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Alternative Measures for Predicting Financial Distress in the Case of Malaysian Islamic Banks: Assessing the Impact of Global Financial Crisis

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Abstract

Purpose: The global financial crisis of 2008 still has an impact on the financial systems around the world, for which funding liquidity has been mentioned as one of the main concerns during that period. This study aims to consider the impact of and extent to which the funding structure of Islamic banks along with deposit structure, macroeconomic variables, other bank-specific variables, including alternative funding mix variables (in terms of funding structure measured as financing/deposit ratio) could play a part in explaining the financial conditions and predicting the failures and performances of Islamic banks in the case of Malaysia under the distress created by the global financial crisis.

Methodology: Multivariate Logit model was utilised with a sample including 17 full-fledged Islamic banks in Malaysia for the period from December 2005 to September 2010 by using quarterly data.

Findings: This study found that the funding mix variable (financing/deposit ratio), the composition of deposits, alternative bank-specific variables, and alternative funding mix variables are statistically significant. In contrast, none of the macroeconomic variables is found to have a significant impact on bank liquidity. In the final models, the variables that showed significant performance were selected as explanatory variables. The results of McFadden *R*-squared for both selected models showed an excellent fit to predict the Islamic banks' performance.

Originality: This empirical study contributes to the literature in two ways: it is one of the first studies to examine the role of the funding structures of Islamic banks in determining their performance, and it also examines the effect of deposit composition (the *mudharabah* and non-*mudharabah* deposits) on Islamic banks' performance.

Keywords: Financial distress, Liquidity risk, Deposits, Islamic banks, Funding structure, Logit modelling

1. Introduction

The 2008 global financial crisis still has an impact on the financial system around the world, for which funding liquidity has been mentioned as one of the main concerns during that period (Bologna, 2011). Based on a study by Bologna (2011), this study further extends the research by examining the impact of and extent to which the funding structure of Islamic banks captured through funding mix variables measured as financing/deposit ratio and other economic and financial factors could play a part in explaining the financial condition of 17 Malaysian full-fledged Islamic banks through quarterly data for the period of December 2005 to September 2010 to examine the impact of the distress created by the global financial crisis. In other words, this study investigates whether any specific funding structure, as well as other predictors, can be taken into account as explanatory variables in predicting the potential failures of Islamic banks, in particular considering the distressing impact of the global financial crisis erupted in 2008.

Since most of the studies in this area were from the perspective of conventional banks located in the US, this empirical study is among the very first studies to investigate the role of the Malaysian Islamic banks' funding structure in predicting their default. Additionally, in analysing Islamic banks' deposits, this study explores and examines in detail at the effects of the deposit composition in accordance with the Islamic contracts used in the Islamic banks' performance, the effect of selected macroeconomic variables, and other bank-specific variables.

The contribution of this empirical analysis can be divided into two aspects: it is one of the first studies to examine the role of the funding structures of Islamic banks in determining their performance. Secondly, it examines the effect of deposit composition, especially the *mudharabah* and non-*mudharabah* deposits, on an Islamic banks' performance.

This study proceeds as follows: after a brief introduction, it provides a review of the literature on banks' defaults and the deposit composition. The next section explains the research methodology used, especially with regard to the selection of appropriate models and the definition of variables included in the models. This is followed by the analysis of the results and the robustness test of the model, carried out by testing the model using alternatives measures such as macroeconomics variables and the alternative bank-specific variables. This section also recommends the best alternative model(s) to measure Islamic banks' distress. The final section presents the conclusion of this study.

2. Literature Review

There have been discussions of credit risk, market risk, and operational risk among academics and regulators but less attention has been paid to liquidity risk until the global financial crisis when it has become one of the major risks faced by banks and financial institutions (*see*: Landskroner and Paroush, 2008). According to the definition of the Basel Committee of Banking Supervision (1997), liquidity risk arises from the inability of a bank to accommodate a decrease in liabilities or to fund an increase in assets.

Worth discussing in this section is the literature on liquidity risk that focuses on bank failures, especially those related to determinants of bank profitability or net interest margin. For example, Bourke (1989) reviews the performance of banks in Europe, North America, and Australia and examines the internal and external factors affecting profitability. A few years

later, a study by Molyneux and Thornton (1992) replicated the same methods used by Bourke (1989) by examining the determinants of bank performance across 18 European countries between 1986 and 1989. The results were in line with the findings of the US-centered and profitability-centred studies.

A study by Shen *et al*. (2001) stated that classical models of the interest margins have the assumption that all banks belong to an identical banking system in a country. The idea that two or more kinds of banking systems can possibly exist at the same time in one country is called the Partial Banking System; it can be divided into two classes: the 'separated banking system' and the 'universal banking system'. Shen *et al.* (2001) found that the net interest margins in the separated banking system are affected by credit risk, interest rate risk, the leverage level as well as the quality of management. Whilst for the universal banking system, the net interest margins are vulnerable to credit risk and the leverage level.

By using bank-level data, Pasiouras and Kosmidou (2007) established that, besides a bank's specific characteristics, the financial market structure and the macroeconomic conditions do affect the profitability of both domestic and foreign banks. Similar results were established by Athanasoglou *et al*. (2008) who examined the effect of bank-specific, industry-specific, and macroeconomic variables on the profitability level of Greek banks for a period between 1985 and 2001. Naceur and Kandil's (2009) study, on the other hand, examined the effect of regulations on the cost of intermediation and profitability and found that a higher capital requirement, the reduction in implicit cost, and an increase in management efficiency, are among the factors that play a positive part in the banks' profitability in the post-regulation period.

To identify the effect of macroeconomic conditions, the commonly used macroeconomic variables are the annual percent change of the GDP and the annual percent change of inflation. Thus, based on previous studies in this area it can be concluded that economic growth (GDP) has a positive effect on a bank's performance (*e.g*. Kosmidou *et al*., 2005; Pasiouras & Kosmidou, 2007; Athanasoglou *et al*., 2008; Anbar & Alper, 2011; Derbali, 2011; Lainà *et al*., 2015; Shijaku, 2016; Pedro *et al*., 2018; de Haan *et al*., 2020). On the other hand, the impact of inflation on a bank's performance has been divided into two aspects: a positive relationship (*e.g.* Kosmidou *et al*., 2005; Athanasoglou *et al.*, 2006; Pasiouras & Kosmidou, 2007; Athanasoglou *et al*., 2008, Pedro *et al*., 2018) or a negative relationship (*e.g.* Kosmidou, 2008; de Haan *et al*., 2020).

As regards to bank liquidity, Shen *et al*. (2009) investigated cases of liquidity by using alternative liquidity risk measures besides the liquidity ratio, who found that liquidity risk is the endogenous determinant of bank performance, which may reduce bank profitability due to the higher cost of funds, but it may also increase a bank's net interest margins. They also found that liquidity risk is negatively related to bank performance in a market-based financial system and it has no effect in a bank-based financial system. In investigating the impact of holding liquid assets on bank profitability in the US and Canada, Bordeleau and Graham (2010) found that holding some liquid assets increases a bank's profitability but holding too many liquid assets eventually reduces it.

By comparing the GCC conventional and Islamic banks for the period of 2000-2007, Hussein (2010) examined the behaviour of the key bank-level stability factors of liquidity, capital, risk-taking, and consumer confidence. The study concluded that, although bank liquidity is not determined by the bank's product mix, non-performing assets do have a positive and significant

impact on the banks' liquidity position. This means that Islamic banks are inclined to take more stringent strategies during the crisis as opposed to conventional banks. The consumer confidence level, as measured by deposits and consumer funding over liabilities, was shown to be higher in Islamic banks than conventional banks. Akhtar *et al.* (2011) also carried out comparison analysis, on liquidity management between Islamic banks and conventional banks in Pakistan to examine the liquidity risk associated with the solvency of financial institutions by evaluating the liquidity risk management (LRM). The authors found that there was a positive but insignificant relationship between the size of the banks and the net-working capital to net assets with liquidity risk. Additionally, they found that the capital adequacy ratio in conventional banks and return on assets in Islamic banks is positive and significant at the 10% significance level.

2.1 Default Issues

Bank related studies show that insolvency, default, and bankruptcy are four different terms which all indicate that a business is in distress failure (*see*: Altman, 1993). Besides bankruptcy and financial distress, there are several other economic definitions of failure used in previous research on corporate failures such as cash insolvency and loan default (Balcaen & Ooghe, 2006).

Many studies were conducted to analyse the specific determinants of the default event in question, be it a systemic crisis or financial institution distress. A study by Demirgüç-Kunt and Detragiache (1998) found that countries with low GDP growth, high real interest rates, high inflation, higher likelihood of a balance-of-payment crisis, and explicit deposit insurance are more likely to face a crisis for the period of 1980 to1994. In another study, Demirgüç-Kunt & Detragiache (2002) confirm the significance of deposit insurance as a risk factor for banks' stability based on evidence from 61 countries for 1980-1997 period.

Based on the literature on forecasting banks failure, distress, and closure, this study focuses on the early identification of banks' financial distress based on financial statements as well as macroeconomic variables. Studies in this area have been developed since the early 1970s and Altman *et al*. (1981) presents a comprehensive review of the early stage literature. For example, Demyanyk and Hassan (2010) analysed the financial and economic conditions linked to the crisis of subprime mortgages in the US and the global financial crisis. Previously, Wheelock and Wilson (2000) also analysed the bank-specific factors that help to explain banks' default in the US during the period 1984 to 1993, whose study evidenced that the probability of failure is higher for banks with lower capitalisation and profitability, as well as poor assets quality.

The earlier study by Diamond and Dybvig (1983) explains why banks choose to issue deposits that are more liquid than their assets, who found that lack of liquidity may lead to a bank run – a sudden unexpected increase in bank deposit withdrawals. Besides, their model has been widely used to understand bank runs and other types of financial crises, as well as ways to prevent such events. Later, Goldberg and Hudgins (2002) examined the role played by uninsured deposits as a source of thrift funding and the depositors' response to market forces. They found that failed institutions showed a declining trend of uninsured deposits-to-total deposits prior to failure. Moreover, these deteriorating institutions draw fewer deposits from uninsured depositors prior to failure as compared to solvent institutions. A study by Gatev *et al*. (2009) showed results that reverse the standard notion of liquidity risk at banks, where runs from depositors had been observed as one of the causes of the bank's problem.

According to Wagner (2007), an increase in a bank's liquidity might well increase banking instability. Although higher asset liquidity may lead to banking stability, it may also make banking crises less damaging. Consequently, banks may be more likely to take on new risk than to assess the positive impact on banking stability. Earlier, Porath (2006) conducted a study on financial distress and the financial strength of German savings and cooperative banks. The study formulated a default prediction model and also analysed the impact of macroeconomic information on forecasting banks' defaults. While most of the findings for the U.S. have shed some doubt on the value of macroeconomics information, Porath (2006) found out that macroeconomics information does notably enhance the default predictions.

By using the US bank data from 1980 to 1992, Cole and Wu (2009) compared the accuracy of the time varying hazard model that was developed by Shumway (2001) and the one-period probit model used by Cole and Gunther (1998). They found that smaller banks with high non-performing loans and deposits as their main sources of funding are more likely to fail and vice versa. They also concluded that a one-period probit model outperformed the time-varying hazard model in predicting the bank's failure. This model, which was designed to fit the 1980s data, is performing astonishingly well in forecasting bank failures during 2009–2010. Subsequently, a study by Cole and White (2010) investigated why commercial banks failed during the global financial crisis. They found that traditional proxies for the CAMELS components, as well as measures of commercial real estate investments, did an excellent job in explaining the failures of banks which were closed during 2009, just as they did in the previous banking crisis of 1985–1992.

Earlier, Shen *et al*. (2009) utilised alternative liquidity measures in addition to the traditional liquidity ratios to investigate the causes of liquidity risk, who found that liquidity risk is the endogenous determinant of bank performance. Among the main causes of liquidity risk in banks are the components of liquid assets and reliance on external funding, supervisory and regulatory factors, and macroeconomic factors. Moreover, the study found that the higher cost of funds may reduce bank profitability, and liquidity risk is negatively related to bank performance in a market-based financial system but has no effect in a bank-based financial system.

For Islamic banks, risk and liquidity management has become a big issue for all banks as well as for the regulators of those banks. A study by Mounira and Anas (2009) presented a brief description of Islamic banks' performance and explained the risks to which Islamic banks are exposed. At the same time, this study also tried to identify the mitigating practices used in these banks.

Focusing on predicting banks' defaults on the US bank data from 1987 to 2008, Van der Ploeg (2010) examines and compares the predictive performance of multiple default prediction models (logit, probit, hazard, and neural networks) and gauges the capability of those models to correctly predict credit rating transition. The study found that all the models have a satisfactory performance in the prediction of banks' defaults. Another study concentrating on the factors behind the Canadian banks' relative resilience during the credit turmoil was conducted by Huang and Ratnovski (2011), which found that high depository funding (as compared to wholesale funding) and a number of regulatory as well as structural factors in the Canadian market make the banks less motivated to take too many risks. A similar study conducted by Serrano-Cinca et al. (2014) analysed the bankruptcy of the US banks since 2009 and proposed several hypotheses on what causes failure. Among the factors that they looked at are loan growth and specialization (focus on real estate). Their results show that five years

before the crisis, failed banks had higher loans growth, a higher focus on real estate loans and higher risk ratios, among others, as compared to the solvent banks. In addition, there was a significant relationship between the percentage of real estate loans and risks in the failed banks. In a later study, using the US commercial bank data from 2004 to 2012, Chiaramonte *et al.* (2016) examined how well z-score can predict bank failure. They found that, on average, Z-score can predict 76% of bank failures and the additional set of bank-level and macroeconomics data did not increase the predictive power of the model. Furthermore, they also found that the predictive power of the z-scores to predict bak defaults remain stable within the three-year forward window.

Berger and Turk-Ariss (2011) examined the importance of regulatory and market discipline during the global financial crisis, who tested the presence of depositor discipline effects in the period leading up to the global financial crisis in the US and EU. The study found a significant impact on depositor discipline in both the US and EU, but it emerged that depositor discipline in US banking organisations was stronger for the largest institutions, thus being consistent with the fact that these organisations rely more on uninsured deposits. Focusing on the European banks, Betz *et al.* (2014) used bank-level data to develop an early-warning model for predicting the banks' distress. The study found that out-of-sample predictions improve significantly when bank-level characteristics are complemented by micro-financial imbalances and banking sector explanatory variables.

To capture the impact of the global financial crisis, Cornett *et al*. (2011) examined the effect of the financial crisis on the credit supply during the financial crisis of 2007 to 2009. They found that banks that relied more heavily on core deposit and equity capital financing tended to lend more to other banks, whereas banks that held more illiquid assets on their balance sheet tended to reduce lending. It can, thus, be concluded that, during the crisis, an effort by banks to manage their liquidity crisis eventually leads to a decline in credit supply. From a different perspective, Derbali (2011) examined the profitability indicators of Tunisian commercial banks; the study found that profitability was positively influenced by the size of the banks, assets composition, credit risk, concentration, market capitalisation, with net interest margin as profitability measures. A similar study conducted by Papadopoulos *et al.* (2018), focusing on European banking systems between 2001 and 2014 for the EU14 crisis of 2007-2008. They developed an early-warning system for predicting a crisis several quarters in advance for the same region and time window by utilising publicly available data for macroeconomics and market variables. In a similar manner but by focusing on a single country case, Ferriani *et al.* (2019) used a logit model to examine the default probabilities for smaller Italian financial institutions under the Bank of Italy supervision for a sample period between 2008 and 2016. The study has selected an extensive list of variables that might give early warnings of a crisis. The results showed a percentage of correct classification in the range of 80% and 90%, with the results improving nearer to the crisis event.

According to Kao *et al*. (2012), short-term financing such as asset-backed commercial paper (ABCP) or repurchase agreements (repo) was prevalent prior to the 2007–2008 financial crises. Banks funded by short-term debts, however, are exposed to rollover risk as the banks are unable to raise sufficient funds to finance their long-term assets. Under such circumstances, the banks' equity holders need to absorb rollover loss. Both deteriorating collateral assets fundamentals and market illiquidity are important drivers of rollover risk.

2.2 Deposit Composition

Deposits play an essential role as one of the banks' sources of funding, and a major fraction of the banks' assets is usually financed by their customer deposits. This fact led to more research in this area related to deposits and their role for the banks. An earlier study was conducted by Diamond and Dybvig (1983). They argued that deposits are subject to bank runs and can be costly for banks due to assets and liability maturity mismatches. Flannery (1998) and Cook and Spellman (1994) are further examples of studies which claim that depositors may still continue to monitor their banks even when the deposits are insured; this could be due to not feeling completely protected by the existing insurance scheme.

As mentioned by Bologna (2011), short-term wholesale funding has shown a positive effect on supplementing the retail deposits, mostly during the years prior to the global financial crisis. Earlier, Calomiris (1991) found that wholesale funding permits investors to monitor their banks, provide market discipline, and take advantage of investment opportunities without being restricted to the availability of the deposit supply. The global financial crisis emphasised the effect of excessive dependence on short-term wholesale funding, as shown by Acharya *et al*. (2011), Huang and Ratnovski (2009), and Goldsmith-Pinkham and Yorulmazer (2010). According to Acharya *et al*. (2011), the debt capacity of an asset is the maximum amount that can be borrowed using the asset as collateral. They showed that a small change in the asset's primary value can be linked with a disastrous drop in the debt capacity, such as the market freeze observed during the crisis of 2007 to 2008.

A number of studies have proved the effect of monitoring efforts and disciplining by customer depositors, and a number of these studies were conducted in the US (Park & Peristiani, 1998; Billet *et al*., 1998; Jordan *et al*., 1999; Jagtiani & Lemieux, 2001; Gilbert & Vaughan, 2001; Goldberg & Hudgins, 2002; and Berger & Turk-Ariss, 2011). Studies by Park and Peristiani (1998), Billet *et al*. (1998), and Berger and Turk-Ariss (2011), found that depositors have a disciplining effect on banks, while studies by Gilbert and Vaughan (2001), Jordan *et al*. (1999), and Jagtiani and Lemieux (2001) found opposite results.

Hussein (2010) examined the behaviour of key bank-level factors of liquidity, capital, risk-taking, and consumer confidence in Islamic and conventional banks in the GCC. He found that the liquidity position is not determined by the bank's product mix but is rather attributed to systemic factors. On the other hand, non-performing assets do have a significant relationship with liquidity, thus suggesting that the Islamic banks are inclined to take rigorous risk strategies during the crisis as compared to conventional banks. In addition to that, although conventional banks had higher averages of liquidity as compared to Islamic banks, consumers do have a higher confidence level in Islamic banks as they are more capitalised. The consumer confidence level or depositors' discipline, as substituted by deposits and customer funding over liabilities, usually emerges to be higher in Islamic banks than conventional banks.

As can be seen, most of the existing literature in this area examines the role of deposits without being able to distinguish between insured and non-insured ones, while economics perspectives point out that these two groups of depositors should be expected to behave differently. Furthermore, from the Islamic banks' perspective, future research should consider different types of depositors according to their types of contracts.

3. Methodology and Modelling

The data collection for this research involves secondary data. Ten out of 17 fully-fledged Islamic banks in Malaysia have been selected as a sample for this study, and quarterly financial reports have been obtained for those banks from December 2005 to September 2010.

Multiple discriminant analysis, binary choice models (logit and probit) and proportional hazard models are among the most commonly used methods for the analysis of financial ratios. By referring to the statistics reported by Aziz and Dar (2004) it can be concluded that more than 30 percent of the research was examined using multiple discriminant analysis, while another 21 percent preferred the logit model; and more than 77 percent of all studies on corporate bankruptcy prediction use statistical models.

Based on the above statistics and in line with Bologna (2011), the logit model is used to analyse the role of funding in explaining Islamic banks' defaults. The logit model is based on a cumulative logistic function; it provides the probability of an Islamic bank belonging to one of the prescribed groups, given by the financial characteristics of the Islamic bank. In this study, the binary dependent variable $Y_{a,t}$ is a variable representing the status of Islamic bank a at time t; when $Y_{a,t} = 0$ a bank is in healthy condition and when $Y_{a,t} = 1$ a bank is in non-healthy condition.

Table 1: Definition of Variables

Variable	**Symbol Used**	**Description**
Asset Quality	NPF	Non-Performing Financing/Total Financing
Capital Adequacy	RWCR	Risk-Weighted Capital Ratio
Profitability	ROE	Net Income/Total Equity Ratio
Financing Rate	BFR	Base Financing Rate
Assets to deposits	ATD	Total Assets/Total Deposits
Funding Mix Variable		
Funding Structure	FTD	Financing/Deposit Ratio
Composition of Deposits		
Mudharabah Deposits	*MD*	*Mudharabah* Deposits/Total Deposits Ratio
Non-*Mudharabah* Deposits	NMD	Non-*Mudharabah* Deposits/Total Deposits
Demand Deposits	DD	Demand Deposits/Total Deposits Ratio
Savings Deposits	SD	Savings Deposits/Total Deposits Ratio
General Investment Deposits	GID	General Investment Deposits/Total Deposits Ratio
Special Investment Deposits	SID	Special Investment Deposits/Total Deposits Ratio
Negotiable Investment Deposits	NID	Negotiable Investment Deposits/Total Deposits Ratio
Alternative Bank Specific Variables		
Reserve to Total Assets Ratio	RTA	Reserve/Total assets
Tangible to Common Equity Ratio	TCE	Tangible Assets/Common Equity
Return on Assets	ROA	Net income/Total Assets

Process flow of the alternative measures is developed through the following steps:

Step 1: Compute all the relevant financial ratios

Step 2: Model 1: Original Model

$$Y_{a,t} = \beta_1 + \beta_2 NPF_{a,t-1} + \beta_3 RWCR_{a,t-1} + \beta_4 ROE_{a,t-1} + \beta_5 BFR_{t-2} + \mu_a$$

Step 3: Model 2: Funding Structure Model

$$Y_{a,t} = \beta_1 + \beta_2 NPF_{a,t-1} + \beta_3 RWCR_{a,t-1} + \beta_4 ROE_{a,t-1} + \beta_5 BFR_{a,t-2} + \beta_6 FTD_{a,t-3} + \mu_a$$

Step 4: Model 3: Deposits Structure Model

$$Y_{a,t} = \beta_1 + \beta_2 NPF_{a,t-1} + \beta_3 RWCR_{a,t-1} + \beta_4 ROE_{a,t-1} + \beta_5 BFR_{a,t-2} + \beta_6 D_{a,k,t-j} + \mu_a$$

Step 5: Model 4: Alternative Macroeconomics variables Model

$$Y_{a,t} = \beta_1 + \beta_2 NPF_{a,t-1} + \beta_3 RWCR_{a,t-1} + \beta_4 ROE_{a,t-1} + \beta_5 ME_{a,t-j} + \beta_6 FTD_{a,t-3} + \mu_a$$

Step 6: Model 5: Alternative Bank Specific Variables Model

$$Y_{a,t} = \beta_1 + \beta_2 RTA_{a,t-1} + \beta_3 TCE_{a,t-1} + \beta_4 ROA_{a,t-1} + \beta_5 BFR_{a,t-2} + \beta_6 FTD_{a,t-3} + \mu_a$$

Step 7: Model 6: Funding Mix Model

$$Y_{a,t} = \beta_1 + \beta_2 NPF_{a,t-1} + \beta_3 RWCR_{a,t-1} + \beta_4 ROE_{a,t-1} + \beta_5 BFR_{a,t-2} + \beta_6 ATD_{a,t-2} + \mu_a$$

Step 8: The Best Alternative Model(s) to Measure Islamic Banks' Distress

Based on the Bologna (2011) result, the Multivariate Logit model has been identified and estimated, but with some changes to the definition of the variables due to the characteristics of Islamic banks:

Model 1:

$$Y_{a,t} = \beta_1 + \beta_2 NPF_{a,t-1} + \beta_3 RWCR_{a,t-1} + \beta_4 ROE_{a,t-1} + \beta_5 BFR_{t-2} + \mu_a$$

where $Y_{a,t}$ being the status of each Islamic bank *a* at time *t,* $NPF_{a,t-1}$, $RWCR_{a,t-1}$, $ROE_{a,t-1}$ being respectively the non-performing financing ratio, the risk-weighted capital ratio, and the return on equity for Islamic bank *a* at time *t-1*. BFR_{t-2} is the based financing rate.

The original model above, Model 1, as shown in Figure 1, has been modified to test whether types of funding (financing and deposits) can be considered as a significant indicator of banks' risky conditions. This can be done by testing Model 2 and Model 3 as depicted in Figure 1 above.

Based on Model 2, the financing-to-deposit ratio was inserted into the original model. This ratio provides a measure of the funding mix used by a bank to finance its financing portfolio. The higher the financing-to-deposit ratio means the less the bank is using its customer deposits to finance their loan portfolio. According to Bologna (2011), if the theory of different monitoring levels by different banks' creditors is correct, with depositors relying more on bank supervision and deposit insurance to look after them, it can be concluded that depositors are more stable sources of funding than other credits. Moreover, the more reliant the bank is on non-deposits funding the more vulnerable it is to defaults. If the findings show that the bank relies heavily on loans instead of deposits, this implies an increase in the possibility of the bank's default. Moreover, a large share of financed funds in banks' assets is fundamentally more unstable as compared to deposits, thus boosting the possibility of default. Based on this, the modified model is shown below.

Model 2:

$$Y_{a,t} = \beta_1 + \beta_2 NPF_{a,t-1} + \beta_3 RWCR_{a,t-1} + \beta_4 ROE_{a,t-1} + \beta_5 BFR_{a,t-2} + \beta_6 FTD_{a,t-3} + \mu_a$$

Model 3 examines the types of deposits which can be considered to be potentially more volatile. In particular, in this study, the composition of deposits at bank level was examined as well as the types of deposits according to the types of Islamic contracts used. According to Bologna (2011), the levels of awareness of depositors and their stability should vary amongst different kind of depositors. Although, as mentioned in Bologna's (2011) study, brokered deposit is found to be a significant variable in explaining banks' default in the US, but as a proxy, this study used *mudharabah* and non-*mudharabah* deposits in explaining the effect of these deposits on banks' defaults. Thus, this study examines the impact of different types of deposits in Islamic banks in Malaysia and their probability of defaults. The modified model is as follows:

Model 3:

$$Y_{a,t} = \beta_1 + \beta_2 NPF_{a,t-1} + \beta_3 RWCR_{a,t-1} + \beta_4 ROE_{a,t-1} + \beta_5 BFR_{a,t-2} + \beta_6 D_{a,k,t-j} + \mu_a$$

where *D* is the deposits, and *k* for different subset of deposits.

Next, based on the logit models presented above, the robustness test was conducted on the use of different sets of macroeconomic variables and alternative bank specific variables. The fourth model was based on Model 2 above, where several macroeconomic variables were tested in alternative specifications of this model by replacing the Based Financing Rate (*BFR*) previously used with the GDP growth rate, unemployment rate, and inflation rate. The estimated Model 4 is as follows:

Model 4:

$$Y_{a,t} = \beta_1 + \beta_2 NPF_{a,t-1} + \beta_3 RWCR_{a,t-1} + \beta_4 ROE_{a,t-1} + \beta_5 ME_{a,t-j} + \beta_6 FTD_{a,t-3} + \mu_a$$

The Model 5 is the modified version of Model 2 by replacing the original bank variables with the alternative variables: reserve to total assets ratio (*RTA*), tangible to common equity ratio (*TCE*), net income before tax to total assets ratio (*ROA*). The *ROA* has been chosen to replace *ROE* due to the stronger correlation between $Y_{a,t}$ and *ROA* as compared to *ROE*. The estimated model is as follows:

Model 5:

$$Y_{a,t} = \beta_1 + \beta_2 RTA_{a,t-1} + \beta_3 TCE_{a,t-1} + \beta_4 ROA_{a,t-1} + \beta_5 BFR_{a,t-2} + \beta_6 FTD_{a,t-3} + \mu_a$$

Finally, to test the robustness of the models, the sixth model is based on Model 2 but has been modified to replace the financing-to-deposits ratio with the assets-to-deposits ratio. The equation including the alternative funding mix is estimated as follows:

Model 6:

$$Y_{a,t} = \beta_1 + \beta_2 NPF_{a,t-1} + \beta_3 RWCR_{a,t-1} + \beta_4 ROE_{a,t-1} + \beta_5 BFR_{a,t-2} + \beta_6 ATD_{a,t-2} + \mu_a$$

4. Empirical Results

The global financial crisis has shown how critical liquidity conditions can affect banks' operations under stress and their probability of survival. The evidence from this study confirms that funding liquidity conditions significantly affect Islamic banks' risk profile and the probability of defaults. This is in line with an empirical study conducted in the US by Bologna (2011), who found that liquidity conditions did affect the U.S. banks' risk profile, thus suggesting that the relevant supervisory and regulatory authorities should better supervise and regulate the banks' liquidity conditions The study also signifies the importance of tighter regulation and supervision of banks' liquidity, not only focusing on U.S. banks but extending to other countries as well.

According to the summarised findings in Table 2, the original model (Model 1) has been enhanced further with the inclusion of funding variables leading to Model 2. The McFadden R^2 has increased from 0.20 in Model 1 to the highest value of 0.34 in Model 2. Based on the McFadden rule of thumb, any value between 0.20 and 0.40 means that the model can be considered as having an excellent fit. Based on Model 2, it seems that only *RWCR* and *FTD* are statistically significant at the 1% level. Thus, it can be concluded that the inclusion of *FTD* into the model has increased the goodness-of-fit of the model.

Table 2: Summary of the Results/Models

Model		Significance Variables	McFadden R^2
Model 1		$RWCR_{t-1}$***	0.202170
Model 2	Model2a	$RWCR_{t-1}$***, FTD_{t-1}***	0.328166
	Model2b	$RWCR_{t-1}$***, FTD_{t-2}***	0.332842
	Model2c	$RWCR_{t-1}$***, FTD_{t-3}***	0.344773
Model 3	Model 3a	$RWCR_{t-1}$***, BFR_{t-2}*, DD_{t-1}***	0.620974
	Model 3b	$RWCR_{t-1}$***, DD_{t-2}***	0.610535
	Model 3c	$RWCR_{t-1}$***, BFR_{t-2}**, DD_{t-3}***	0.623739
	Model 3d	$RWCR_{t-1}$***, SD_{t-1}**	0.339952
	Model 3e	$RWCR_{t-1}$***, SD_{t-2}**	0.344607
	Model 3f	$RWCR_{t-1}$***, SD_{t-3}**	0.344196
	Model 3g	$RWCR_{t-1}$***, GID_{t-1}**	0.327858
	Model 3h	$RWCR_{t-1}$***, GID_{t-2}**	0.335548
	Model 3i	$RWCR_{t-1}$***, GID_{t-3}***	0.344131
	Model 3j	$RWCR_{t-1}$***, SID_{t-1}**	0.321499
	Model 3k	$RWCR_{t-1}$***, SID_{t-2}**	0.324654
	Model 3l	$RWCR_{t-1}$***, SID_{t-3}**	0.326716
	Model 3m	$RWCR_{t-1}$***	0.300580
	Model 3n	$RWCR_{t-1}$***	0.299204
	Model 3o	$RWCR_{t-1}$***	0.300023
	Model 3p	$RWCR_{t-1}$***, NPF_{t-1}*,MDR_{t-1}**	0.326299
	Model 3q	$RWCR_{t-1}$***, NPF_{t-1}*,MDR_{t-2}**	0.332263
	Model 3r	$RWCR_{t-1}$***, NPF_{t-1}**,MDR_{t-3}**	0.337086
	Model 3s	$RWCR_{t-1}$***, NPF_{t-1}*,$NMDR_{t-1}$**	0.326299
	Model 3t	$RWCR_{t-1}$***, NPF_{t-1}*,$NMDR_{t-2}$**	0.332263
	Model 3u	$RWCR_{t-1}$***, NPF_{t-1}**,$NMDR_{t-3}$**	0.337086
Model 4	Model4a	$RWCR_{t-1}$***, FTD_{t-2}***	0.395443
	Model4b	$RWCR_{t-1}$***, MDR_{t-1}**	0.327258
	Model4c	$RWCR_{t-1}$***, $NMDR_{t-1}$**	0.327258
	Model4d	$RWCR_{t-1}$***, FTD_{t-2}***	0.399022
	Model4e	$RWCR_{t-1}$***, MDR_{t-1}**	0.328023

	Model4f	$RWCR_{t-1}$***, $NMDR_{t-1}$**	0.328023
	Model4g	$RWCR_{t-1}$***, FTD_{t-2}***	0.395627
	Model4h	$RWCR_{t-1}$***, MDR_{t-1}**	0.324356
	Model4i	$RWCR_{t-1}$***, $NMDR_{t-1}$**	0.324356
	Model4j	$RWCR_{t-1}$***, FTD_{t-2}***	0.402407
	Model4k	$RWCR_{t-1}$***, FTD_{t-2}***, MDR_{t-1}***	0.463808
	Model4l	$RWCR_{t-1}$***, FTD_{t-2}***, $NMDR_{t-1}$***	0.463808
Model 5	Model5a	RTA_{t-1}***, TCE_{t-1}***, FTD_{t-2}***	0.532479
	Model5b	TCE_{t-1}***, ROA_{t-1}***	0.168980
	Model5c	TCE_{t-1}***, ROA_{t-1}***	0.168980
	Model5d	RTA_{t-1}***, TCE_{t-1}***, FTD_{t-2}***	0.532453
	Model5e	TCE_{t-1}***, ROA_{t-1}***	0.168603
	Model5f	TCE_{t-1}***, ROA_{t-1}***	0.168603
Model 6		$RWCR_{t-1}$***, ATD_{t-2}*	0.318685
Model 7	Model 7a	$RWCR_{t-1}$***, FTD_{t-2}***, DD_{t-3}***, MDR_{t-1}**	0.721201
	Model 7b	RTA_{t-1}***, TCE_{t-1}***, FTD_{t-2}***, DD_{t-3}***, MDR_{t-1}*	0.689368

Note: *, **, *** significance at 10 percent, 5 percent and 1 percent respectively

Next, all models under Model 3 have shown a better performance as compared to Model 2 and Model 1. A maximum McFadden R^2 value of 0.62 for Model 3c implies that about 62% of the total variations in the performance of Islamic banks are explained by the explanatory variables included in Model 3c, consisting of NPF_{t-1}, $RWCR_{t-1}$, ROE_{t-1}, BFR_{t-2}, and DD_{t-3}. The R^2 value is acceptably high, particularly for logit and probit models, for which literature (*see*: Harper *et al*., 1990) show that goodness-of-fit points to a range of 0.20 and 0.40. Moreover, the results show that $RWCR_{t-1}$ and DD_{t-3} are statistically significant at the 1% level, and BFR_{t-2} is marginally significant (5% significance level). Thus, the inclusion of the deposits structure into Model 3 does increase the goodness-of-fit of the model. In addition, all the models under Model 3 do show a steady performance with McFadden R^2 ranging from 0.299204 (Model 3n) to 0.623739 (Model 3c), which is much higher than the McFadden R^2 for the original model (Model 1).

Model 4 is the first robustness test to use the macroeconomic variables as the explanatory variables in the model. As mentioned earlier in the results section, the macroeconomic variables have been tested in alternative specifications of the model by replacing the previously used financing rate with the GDP growth rate, the unemployment rate, and the consumer price index. All the models under Model 4 have shown similar performance as shown by Model 3. The McFadden R^2 ranged from the lowest 0.324356 (Model 4h, Model 4i) to the highest 0.463808 (Model 4k, Model 4l). A maximum McFadden R^2 value of 0.46 for Model 4k and Model 4l means that 46% of the total variations in the performance of Islamic banks are explained by the explanatory variables included in Model 4k and 4l, which consist of NPF_{t-1}, $RWCR_{t-1}$, ROE_{t-1}, GDP_{t-1}, $INFLATION_{t-1}$, $UNEMPLOY_{t-3}$, FTD_{t-2}, MDR_{t1}(Model4k), and $NMDR_{t-1}$(Model4l). The results show that $RWCR_{t-1}$, FTD_{t-2}, MDR_{t1}(Model4k), and $NMDR_{t-1}$ (Model4l) are statistically significant at the 1% level, while the rest of the variables are not significant.

Based on models 4d, 4e and 4f, with the inclusion of inflation as the determining factor, this study found that inflation has a positive impact on bank performance, although it is not significant. This means that the higher the inflation rate the higher the probability of the banks' default. The relationship between inflation and performance is ambiguous. According to Perry

(1992), the relationship between inflation and performance does depend on whether inflation expectations are fully anticipated. Inflation that is fully anticipated by the banks' management entails that the banks can properly adjust their interest rates to increase profits faster than costs. Thus, unanticipated inflation results in faster increases in banks' costs and subsequently produces a negative effect on the banks' profitability. This is similar to the other macroeconomic variables, GDP_{t-1} and $UNEMPLOY_{t-3}$, where neither of these two variables significantly affect the performance of Islamic banks.

The second robustness test is done by replacing the original bank variables previously used in Model 2 with the alternative set of banks' specific variables; RTA_{t-1}, TCE_{t-1}, and ROA_{t-1}. In this last specification of the alternative model, all control variables have been replaced from the original model showing their level of significance. In the original model, only $RWCR_{t-1}$ has shown a consistent significance performance throughout the study. However, in this last specification of the alternative model, all alternative variables have shown a significant performance. In other words, the main difference here is that with this alternatively specified set of banks' specific variables – the RTA_{t-1} (replaced NPF_{t-1}) and ROA_{t-1} (replaced ROE_{t-1}) – it transpires that the original variables used previously were never significant, but the model becomes somewhat significant in explaining the banks' default probability once replaced with the alternative set of banks' specific variables. The *ROA* has been selected to replace *ROE* due to the stronger correlation between *ROA* and $Y_{\alpha,t}$ as compared to *ROE* and $Y_{\alpha,t}$. Based on the correlation test results, $Y_{\alpha,t}$ and *ROA* has shown a moderate positive correlation whereas there is a weak negative correlation between $Y_{\alpha,t}$ and *ROE*. This result is in line with the study conducted by Akhtar *et al.* (2011) that compared the liquidity management between Islamic and conventional banks in Pakistan. The study found that there was a positive and significant relationship between liquidity risk and *ROA* in Islamic banks.

Moreover, the only variables that remain highly significant are $RWCR_{t-1}$ and FTD_{t-2}, thus confirming the robustness of the estimates. A maximum McFadden R^2 value of 0.532479 for model 5a implies that about 53% of the total variations in the performance of Islamic banks are explained by the explanatory variables included in Model 5a consisting of RTA_{t-1}, TCE_{t-1}, ROA_{t-1}, BFR_{t-2}, and FTD_{t-2}. The results from Model 5a show that RTA_{t-1}, TCE_{t-1} and FTD_{t-2} are statistically significant at the 1% level. While for Model 5b, a McFadden R^2 value of 0.532453 implies that about 53% of the total variations in the performance are explained by the explanatory variables included consisting of RTA_{t-1}, TCE_{t-1}, ROA_{t-1}, $UNEMPLOY_{t-3}$, and FTD_{t-2}, showing that RTA_{t-1}, TCE_{t-1} and FTD_{t-2} are statistically significant at the 1% level.

Subsequently, FTD_{t-2} has been replaced with the asset-to-deposit ratio (ATD_{t-2}) as an alternative for the bank funding mix. The results proved that ATD_{t-2} can also be used as an alternative measure of funding mix besides FTD_{t-2}, although the FTD_{t-2} is significant at the 1% level, while ATD_{t-2} is only significant at the 10% level when used in the model. In other words, it seems that FTD_{t-2} is statistically significant at the 1% level, but ATD_{t-2} is marginally significant. However, the inclusion of ATD_{t-2} as an alternative measure for the funding mix shows that it does not much affect the McFadden values for both models (Model 2 and Model 6).

Finally, based on the models above, the variables that showed a significant performance were selected as explanatory variables for the final models. This study suggested two final models and the results of McFadden R^2 for both recommended final models showed an excellent fit to predict Islamic banks' performance. The inclusion of the significant variables into the final models has proved to have a major impact on the performance of the models as suggested by the values of McFadden R^2 for Model 7a and Model 7b, which are 0.721201 and 0.689368

respectively. This study recommended these final two models as part of the monitoring process of Islamic banks in Malaysia, which complements the existing methods used by the relevant authorities in monitoring the banks' performance, instead of replacing the current practices.

This study used the funding mix variable, composition of deposits variables, macroeconomic variables, alternative banks' specific variables as well as the alternative funding mix variable, to investigate the variables that can affect the banks' performance. This study found that the funding mix variable (FTD_{t-2}), the composition of deposits (*DD, SD, GID, SID, MDR* and *NMDR*), alternative banks' specific variables (RTA_{t-1}, TCE_{t-1} *a*nd ROA_{t-1}), and alternative funding mix (ATD_{t-2}) are statistically significant in the models. In contrast, none of the macroeconomic variables tested show as a significant factor in the models, thus suggesting that the performance of Islamic banks in Malaysia was not affected by the economic conditions throughout the study period. Furthermore, the Inflation rate, *GDP* growth rate and unemployment rate in Malaysia have been consistent and did not show major movement during the study period. This may be due to the efficient regulation and supervision by the relevant authorities, in this case Bank Negara Malaysia. According to Shen *et al*. (2001), countries with greater official power and higher restrictiveness make the banks under their purview less liable to suffer from liquidity risk. In addition, bank liquidity risk could be reduced with direct government supervision and regulation of the banks' activities. The results of this study also confirm the results found in Shen *et al*.'s (2001) study that macroeconomics has no effect on bank liquidity in a bank-based financial system, and liquidity risk has different effects on bank performance in different financial systems.

The findings show the relationship between banks' funding profiles and Islamic banks performance in Malaysia. The regulatory framework for liquidity risk adopted by the Basel Committee on Banking Supervision (2010) seems to have all the potential and features that may help the banks to reduce the probability of high liquidity risk. This new framework has correctly distinguished the different influences of all types of deposit on the banks' performance by differentiating the treatment of these deposits, as either more stable or less-stable deposits. In the case of Islamic banks, the relevant authorities should not neglect the effect of different types of deposits to avoid further deterioration of the Islamic banks' performance ahead of any further financial crisis.

Finally, based on the models discussed above, this study took the most significant variables to be the explanatory variables for the final models. This study suggested two final models as follows:

Model 7a:

$$Y_{a,t} = \beta_1 + \beta_2 RWCR_{a,t-1} + \beta_3 BFR_{a,t-2} + \beta_4 FTD_{a,t-2} + \beta_5 DD_{a,t-3} + \beta_6 MDR_{a,t-1} + \mu_a$$

and,

Model 7b:

$$Y_{a,t} = \beta_1 + \beta_2 RTA_{a,t-1} + \beta_3 TCE_{a,t-1} + \beta_4 BFR_{a,t-2} + \beta_5 FTD_{a,t-2} + \beta_6 DD_{a,t-3} + \beta_7 MDR_{a,t-1} + \mu_a$$

Table 3: Final Models (Dependent variable: Islamic banks' status -healthy/non-healthy)

Variables	Model 7a	Model 7b
Constant	-21.22802 (8.600198)**	-7.969269 (7.455780)
Capital Adequacy ($RWCR_{t-1}$)	1.295227 (0.289061)***	
Alternative Asset Quality (RTA_{t-1})		1.915017 (0.538334)***
Alternative Capital Adequacy Ratio (TCE_{t-1})		1.540563 (0.363095)***
Lending rate (BFR_{t-2})	0.988050 (0.865238)	0.480843 (0.929985)
FTD_{t-2}	-0.073624 (0.022217)***	-0.224483 (0.052258)
MDR_{t-1}	-0.056580 (0.026019)**	0.051192 (0.028152)
DD_{t-3}	0.276188 (0.068882)***	0.234497 (0.064928)
McFadden R^2	0.721201	0.689368
Log likelihood	-22.51622	-25.08707

Note: *, **, *** significance at 10 percent, 5 percent and 1 percent respectively.

Based on results shown in Table 3, the estimated models with the respective coefficient values for *Model 7a* are as follows:

$$Y_{a,t} = -21.22802 + 1.295227\, RWCR_{a,t-1} + 0.988050\, BFR_{a,t-2} - 0.073624\, FTD_{a,t-2} + 0.276188\, DD_{a,t-3} - 0.056580\, MDR_{a,t-1} + \mu_a$$

and, for *Model 7b* are as follows:

$$Y_{a,t} = -7.969269 + 1.915017\, RTA_{a,t-1} + 1.540563\, TCE_{a,t-1} + 0.480843\, BFR_{a,t-2} - 0.224483\, FTD_{a,t-2} + 0.234497\, DD_{a,t-3} + 0.051192\, MDR_{a,t-1} + \mu_a$$

Based on the results described above, it can be concluded that both final models, based on the results from all the models developed earlier, have shown highly satisfactory performance. This means that the inclusion of selected significant variables from the previous models has proved to be momentous to the performance of the final models. This study recommends two final models: the first model (Model 7a) includes $RWCR_{a,t-1}$, $BFR_{a,t-2}$, $FTD_{a,t-2}$, $DD_{a,t-3}$, and MDR_{t-1} as explanatory variables, and the second model (Model 7b) includes RTA_{t-1}, TCE_{t-1}, $BFRa_{,t-2}$, $FTD_{a,t-2}$, $DD_{a,t-3}$, and MDR_{t-1}. With McFadden R^2 values of 0.721201 (Model 7a) and 0.689368 (Model 7b), this means that both models are an excellent fit and about 72% or 68% of the total variations in the performance of Islamic banks are explained by the explanatory variables included in both models. These McFadden R^2 values are considered as extremely high.

ROA and *ROE* are important components in banking for measuring corporate performance. The former measures the effectiveness of an organization in generating profits from their pool of assets, whereas *ROE* tells us how effectively an organization is taking advantage of its equity. The main difference between *ROA* and *ROE* is the way how companies manage their leverage or debt. As for this study, *ROA* has been used to replace *ROE*. Based on the results from the logit models 1- 4 and model 6, show that *ROE* is insignificant in all models. Thus, even if the

ROE results show a significant relationship, it might not insert a big impact on the status of Islamic banks due to the weak relationship between $Y_{\alpha,t}$ and *ROE*. Whereas the results for model 5, with *ROA* as a replacement for *ROE*, shows that *ROA* is one of the significant variables in Model 5 and has been selected to be included as one of the variables in the final model (Model 7b). Due to the stronger correlation between $Y_{\alpha,t}$ and *ROA* as compared to $Y_{\alpha,t}$ and *ROE*, *ROA* presents a larger impact on the status of Islamic banks.

5. Concluding remarks

Due to bankruptcy risk, numerous studies have attempted to develop credit risk or default prediction models by using several statistical methods. Multivariate Discriminant Analysis (MDA) and Logistic Regression Analysis (Logit) are two of the most commonly used statistical techniques in this field of studies. Contradictory to international studies, no previous studies have been conducted in Malaysia in developing the bankruptcy prediction models for Islamic financial institutions. Furthermore, the impact of the global financial crisis still has been discussed and affected the financial systems around the world, for which funding liquidity has been mentioned as one of the main concerns during that period. All these have led to the conduct of the present study. This study was conducted on a sample of 10 Islamic banks in Malaysia and quarterly financial reports have been obtained for those banks. The logit model is used to analyse the role of funding in explaining Islamic banks' defaults. As mentioned earlier, the logit model has been used frequently in previous bank failure prediction studies and this model is based on a cumulative logistic function; it provides the probability of an Islamic bank belonging to one of the prescribed groups, given by the financial characteristics of the Islamic bank.

This study is a modest attempt to establish the first empirical evidence with the aims to consider the impact of and extent to which the funding structure of Islamic banks along with deposit structure, macroeconomics variables, other bank-specific variables, including alternative funding mix variables could play a part in explaining the financial conditions and predicting the failures and performances of Islamic banks in the case of Malaysia. The finding of this study suggests that the funding mix variable, the composition of deposits, alternative banks' specific variables and alternative funding mix variables are significant in the models. Those variables are FTD_{t-2}, *DD, SD, GID, SID, MDR*, *NMDR*, RTA_{t-1}, TCE_{t-1}, ROA_{t-1} and ATD_{t-2}. On the contrary, none of the macroeconomic variables shows as a significant factor in the models. This finding serves as an indicator that the performance of Islamic banks in Malaysia was not affected by the economic conditions throughout the study period. This study also validates the previous studies that bank specific variables were significant in explaining the banks' financial condition. The empirical findings show the significant effect of deposit composition, especially the *mudharabah* and *non-mudharabah* deposits, on an Islamic banks' performance.

This empirical study, hence, contributes to the literature in two ways: it is one of the first studies to examine the role of the funding structures of Islamic banks in determining their performance, and it also examines the effect of deposit composition (the *mudharabah* and non-*mudharabah* deposits) on Islamic banks' performance.

In the case of Islamic banks, the relevant authorities should not neglect the effect of different types of deposits to avoid further deterioration of the Islamic banks' performance ahead of any further financial crisis. Furthermore, Islamic banks in Malaysia might benefit from the newly developed models to achieve higher predicting accuracy of bankruptcy level. For future

research, Islamic banks from different jurisdictions, with their own unique structures, can also benefit from developing their own models by following the process as shown in this study.

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