c,***	-
	SIZE	Market Size	Total Firm Asset / Total Industry Asset	9.09	34.89	0.15	10.36	I(0) c,***	I(1) c,***	I(0)**	-
	GOVDBT	Government Debt Ratio	Government Investment / Total Investment	13.91	49.96	0.46	10.62	I(0)***	I(1) c,***	I(1)***	-
	D_FBNK	Foreign Bank	Dummy Variable (Banks Specific)	0.36	1.00	-	0.48				
	D_CBnk	Commercial Bank Dummy	Dummy Variable (Banks Specific)	0.55	1.00	-	0.50				
Macroeconomic & Industry	HHI	Herfindahl-Hirschman Index	Square & Sum of Market Share	3,047.88	3,580.83	2,083.04	637.33	I(1)***	I(1) c,***	I(1)***	difference
	INTVOL	Interest Rate Risk	Quarterly Interbank Rate Variance	2.03	15.12	0.07	3.18	I(0)***	I(1) c,***	I(0)***	-
	DRGDP	Real GDP Gwth	Real GDP Growth	(0.23)	1.98	(2.61)	1.62	I(0)***	I(0) c,***	I(0)***	-
	DCPIJA	Consumer Price Index	Consumer Price Index (End of Period)	8.95	16.84	3.96	3.74	I(0)***	I(0) c,***	I(0)***	-
	TBILL	Interest Rate	180 day Treasury Bill	10.73	22.01	6.73	5.52	I(0)***	I(1) c,***	I(0)***	difference
	PDEBT	Public Debt to GDP Ratio	Public Debt / Annual Real GDP * 100	125.87	143.09	79.99	22.98	I(0) c,***	I(1) c,***	I(1)***	difference
	D_GCRISIS	Global Financial Crisis	Dummy (Post Dec-2008 Quarter)	1.00	1.00	1.00	-				
Regulatory Indicators	CRESV	Cash Reserve Ratio	(Required Reserves + Vault Cash)/Deposits * 100	12.45	14.34	11.20	0.89	I(0)**	I(0) c,***	I(0) c,**	-
	CBURR	Credit Bureau Introduction	Count of Reports Provided	6.63	77.69	-	16.82	I(1)***	I(1) c,***	I(1)***	difference
	ATM	ATM Transaction Count	ATM Transaction Count	23,835.96	57,473.81	5,940.82	13,727.12	I(1)***	I(1)c,***	I(1)***	difference
	PLOAN	Private Sector Loan Share	ComBnk Private Loan/ Total Loan * 100	64.48	67.55	60.59	1.95	I(1)***	I(1)c,***	I(1)***	difference
	ASTAX	Asset Tax	Asset tax rate for each period.	1.16	1.25	1.00	0.11				
	D_NDX	National Debt Exchange	Dummy (Post Mar-2010)	0.71	1.00	-	0.45				
	D_JDX	Jamaica Debt Exchange	Dummy (Post Mar-2013)	0.71	1.00	-	0.45				

Table 4: Correlation Matrix

	NIM	NII	ROA	OC	LR	CR	FR	CRAR	SIZE	DHHI	DLOG(ATM)	DPLOAN	INTVOL	XRVOL	CRESV	DCBURR	ASTAX	DRGDP	DCPIJA	DTBILL	DPDEBT
NIM	100	0.12	0.03	0.85	-0.14	-0.34	-0.05	-0.20	-0.08	-0.01	-0.02	-0.03	0.01	0.01	0.02	-0.01	-0.03	-0.07	0.05	-0.01	0.03
NII	0.12	100	0.32	0.26	0.38	0.09	-0.33	-0.34	0.33	-0.08	0.05	0.00	-0.03	0.10	0.06	0.12	0.17	0.04	-0.11	0.07	-0.06
ROA	0.03	0.32	100	-0.32	-0.12	-0.09	0.26	0.19	0.20	-0.01	0.08	-0.02	0.04	0.01	-0.11	-0.12	-0.20	-0.01	0.14	0.04	0.03
OC	0.85	0.26	-0.32	100	-0.03	-0.21	-0.28	-0.31	-0.09	-0.05	0.00	-0.06	0.06	0.03	0.00	0.03	0.00	-0.05	0.04	0.01	0.03
LR	-0.14	0.38	-0.12	-0.03	100	0.06	-0.49	-0.27	0.09	0.00	-0.01	0.00	0.01	0.01	0.03	0.02	0.03	0.00	-0.02	-0.02	-0.02
CR	-0.34	0.09	-0.09	-0.21	0.06	100	-0.03	0.00	0.29	0.05	-0.03	0.07	-0.07	-0.06	0.03	-0.06	-0.06	0.00	-0.03	-0.05	0.06
FR	-0.05	-0.33	0.26	-0.28	-0.49	-0.03	100	0.39	-0.13	0.00	-0.04	-0.03	-0.04	0.08	0.19	0.08	0.14	-0.11	-0.07	-0.01	-0.03
CRAR	-0.20	-0.34	0.19	-0.31	-0.27	0.00	0.39	100	-0.30	-0.02	0.01	0.03	-0.03	-0.10	-0.03	-0.06	-0.13	0.02	0.05	-0.09	0.03
SIZE	-0.08	0.33	0.20	-0.09	0.09	0.29	-0.13	-0.30	100	0.00	0.01	0.00	0.01	-0.01	-0.03	-0.01	-0.02	0.02	0.01	0.00	0.00
DHHI	-0.01	-0.08	-0.01	-0.05	0.00	0.05	0.00	-0.02	0.00	100	-0.52	0.27	0.06	0.03	0.08	-0.09	-0.09	-0.09	0.01	-0.04	-0.01
DATM	-0.02	0.05	0.08	0.00	-0.01	-0.03	-0.04	0.01	0.01	-0.52	100	-0.11	-0.03	-0.10	-0.31	-0.06	-0.02	0.23	0.03	0.22	-0.04
DPLOAN	-0.03	0.00	-0.02	-0.06	0.00	0.07	-0.03	0.03	0.00	0.27	-0.11	100	-0.14	-0.29	-0.02	-0.01	0.05	0.35	-0.19	0.02	0.09
INTVOL	0.01	-0.03	0.04	0.06	0.01	-0.07	-0.04	-0.03	0.01	0.06	-0.03	-0.14	100	0.38	-0.26	0.00	-0.14	-0.02	0.33	0.61	0.06
XRVOL	0.01	0.10	0.01	0.03	0.01	-0.06	0.08	-0.10	-0.01	0.03	-0.10	-0.29	0.38	100	0.24	0.04	0.19	-0.28	0.02	0.32	-0.01
CRESV	0.02	0.06	-0.11	0.00	0.03	0.03	0.19	-0.03	-0.03	0.08	-0.31	-0.02	-0.26	0.24	100	0.13	0.26	-0.59	-0.36	-0.35	0.10
DCBURR	-0.01	0.12	-0.12	0.03	0.02	-0.06	0.08	-0.06	-0.01	-0.09	-0.06	-0.01	0.00	0.04	0.13	100	0.61	0.04	-0.30	0.00	-0.15
ASTAX	-0.03	0.17	-0.20	0.00	0.03	-0.06	0.14	-0.13	-0.02	-0.09	-0.02	0.05	-0.14	0.19	0.26	0.61	100	0.12	-0.56	0.04	-0.38
DRGDP	-0.07	0.04	-0.01	-0.05	0.00	0.00	-0.11	0.02	0.02	-0.09	0.23	0.35	-0.02	-0.28	-0.59	0.04	0.12	100	-0.33	0.17	-0.39
DCPIJA	0.05	-0.11	0.14	0.04	-0.02	-0.03	-0.07	0.05	0.01	0.01	0.03	-0.19	0.33	0.02	-0.36	-0.30	-0.56	-0.33	100	0.13	0.30
DTBILL	-0.01	0.07	0.04	0.01	-0.02	-0.05	-0.01	-0.09	0.00	-0.04	0.22	0.02	0.61	0.32	-0.35	0.00	0.04	0.17	0.13	100	-0.01
DPDEBT	0.03	-0.06	0.03	0.03	-0.02	0.06	-0.03	0.03	0.00	-0.01	-0.04	0.09	0.06	-0.01	0.10	-0.15	-0.38	-0.39	0.30	-0.01	100

Figure 5: Charts of Series*:*

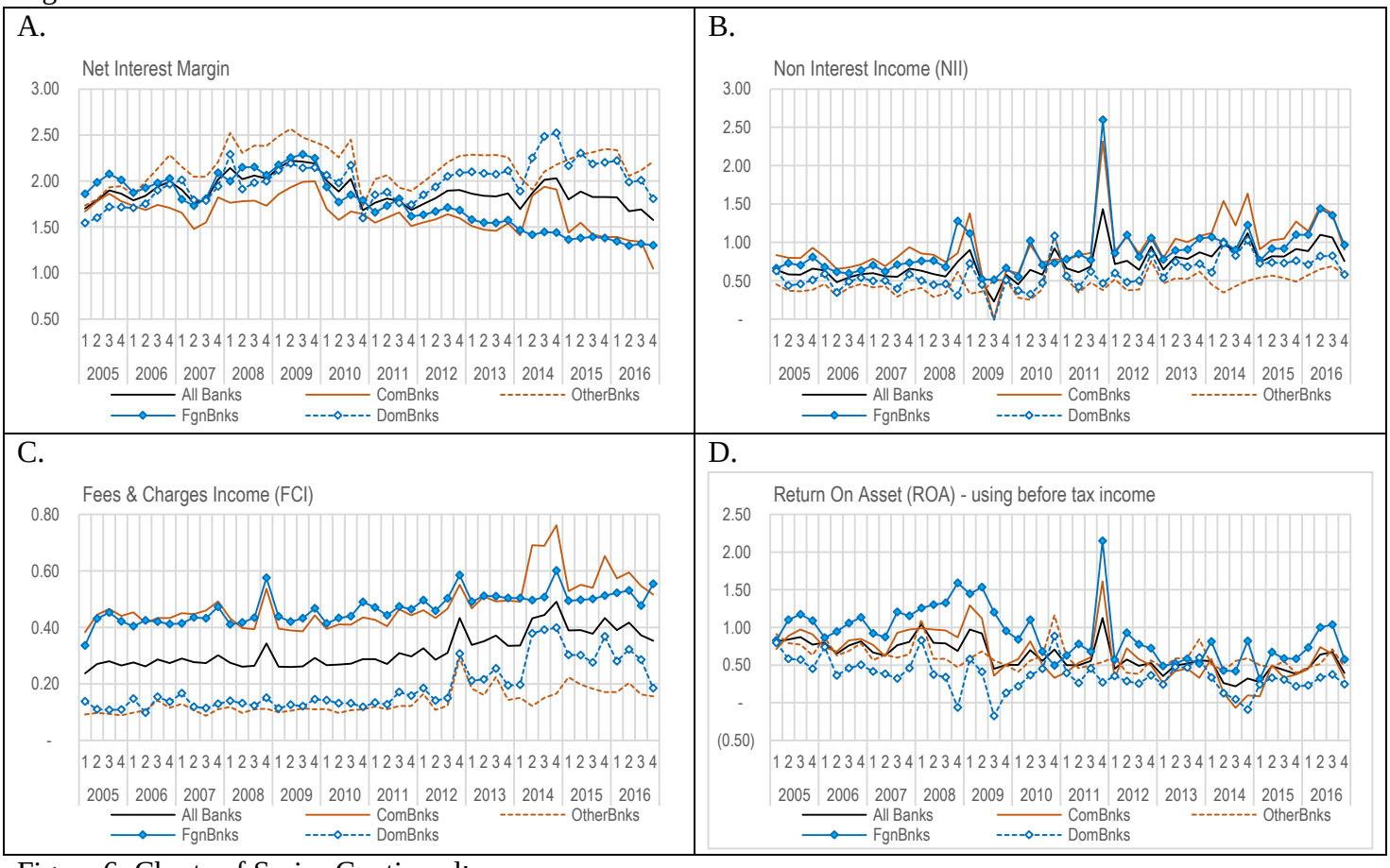
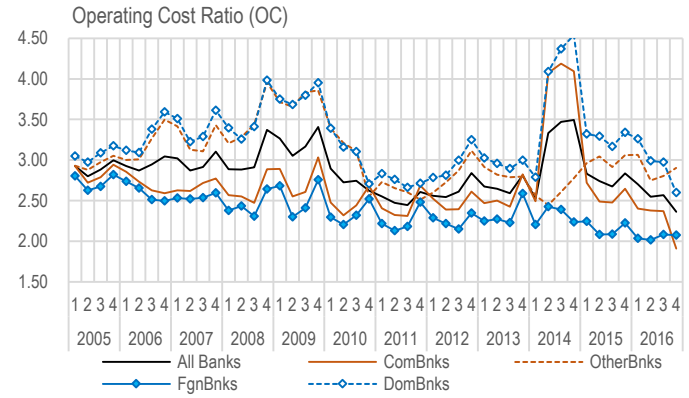


Figure 6: Charts of Series Continued:

F.


Operating Cost Ratio (OC)
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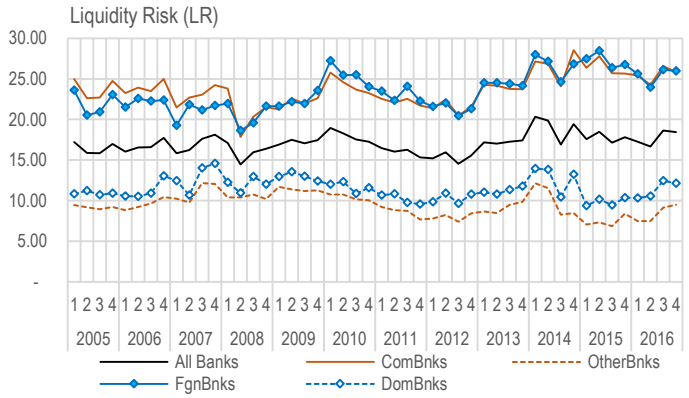
4.00
3.50
3.00
2.50
2.00
1.50
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
All Banks
ComBnks
OtherBnks
FgnBnks
DomBnks

G.


Liquidity Risk (LR)
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25.00
20.00
15.00
10.00
5.00
-
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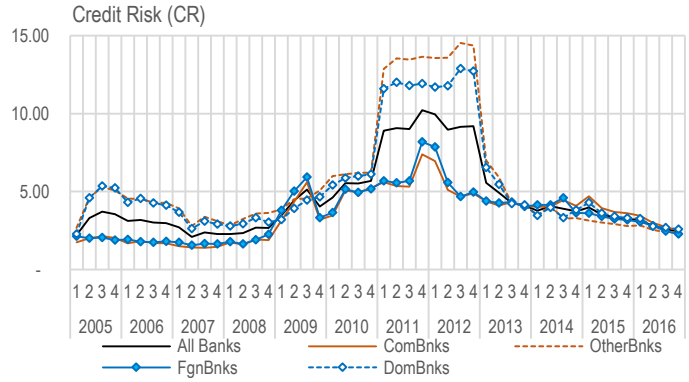
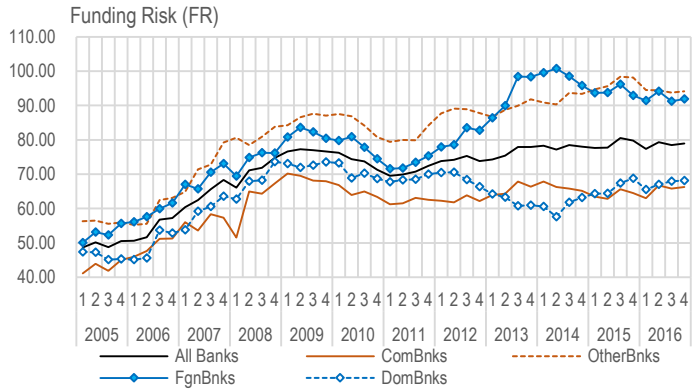
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
All Banks
ComBnks
OtherBnks
FgnBnks
DomBnks

H.


Credit Risk (CR)
15.00
10.00
5.00
-
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
All Banks
ComBnks
OtherBnks
FgnBnks
DomBnks

I.


Funding Risk (FR)
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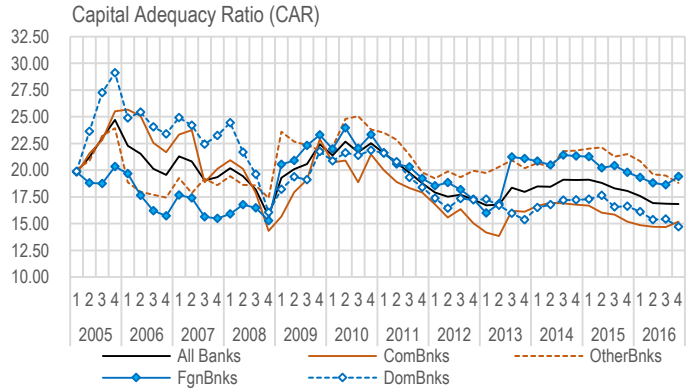
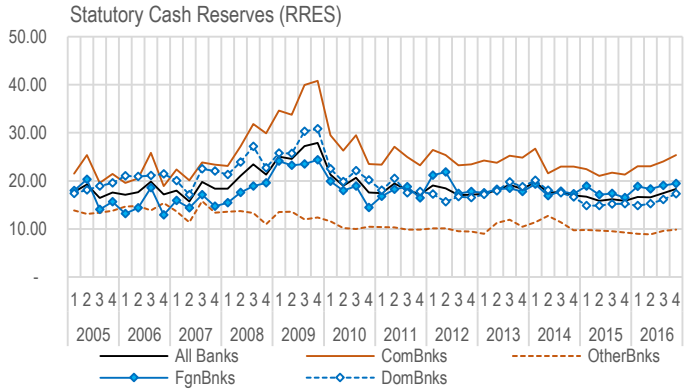
100.00
90.00
80.00
70.00
60.00
50.00
40.00
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
All Banks
ComBnks
OtherBnks
FgnBnks
DomBnks

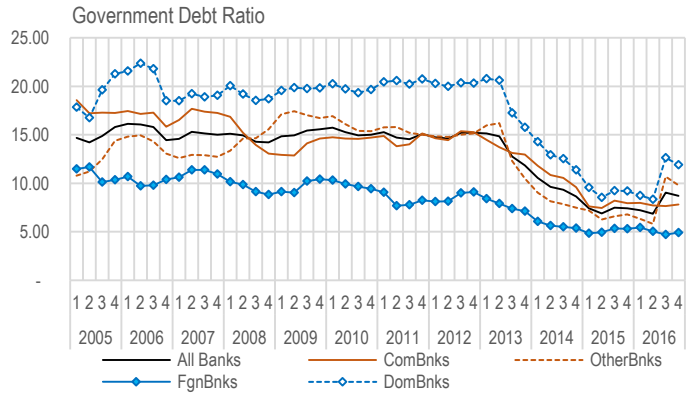
J.


Capital Adequacy Ratio (CAR)
32.50
30.00
27.50
25.00
22.50
20.00
17.50
15.00
12.50
10.00
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
All Banks
ComBnks
OtherBnks
FgnBnks
DomBnks

K.


Statutory Cash Reserves (RRES)
50.00
40.00
30.00
20.00
10.00
-
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
All Banks
ComBnks
OtherBnks
FgnBnks
DomBnks

L.


Government Debt Ratio
25.00
20.00
15.00
10.00
5.00
-
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
All Banks
ComBnks
OtherBnks
FgnBnks
DomBnks

M.

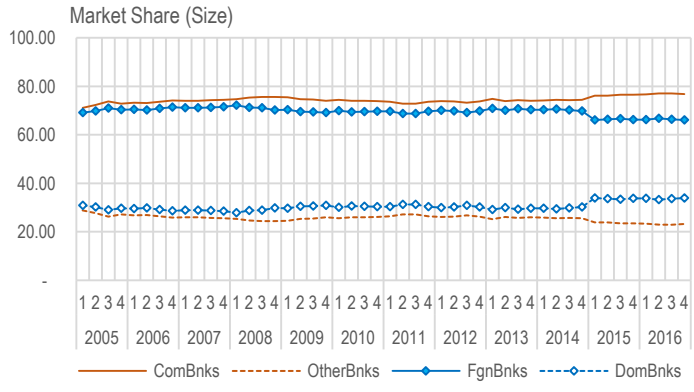

Market Share (Size)
100.00
80.00
60.00
40.00
20.00
-
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
ComBnks
OtherBnks
FgnBnks
DomBnks

Table 5 - Panel Test Statistics for NIM and NII Specifications

Heteroskedasticity Test: NIM Fixed Effects

Residual Cross-Section Dependence Test
Null hypothesis: No cross-section dependence (correlation) in residuals
Equation: NIM_FE_PARSIMONIOS
Periods included: 66
Cross-sections included: 11
Total panel (unbalanced) observations: 649
Test employs centered correlations computed from pairwise samples

Test	Statistic	d.f.	Prob.
Breusch-Pagan LM	316.2534	55	0.0000
Pesaran scaled LM	23.86072		0.0000
Bias-corrected scaled LM	23.77611		0.0000
Pesaran CD	0.405788		0.6849

Heteroskedasticity Test: NII Fixed Effects

Residual Cross-Section Dependence Test
Null hypothesis: No cross-section dependence (correlation) in residuals
Equation: FE_NII_PARSIMONIOUS_01
Periods included: 54
Cross-sections included: 11
Total panel (unbalanced) observations: 564
Test employs centered correlations computed from pairwise samples

Test	Statistic	d.f.	Prob.
Breusch-Pagan LM	174.0636	55	0.0000
Pesaran scaled LM	10.30346		0.0000
Bias-corrected scaled LM	10.19969		0.0000
Pesaran CD	9.466066		0.0000

The Breusch Pagan LM test checks for the presence of correlation between the residuals and cross section units. The null hypothesis is for homoscedasticity such that there is no correlation (dependence) between the residuals and cross section (individual) effects. Results from the Breush Pagan LM test statistic strongly rejects the null of no cross sectional dependence for both the NIM and NII specification suggesting the existence of heterogeneous effects in both modesl across banks. Given these results, the selected models should account for individual effects instead of being pooled. (Note) The Breusch Pagan LM test statistic was derived from the parsimonious estimates of a fixed effects model obtained from the list of variables considered for this assessment.

Hausman Misspecification Test: NIM Random Effects Model

Correlated Random Effects - Hausman Test
Equation: NIM_FE_PARSIMONIOS
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	4.812006	5	0.4393

Cross-section random effects test comparisons:

Variable	Fixed	Random	Var(Diff.)	Prob.
NII	-0.404639	-0.404346	0.000001	0.7943
OC	0.405601	0.411241	0.000017	0.1673
LR	-0.011391	-0.011043	0.000001	0.6494
CRESV	0.053188	0.053234	0.000000	0.8526
DCPIJA	0.011563	0.011607	0.000000	0.7135

Hausman Misspecification Test: NII Random Effects Model

Correlated Random Effects - Hausman Test
Equation: Untitled
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	0.000000	8	1.0000

* Cross-section test variance is invalid. Hausman statistic set to zero.

Cross-section random effects test comparisons:

Variable	Fixed	Random	Var(Diff.)	Prob.
NIM	-0.655322	-0.652658	0.000032	0.6363
ROA	0.884381	0.883575	0.000002	0.5638
OC	0.597952	0.599397	0.000002	0.2751
HHI	0.000124	0.000125	0.000000	0.6664
DLOG(ATM)	-0.306371	-0.304402	0.000003	0.2739
PLOAN	0.080882	0.080897	0.000000	0.8839
(LNGDP-LNGDP(-4))	-2.986168	-2.986888	0.000027	0.8898
INTVOL	-0.018260	-0.018260	0.000000	0.9990

The Hausman Misspecification Test checks if there is correlation between the random effects and explanatory variables. In both the NIM and NII models, the Hausman test results fails to reject the null that the random effects model yields consistent estimates. Since the RE model yields more efficient estimates when correctly specified, it should be used instead of the FE model. (Note) The Hausman Misspecification test statistic was derived from the parsimonious estimates of a random effects model obtained from the list of variables considered for this assessment.

Arellano and Bond Serial Correlation Test: NIM Differenced GMM

Arellano-Bond Serial Correlation Test
Equation: NIM_DIF_PARSIMONIOS
Date: 04/06/17 Time: 01:44
Sample: 2000Q1 2016Q4
Included observations: 492

Test order	m-Statistic	rho	SE(rho)	Prob.
AR(1)	0.771221	40.875549	53.001064	0.4406
AR(2)	0.547501	28.315350	51.717401	0.5840

Arellano and Bond Serial Correlation Test: NII Differenced GMM

Arellano-Bond Serial Correlation Test
Equation: NII_GMM_ALLBNKS_FINAL01
Date: 04/21/17 Time: 12:01
Sample: 2000Q1 2016Q4
Included observations: 542

Test order	m-Statistic	rho	SE(rho)	Prob.
AR(1)	-0.846741	-9.064668	10.705362	0.3971
AR(2)	-1.964075	-33.243091	16.925568	0.0495

For serially uncorrelated residuals, the Arellano and Bond Serial Correlation Test requires that the parameter on the AR(1) term be significant while that on the AR(2) term be insignificant. Test results for both the NIM and NII specifications indicate the presence of serial correlation in the residuals and the need for a dynamic representation of an instrumental variables approach such as the GMM specification. (Note) The Arellano and Bond Serial Correlation Test was derived from parsimonious results of the GMM estimation using differenced data.

Table 6: Granger Causality Tests

Pairwise Dumitrescu Hurlin Panel Causality Tests (Lags: 1)
Date: 04/23/17 Time: 19:58; Sample: 2005Q1 2016Q4

Null Hypothesis:	W-Stat.	Zbar-Stat.	Prob.
NII does not homogeneously cause NIM	0.55898	-1.05562	0.2911
NIM does not homogeneously cause NII	1.57913	1.13851	0.2549

Pairwise Granger Causality Tests
Date: 04/23/17 Time: 20:01; Sample: 2005Q1 2016Q4

Null Hypothesis:	Obs	F-Statistic	Prob.
NII does not Granger Cause NIM	513	0.01235	0.9115
NIM does not Granger Cause NII		2.91497	0.0884

Pairwise Dumitrescu Hurlin Panel Causality Tests (Lags: 2)
Date: 04/23/17 Time: 20:00; Sample: 2005Q1 2016Q4

Null Hypothesis:	W-Stat.	Zbar-Stat.	Prob.
NII does not homogeneously cause NIM	1.31064	-1.18816	0.2348
NIM does not homogeneously cause NII	2.93392	1.23137	0.2182

Pairwise Granger Causality Tests
Date: 04/23/17 Time: 20:01; Sample: 2005Q1 2016Q4

Null Hypothesis:	Obs	F-Statistic	Prob.
NII does not Granger Cause NIM	512	0.00579	0.9942
NIM does not Granger Cause NII		1.10034	0.3336

Table 7: Estimation Results – Dynamic GMM

Dependent Var	**Expected**	**Equation 1**			**Equation 2**			**Equation 3**			**Equation 4**			**Equation 5**		
NIM	**Sign**	**All Banks**			**ComBnks**			**Non-ComBnks**			**Fgn Banks**			**Domestic Banks**		
NII	--															
OC	+	0.8860	*(51.99)*	***	0.2663	*(4.74)*	***	0.8340	*(48.77)*	***	0.3509	*(2.44)*	**	0.8150	*(54.96)*	***
LR	+/-	-0.0495	*(-8.1)*	***	0.0114	*(1.76)*	*				-0.0167	*(-2.71)*	**	0.0283	*(3.53)*	***
CR	+/-	0.0952	*(2.05)*	**												
FR	--				0.0063	*(3.46)*	***							-0.0133	*(-5.98)*	***
SIZE	+/-				0.0245	*(4.55)*	***				0.0307	*(3.11)*	***			
GOVDBT	+	-0.0356	*(-4.83)*	***				-0.0269	*(-5.43)*	***						
D_FBNK	--	0.7590	*(5.7)*	***				1.3500	*(11.35)*	***						
D_CBNK		0.2413	*(2.28)*	**												
D_F&CBNK																
DHHI	+/-															
INTVOL	+															
XRVOL	+													-0.2092	*(-3.72)*	***
INTXRVOL	+	-0.0292	*(-3.29)*	***	-0.0116	*(-3.01)*	***									
DRGDP	--															
DCPIJA	+							-0.0326	*(-2.46)*	**	0.0354	*(2.54)*	**			
DTBILL	+															
PDEBT	+				-0.0055	*(-2.04)*	**									
D_GCRISIS																
CRESV	+															
CRAR	+	0.0115	*(2.33)*	**							0.0373	*(6.47)*	***	-0.0168	*(-4.65)*	***
DCBURR	--							-0.2988	*(-2.63)*	***						
ASTAX	+															
D_JDX																
D_NDX								0.2113	*(2.08)*	**				0.4980	*(4.75)*	***
AR(1)		0.6294	*(13.45)*	***	0.8375	*(18.73)*	***	0.5421	*(7.46)*	***	0.7280	*(9.41)*	***	0.4539	*(6.65)*	***
Method		Panel GMM-EGLS			Panel GMM-EGLS			Panel GMM-EGLS			Panel GMM-EGLS			Panel GMM-EGLS		
Sample Periods		47			46			46			47			47		
Cross Sections		11			6			5			4			7		
Observations		490			261			219			188			315		
Wgt. Matrix		White Cross-Section			White Cross-Section			White Cross-Section			White Cross-Section			White Cross-Section		
Instr-Rank		12			12			10			11			12		
R-Square		0.9657			0.8587			0.9785			0.8242			0.9660		
Adj.R-Square		0.9651			0.8554			0.9779			0.8193			0.9653		
SE.Regression		0.4344			0.2435			0.2903			0.2647			0.4117		
Durbin Watson		2.2503			2.2973			2.1120			2.1484			2.0833		
Mean Dependent Var		2.8278			1.8392			2.4482			1.8618			2.7059		
S.D Depended Var		2.8575			0.7971			2.1265			0.8672			2.1941		
Sum Sq.Resid		90.7620			15.0601			17.8634			12.7478			52.1985		
J-Statistic		0.1534			0.3687			0.5751			0.5918			0.2878		
Prob J-Statistic)		0.9847			0.9961			0.9021			0.9884			0.9979		

+ EGLS represents Estimated (or Feasible) Generalized Least Squares
++ Arrelano & Bond serial correlation test-statistics derived from difference panel GMM using significant variables above except for binary variables.
*Note: Critical values withinn 10%, 5% and 1% significance represented as *, ** and ***, respectively. T-statistic values are displayed within parentheses*

Table 8: Estimation Results – System of Dynamic GMM Equations

Dependent Var	Expected	Equation 1			Equation 6			Equation 7					
NIM	**Sign**	**NIM - All Banks**			**NII - All Banks**			**System NIM**			**System NII**		
NIM					0.1200	*(5.16)*	***				0.0920	*(3.78)*	***
NII	--												
ROA					-0.2710	*(-7.48)*	***				-0.3288	*(-3.84)*	***
OC	+	0.8860	*(51.99)*	***				0.8751	*(22)*	***			
LR	+/-	-0.0495	*(-8.1)*	***	0.0067	*(3.06)*	***	-0.0478	*(-4.36)*	***	0.0133	*(3.94)*	***
CR	+/-	0.0952	*(2.05)*	**				0.1096	*(0.98)*				
FR	--				-0.0004	*(-1.8)*	*				-0.0004	*(-0.52)*	
SIZE	+/-				0.0265	*(14.83)*	***				0.0250	*(7.32)*	***
GOVDBT	+	-0.0356	*(-4.83)*	***				-0.0377	*(-3.01)*	***			
D_FBNK	--	0.7590	*(5.7)*	***				0.6208	*(2.49)*	**			
D_CBNK		0.2413	*(2.28)*	**				0.2908	*(1.24)*				
D_F&CBNK													
DHHI	+/-												
DLATM													
DPLOAN													
INTVOL	+												
XRVOL	+												
INTXRVOL	+	-0.0292	*(-3.29)*	***				-0.0280	*(-3.94)*	***			
DRGDP	--												
DCPIJA	+												
DTBILL	+												
PDEBT	+												
D_GCRISIS													
CRESV	+												
CRAR	+	0.0115	*(2.33)*	**				0.0105	*(1.02)*				
DCBURR	--												
ASTAX	+				0.2365	*(4.74)*	***				0.2717	*(3.17)*	***
D_JDX													
D_NDX													
AR(1)		0.6294	*(13.45)*	***	0.2036	*(5.25)*	***	0.7662	*(10.12)*	***	0.1556	*(2.43)*	**
Method		Panel GMM-EGLS			Panel GMM-EGLS			System GMM					
Sample Periods		47			47			47					
Cross Sections		11			11			11					
Observations		490			500			490			500		
Wgt. Matrix		White Cross-Section			White Cross-Section			White Cross-Section					
Instr-Rank		12			11								
R-Square		0.9657			0.6604			0.8869			0.0060		
Adj.R-Square		0.9651			0.6562			0.8851			-0.0061		
SE.Regression		0.4344			0.5922			0.4392			0.6600		
Durbin Watson		2.2503			2.0677			2.1609			2.0396		
Mean Dependent Var		2.8278			1.0072			1.8954			0.7288		
S.D Depended Var		2.8575			0.8362			1.2953			0.6580		
Sum Sq.Resid		90.7620			172.8698			92.7660			214.7747		
J-Statistic		0.1534			1.3886			Determinant Resid Cov			0.0806		
Prob J-Statistic)		0.9847			0.8462			J-Statistic			0.0564		