University of Sunderland

Mogaji, Peter Kehinde (2018) Probit Modelling and Evaluation of Banking Sector Fragility within the West African Monetary Zone. Working Paper. UNSPECIFIED. (Unpublished)

Probit Modelling and Evaluation of Banking Sector Fragility within the West African Monetary Zone

by

Peter Kehinde Mogaji
(University of Sunderland in London)

Abstracts

This paper aimed at investigating the fragility of banking sectors within the West African Monetary Zone and drawing inferences on the implications of the instability (or otherwise) of the banking systems for the proposed currency union in West Africa. As a matter of relevance and significance, the degree of fragility of the six banking sectors within the WAMZ was investigated so as to determine the extent to which this future currency union in prone to banking sector-induced financial instability which could bring the feasibility and sustainability of the currency union into jeopardy and doubt. Drawing from the theoretical underpinnings of probit model, multivariate probit regression models of banking sector fragility were constructed for the banking sectors in the member countries of the WAMZ. Determinants of the probability of crisis within these banking sectors were employed in multivariate probit models specification with annual data of these six WAMZ countries spanning over a period of time between 1980 and 2013 in which event approach was adopted in identifying episodes of banking problems over this 14-year period. The study noted the stability (or otherwise) of the Nigerian banking sector as paramount, conveying crucial implications for overall banking sector of the proposed WAMZ, given the country's banking strength and presence across the whole sub-continent. From the general outcomes of the probability tests of banking fragility across the WAMZ, banking systems within the zone portend moderate stability which gives assurance of a stable monetary integration of the WAMZ for now.

1   Background

Some of the lessons drawn from Eurozone crisis have turned banking sector stability to an issue of importance for the existing and future monetary unions. The important question that comes to mind here is about the probability of banking sector fragility in member countries of these currency unions. Answers to this question are very crucial in determining the failure and otherwise of an existing monetary union as well as the feasibility and prospects of currency unions the pipeline. Since banking sector stability is pivotal for the stability of financial systems within a monetary union, the fragility of banking systems has been a major area of focus in recent research works. This makes this study on the fragility of banking systems within the bank-based underdeveloped financial systems of the West African Monetary Zone (WAMZ) countries worthy of empirical analysis and academic exercise. Banking crisis is one of the three major forms of financial crisis. The two others in this category are currency crisis and sovereign debt crisis. The WAMZ was made up of The Gambia, Ghana, Guinea, Liberia, Nigeria and Sierra Leone.

Developments from the Eurozone crisis and the need for banking sector stability within a monetary union brought crucial lessons for prospective currency union like the WAMZ and others. Within a currency union, fragile banking sectors are pivotal for financial instability of such currency union, while strong banking sectors are 'preventives' for financial instability of prospective and existing currency union. Consequent upon these background and Eurozone experience, the menace of banking sector fragility in a monetary union cannot be over emphasised. Therefore, the stability (or otherwise) of the banking sectors in the WAMZ is a strong factor that could determine how feasible and sustainable the WAMZ would be, as a monetary union from the view-point of its desired long term stability.

The major aim of this paper is the investigation of the fragility of banking sectors within the WAMZ and draw inferences on the implications of the instability (or otherwise) of the banking systems for the proposed currency union in West Africa. As a matter of relevance and significance, the degree of fragility of the six banking sectors within the WAMZ is investigated so as to determine the extent to which this future currency union in prone to banking sector-induced financial instability which could bring the feasibility and sustainability of the currency union into jeopardy and doubt.

2   Overview and Features of African Banking Sectors

Right from the colonial days up till the late 1990s, the entire African banking sector was hugely dominated by banks having European origin. Since the 1980s, banking in the sub-Saharan Africa (SSA) has witnessed significant changes with the advent of sophisticated banking in many African countries, due to the spread of new technologies. Despite the strong growth in the African banking sector, in comparison with other continents of the world, banking sectors in SSA are relatively under-developed, just as the financial sectors across Africa are under-developed. It is necessary to highlight that banking sectors greatly dominate the Africa financial sector (which is generally underdeveloped). The banking sectors account for a big share of assets and services of the financial sectors. It is evident that banking systems in Africa are small in size (absolutely and relatively). As at 2013, total assets of the entire African banking sectors was less than US$300 billion (South Africa not included), this an equivalent of about one-tenth of the size of Chinese largest bank and about the size of Swedish third largest bank.[1] Most banks exhibit low loan/deposit ratios while government securities is the greater proportion of banks' assets. In the SSA as at 2012, South Africa and Nigeria (a member of the WAMZ) dominating the African banking sector, reporting 36% and 9% respectively in assets while the respective net banking income was 45% and 15%.[2]

African banking sector suffers inefficient, small size and low financial intermediation and are characterized by low competition, little barrier to entry and exits (causing the evident dominance of foreign banks), lowest access to finance (an obstacle to business growth, curtailing the continent's full economic growth potentials). A large proportion of African population is unbanked, thereby making the access to credit by small and medium scale enterprises very tight. This banking sector is generally diverse, showing high rates of banking concentration and penetration.[3]The nature of bank lending in the SSA is short term with over two-third of bank advances having maturity period of below one year. The oligopolistic nature of banking market structures in Africa reflect in the high share of total assets of three largest banks Africa; and this put constraints on the intensity of banking competition in Africa. (Mlachila et al, 2013). The high degree of fragmentation in African banking sector is reflected in the largest banking group in the

---

[1] Sourced from Lefilleur (2013)

[2] Sourced from Derreumaux (2013)

[3] This is for instance, more than 50% in South Africa

continent having (as at 2012), total assets of US$17 billion which is equivalent to around 33% of the size of the Cypriot largest bank.[4]

Branches of banks are concentrated in few urban areas, yet there are high costs of banking operations as reflected in high fees and high interest rates spreads across Africa banking. Lack of banking innovation, under-performances and inability to generate returns of scale are root causes of the lack of the capabilities of making banking environments healthy and competitive, while African banking sectors settle for banking activities that are of low risks within a market displaying the niche for high profitability and which could not have serious impact on the finance of private sectors. Due to the under-development of African banking, total credits to private sector revolve around just one-fifth of African GDP over past years. Nigeria has six of the seven largest banks in the SSA and this makes Nigeria's banking sector to be competitive, with the ability to offer substantial financial services. Nigeria banks (United Bank for Africa (UBA), GT Bank, Zenith Bank, Access Bank) now play dominant roles in the WAMZ member countries.

One other feature of African banking is the co-existence of large and small scale banks. Most of these small banks are government-owned. Due to the lack of the drive of the regulatory authorities to restructure banking sectors in Africa, these small banks are prone to insolvency which could cause the banks to fold up or taken over. Within the African banking sector, dominant banks have strongest and influential powers. In a study by Honohan and Beck (2007), finding revealed that the banking market share of around 73% were held by three banks in the representative African countries samples investigated and this is usually around 60% is the other banking markets around the world. The stylized feature of banking systems in Africa in evident in the combination of some factors: (i) small absolute sizes of banks and the entire banking systems, (ii) low level of income, (iii) low financial literacy levels, large informal sectors, (iv) infrastructural weaknesses, (v) weak judicial enforcement mechanisms, (vi) weak contractual frameworks for banking activities, (vii) weak creditors' rights and (viii) political risks (Mlachila et al, 2013).However, across Africa, there are significant variances in economic importance of banking as shown by differences in legal codes,

---

[4] Only a dozen banking groups have total assets in excess of US$5 billion (Lefilleur, 2013)

laws and regulations, economic sizes, dependence on resources, public policies, history and population density.

Another salient feature of banking sectors in SSA is that banking systems operate significantly excessive liquidity which implies the scarcity of creditworthy fund users and further consequences of this factor for monetary policies in these countries is the effectiveness of policies in serving as instrument that could be applied in influencing bank lending, inflation and other monetary variables. The basic funding bases of African banking system are domestic economies in which non-residents funding are negligible. Viewing this as a demand-side phenomenon, creditworthy borrowers constrain African bank lending growth. Nevertheless, African banks will become more viable if they are to grow as fast as possible to become major players in financial markets just as the entire African economy is growing and moving towards integration, alongside with booms in international trade across the continent.

A look into the history of banking in Africa would reveal that a major cause of banking crisis has been poor lending activities of banks which led to deteriorating bank assets quality and increase in the size of nonperforming loans of banks. Consequent upon this and other issues raised above, the major worry about African banking is the 'home-grown risks' since there were no serious risk-effect of the global economic slow-downs and the Eurozone financial crisis on African banking. The degree of this concern/worry is high for African countries where the bank portfolio of private sector credit is growing rapidly and sustained. Care should be taken so that the combination of poor governance and unreliable/inconsistent supervisory responses to developments in finance and macro-economy would not lead to full-fledged systemic crisis in Africa banking. This could be costly, disruptive and further affect the proposed monetary integration of the regional blocks of the African continent (including the WAMZ). Laeven and Valencia (2012) could establish that since the eruption of the systemic fragility of banks in the 1980s and 1990s, African banking sectors have experienced few banking crises. However, this does not rule out the possibility of pockets of bank fragilities which could be sparked-off or revealed by political crises or deficiencies in governance, though these fragilities may be hidden now.

Nevertheless, it is essential to note that African banking market could not be much impacted by the 2008/2009 global financial crisis due to the shallow nature of the banking systems in Africa owing to the limited integration of African banking markets within global financial markets as well as limited exposure of these banking sectors to 'toxic assets'. This 'shallow nature' enabled the African banking systems to evade the direct consequences of the global crisis and survive through the crisis that impacted the real sectors of these economies in the form of diminishing FDI and exports.

Box 1 contains the highlights and explanations of reasons why banking sector in Africa may be difficult and challenging:

Box 1: *Why Banking in Africa has been more Challenging*		
	Reasons	*Explanations and Effects*
1	Small sizes of many African economies	* This prevents providers of financial services from taking advantage of economies of scale. *Greater proportion of the populace are not commercially viable bank customers as evident by limited demand for banks' products and services - credit, savings, insurance etc. * There is cost effectiveness of banking services outside urban areas given population dispersion in Africa.
2	Informal sector operations of African economies and economic agents	* Large proportion of the populace are excluded from formal banking and financial services and consequently, large proportion of economic agents operates in informal sector and lack proper documentation that facilitates bank financial intermediation. * This causes risks and costs of banking in Africa to be on the increase.
3	Governance problem	* Bad quality of corporate governance in African plagues banking institutions in the continent; * This undermines the provision of banking and financial services, reforms and the intervention of government in attending to financial market failure.
4	Volatilities in African banking	* Volatilities take the aggregate forms of wars, social and political unrests, epidemics and large swing nature of primary commodity prices on which many African economies depend. * Inconsistency and fluctuations in income streams of households and small businesses are the nature of individual volatilities. * These all increase cost of banking services as a well as undermine the management of risks within the banking sector.

Source: Author's explanations and Beck and Cull (2013)

Banking sectors in the WAMZ six member countries are predominantly made up of domestic banks as well as pan-African banks. As characterised by the banking systems across the SSA, banking the WAMZ is generally under-developed and concentrated, exhibiting low degree of competition in spite of low level of entry barrier in the African banking world. Practices and features of banking systems in the WAMZ are reflections

of obtain across African banking sectors. The breakdown of the number of commercial banks in the WAMZ as at the end of 2018, is as shown in Table 1 below:

Table 1 Number Licensed Banks in the WAMZ's Countries

WAMZ Country	Number of Banks
The Gambia	14
Ghana	23
Guinea	15
Liberia	9
Nigeria	22
Sierra Leone	13

Source: Author's compilation

The banking sectors in the six countries consist of big domestic commercial banks, international banks' subsidiaries or branches (pan-African banks) and small (microfinance) banks.

3   Theoretical Background to Banking Sector Fragility

Banking sector fragility is about the riskiness of the banking system. For a monetary union, financial system stability is of paramount importance. This is due to the effects of the high degree of interrelationships of the components of a financial system and the contagion effect of financial crisis on the stability of the economies of member states of the currency union. If literature has established that banking sector is the dominant sector of many financial systems, therefore, the stability of the sector is greatly crucial for economic stability in particular, of developing economies where there are strong links between the financial systems and the macro economy. For monetary unions, this is specifically a reason why the study of banking system vulnerability and fragility is of great relevance towards revealing the stability of the banking sector as well as exposing and analysing early signs of banking crisis given the lessons put to the fore by the Eurozone crisis.

Banking system impacts economic growth and business cycles. For an economy, a stable and strong banking system propels future growth in GDP and enhances the performance of the economy. It is suffice to state that the causal link between banking sector stability and economic growth is not unidirectional. Positive functioning and sound performances of an economy impacts the state of the banking sector; hence, banking system fragility may be the consequence of weak and poor macroeconomic conditions and weaknesses in structural characteristics. Owing to the manifestation of some varied systemic risks within the financial system, it is essential to highlight that there is a strong association between banking fragility and high inflation rate, low

growth rate of GDP and high real exchange rate. Furthermore, the banking system could be impaired if the financial condition of the borrowers move from bad to worse. Demirguc-Kunt and Detragiache (2005) are of the view that poor economic growth and loss of monetary control had many times, been precursors of banking crises. On the other hand, if banks are highly liquid, well capitalised and operate within a baking system where the degree of competition is high, the incidence of banking sector fragility would be minimal.

Banking fragility could be determined by the assessment of total asset/equity ratio which indicates the degree of decline in the asset value of a bank before equity can be wiped off and the bank become insolvent. One further way of capturing bank fragility is to calculate for a bank, the liquidity mismatch index (LMI) that measures the mismatch between market liquidity of the bank's assets (which is the ease at which bank's assets could be exchanged for cash) and funding liquidity of the bank's liabilities (which is the ease at which the bank is instantly able to meet the claims of its creditors). There could be bank runs, usually due to maturity mismatch of bank's liabilities and assets, leading to panics among bank depositors when they felt that the banks may not have liquid resources that are sufficient enough to meet requests by all depositors. The LMI reflects the degree of shortage of fund (in currency units) towards meeting the claims of the creditors. It gives the picture of the amount of fund obtainable by a bank at a particular time in excess of what is needed to meet creditors' claims. LMI may be positive or negative. A negative LMI portends huge difficulties in raising funds to meet claims by creditors.

Banking sector vulnerability may in general originate from: (i) inability of banks within the sector to play the traditional financial intermediation roles; (ii) economic agents' loss of confidence in the banking system; and (iii) the spread of the banking sector vulnerability to the financial system and the economy at large. This is the general notion of banking sector vulnerability. If individual banks within an economy are weak, the aggregation of this is the weakness of the entire banking sector which may further be aggregated by some negative externalities.

There are two different viewpoints to bank fragility. These are the asset viewpoint and the liability viewpoint. Deterioration in the quality of bank's loan assets and bank runs

are the respective examples of asset and liquidity sides of bank fragility. When there two fragility viewpoints are combined, a banking sector is prone to fragility; this would then be on the event of precarious situations like the non-performing loan asset/total loan ratio exceeding an appropriate threshold of, say 10% (asset side); banking sector rescue operation cost of at least, 2% of GDP (asset side); bank runs (liability side) and other emergency measure taken by government (like deposit freezing, generalised deposit guarantees, prolonged bank holidays etc (Demirguc-Kunt and Detragiache, 2005).

History of banking sector crisis has shown that as consequences of banks' core functions within an economy, banks are fragile financial institutions and are consequently vulnerable to instability. Features and characteristics of banking play significant roles in the fragility of the banking system. Some of these features are capital adequacy, asset quality, efficiency of management, profitability, liquidity, competition, liabilities/assets maturity transformation, diversification, among others. Well capitalised banks operating within a country or a currency area reduce the possibility of the contagion effects of bank failure on such country's banking system, as well as on member economies of the currency union. Good level of liquidity buffers liquidity shock while enhancing stability of the banking sector at national and regional/monetary union's levels. Liabilities-assets maturity transformation is core, as maturity mismatch would signal bank fragility. High levels of bad loans (non-performing loans) as percentage of the total loans are at the centre of the measurement of bank fragility. Studies have revealed positive correlation between low bank concentration in the banking system and systemic banking crises; this indicating that large scale diversification of banks assists explains the positive link between stability and concentration within banking systems. The effect of the presence of foreign banks within a banking system (which stimulates competition as well as banking efficiency within the domestic banking sector) is another factor that has positive effect on the stability of banking sectors. However, in spite of this benefit, foreign banks may be sources of cross-border contagion transmitting shocks from one financial system to the other. The matrix below expresses the interrelationship between macroeconomic shock and banking sector fragility:

Box 1: **Matrix of Fragility and Shock**		
	Weak Shock	*Strong Shock*
Low Bank Fragility	Unlikely	Possible
High Bank Fragility	Possible	Likely

This interactions basically express the probability of banking crisis. For instance, when the degree of fragility in a banking sector is high, a weak macroeconomic shock could be enough to spark-off a banking crisis. Further explanation is that banking crisis manifests when there is a high degree of defaults in the corporate and financial sectors of the country, and financial institutions and firms are having great difficulties in timely repayment credit contracts. This results in sharp increases in non-performing loans causing most capital of the aggregate banking system to be exhausted. Sharp increase in the real interest rate reversal/slowdown in capital flows and depressed assets price on the heels of run-ups preceding the crisis may all accompany the situation. Deposit runs on banks triggers bank crisis in some cases but in most cases, the general realisation is that there are distresses in systematically important financial institutions. Systemic banking crisis occurs when there is a significant number of defaults within the financial and banking industry of a country, and financial entities face difficulties in fulfilling financial contracts as at when due (Laven and Valencia, 2010).

Box 2 below expresses the common measures/variables of crisis in the financial sector with specific reference to the banking sector; it also indicates what these variables measure as well as what they signal:

Box 2: **Variables of Banking Crisis and Implications**		
Variables	*Measuring*	*Implications*
(i) Growth in bank credit	The degree of riskiness and fragility of banking sector	(i) Rapid growth in bank credit portfolio in associated with decline in standard or rather results in poor loan standard and subsequently, greater risk for the banking system.
(ii)Non-performing loans (NPL)		(ii)Higher NPL/GDP ratio depicts higher cost of banking crisis to the economy.
(iii) Bank leverage ratio		(iii) High loan losses, high risk premium and high bank leverage ratio in excess are precursors of banking crisis.
Capital adequacy ratio	The cushion power and size of banks' capital in handling unexpected (and expected) losses.	Low capotal adequacy ratio (in excess) points to possible future banking crisis.
Liquidity ratio	Available short term fund at disposal for the purpose of meeting short term obligations.	Systemic banking crisis can erupt if this ratio is excessively low.

In the analysis of the causes of banking fragility, literature on banking theory had largely ignored the perceived multifaceted and complex association between competition in the banking sector and bank fragility. Explanations of the relationship have brought two assumptions to the fore that: (a) bank competition enhances bank fragility (competition fragility); (b) bank competition enhances stability (competition stability). The assumption of competition fragility is in the argument that bank fragility emanates from banks' risky activities of competing for deposits, deregulation of banking as well as other risky acts of banks. The analysis is associated with 'competition stability' which is about the view that the reduction in information asymmetries and/or increase in liquidity within interbank markets are factors causing bank competition that will promote bank stability. However, some empirical studies are able to establish the ambiguities in the bank concentration and bank fragility relationships as there is the argument that while there is higher risk of banking crisis in the less competitive banking system (an in countries characterised by less developed legal system), risk of bank fragility is less when the degree of bank concentration is high within a banking system. It is important to mention that the general suggestion among economists is of the positive and strong correlation between market structures and banking sector fragility when and if there is information asymmetries.

It is therefore important to consider the impact of market structures on the fragility of banking sectors. When the market powers of banks are hampered by competition (competition fragility),[5] the profit and margins are reduced. This thus leads to fragility when banks are prompted to embark on taking more risks in order to make-up for the resultant losses so as to enhance the level of operating incomes. The general consensus is that when competition in the credit market is intense, banks may be prompted to take on bad risk whenever they offer credit terms that sharply deviate from borrowers' risk profile and/or bank's credit policy.[6]Boyd and De Nicolo (2005) got empirical evidence to infer that there could be bank fragility when high interest rates on lending are

---

[5]Competition-fragility notion centres around "view, intense bank competition eroding market power, decreasing banks' profit margins, which together leads to reduction in the value of banks and eventually encourages banks to take on more risks.

[6] This is particularly applicable in the case of loans conditioned on non-risk-adjusted pricing' which would generate income that is not associated with the lending risks involved. Despite the arguments in favour of the position that banks' excessive risk-taking are caused by competitive factors within the banking sector, many opinions were against the view.

applied and loan repayment becomes difficult as the aftermath would be increases in moral hazard and borrowers being encouraged to undertake projects with higher degree of risks. One other view highlighted in the study is that the increase in the banking sector excessive risk, which consequently raises the probability of bank fragility in the banking sector, stems from low competition in the credit market. But when credit market competition is high, this tends to reduce the lending rate paid by borrowers (firms) and as well as reduces their incentives to take on risky projects because of the increase in their own returns (profits).

In developing economies, as already indicated, the banking sector serves as the dominant sector and the most important link within the financial system. This is because bank financing is the most requested form of financing in countries that fall in this category. The consequence of bank fragility (or bank failure) would be very harmful and catastrophic on the finance of trade, businesses and investment projects and on the aggregate economic activities. There could also be systemic failure manifesting as consequences of contagious bank collapse. There are negative impacts of a weak banking system on the macro economy; and from the opposite direction, the well-functioning of a bank could be impaired by faulty macro economy. This bi-directional effects could be more pronounced in developing economies where the financial intermediation roles of banks is crucial and important in the development of the private sectors and the restraining of the multiplier effect of savings on output growth. As witnessed in the Eurozone (and other regions), financial crisis saturated the banking sector as reflected in increased credit default risks, reduced customers' confidence in the banking sector and risks aversion by banks. The strength of the banking sectors of the developing economies of the WAMZ is therefore very crucial to the success of the proposed currency union. This is because of the overwhelming fiscal, monetary and economic costs of banking crisis which might not be affordable.

Generally and specifically in the WAMZ, banks are opened to various forms of risks (which are indicators of fragility in banking) as indicated in Box 3:

Box 3:*Risks Indicators of Banking Sectors Fragility opened to the WAMZ Countries*	
Risk Indicators	*Implications*
Liquidity Risk	* may be caused by sudden and unexpected loss of confidence of banks' depositors; * may lead to runs on banks, depleting the liquidity levels; *may be due to information asymmetry between banks, depositor and borrower and maturity transformation in which banks' invest short term deposits (liabilities) in long term loans (asset), leading to bank runs when the level of the available short term investment is lower than the total value of withdrawal requests; * the rush in bank runs would generate panics which may induce banking crisis.
Credit (Default) Risk	* may arise when bank debtors find it difficult to continue to honour their commitments (principal and interest) to banks, which may be due to losses leading to insolvencies of firms and bankruptcies.
Market Risk	Market risks are risks caused by loss of standing and position of the banking system due to factors that are external to banks and the banking sector. *Interest rate risks - may be caused by adverse interest rate changes in intermediation operations (when there are different rate references for loans and debt) and financial market operations (interest risks taken on the basis of anticipation of the bank involved). *Exchange rate risks - may be caused by adverse fluctuations in exchange rate when bank transactions are denominated in two currency. This is more pronounced in times of high volatilities of these currencies. *Commodity price risk - may be caused by adverse movements in prices of primary commodities. (This is of high significance in West Africa).
Operations Risk	*may be evident by poor internal controls and dysfunction in the banking system; *may be associated with risk of loss (direct or indirect) emanating from inadequacies or failure in people, procedures, internal system (or external events), banks' inefficient resources management.
Solvency Risks	*may be an easy consequence of liquidity risk; *usually implies the inability of the bank to pay its obligations when they fall due without causing interruptions to the operations and activities of the bank; *may be occur if in a bank's balance problem situation when the existing total assets are lower than current liabilities (causing the inability of the bank to pay its debts). *it is associated with liquidation or cessation of banking operations/activities.

Further to the risk indicators in Box 2, there are some banking system characteristics that may have some African-specific influence banking sector fragility (stability) in the WAMZ; and these are expressed in Box 3:

Characteristics	Details and Effects
The extent of liquidity of banks in the WAMZ	*This is about the maintenance of adequate level of liquidity by individual national banks is necessary within the proposed currency union. This is due to the role and purpose of liquidity as the first line of defence against liquidity shocks that may be experienced. *Adequate liquidity level enables banks to absorb liquidity shocks that may face banking systems at national levels, prevent possible contagion and further enhance the stability of the entire currency union banking sectors, thereby prevent possible crisis and eventual collapse of the monetary union.
The level of capitalisation of banks in the WAMZ	*If a higher level of capital bases of national banks is a strong cushion against insolvency, a well-capitalised bank would therefore depict a higher degree of banking system stability, reduce the possible effects of individual bank distress (at national levels) on the currency union's banking sectors as a whole. *Many empirical studies have established that increase in the level of bank capitalisation has effects on the reduction in the incidence of bank fragility.
The degree of concentration of banks and competition among banks in the WAMZ	*There is complexity in the correlation between the degree of banking competition and bank fragility. *According to the Competition-Fragility Hypothesis, market power is eroded by banking competition and this may lead to excessive risks taking by banks. *On the other hand, Competition-Stability Hypothesis posits that market power is increased when banks take excessive on risks due to exacerbating level of moral hazard as higher interest rate are charged on loans. * Bank concentration takes the form of few big banks taking on more risks while hinging on the belief that they are too-strong-to-collapse. * In the WAMZ, increased competition is necessary for the stability of banking systems.
The extent of diversification of the operations/activities of banks in the WAMZ	* The stability of the banking sector could either improve or deteriorate when activities of banks at national levels are diversified. There have been mixed views and opinions about this, given the various evidence and conclusions in many related empirical studies. * However, there is an argument that systemic banking risk could be reduced if banks specialise in traditional banking activities. * On the contrary, further argument posits that because banks diversify, the likelihood of systemic risk may increase within a financial system even if such diversification causes reduction in individual bank's risk status.
The degree of co-existence of domestic banks with foreign banks	* The impact of the presence of foreign banks on bank fragility takes many opposing forms. Firstly, foreign banks' presence could cause high-level banking competition and increased efficiency within the national banking systems. * There is empirical evidence to support the view that when a foreign banks having their headquarters in advanced country operate in host country characterised by relatively weak regulations, such foreign banks tend to improve in performances. * Secondly, there may be cross-border contagion drawn from the operations of foreign banks which could transmit shock across borders. * The strong overall position is that even as foreign banks may import negative shocks into a domestic banking sector, thus increasing the risk of fragility in the WAMZ, these foreign banks may contribute positively to financial stability in situation of any domestic-oriented banking crisis in the proposed currency union.

The financial crisis of 2007/2009 and the Eurozone crisis have been able to reveal that banking sector fragility at national levels could affect the national financial systems as well as those of the countries in the same region or in the same monetary union, through rapid-moving contagion effects of cross-border linkages and common exposure which could cause for concern about banking system instability and the accompanying impacts at these aggregate regional and/or monetary union levels. It is apparent that the implications of the globalisation of banking conjectures that a shock affecting a domestic bank (at national levels) could have ripple effects not only on the domestic financial system but economies and financial systems of other countries. Banking sector contagion is more drastic and crucial than contagion in the other sectors of the economy for some observations identified by Kaufman (1994) cited by Raoudha (2014): (a) contagion is more widely distributed within the banking system; (b) contagion occurs rapidly and spread beyond the banking sector up to other sectors of the economy as well as other countries and could this lead to many other catastrophic failures and significant losses to bank depositors. Box 8.5 highlights some possible sources of inter-banking sector contagion in the WAMZ, a proposed currency union.

Box 5: ***Possible Sources of Inter-banking Sector Contagion in the WAMZ***
(i) ***Shortage of bank liquidity within the proposed currency union***: This could be made possible if banks in various banking sector place high hope and confidence on the strength of interbank markets to absorb temporary liquidity shocks; and due to this reliance on the interbank ability, banks would be prompted to cut liquid asset investment. This could create difficulties if the aggregate liquidity in inadequate. This could also lead banks to avoid liquidating their assets in the long run, but liquidate claims on other banks operating in the currency union. This can thereby bring about contagious effect of liquidity problems across the WAMZ.
(ii) ***Externalities:*** Bank run by depositors lead to panics in the banking sector. Out of fear, this could lead depositors of other banks to decide to withdraw their deposits from all banks within the currency union on large scale, thus causing another form of liquidity issue within the WAMZ.
(iii) ***Domino effect***: This could be caused by insolvency of bank which in turn, would affect all individuals, institutions and firms associated with such insolvent bank. This could threaten confidence in the banking markets with the WAMZ and the contagion would be greatly pronounced by interbank direct linkages.

Source: Author's explanations and Raoudha (2014)

4   Data and Methods

This research study takes cognisance of the nature of the economic and banking environments of the WAMZ countries and the extent to which these can breed banking sector instability and cause systemic banking crisis within the entire banking sector of the future currency union. The determinants of the probability of crisis within these banking sectors are employed in a multivariate probit model specification with annual data of these six WAMZ countries. These are the crucial factors in sourcing data for this study spanning over a period of time between 1980 and 2013 in which event approach was adopted in identifying episodes of banking problems during this period.

Data availability and the macroeconomic theory of banking and banking fragility serve as factors in the determination of the predictors and binary dependent variables in the probit model for which all necessary data were sourced for the six WAMZ countries, over the period covered by study. The following annual data were sourced for the six WAMZ countries: real GDP growth, GDP deflator (inflation), nominal exchange rate, private credit/deposit ratio, deposit liabilities/GDP ratio, bank credit to private sector/GDP ratio, capital adequacy ratio, gross foreign liabilities/GDP ratio, primary commodity price shock, real interest rate, real per capita income, budget surplus/GDP ratio, M2/foreign reserve ratio, aggregate bank liabilities, aggregate bank assets and non-performing loan(NPL)/total assets ratio and Z-score. There is a case in favour of macroeconomic variables because these variables may more likely lead to banking crisis as banks choose to settle for risky loan portfolio which would increase the share of nonperforming loans. Macroeconomic shocks are therefore captured by GDP growth rate, real short term interest rate, inflation rate, commodity price, real per capita income, M2/foreign reserve ratio, nominal exchange rate depreciation, budget balance/GDP ratio among others.

As appropriate, some of the data were processed further for annual change while capital adequacy ratio, non-performing loan(NPL)/total assets ratio, bank credit to private sector/GDP ratio, aggregate bank liabilities and aggregate bank assets in order to yield the binary dependent variable given the specified threshold levels. Box 6 below shows the predictors and the explanation of the justification of their use in this study:

	Box 6: Explanatory Variables and Justification	
	Variable	***Justification***
1	Real GDP growth	This is about economic growth. The impact of economic growth on ability of bank borrowers to repay their debts can be transferred to the banking system's credit quality. This is more pronounced in developing economies (like the WAMZ member economies) in which low levels of economic diversification cause the concentration of the exposure of banks within the system in a way that there could be systemic crisis arising from shocks to the sector that dominate the economy (like banking sector in developing economies). This controls for macroeconomic factors that may affect banks' assets quality and profitability.
2	Inflation - GDP deflator	If high level of inflation bloats the financial sector through excessive liquidity, the balance sheets of institutions within the financial sector would harm inflation stabilisation expectations which raises the probability of banking crisis. Overblown financial institutions would benefit from 'float on payment'; and where there is drastic reduction in inflation rates, banks' main sources of revenue are blocked and banking sector problems results.[7] Furthermore, banking sector crisis is very likely when real economy activities, caused by decline in real economic activities due to inflationary volatility. High rates of inflation may imply an indication of mismanagement of the economy which raises the probability of banking sector crisis through some channels. However, inflation rate is considered to be associated with high nominal interest rate. Inflation is related to macroeconomic instability which affects the real return on asset, discourages savings, encourages borrowings and hence increases the probability of banking sector crisis. Logarithmic transformation of inflation may be necessary so as to smooth out larger changes in inflation rates which is common in developing and transition countries. This serves as control for macroeconomic factors that may affect banks' assets quality and profitability.
3	Nominal exchange rate depreciation	This controls for international forces influencing bank vulnerability. Exchange rate depreciation is destabilising if and when a banking sector is intensively exposed to foreign exchange risks. This tests the conjecture that exposure to excessive foreign exchange risks by the banking system or bank customers (borrowers) is a propelling force of banking crisis.
4	Change in private credit/deposit ratio	This relates to the liquidity position of banks. If this ratio is high, the capacity of banking system to withstand bank runs would be minimal and thus increases the likelihood of bank fragility. This also proxies for financial liberalisation.
5	Change in deposit liabilities/GDP ratio	This reflects the loss of confidence in the banking system as depicted by the existence of bank deposit runs. It also indicates the extent to which banks' balance sheets have shrink for some other reasons.
6	Change in private credit/GDP ratio	If this ratio is growing, it means the banking sector is well extended and this increases the probability of banking crisis. This triggers banking fragility through system-wide deterioration in asset quality or reduction in liquidity when funding sources are volatile. If credit growth is excessive, banking instability can emanate through deteriorating assets quality and/or when there is reduction in liquidity (particularly, if the source of funding is volatile).

[7] Eichengreen and Rose (2004)

7	Change in gross foreign liabilities/GDP ratio	This measure the extent to which the banking system relies on foreign capital inflows to fund banking operations. This proxies for banking fragility arising from being vulnerable to sudden cessation of foreign capital inflows.
8	Short term real interest rate	This is estimated as nominal interest rate minus the contemporaneous rate of inflation. High real interest rate is a further harm to highly indebted bank customers (firms and households); and this affects banks' balance sheets in that lending rate could not be increased rapidly. This controls for macroeconomic factors that may affect banks' assets quality and profitability. This is a form of control for macroeconomic factors that may affect banks' assets quality and profitability.
9	Real per capita income	This controls for the level of economic development of the developing WAMZ countries
10	Budget surplus/GDP ratio	Huge government budget deficits prevents financial liberalisation. This ratio shows the central government's financial needs. The inclusion of the ratio is justified because a government that is 'strapped' for fund would be unable to bring up measures that would eventually support strengthening banks' balance sheets. Furthermore, the lack of control of budget deficit hugely obstructs successes of financial liberalisation, and when financial liberalisation is thwarted, there would be problems created for the banking sector.[8] Even if government is willing to intervene in situations banking problems in spite of the budgetary problems, public may think that such intervention is not possible, this leading to bank runs which compounds and transforms the initial problem to a full crisis.[9]
11	M2/International reserve ratio	This controls for international forces influencing bank vulnerability. The ratio indicates the extent to which the economy is able to withstand reversals of capital inflow, particularly in a pegged exchange rate regime. Banking sectors have higher probability of plunging into crisis when this rate is high, with higher consequences of capital outflow vulnerability. This also predicts the vulnerability to of an economy to balance of payments crisis.
12	Private credit/GDP ratio	This portrays banking system liquidity position. The capacity of the banking system to withstand deposit withdrawal is low (and hence the high possibility of banking crisis) when/if this ratio is high. This is crucial for banking sectors of developing economies (like the WAMZ) that demonstrate high degree of deposit turnover and limited (or lack of) alternative funding sources.

Drawing from the theoretical underpinnings of probit model, a multivariate probit regression model of banking sector fragility is constructed for the banking sectors in the member countries of the WAMZ. The probit model will determine a causal relationship the discrete probability of 'bank fragility' or 'no bank fragility' and a set of explanatory variables that are considered necessary before the probability of any of the two discrete events in the WAMZ member countries can take place. In a nutshell, the estimation of the probit models would give the expected probability of failure (bank fragility) in order to distinguish the WAMZ member countries according to the extent of risk factors in an

---

[8] McKinnon (1991),

[9] Demirguc-Kunt and Detragiache (1998)

assessment of the stability of the feasibility of the proposed currency union in the West African sub-continent.

Due to some problems inherent in some of the methods in determining banking sector fragility (signal approach, stability index etc), probit econometric method is one of the approaches that address these problems. In this approach to the assessment of the covariates of banking crisis, the probability of banking sector fragility is assumed to be a function of a vector of explanatory variables. In the probit model fitted to the data, estimate of banking crisis probability is derived through the MLE function, leading to estimated probability of banking sector fragility in the information yielded by the predictors in the model.

In the probit model for the WAMZ countries, the dependent variable has a value of zero (0) for 'no banking crisis' years and takes the value of one (1) for each year of 'banking crisis'. The dependent variable is thus expressed as:

$$y^* = \begin{cases} 1 \ if \ there \ is \ banking \ sector \ crisis \\ 0 \ if \ there \ is \ no \ banking \ sector \ crisis \end{cases}$$

There are many postulated definitions and explanations of banking system fragility and banking stability in extant literature. Apart from adapting the 'banking crisis dummy' definition of banking systemic crisis (as published by the IMF) for the evaluation of banking stability in the WAMZ, this study put forward five other definitions of banking system fragility and stability status in the proposed currency area as:

a. 'fragile' when its Bank Capital/Assets Ratio is below threshold of 8% (the Basel II Capital Adequacy Ratio (CAR) benchmark of the Bank for International Settlement); and 'stable' if otherwise;

b. 'fragile' when its Non-performing Loan/Gross Loan Ratio is above the 3-WAMZ country average of 17.21 plus 2 standard deviation threshold over the periods of banking system stability reported by the IMF; and 'stable' if otherwise;

c. 'fragile' when its Bank Credit/Deposit Ratio is above the WAMZ countries' zonal average of 59.20 plus 2 standard deviation threshold over the periods of banking system stability reported by the IMF; and stable if otherwise;

d. 'fragile' when its Bank Liquid Reserves/Assets Ratio is below the 4-WAMZ country average of 17.05 less 2 standard deviation threshold over the periods of banking system stability reported by the IMF; and 'stable' if otherwise;

e. 'fragile' when its Z score is below the threshold of 2.0 (the mid-point between the extremes of the Altman Z Score Model's Grey Zone of Discrimination); and 'stable' if otherwise.

In the first instance of banking fragility/stability applied in the research, there were four factors taken into cognisance in generating the banking crisis dummies.[10] These are instances when: (i) the non-performing loan/total asset of a banking system exceeded 10%; (ii) the cost of a banking system's rescue operation was more than 2% of the GDP; (iii) banking sector problems caused large scale nationalisation of banks; (iv) there were extensive bank runs, emergency measures decision-taking and general deposit insurance policy introduced.[11]

In the second instance of banking fragility/stability applying the ratio bank capital/asset ratio, adequate capital for banks speaks volume about the health and the extent of robustness of banks within the WAMZ toward absorbing or withstanding shocks to balance sheets. The dependent variable in this instance is expressed as:

$$y^* = \begin{cases} 1 \; if \; \dfrac{Bank\ Capital}{Total\ Assets} \; ratio_{it} < 8\%\ benchmark\ of\ the\ BIS \\ 0 \; if \; \dfrac{Bank\ Capital}{Total\ Assets} \; ratio_{it} > 8\%\ benchmark\ of\ the\ BIS \end{cases}$$

In the third instance of banking fragility/stability employing the asset quality ratio of non-performing loan/gross loan (NPL), it is assumed that credit risk or asset quality is a major determinant of banking sector stability and fragility in the WAMZ. In this instance, the dependent variable is expressed as:

$$y^* = \begin{cases} 1 \; if \; \dfrac{NPL}{Total\ Assets} \; ratio_{it} > average\ of\ 17.21\ plus\ 2\ standard\ deviation \\ 0 \; if \; \dfrac{NPL}{Total\ Assets} \; ratio_{it} < average\ of\ 17.21\ plus\ 2\ standard\ deviation \end{cases}$$

---

[10] Making references to the IMF publications.

[11] These are in conjunction with the studies carried out by Demirguc-Kunt and Detragiache, 2005

The fourth instance of banking fragility/stability applying the bank liquidity ratio of bank credit/deposit, bank liquidity is assumed a determinant of banking sector stability. In this market risk instance, banking crisis is strongly hypothesised to be preceded by decline in loan standards which always result in the volume of bank loan surpassing the volume of bank deposits. Here, the dependent variable is expressed as:

$$y^* = \begin{cases} 1 \; if \; \dfrac{Bank \; Credit}{Bank \; Deposit} \; ratio_{it} > \text{average of 59.20 plus 2 standard deviation} \\ 0 \; if \; \dfrac{Bank \; Credi}{Bank \; Deposit} \; ratio_{it} < \text{average of 59.20 plus 2 standard deviation} \end{cases}$$

Another measure of bank liquidity applied in this work is the ratio of bank liquid reserves/assets. This fifth instance relates to when a banking crisis is a situation in which the value of aggregate banking sector liabilities is greater than the value of aggregate banking sector assets. Here, banking crisis is strongly hypothesised to be indicated by preceded by the volume of bank liquid reserves falling below the volume of bank quick assets. In this case, we express the binary dependent variable as:

$$y^*$$
$$= \begin{cases} 1 \; if \; \dfrac{Bank \; Liquid \; Reserves}{Bank \; Asset} \; ratio_{it} < \text{average of 17.05 plus 2 standard deviation} \\ 0 \; if \; \dfrac{Bank \; Liquid \; Reserve}{Bank \; Asset} \; ratio_{it} > \text{average of 17.05 plus 2 standard deviation} \end{cases}$$

In the sixth instance of banking fragility/stability, solvency/distance-to-default of the WAMZ banking systems are considered applying the probability of default Z Scores of the banking systems. The binary dependent variable in this instance is expressed as:

$$y^* = \begin{cases} 1 \; if \; Z \; Score_{it} < 2.0 \\ 0 \; if \; Z \; Score_{it} > 2.0 \end{cases}$$

In the five banking crisis situations in the study, the threshold values for the determination of the binary dependent variable are established such that when these thresholds are cross (towards the indicated direction) they signal a banking crisis year.

Many literature on currency/banking crises are able to conclude that the dynamic model in which lagged binary dependent variable is included outperforms other specifications (static probit model, Markov- switching models etc) for in-sample and out-of-sample forecasts. This has an implication that dynamic specifications are the

ultimate for modelling early warning signs (EWS) of banking sector fragility. In determining systemic banking risks, it is therefore more appropriate to employ the use of dynamic model so that all risk factors are revealed ahead of time t. The dynamic structure indicates that the banking risks factors are in advance known k period. What this means is that the banking sector fragility probability in period t is conditional on information that are know at time $t - k$. This is necessary in giving time for reaction against the warning signal. Consequently, the dynamic probit model would enable efficient use of macroeconomic and banking sector information in the panel data in the estimation of probabilities of impending banking sector crises in the WAMZ as a prospective currency union, thereby yielding the prediction of the probability of the occurrence of a binary variable. Therefore, the application of the population-averaged dynamic probit estimator would reveal the probability of banking sector fragility through the analysis of the parameter estimates obtained from the probit regressions and marginal effects. These are all about the construction of the probability of banking sector fragility. However, due to data-availability related problems, this empirical analysis applies an unbalance panel of annual data of the six countries (The Gambia, Ghana, Guinea, Liberia, Nigeria and Sierra Leone) involved, spanning over a maximum period of time between 1980 and 2013 as applicable.

This chapter of the thesis therefore consider the application of a dynamic panel probit model of EWS based on exact MLE for forecast banking sector instability in the WAMZ countries. All explanatory variables in the dynamic probit model are lagged by one or more period in order to avoid the potential problem endogeneity problems in the contemporaneous explanatory variables and make explanatory variables to be leading indicators in banking sector fragility prediction. This method addresses the exogenous (relating to macroeconomic variables) and endogenous crisis persistence problems which are not apparent in the static probit model. One of the ways through which the endogenous dynamics of crisis could be handled is the inclusion of lagged binary crisis variable. This makes the effect of the explanatory variable to depend on the value of lagged binary variable which is the previous state of the economy. Secondly, the lagged value of the macroeconomic crisis indicator would be linearly added to the right hand side of the model. This gives room for richer dynamics in the process of crisis forecasts. It also makes the estimation of banking sector fragility signs to rely on an

autoregressive model in which the lagged value of crisis variable gives the summary of all past information within the system. Thirdly, the first and the second methods of dynamic could be incorporated simultaneously.

In estimating the parametric EWS for the WAMZ countries, this research work applies these three solutions that address the problem of endogenous persistence of banking sector crisis by incorporating the extension into the general specifications of the dynamic probit model. These model specifications allow for the presence of past banking sector variables as well as the exogenous crisis persistence macroeconomic variables (standing for economic policies) of the WAMZ countries. The time series framework in this study is extended to a random effect dynamic probit panel analyses.

Essentially, in consideration of the time series version of the dynamic binary choice model, the one-step ahead specification of the dynamics involved (in which the lagged binary dependent variable, lagged predictors and the lagged crisis indicator are included) is specified as:

$$Pr_{t-1}(y_t = 1) = F(\pi_t) = F(\delta\pi_{t-1} + \alpha y_{t-1} + x_{t-1}\beta) \qquad 1$$

where $Pr_{t-1}(y_t = 1)$ is the conditional probability of banking sector instability given the available information at time $t - 1$. y_{t-1} is the lagged banking sector instability crisis binary variable (which takes the value of 1 or 0), x_{t-1} is the matrix of lagged explanatory variables, π_{t-1} is the banking crisis indicator while F is the Gaussian cumulative distribution function (CDF) of the dynamic probit model.

Given the foregoing analysis, three dynamic probit models for each of the six specified instances are specified for the assessment of banking sector fragility in the WAMZ. These are:

   i.   dynamic probit model with lagged value of binary dependent variable (y_{t-1}), in addition to the lagged values of the predictors (x_{t-1}) on the right hand side of the equation. This gives the assessment of the effects, on the crisis probability, of the prevailing previous period regime. This is modelled as:
$$Pr_{t-1}(y_t = 1) = F(\pi_t) = F(\delta\pi_t + \alpha y_{t-1} + x_{t-1}\beta) \qquad 2$$
   ii. dynamic probit model with lagged value of crisis indicator (π_{t-1}), in addition to the lagged values of the explanatory variables (x_{t-1}) on the right hand side of the

equation. This linearly transmits the enormousity of the indicator to the next period, thereby demonstrating the appropriate effects on the banking sector crisis probability. This is modelled as:

$$Pr_{t-1}(y_t = 1) = F(\pi_t) = F(\delta\pi_{t-1} + \alpha y_t + x_{t-1}\beta) \qquad 3$$

iii.   dynamic probit model incorporating on the right hand side of the equation both lagged value of the dependent variable (y_{t-1}) and the lagged value of the crisis indicator(π_{t-1}), further to the lagged values of the independent variables (x_{t-1}). This is modelled as:

$$Pr_{t-1}(y_t = 1) = F(\pi_t) = F(\delta\pi_{t-1} + \alpha y_{t-1} + x_{t-1}\beta) \qquad 4$$

The issue of satisfying the stationarity condition is crucial in the estimation of Equations 3 and 4 since δ is an autoregressive parameter. The implementation of the constrained MLE will solve this problem. Generally, a log likelihood function is expressed thus:

$$LogL(\theta) = \sum_{t=1}^{T} ln_i(\theta) = \sum_{t=1}^{T}[y_t(logF(\pi_t(\theta)) + (1 - y_t)\log(1 - F(\pi_t(\theta))] \qquad 5$$

At this point, it is important to state at this research work employs a panel data analysis approach dynamic probit model (population-averaged) estimation of banking fragility in the WAMZ by pooling the available macroeconomic and banking system information in the six WAMZ countries. Consequently, the three dynamic panel binary choice probit model of banking crisis estimated are expressed in Equations 6 to 8 below:

$$Pr_{t-1}(y_{it} = 1) = F(\delta\pi_{it} + \alpha y_{it-1} + \beta x_{t-1} + \eta_i + \varepsilon_{it}), \ (for \ t = 0,1,2, \dots T \ and \ i = 1,2, \dots N) \quad 6$$

$$Pr_{t-1}(y_{it} = 1) = F(\delta\pi_{it-1} + \alpha y_{it} + \beta x_{t-1} + \eta_i + \varepsilon_{it}), \ (for \ t = 0,1,2, \dots T \ and \ i = 1,2, \dots N) \quad 7$$

$$Pr_{t-1}(y_{it} = 1) = F(\delta\pi_{it-1} + \alpha y_{it-1} + \beta x_{t-1} + \eta_i + \varepsilon_{it}), \ (for \ t = 0,1,2, \dots T \ and \ i = 1,2, \dots N) \quad 8$$

where T is the number of time series observations for each country being investigated; N is the number of the WAMZ countries being assessed; η_i is the time invariant unobserved heterogeneity (random effects) between the countries being examined; ε_{it} is a time varying error terms. The log likelihood (concentrated likelihood) of the models in Equations 6 to 8 could generally be given as:

$$LogL(\theta, \eta_i = \sum_{i=1}^{N} LogL_i(\theta, \eta_i) = \sum_{i=1}^{N}\sum_{i=1}^{T}[y_{it}\log(F_{it}) + (1 - y_{it})\log(1 - F_{it}) \qquad 9$$

where is θ the vector of parameters.

Many empirical literatures have established that the use of panel data approach in a study of systemic banking sector crisis is advantageous because of the rare nature of banking sector crisis. In a study of the prediction of the US recession, Kauppi and Saikkonen (2005) show that dynamic probit models outperform the static probit models and that dynamic models with lagged values of the binary response are more superior to models in which dynamics were affected only through lagged probit probability. In spite of the benefit of exploiting information from several time series and obtaining the parameter estimate of β which is more precise and reliable, when a panel data approach is used in econometric analysis, a major flaw is the imposition of false restriction in which β is seen as common for all countries under examination.

In the dynamic panel probit model, there are complication in the application of standard probit model is the presence of individual effect in the panel data. There would be increases in the number of error terms parameters as the number of countries under investigation increases and there cannot be consistent estimation of this for a fixed time period, thus necessitating the application of the panel probit model estimator in the estimation process.

In sum, with the population averaged dynamic probit regression of banking crisis indicators and macroeconomic and banking sector variables of the WAMZ countries, banking fragility probability is calculated with the estimated coefficient generated by the results of the dynamic probit model regression. This makes the probability of banking sector instability to be a non-linear function of the identified/ selected banking sector crisis indicators as well as other macroeconomic/banking sector variables.

5 Findings and Results

The descriptive statistics the macroeconomic, banking sector and institutional variables applied by this chapter on banking fragility and stability in the WAMZ at their averages, variability and maximum and minimum values over the period covered by the study are exhibited in Table 2 below. Growth in the banking sector domestic credit has the highest degree of volatility of 177 as well as the highest average of 114.07, followed by the foreign liability/GDP ratio of 148.05.

Table 2: Descriptive Statistics of Macroeconomic, Banking Sector and Institutional Variables of Banking Fragility/Stability in the WAMZ

Variables	Mean	St. Dev.	Min	Max
Macroeconomic Variables:				
GDP Growth	3.24	12.46	-51.03	106.28
Inflation	20.17	26.56	-10.0	165.59
Nominal Exchange Rate Depreciation	21.93	46.37	-18.47	321.90
Short term Real Interest Rates	3.60	18.45	-96.87	33.46
M2/International Reserve Ratio	9.05	24.90	0.36	230.02
Unemployment Rates	5.73	2.35	3.20	10.40
Budget Surplus/GDP Ratio	-3.84	3.11	-14.85	3.50
Money Supply Growth	27.33	12.43	1.32	57.78
Money Market Rates	15.89	6.73	3.54	32.42
Banking Sector Variables:				
Bank Deposit/Loan Ratio	58.71	26.82	17.15	184.48
Bank Liquid Reserve/Asset Ratio	18.71	6.63	5.56	31.07
Non-performing Loan/Gross Loan Ratio	16.52	7.48	3.24	37.90
Bank Capital/Assets Ratio	13.69	4.73	1.50	22.50
Z Scores	5.78	2.85	-4.14	10.95
Domestic Credit Growth	47.76	177.87	-100.14	1782.9
Domestic Credit/GDP Ratio	9.42	6.38	1.54	38.39
Foreign Liability/GDP Ratio	114.07	148.05	1.94	88.21
Private Credit/GDP Ratio	9.18	6.34	1.54	38.35
ΔPrivate Credit/Deposit Ratio	1.82	27.44	-39.80	257.55
ΔDeposit Liabilities/GDP Ratio	6.80	25.96	-67.88	165.71
ΔPrivate Credit/GDP Ratio	4.64	23.26	-59.87	86.60
ΔGross Foreign Liabilities/GDP Ratio	1.25	27.19	-85.06	112.49
Lending Rates	22.59	8.41	8.43	62.83
Deposit Rates	12.92	7.56	2.0	54.67
Interest Rates Spread	8.85	6.66	-24.76	23.46
Return on Equity	28.21	18.86	0.94	74.27
Institutional Variables:				
Governance - Rule of Law	-0.79	0.55	-1.52	0.11
Governance - Regulatory Quality	-0.65	0.46	-1.38	0.13
Governance - Political Instability	-0.79	0.86	-2.19	0.18

Source: EIU WDI and IMF Databases and Author's Estimations

Instances of banking sector crisis in the WAMZ are determined applying the five definitions of banking system fragility/stability employed in this study. When 'banking crisis' is defined by the four-factor banking crisis dummy, information exhibited in Table 3 below shows when the each WAMZ countries, on annual basis experienced banking sector crisis between 1980 and 2013.

Table 3: Instances of Banking System Stability/Fragility in the WAMZ –
(4-factor Banking Crisis Dummy)

Year	Gambia	Ghana	Guinea	Liberia	Nigeria	S/Leone
\multicolumn dep						

Year	Gambia	Ghana	Guinea	Liberia	Nigeria	S/Leone
1980	Stable	Stable	na	na	Stable	Stable
1981	Stable	Stable	na	na	Stable	Stable
1982	Stable	Fragile	na	na	Stable	Stable
1983	Stable	Fragile	na	na	Stable	Stable
1984	Stable	Stable	na	na	Stable	Stable
1985	Stable	Stable	na	na	Stable	Stable
1986	Stable	Stable	na	na	Stable	Stable
1987	Stable	Stable	na	na	Stable	Stable
1988	Stable	Stable	na	na	Stable	Stable
1989	Stable	Stable	na	na	Stable	Stable
1990	Stable	Stable	Stable	na	Stable	Fragile
1991	Stable	Stable	Stable	na	Fragile	Fragile
1992	Stable	Stable	Stable	na	Fragile	Fragile
1993	Stable	Stable	Fragile	na	Fragile	Fragile
1994	Stable	Stable	Stable	na	Fragile	Fragile
1995	Stable	Stable	Stable	na	Fragile	Stable
1996	Stable	Stable	Stable	na	Stable	Stable
1997	Stable	Stable	Stable	na	Stable	Stable
1998	Stable	Stable	Stable	Stable	Stable	Stable
1999	Stable	Stable	Stable	Stable	Stable	Stable
2000	Stable	Stable	Stable	Stable	Stable	Stable
2001	Stable	Stable	Stable	Stable	Stable	Stable
2002	Stable	Stable	Stable	Stable	Stable	Stable
2003	Stable	Stable	Stable	Stable	Stable	Stable
2004	Stable	Stable	Stable	Stable	Stable	Stable
2005	Stable	Stable	Stable	Stable	Stable	Stable
2006	Stable	Stable	Stable	Stable	Stable	Stable
2007	Stable	Stable	Stable	Stable	Stable	Stable
2008	Stable	Stable	Stable	Stable	Stable	Stable
2009	Stable	Stable	Stable	Stable	Fragile	Stable
2010	Stable	Stable	Stable	Stable	Fragile	Stable
2011	Stable	Stable	Stable	Stable	Fragile	Stable
2012	Stable	Stable	Stable	Stable	Fragile	Stable
2013	Stable	Stable	Stable	Stable	Fragile	Stable

The header row beneath the title reads: *Dependent Variable: Bank Crisis Dummy of the IMF (4 Factors)*

Source: Author's estimations

Guinea and Liberia lack the necessary information needed for some years between 1980 and 1997 as revealed by the table. Interest is placed in the Nigerian banking system which witnessed instability between 1991 and 1995, and again, between 2009 and 2013. As earlier noted in this chapter, the stability (or otherwise) of the Nigerian banking sector is paramount and has crucial implications for overall banking sector of the proposed WAMZ, given the country's banking strength and presence across the

whole sub-continent. Furthermore, there were other narrowed-down definitions of banking system fragility/stability in the WAMZ, closely similar to the CAMEL (a common acronym of banking stability evaluation) that signify the status of banking system in the six WAMZ countries over various periods of evaluation.

Table 8.4: Instances of Banking System Stability/Fragility in the WAMZ - Capitalisation

Year	Gambia	Ghana	Guinea	Liberia	Nigeria	S/Leone	
Dependent Variable: Bank Capital/Assets Ratio							
2000	na	Fragile	1na	na	Stable	Fragile	1
2001	na	Fragile	1na	na	Stable	Fragile	1
2002	na	Fragile	1na	na	Fragile	Fragile	1
2003	na	Fragile	1na	na	Stable	Fragile	1
2004	na	Fragile	1na	na	Stable	Fragile	1
2005	na	Fragile	1na	na	Fragile	Fragile	1
2006	na	Fragile	1na	na	Fragile	Fragile	1
2007	na	Fragile	1na	na	Fragile	Fragile	1
2008	na	Fragile	1na	na	Fragile	Fragile	1
2009	na	Fragile	1na	na	Stable	Fragile	1
2010	na	Fragile	1na	na	Stable	Fragile	1
2011	na	Fragile	1na	na	Fragile	Fragile	1
2012	na	Fragile	1na	na	Fragile	Fragile	1
2013	na	Fragile	1na	na	Stable	Fragile	1

Source: Author's estimations

*Note: A banking system is defined as 'fragile' when its Bank Capital/Assets Ratio is below threshold of 8% (the Basel II Capital Adequacy Ratio (CAR) benchmark of the Bank for International Settlement); and 'stable' if otherwise. *The Gambia, Guinea and Liberia were dropped due to non-availability (na) of enough data.*

Table 4 above shows that when adequate capitalisation of banks in the WAMZ countries are examined in consideration of the capital adequacy ratio of 8% benchmark in line with the BASEL II provisions of the BIS, the three countries considered reported some years of fragility as well as stability as there are strong indications that between 2000 and 2013, banking sector of Ghana and Sierra Leone were grossly fragile due to undercapitalisation. This raises some serious question concerns when the banks' undercapitalisation (and subsequent recapitalisation problems leading to national fiscal problem in the Eurozone) is brought into cognisance. The Nigerian banking sector was staggering in-between fragility and stability.

Table 5: Instances of Banking System Stability/Fragility in the WAMZ - Asset Quality

Dependent Variable: Non-performing Loans/Gross Loan Ratio						
Year	*Gambia*	*Ghana*	*Guinea*	*Liberia*	*Nigeria*	*S/Leone*
1998	na	Stable	na	na	Stable	na
1999	na	Stable	na	na	Fragile	na
2000	na	Stable	na	na	Fragile	Fragile
2001	na	Fragile	na	na	Fragile	Fragile
2002	na	Fragile	na	na	Fragile	Stable
2003	na	Stable	na	na	Fragile	Stable
2004	na	Stable	na	na	Fragile	Stable
2005	na	Stable	na	na	Stable	Fragile
2006	na	Stable	na	na	Stable	Fragile
2007	na	Stable	na	na	na	Fragile
2008	na	Stable	na	na	Stable	Stable
2009	na	Stable	na	na	Fragile	Stable
2010	na	Stable	na	na	Stable	Stable
2011	na	Stable	na	na	Stable	Stable
2012	na	Stable	na	na	Stable	Stable
2013	na	Stable	na	na	Stable	Fragile

Source: Author's estimations
*Note: A banking system is defined as 'fragile' when its Non-performing Loan/Gross Loan Ratio is above the 3-WAMZ country average of 17.21 plus 2 standard deviation threshold over the periods of banking system stability reported by the IMF; and 'stable' if otherwise.*The Gambia, Guinea and Liberia were dropped due to non-availability (na) of enough data.*

The statuses of the three WAMZ countries' stability in the asset quality measurement of banking sector fragility/stability are expressed in Table 5 above. The Ghanaian banking sector displays more stability here, while the banking sectors in Nigeria and Sierra Leone had almost equal proportion of banking stability and fragility. This is an indication that the banking sectors in the two countries (particularly in Nigeria) need to look into the problem of non-performing loan within their loan portfolios towards increasing banking sector confidence and the chance of survival within the proposed currency union.

Table 6: Instances of Banking System Stability/Fragility in the WAMZ - Liquidity (Credit/Deposit Ratio)

Dependent Variable: Bank Credit/Bank Deposit Ratio						
Year	*Gambia*	*Ghana*	*Guinea*	*Liberia*	*Nigeria*	*S/Leone*
1980	Fragile	Stable	na	Fragile	Fragile	Stable
1981	Fragile	Stable	na	Fragile	Fragile	Stable
1982	Fragile	Stable	na	Fragile	Fragile	Stable
1983	Fragile	Stable	na	Stable	Fragile	Stable
1984	Fragile	Stable	na	Fragile	Fragile	Stable
1985	Fragile	Stable	na	Fragile	Fragile	Stable
1986	Fragile	Stable	na	Stable	Fragile	Stable
1987	Fragile	Stable	na	Stable	Fragile	Stable
1988	Fragile	Stable	na	Stable	Fragile	Stable
1989	Fragile	Stable	na	Stable	Fragile	Stable
1990	Fragile	Stable	na	na	Fragile	Stable
1991	Fragile	Stable	na	Stable	Stable	Stable
1992	Stable	Stable	Fragile	Stable	Fragile	Stable
1993	Stable	Stable	Fragile	Stable	Fragile	Stable
1994	Fragile	Stable	Fragile	Stable	Fragile	Stable
1995	Stable	Stable	Fragile	Stable	Fragile	Stable
1996	Stable	Stable	Fragile	Stable	Fragile	Stable
1997	Stable	Stable	Fragile	Stable	Fragile	Stable
1998	Stable	Stable	Fragile	Fragile	Fragile	Stable
1999	Stable	Fragile	Fragile	Stable	Fragile	Stable
2000	Stable	Fragile	Fragile	Stable	Fragile	Stable
2001	Stable	Fragile	Stable	Fragile	Fragile	Stable
2002	Stable	Stable	Fragile	Fragile	Fragile	Stable
2003	Stable	Stable	Stable	Stable	Fragile	Stable
2004	Stable	Stable	Stable	Stable	Fragile	Stable
2005	Stable	Fragile	Stable	Stable	Fragile	Stable
2006	Stable	Fragile	Stable	Stable	Fragile	Stable
2007	Stable	Fragile	Stable	Stable	Fragile	Stable
2008	Stable	Fragile	Stable	Stable	Fragile	Stable
2009	Stable	Fragile	Stable	Stable	Fragile	Stable
2010	Stable	Fragile	Stable	Stable	Fragile	Stable
2011	Stable	Fragile	Stable	Stable	Fragile	Stable

Note: A banking system is defined as 'fragile' when its Bank Credit/Deposit Ratio is above the WAMZ countries' zonal average of 59.20 plus 2 standard deviation threshold over the periods of banking system stability reported by the IMF; and 'stable' if otherwise.

Table 7: Instances of Banking System Stability/Fragility in the WAMZ – Liquidity
(Liquid Reserves/Assets Ratio)

Dependent Variable: Bank Liquid Reserves/Assets Ratio						
Year	*Gambia*	*Ghana*	*Guinea*	*Liberia*	*Nigeria*	*S/Leone*
2001	Stable	Fragile	na	na	Stable	Stable
2002	Fragile	Fragile	na	na	Stable	Stable
2003	Stable	Stable	na	na	Stable	Fragile
2004	Stable	Stable	na	na	Stable	Fragile
2005	Stable	Stable	na	na	Stable	Stable
2006	Stable	Stable	na	na	Fragile	Fragile
2007	Stable	Stable	na	na	Stable	Fragile
2008	Stable	Fragile	na	na	Fragile	Fragile
2009	Stable	Stable	na	na	Fragile	Fragile
2010	Stable	Stable	na	na	Fragile	Fragile
2011	Stable	Stable	na	na	Fragile	Fragile
2012	Stable	Stable	na	na	Fragile	Fragile
2013	Stable	Stable	na	na	Stable	Fragile

Source: Author's estimations
*Note: A banking system is defined as 'fragile' when its Bank Liquid Reserves/Assets Ratio is below the 4-WAMZ country average of 17.05 less 2 standard deviation threshold over the periods of banking system stability reported by the IMF; and 'stable' if otherwise. * Guinea and Liberia were dropped due to non-availability (na) of enough data.*

The results of the two measures of 'banking sector liquidity' are expressed in Tables 6 and 7 above. For the results of credit/deposit ratio measure shown in Table 6, the dangerous indication is that the Nigerian banking sector is characterised by fragility for almost all the period covered in the evaluation, while the banking sector of The Gambia, Liberia, and Guinea had more periods of stability. The Ghanaian banking sector was fragile in the last year of the period covered. Again, the status of Nigerian banking sector should call for concern towards having a positively sustainable bank credit/bank deposit match, increasing the level of its bank deposits and reducing the level of credits offered. The reflection of the banking sector fragility/stability status as explained by the second measure of liquidity are highlighted in Table 7 where The Gambian and the Ghanaian banking sectors exhibited some high levels of banking system fragility. The application of Bank Z Score of solvency and probability of default shows in Table 8 below that all the banking six banking sectors within the WAMZ are stable, though the Nigerian banking sector still exhibit signs of insolvency in 2009 and 2010. Overall, these trends in the Z Scores signify positive implications for the confidence in the banking sectors of the proposed currency union.

Table 8: Instances of Banking System Stability/Fragility in the WAMZ
(Bank Solvency/Probability of Default)

Year	Gambia	Ghana	Guinea	Liberia	Nigeria	S/Leone
Dependent Variable: (Bank Z Score)						
1998	na	Stable	Stable	na	Stable	Stable
1999	na	Stable	Stable	na	Stable	Stable
2000	Stable	Stable	Stable	na	Stable	Stable
2001	Stable	Stable	Stable	na	Stable	Stable
2002	Stable	Stable	na	na	Stable	Stable
2003	Stable	Stable	na	na	Stable	Stable
2004	Stable	Stable	Stable	na	Stable	Stable
2005	Stable	Stable	Stable	na	Stable	Stable
2006	Stable	Stable	Stable	na	Stable	Stable
2007	Stable	Stable	Stable	Stable	Stable	Stable
2008	Stable	Stable	Stable	Stable	Stable	Stable
2009	Stable	Stable	Stable	Stable	Fragile	Stable
2010	Stable	Stable	Stable	Stable	Fragile	Stable
2011	Stable	Stable	Stable	Stable	Stable	Stable
						Stable

Source: Author's estimations
Note: A banking system is defined as 'fragile' when its Z score is below the threshold of 2.0 (the mid-point between the extremes of the Altman Z Score Model's Grey Zone of Discrimination); and 'stable' if otherwise.

Table 9 below reports the summary of fragility and stability under the six instances. The table shows the scores by each banking sector ranging between 71% and 100% evidence of banking sector stability in the six countries under the instances of banking sector solvency and the four-factor analyses. It is vital to state at this point that regardless of the percentages scored by a country in a probability study of banking fragility like this, 'fragility' outcome for a WAMZ country under any of the six circumstances of evaluation in this research study denote possible banking instability.

Table 9: Proportions of Banking Fragility and Banking Stability in the WAMZ

Instance 1 Four-factor		
WAMZ Country	*% Fragility*	*% Stability*
The Gambia	0	100
Ghana	0.05	99.95
Guinea	0.04	99.96
Liberia	0	100
Nigeria	29	71
Sierra Leone	15	85
Instance 2- Bank Capitalisation		
WAMZ Country	*% Fragility*	*% Stability*
The Gambia	na	na
Ghana	100	0
Guinea	na	na
Liberia	na	na
Nigeria	50	50
Sierra Leone	100	0
Instance 3 - Asset Quality		
WAMZ Country	*% Fragility*	*% Stability*
The Gambia	na	na
Ghana	13	87
Guinea	na	na
Liberia	na	na
Nigeria	44	56
Sierra Leone	43	57
Instance 4 - Bank Liquidity (Credit/Deposit)		
WAMZ Country	*% Fragility*	*% Stability*
The Gambia	41	59
Ghana	31	69
Guinea	50	50
Liberia	26	74
Nigeria	100	0
Sierra Leone	0	100
Instance 5 - Bank Liquidity (Liquidity Reserves/Assets)		
WAMZ Country	*% Fragility*	*% Stability*
The Gambia	0	100
Ghana	23	77
Guinea	na	na
Liberia	na	na
Nigeria	46	54
Sierra Leone	77	23
Instance 6 - Bank Solvency and Probability of Default (Bank Z Score)		
WAMZ Country	*% Fragility*	*% Stability*
The Gambia	0	100
Ghana	0	100
Guinea	0	100
Liberia	0	100
Nigeria	0.10	99.1
Sierra Leone	0	100

Source: Author's Estimation

The outcomes of the dynamic probit model estimations of the panel data of the six WAMZ countries, within the context of the six instances of banking sector fragility/stability are given in Tables 10 through to Table 16.

Table 10: Marginal Effects Predictions of Probability of Banking System Fragility in Dynamic Panel Probit Models: Four-factor Banking Crisis Dummy (as Dependent Variable)

Estimation Results of Panel 1: Four-factor Banking Crisis Dummy	
WAMZ Countries in the Panel - The Gambia, Ghana, Guinea Liberia, Nigeria and Sierra Leone	
Variables	*Probability Predictions*
Macroeconomic Variables (Lagged):	
Banking Crisis Dummy:	0.3640*
Real GDP Growth:	0.0013
Inflation:	-0.0027***
ΔNominal Exchange Rate:	-0.0005
ΔGross Foreign Liability/GDP Ratio:	0.0001
Real Per Capita Income:	0.0228
Money Supply/International Reserve Ratio:	-0.0038***
Short term Real Interest Rate:	-0.0044**
Budget Surplus/GDP Ratio:	0.0013
Banking Sector Variables (Lagged):	
ΔDeposit Liability/GDP Ratio:	0.0008
Domestic Credit Growth:	-0.0002**
ΔPrivate Credit/Deposit Ratio	0.0001
Sample size:	122
Wald X² Prob.:	0.00

Source: Author's Estimations and Stata 14 Output

The estimation results of the model of Panel 1 reported in Table 10 above indicate joint significance at 1% level. Most of the macroeconomic variables did not yield the expected signs, even at their levels of significance. Theoretically, real GDP growth, real per capita income, private credit/deposit ratio variable should be negative. The results show that the probability of banking crisis in the WAMZ (in consideration of the four factors) does not depend on the insignificant real growth, nominal exchange rate changes, changes in gross foreign liabilities/GDP ratios budget surplus ratios, changes in private credit/deposit ratio and changes in the deposit liability/GDP ratio. The external vulnerabilities in money supply/international reserves ratios affect banking crisis in the opposite direction with the implication that a unit increase in this ratio will decrease the probability of banking crisis in the WAMZ by around 0.38%. The banking system are not vulnerable to real interest rate and inflationary shocks. This is against the theoretical hypothesis. Though, these variables are significant, they work in the opposite directions. As the domestic credit growth is significant and negative, the result implies that as volume of domestic credit declines, banking crisis would likely increase. The lagged banking crisis dummy is significant and expectedly positive as explanatory variable, meaning that one unit increase in the previous status of banking sector stability/fragility has the likelihood of influencing banking crisis by 36%.

Table 11: Marginal Effects Predictions of Probability of Banking System Fragility in Dynamic Panel Probit Models: (Capital Adequacy Ratio as Dependent Variable)

Estimation Results of Panel 2: Bank Capitalisation	
WAMZ Countries in Panel: Ghana Nigeria and Sierra Leone	
Marginal Effects Predictions of Probability of Banking System Fragility	
Variables	*Prob. Predictions*
Macroeconomic Variables (Lagged):	
Inflation:	-0.0020
Real GDP Growth:	0.0032
Short Term Real Interest Rates:	-0.0025
Banking Sector Variables (Lagged):	
Capital Adequacy Ratio:	-0.1975
Bank Z Scores:	-0.0343
Sample size:	33
Wald X^2 Prob.:	0.00

Source: Author's Estimations and Stata 14 Output

For the Panel 2 in which inflation, real GDP growth, short term interest rate and bank Z score are modelled to explain the probability of the occurrence of banking crisis in the context of bank capital adequacy, it is revealed that the probability of banking crisis in the WAMZ is not dependent upon these variables as displayed in Table 11 above because none of these variables exhibits statistical significance. None of the variables produced the expected signs. Although, the estimations, due to the lack of enough data, was limited to three WAMZ countries: Ghana, Nigeria and Sierra Leone. There is joint statistical significance of the variables in the model.

Table 12: Estimation Coefficients and Probability Predictions Dynamic Panel Probit Models (Non-Performing Loan Ratio as Dependent Variable)

Estimation Results of Panel 3: Asset Quality	
WAMZ Countries in Panel: Ghana, Nigeria and Sierra Leone	
Marginal Effects Predictions of Probability of Banking System Fragility	
Variables	*Probabilty. Predictions*
Macroeconomic Variables (Lagged):	
Inflation:	0.0051***
Real GDP Growth:	-0.0074
Banking Sector Variables (Lagged):	
Non-Performing Loan/Total Loan Ratio:	0.1670
Domestic Credit Growth:	-0.0007
Lending Rate:	0.0175
Institutional Variables (Lagged):	
Governance: Rule of Law:	-0.4378
Sample size:	39
Wald X^2 Prob.:	0.00

Source: Author's Estimations and Stata 14 Output

In Panel 3 results exhibited in Table 11 above, the estimations of banking crisis within the 'asset quality' definition show statistical significance and correct signs (positive) for inflation, indicating that in this respect, inflation is an indicator of the likelihood of banking crisis caused by poor qualities of bank assets (non-performing loans). One unit increase in inflation in the WAMZ is likely to trigger such banking crisis by 0.5%. All other variables, though reflect the expected signs, do not explain poor-asset-quality-determined banking crisis in the WAMZ. The model was estimated for the WAMZ countries due to lack of enough data for The Gambia, Guinea and Liberia.

In Panel 4, there are two dynamic probit models of bank liquidity crisis assessments (Models 1 and Model 2), based on the level of bank credit/bank deposit ratio. For Model 1 in this panel, real GDP growth, inflation, changes in nominal exchange rate and three banking sector variables of loan/deposit ratio, lending rate and deposit rate are incorporated as explanatory variables. For Model 2 in this same context, all the variables in the first model were applied except the nominal exchange rate change variable and inflation that are insignificant in the results of the first estimated model. The results are displayed in Table 13 below.

Table 13: Estimation Coefficients and Probability Predictions Dynamic Panel Probit Models (Bank Credit/Bank Deposit Ratio as Dependent Variable)

Estimation Results of Panel 4: Bank Liquidity (1)		
WAMZ Countries in Panel: The Gambia, Ghana, Guinea, Liberia, Nigeria and Sierra Leone		
Marginal Effects Predictions of Probability of Banking System Fragility		
Variables	*Model 1 Probability Predictions*	*Model 2 Probability Predictions*
Macroeconomic Variables (Lagged):		
Real GDP Growth:	0.0041***	0.0041***
Inflation:	-0.0013	
ΔNominal Exchange Rate:	-0.0003	
Banking Sector Variables (Lagged):		
Loans/Depositors Ratio:	0.4032*	0.4060*
Lending Rate:	-0.0143**	-0.0146**
Deposit Rate:	0.0147***	0.0140***
Sample size:	163	163
Wald X²Prob.:	0.00	0.00

Source: Author's Estimations and Stata 14 Output

In the two models, real GDP growth, and all the three banking sector variables are significant. The emphasis here is placed on the significant banking sector variables. From the theoretical position, lending rates and deposit rates work in the same

direction as well as having the same effects on the liquidity ratio of banking crisis measurement in Panel 4 (Table 13). While increase in lending rate discourages bank customers from taking more credits and thereby lowers the level of bank credits, same measure of increase in deposit rates encourages bank customers to increase their savings and deposits, thereby increasing banks' deposit bases. Increase in lending rates positively influences the level of banks' liquidity (reducing effects on bank loans levels), just as increases in deposit rates would also have positive effects on banks' liquidity levels (increasing effects on bank deposits levels). Given these opposing effects on the ratio's numerator (bank loans) and denominator (bank deposits), lending rate (with its 'reducing' effects) is expected to yield negative signs while deposit rate (with its 'increasing' effects) should show positive signs. Consequently upon these, the results of the two models in Panel 4 is a reflection of these banking sector variables yielding the correct signs and are statistically significant. When the change in nominal exchange rate is included in Model 1 (of Panel 4), a unit increase in the lending rates and deposit rates each have 1.4% probability of propelling banking liquidity crisis in the WAMZ. When the insignificant inflation and nominal exchange rate change were deleted from Model 1, these banking sector variables, still significant at the same levels (with expected signs) yield same results in Model 2 of Panel 4 (as in Model 4 of same panel). The one-period lagged liquidity level binary response variable of bank liquidity crisis in this context shows the likelihood of the past liquidity position leading to new bank liquidity crisis at 40%. The two models show joint statistical significance at 1% level of significance. It is significant to note that Panel 4 estimations fully encompass all the six WAMZ countries and that all the variables of interest are statistically significant.

Table 14: Estimation Coefficients and Probability Predictions Dynamic Panel Probit Models (Bank Liquid Reserves/Assets Ratio as Dependent Variable)

Estimation Results of Panel 5: Bank Liquidity (2)	
WAMZ Countries in Panel: The Gambia, Ghana, Nigeria and Sierra Leone	
Marginal Effects Predictions of Probability of Banking System Fragility	
Variables	*Probability Predictions*
Macroeconomic Variables (Lagged):	
Real GDP Growth:	-0.0088
Inflation:	0.0024
Money Market Rates	-0.0801
Banking Sector Variables (Lagged):	
Bank Liquid Reserves/Asset Ratios:	-0.0248
Net Interest Margin:	-0.0514**
Institutional Variables (Lagged):	
Governance: Political Instability:	0.0070
Sample size:	43
Wald X² Prob.:	0.23

Source: Author's Estimations and Stata 14 Output

The Panel 5 results of the bank liquidity crisis determination in the context of second measure of bank liquidity in which bank liquid reserves/assets ratio proxies as the indicator is expressed in Table 14 above. Money market rates fail to exhibit the correct sign; and low levels of economic growth and inflation in the WAMZ are not associated with bank liquidity crisis in this context. The previous period level of bank liquidity is negatively related to current liquidity crisis. For net interest margin of banks, the result portends that within the WAMZ's banking sectors, decrease in net interest margin by one unit increases the likelihood of banking fragility by 5%. The model estimation however, fails the joint significant test at χ^2 probability value of 0.23, thus giving way to the preference of the estimation results in Table 13 of the earlier model of liquidity.

Table 15: Estimation Coefficients and Probability Predictions Dynamic Panel Probit Models (Bank Z Score as Dependent Variable)

Estimation Results of Panel 6: Bank Solvency/Probability of Default	
WAMZ Countries in Panel: The Gambia, Ghana, Guinea, Liberia, Nigeria and Sierra Leone	
Marginal Effects Predictions of Probability of Banking System Fragility	
WAMZ Countries in Panel: The Gambia, Ghana, Guinea, Liberia, Nigeria and Sierra Leone	
Variables	*Probability Predictions*
Macroeconomic Variables (Lagged):	
Real GDP Growth:	-0.0036
Inflation:	-0.0045
Money Market Rates:	-0.0089***
Banking Sector Variables (Lagged):	
Bank Z Scores:	0.5199*
Domestic Credit Growth:	-0.0010
Commercial Bank Assets:	-0.03127
Sample size:	61
Wald X^2:	0.00

Source: Author's Estimations and Stata 14 Output

The outcomes of the bank solvency/probability of default crisis for Panel 6 are presented in Table 15 above where it shows that only money market rate (with an unexpected sign) and lagged binary outcome values of bank Z scores are significant. Real growth, inflation, domestic credit growth and commercial bank assets are not significant indicators of banking sector solvency and default crisis in the WAMZ, just as the previous status of default/solvency has 52% likelihood of contributing to new solvency crisis. Domestic credit growth could not, in this context, serve as a determinant of banking crisis given its insignificance and incorrect signs. Commercial bank assets (made up of values owned by the banking sector) generates the correct negative signs but is insignificant suggesting that solvency crisis in the WAMZ in the WAMZ banking sector is not dependent on this variable, though a unit change in the variable may reduce the likelihood of banking solvency crisis by 3%.
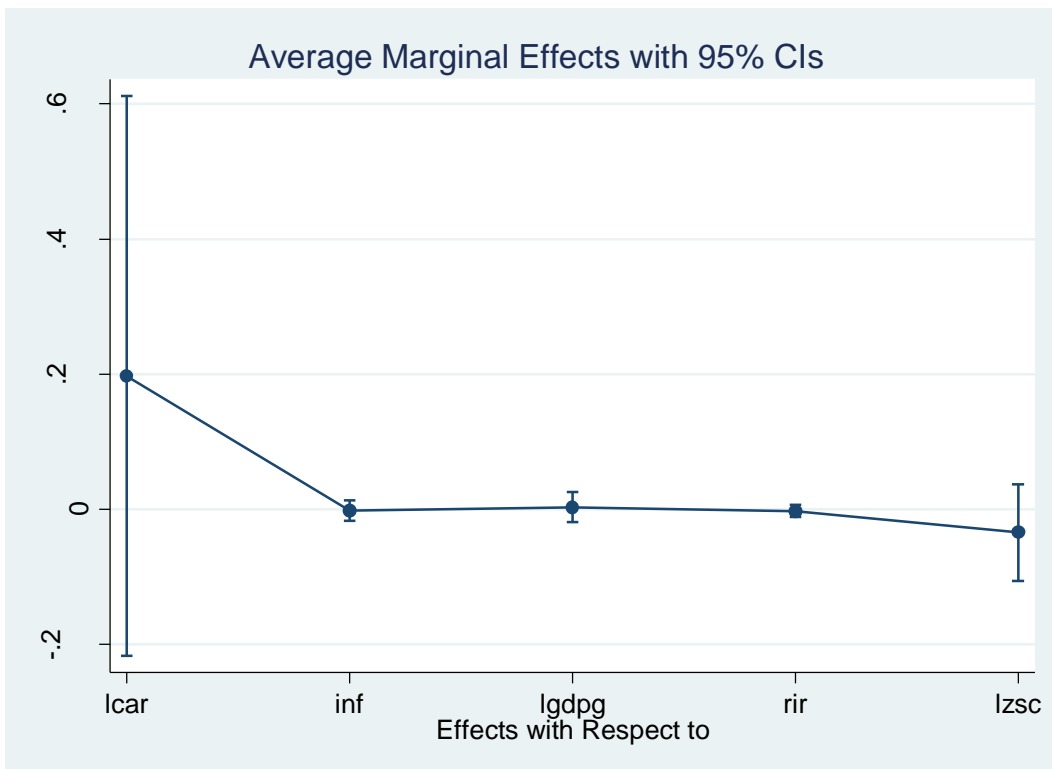
Further to the results of the five-panel-data estimations of dynamic probit models for the banking sectors in the WAMZ, Figures 1 below displays the plots of average marginal effects for the estimations of each models in the five panels, at 95% confidence levels. These plots reflect the effects of each response variables employed in the models in each panel, on the probability of the WAMZ's banking sector turning from stability to fragility under the five definitions of banking sector crisis applied in this study.

Figure 1: Plots of Average Marginal Effects of Banking Fragility/Stability Assessments in the WAMZ
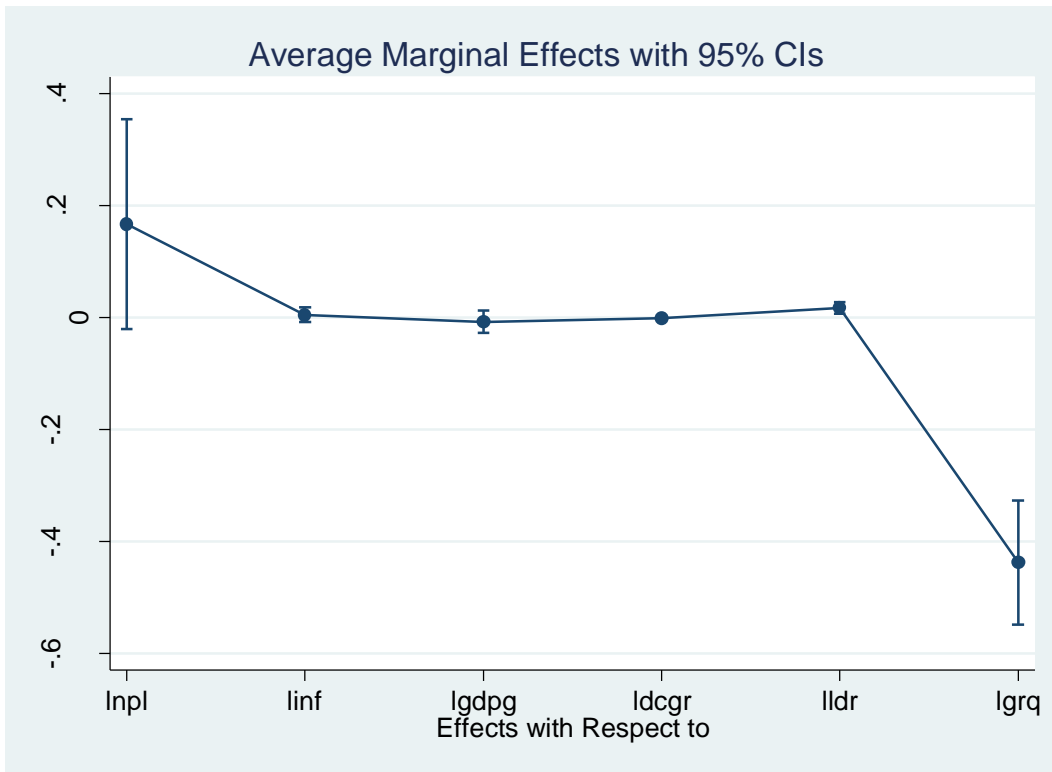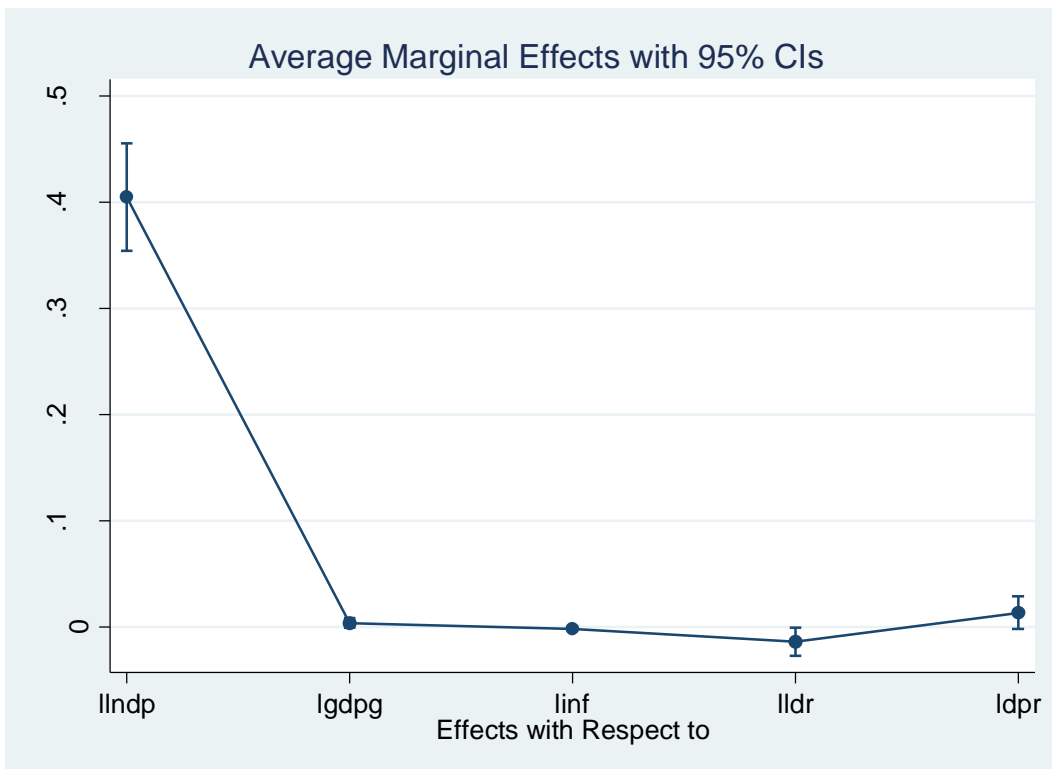
Four-factor Banking Crisis Dummy:

Average Marginal Effects with 95% CIs

Bank Capitalisation:

Average Marginal Effects with 95% CIs

Asset Quality:
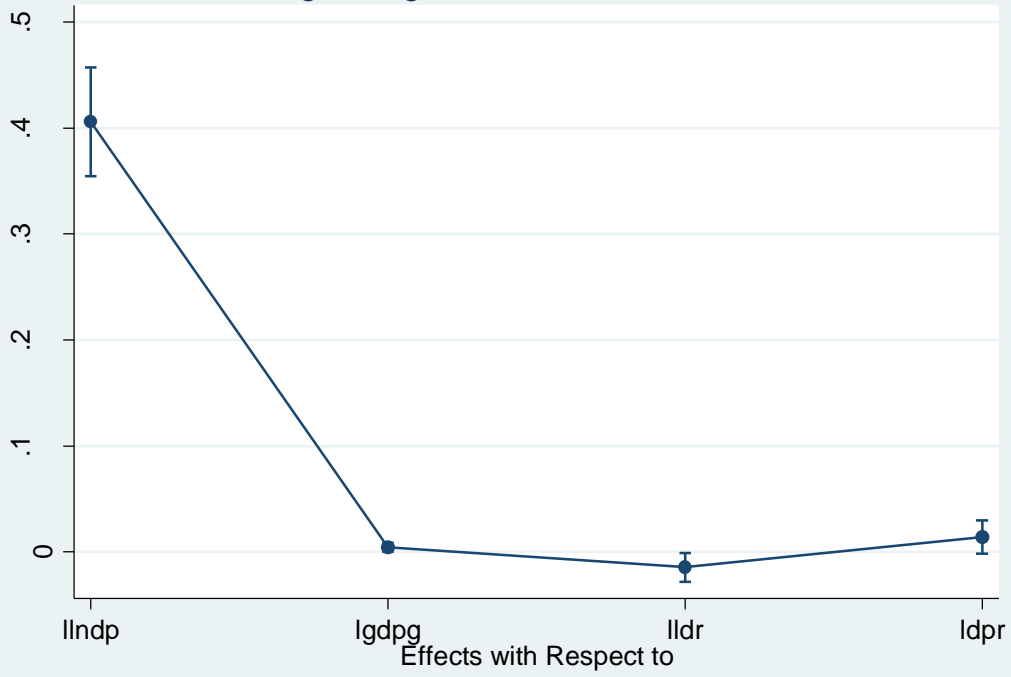

Average Marginal Effects with 95% CIs

Effects with Respect to
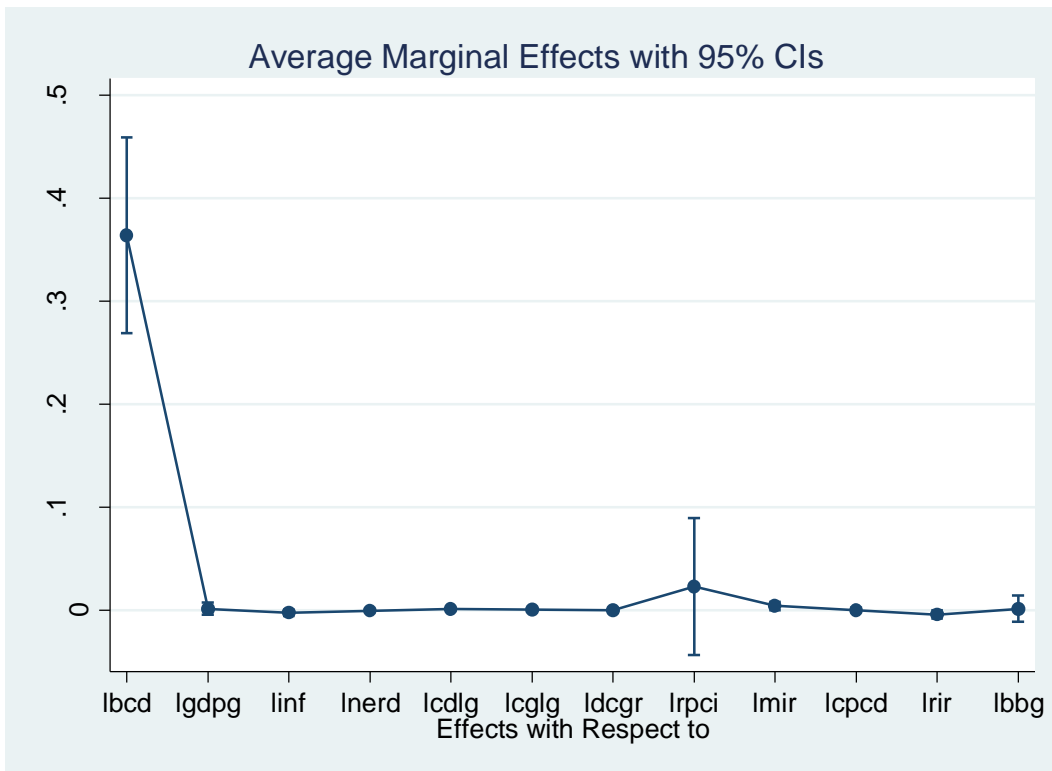
Liquidity-Bank Credit/Bank Deposit Ratio:

Average Marginal Effects with 95% CIs

Effects with Respect to
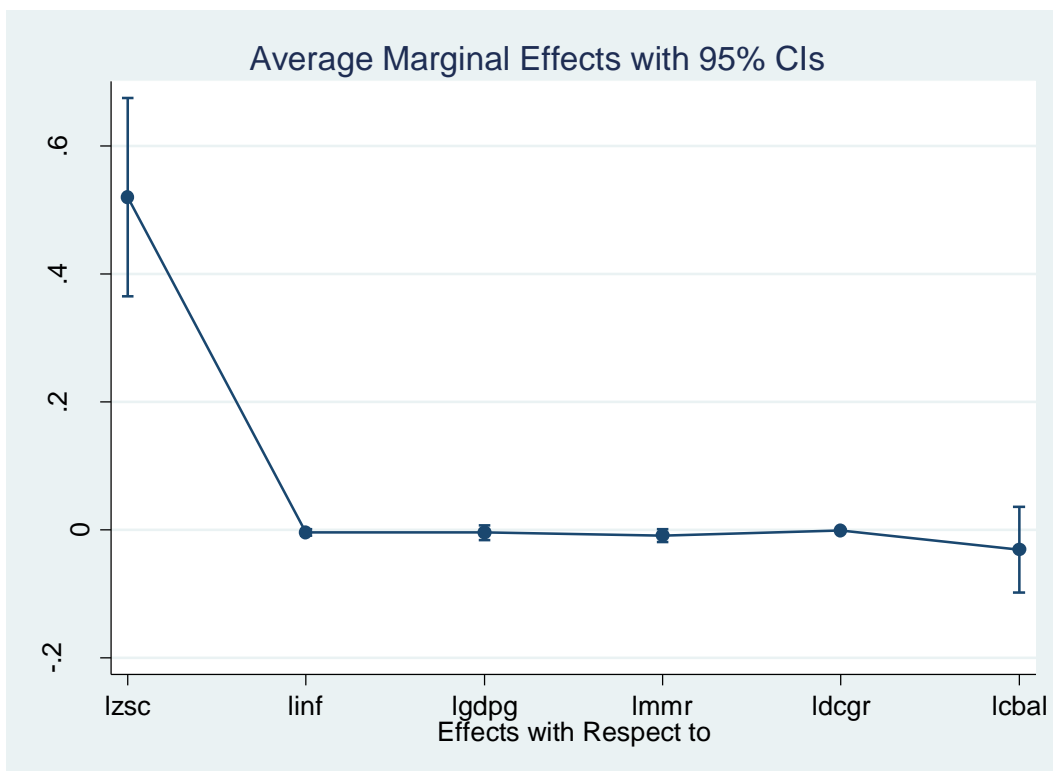
Average Marginal Effects with 95% CIs

Average Marginal Effects with 95% CIs
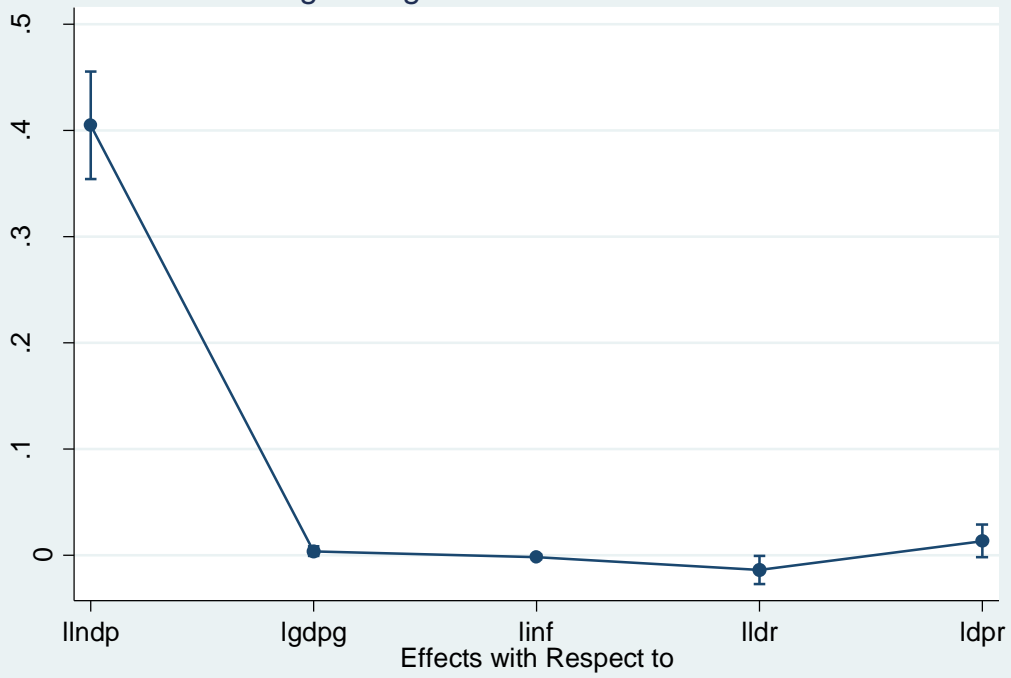
Liquidity - Bank Liquid Reserve/Asset Ratio:
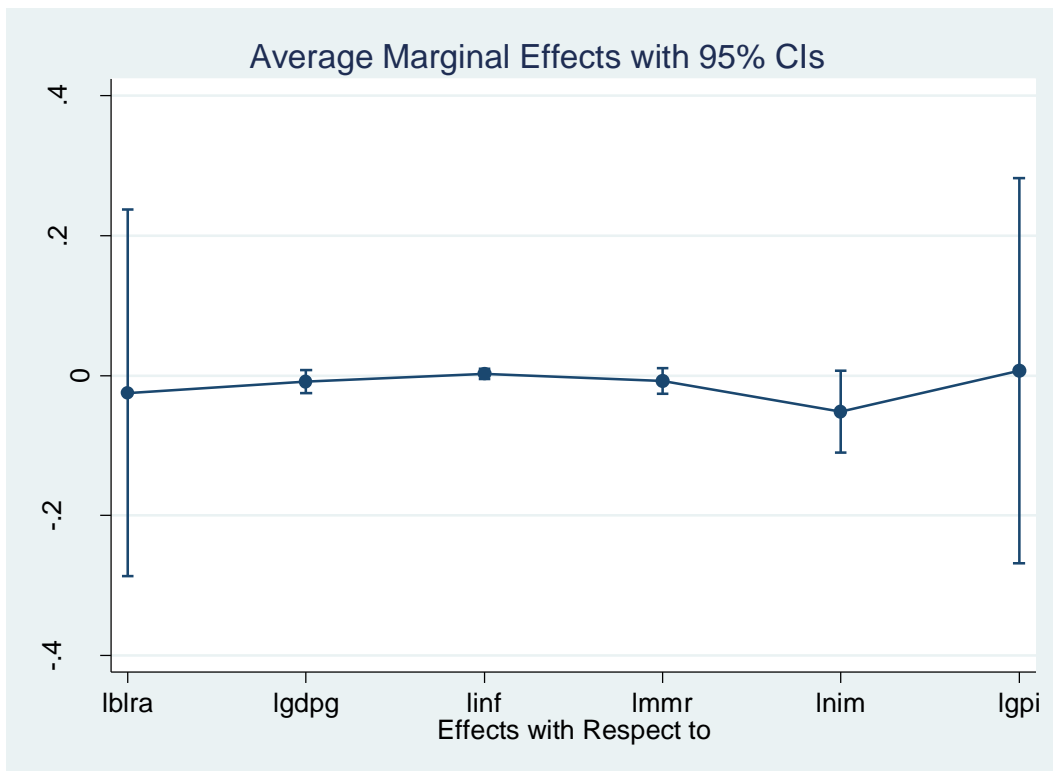
Banks' Z Scores:

Conclusions

Given the necessity of banking sector stability for the viability of monetary integration of a geographic bloc (as exposed by the financial crisis), this study built dynamic panel data probit models to estimate the trends of stability (or fragility) of banking systems across the WAMZ based on five possible instances: (i) IMF-generated banking crisis dummy (ii) non-performing loans, (iii) bank capital inadequacy, (iv) illiquidity, (v) poor Z-score. All relative explanatory variables in the dynamic probit models were lagged by one or more period in order to avoid the potential problem endogeneity problems in the contemporaneous explanatory variables and make explanatory variables to be leading indicators in banking sector fragility prediction.

The study noted the stability (or otherwise) of the Nigerian banking sector as paramount, conveying crucial implications for overall banking sector of the proposed WAMZ, given the country's banking strength and presence across the whole sub-continent. Nigerian banking system witnessed instability between 1991 and 1995, and between 2009 and 2013 in the dynamic probit estimation of banking crisis dummy.

With the BASEL II capital adequacy ratio of 8% of the BIS as benchmark, The Gambia, Guinea and Liberia were not included in the capitalisation consideration of banking fragility due to inavailability of enough data. From the estimation results, there are strong indications that between 2000 and 2013, banking sector of Ghana and Sierra Leone were grossly fragile due to undercapitalisation. This raises some serious question concerns when the banks' undercapitalisation (and subsequent recapitalisation problems leading to national fiscal problem in the Eurozone) is brought into cognisance. The Nigerian banking sector was staggering in-between fragility and stability. The asset quality tests of banking fragility reveal that the Ghanaian banking sector displays more stability here, while the banking sectors in Nigeria and Sierra Leone had almost equal proportion of banking stability and fragility.

Bank Credit/Bank Deposit and Bank Liquid Reserves/Assets ratios are the two measures of bank liquidity levels employed in this study. The results of the bank liquid reserve/assets ratio instance of bank fragility estimations is jettisoned because of the statistical insignificance of the banking sector independent variables applied in the estimation as well as the comparatively lower number observations. The credit/deposit ratio liquidity tests of banking sector fragility suggest the dangerous indication is that

the Nigerian banking sector is characterised by fragility for almost all the period covered in the evaluation, calling for concern. The banking sector of The Gambia, Liberia, and Guinea had more periods of stability. The Ghanaian banking sector was fragile in the last year of the period covered.

The Bank Z Score of solvency and probability of default tests suggest that all the banking six banking sectors within the WAMZ are stable, though the Nigerian banking sector exhibits signs of insolvency in 2009 and 2010. On the overall, these trends in the Z Scores signify positive implications for the confidence in the banking sectors of the proposed currency union.

Generally, going through the outcomes of the probability tests of banking fragility across the WAMZ, banking systems within the zone portend moderate stability which gives assurance of a stable monetary integration of the WAMZ for now.

References:

Lefiller, J (2013). 'Strengthening the Africa Banking sector: How Development Finance Institution Can Help'. *The African Business Review*. Sept. 2013.

Derreumaux, P. (2013). 'The Renewal of African Banking Sector in 'New Players and New Banking Models for Africa' *Private Sector and Development Proparco's Magazine*, No. 16 May 2013.

Mlachila, M. Park, S.G. and M. Yabara (2013). 'Banking in Sub-Saharan African: The Macroeconomic Context'. International Monetary Fund, African Department.

Honohan, P. and T. Beck (2007). 'Making Finance Work for Africa'. *World Bank.*

Beck, T. and R. Cull (2013). 'Banking in Africa'. *CSAE Working Paper* WPS/2013-16.

Laeven, L. and F. Valencia (2012). 'Systemic Banking Crises Database: An Update'. *IMF Working Paper* 12/163.

IMF (2013). 'Nigeria: Financial Sector Stability Assessment'. *IMF Country Report* 13/140. May, 2013.

Demirgue-Kunt, A. and E. Detragiache (2005). 'Cross Country Empirical Studies of Systemic Banking Distress: A Survey'. *IMF Working Paper* WP/05/96.

Laeven, L. and F. Valencia (2010). 'Resolution of Banking Crises: The Good, the Bad and the Ugly'. *IMF Working Paper*, WP/10/146

Boyd, J. H. and G. DeNicolo (2005). 'The Theory of Bank Risk Taking and Competition Revisited'. *Journal of Finance*, 60 pp.1329-1345.

Degryse, H. Elahi, M. A. and M. F. Penas (2013). 'Determinants of Banking Fragility: A Regional Perspective'. *European Central Bank Working Paper* 1567 (July).

Raoudha, A. (2014). 'Market Structure and Bank Fragility: Application to the Tunisia Banking System'. *Zagreb International Review of Economic and Business* 17 (2) pp. 1-20.

Wooldridge, J. M. (2013). '*Introductory Econometrics: A Modern Approach, 5th Edition*'. South Western Cengage Learning, USA: Mason.

Hill, R. C., Griffiths, W.E. and G. C. Lim (2008). *'Principles of Econometrics 3rd Edition*'. John Wiley and Sons: New Jersey.

Kauppi, H. and P. Saikkonen (2005). 'Predicting US Recession with Dynamic Binary Response Models'. *Helsinki Centre of Economic Discussion Paper* 79, November 2005.

Stewart, M. (2006). 'Maximum Simulated Likelihood Estimation of Random Effect Dynamic Probit Model with Autocorrelated Error'. *The Stata Journal*, 6 (2) pp. 255-272.

Soderban, M. (2004). '*Estimation of Binary Choice Models with Panel Data*'. ERSA Training Workshop Lecture Note 5.

Heckman, J. J. (1981). 'The Incidental Parameter Problem and the Problem of Initial Conditions in Estimating a Discrete Time-discrete Data Stochastic Process'. In *Structural Analysis of Discrete Data and Econometric Application*, ed. C. F. Manski and D. L. McFadden, pp. 114-178. Cambridge, MA: MIT Press.