Bank Concentration and Financial Risk in Jordan

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ABSTRACT

The main aim of this paper is to investigate the relationship between bank concentration and bank risk in the Jordanian banking industry from 2005 to 2016. While controlling for bank fundamentals and business cycle, we used two measurements to measure bank risk (Z-score and Non-performing loan ratio) and three measurements of bank concentration (Herfindahl–Hirschmann Index, Concentration Ratio and the Lerner Index). We applied the two-step Generalized Method of Moments (GMM) to analysis this relationship between concentration and risk. The empirical evidence shows bank concentration has a positive relationship with risk measured using non-performing loan ratio, and a negative relationship using Z-score. This suggests greater market power leads to greater risks, which in turn supports the concentration-fragility theory.

INTRODUCTION

A well-functioning financial system is the key to ensure the smooth flows of funds in an economy, which in turn contributes to the long-term growth and development in the country.¹ Past banking crises, such as the European banking crisis in 1992, the Venezuelan banking crisis in 1994, the Asian financial crisis in 1997 and the Ecuador banking crisis in 1998 are among many that show the serious damage and contagion resulting from a banking crisis to an economy and those of neighbouring countries.

In addition, the banking crises throughout the world, especially the 2008 financial crisis, showed the importance of bank concentration to the industry. Up until the present, the relationship

¹ According to Jordinvest (2012), the report of the banking system in Jordan: “The Jordanian banking sector is one of the key pillars supporting the Jordanian economy and has a positive and active role in developing the national economy”. The banks function as an intermediary connecting between the lender and the borrower, which makes the borrower create or expand the business, which leads to contributes to economic development.
between bank concentration and stability has not been clear. Past studies employed two main theories that explain the relationship between bank concentration and risk, i.e., (1) bank concentration and stability and (2) bank concentration and fragility. The first, concentration-stability, is based on the concept that banks with a larger market share have greater opportunity to improve their profit rates and therefore decrease their financial fragility through higher “capital buffers” (Boyd, De Nicoló, and Smith, 2004). Additionally, large banks prefer to participate in “credit rationing” which is a method that makes credit less easily accessible or subject to high interest rates. Finally, larger banks that increase their “charter value” encourage their bank managers to make less risky decisions.

The second view, concentration-fragility, is the opposite of the first, and describes the point at which banks with large capitalization become “too big to fail” and leads the banks to take more risks. Moreover, larger banks will ask for higher interest rates, which, when imposed by banks with large market capitalization may cause a higher default rate from their borrowers (Boyd and De Nicolo, 2005). In addition, the higher degree of risk present might cause a drop in the banks’ management productivity, resulting in a higher degree of operational risk (Uhde and Helmeshoff, 2009).

Over the past 11 years, the Jordanian banking sector has shown considerable fluctuations in bank concentration levels. Based on the 2017 report issued by the Central Bank of Jordan, out of a total of twenty-five banks operating in Jordan, the assets of the five largest banks decreased from approximately 59.6% of total assets of the licensed banks at the end of 2006 to approximately 53.9% at the end of 2015. However, in 2016 the concentration ratio increased to 54.3%. These figures reveal a significant degree of fluctuation in the bank concentration ratio in Jordan. The aim of this research is to determine which of the two views is applicable to the Jordanian banking industry so as to help banks avoid financial shocks or crises.

Thus, this study aims to investigate the relationship between bank concentration and risk for the Jordanian banking industry over the period from 2005 to 2016. Data obtained from the financial statements of seventeen commercial and Islamic banks operating in Jordan between 2005 and 2016 were collected. The study employed two proxies for bank risk: Z-score and non-performing loan ratio, and three proxies for bank concentration: Herfindahl-Hirschmann Index (HHI), Concentration ratio (CCR) and the Lerner Index. It also applied a two-step Generalized Method of Moments (GMM) for testing the data. To the best of our knowledge, this research will be the first to examine the relationship between bank concentration and bank risk and will specifically focus on data obtained from Jordan. This focus on a single country’s data should furnish greater understanding of the relationship between bank concentration and risk. Additionally, most studies have investigated the relationship between bank concentration and bank stability by referring to data taken from a single country in an advanced market rather than one from an emergency market. Moreover this research is different from that of other research in that it applies several measurements of bank concentration in the one study, i.e., concentration ratio of the largest 3, 5 and 7 banks (assets and loan), two measurement of HHI (total assets and total loans) and Lerner index.

The results obtained in this study show that bank concentration (HHI and concentration ratio) are significantly positive when non-performing loans is employed, and significantly negative when using Z-scores. However, the Lerner Index results are significantly negative for both Non-performing loans and Z-scores. Our analysis implies that the more concentrated a banking industry

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2 While there has been limited research conducted in Jordan using these factors, the main objectives of previous studies were to examine whether the Jordanian banking environment is competitive or concentrated, e.g., Demirguc-Kunt and Martinez Peria 2010.

3 Furthermore, studies such as Ben Ali et al. 2018, focus on more than one country, and include Jordan with other countries.

4 For studies of advanced markets see Chu, 2015 and Kasman and Kasman, 2015. For studies of emergency markets see Nguyen et al., 2018.
is, the riskier it becomes. The conclusion of our analysis provides support to the application of concentration-fragility to the Jordanian banking sector.

The following sections of this paper are organized as follows: Section 2 discusses relevant past studies; Section 3 explains methodologies adopted for this study; Section 4 discusses findings and their applications; and Section 5 presents our conclusion.

1. LITERATURE REVIEW

Based on previous studies, it is difficult to conclude the exact impact of banking market concentration on financial risk. The literature provides two contradictory views of the relationship between concentration and financial risk: concentration-stability and concentration-fragility.

1.1 Concentration-fragility

Concentration-fragility is one of the two views regarding the relationship between concentration and bank stability. This view argues that the higher the concentration, the more risk a bank takes. According to Boyd and De Nicolo (2005), banks often demand higher interest rates from their borrowers when there is little competition in the market. This places additional burdens on the borrower to cover the associated increases to the loan. Therefore, the chance of loan defaults would become greater, resulting in a higher chance for banks to fail.

Several studies have found evidence supporting the concentration-fragility view. Uhde and Heimeshoff (2009) conducted on 2,600 banks located in 25 European countries from 1997 to 2005 found clear evidence that banking market concentration negatively affects a bank's financial stability. Further confirmation was provided by Fiordelisi and Mare (2014), who used data collected from 2529 European banks between 1998 and 2009 to show that market power and financial stability are negatively associated.

Schaeck, Cihak, and Wolfe's (2009) study encompassing 38 nations and 28 systemic banking crises from the year of 1980 to 2003 found that the presence of concentration lowers the chance of a systematic crisis from happening, thereby supporting the concentration-fragility view. Liu, Molyneux, and Nguyen (2012) collected data from 4 different South East Asian countries. Their results showed concentration does increase a bank's risk-taking levels and so their study confirms the concentration-fragility theory. Fu et al. (2014) collected data from 14 Asian Pacific nations for the period from 2003 to 2009. The study concluded that when a high concentration level is present, a higher level of financial fragility is also present. A recent research by Li (2019) examined banks in 22 transition countries during the period from 1998 to 2016 and found support for the concentration-fragility view by applying NPL and Z-score for bank risk and Lerner index for bank competition.

1.2 Concentration stability

Some researchers have argued that the larger banks in a more concentrated market would have a better stability rate. When bankruptcy does occur, it causes higher opportunity costs which result in higher franchise values. Keeley (1990) states that larger banks which increase their charter value encourage bank managers to make less risky decisions. Moreover, Keeley concludes that an increase in competition will result in a reduction of a bank’s value which will put it at risk and result in a lessening of its financial stability. Boyd et al. (2004) mention that the larger banks could improve their profit rates which would lead to a decrease in financial fragility through increased “capital buffers”. This view suggests that if concentration is positively associated with banks, it will cause an increase in the probable rate of return on the banks’ possessions as well as the standard deviation of their revenues.
In support of concentration-stability, Chang, Guerra, Lima, and Tabak (2008) used the banks’ NPLs in order to study the association between credit risk and bank concentration in Brazilian banks. The results showed that having a more concentrated financial system helps to enhance financial stability by further reducing the lower default rates of its borrowers. In addition, Chu (2015) studied the relationship between these two factors in Canadian banks by examining data from 1867 to 1935. The results agreed with those of Chang, Guerra, Lima, and Tabak (2008), confirming the positive relationship between concentration and stability. A recent study by Albaity, Mallek, and Noman (2019) applied GMM to examine bank competition in MENA countries from 2006 until 2015 by using two measurements of bank stability and competition. They reviewed data from 276 banks and also found support for the concentration-stability view. Degl’Innocenti, Fiordelisi et al. (2019) examined seven developed investment banking industries from 1997-2014; they found that high market power leads to more bank stability. Marchionne and Zazzaro (2018) examined the Italian banking industry from 2006 to 2010; their results confirm concentration-stability.

Moreover, Azmi, Ali, Arshad, and Rizvi (2019) testing data from fourteen dual banks from 2005 till 2016 found the relationship between HHI and Z-score to be statistically positive. After reviewing bank data in 27 EU countries for both the long-term and short-term, Davis and Karim (2019) found a positive relationship between the Lerner index and Z-score. Hence, these findings weaken the concentration-fragility hypothesis and confirm the concentration-stability view. Phan, Anwar, Alexander, and Phan (2019), using bank data from China, Malaysia, Vietnam and Hong Kong from 2004 until 2014, found strong support for the concentration-stability view. Furthermore, Beck et al. (2006) collected data from 69 nations between 1980 and 1997 in order to study the relationship between concentration and financial stability. The result was that market power decreases the likelihood that a nation will be subjected to a universal banking crisis, thus confirming the concentration-stability view.

### 1.3 U-shaped relationship

Several researchers have found the existence of a U-shaped relationship between bank concentration and bank risk. Ben Ali et al. (2018) studied the association between banking concentration and stability on data collected from 173 industrialized and developing nations for the period from 1980 to 2011. The results prove that both the concentration-stability and concentration-fragility views are possible. Căpraru and Andrieş (2015) examined data from 923 commercial banks in 27 European nations from the period between 2001 and 2009. Their results show a variation in the relationship between concentration and financial stability with some countries showing a positive relationship between the two factors and others showing a negative one. González, Razia, Búa, and Sestayo (2017) examined 356 banks operating in MENA countries during the period from 2005 to 2012. They also found empirical support for concentration-stability and concentration-fragility views. Noah, Jacolin, and Brei (2018) found a U-shaped relationship between bank concentration and bank credit risk in Sub-Saharan Africa for the period from 2000 to 2015.

In addition, following examination of banks located in Canada, U.K and the U.S.A., Kanas, Al-Tamimi, Albaity and Mallek (2019) found that the relationship between the Lerner Index and Non-performing loan is statistically negative. However, they also found the relationship between market concentration for the biggest 5 banks and NPL is positively significant. This finding also supports the two views. Kasman and Kasman (2015) examined data from Turkish banks for the period from 2002 until 2012 by using the NPL and Z-score to measure the level of stability, and using HHI and concentration ratio (five largest banks) to measure market power. Their results indicate that the level of concentration and a bank's credit risk taking (NPL) are positively linked; however, the concentration ratio and the Z-score are negatively linked. In the case of Vietnam, Nguyen, Le, and Tran (2018) found a U-shaped relationship between market power and bank risk.
2. METHODOLOGY

This research uses a two-step GMM system to study the relationship between bank concentration and financial risk for 17 banks in Jordan during the period from 2005 to 2016. The sample includes the annual reports of Islamic and commercial banks in Jordan. We used a dynamic panel to analyze the connections between concentrations and financial risk. In addition, the dynamic panel data contained one or more lagged for the dependent variable. Our GMM regression model is specified as follows:

\[ \text{Risk}_{it} = \alpha + \beta \text{Risk}_{it-1} + \beta_1 \text{Con}_{it} + \lambda \text{Bank Specifics}_{it} + \delta \text{Business Cycle}_{it} + \varepsilon_{it} \]  

Where \( \text{Risk}_{it} \) is Z-score and Non-performing loan ratio for \( i \) banks and \( t \) time, \( \text{Risk}_{it-1} \) is the lag of the risk. \( \text{Con}_{it} \) is concentration. For instance, considering Non-Performing Loan ratio as the dependent variable in the above equation, a negative value of the coefficients would decrease the NPL and lead to support of the concentration-stability view. However, a positive value for \( \beta_1 \) would furnish empirical support for the concentration-fragility view. Therefore, as concentration, measured by the Herfmdahl-Hirschmann Index (HHI), Concentration ratio (CCR) and Lerner Index, increases, bank Non-performing loan would also increase. In addition, if the coefficients show different signs, the results would support a U-shaped relationship. Bank Specifics and Business Cycle are control variables which include Earnings, Liquidity, Bank Size, Growth of GDP and Inflation. Finally, \( \varepsilon_{it} \) is a composite error term.

The data were collected from several databases. For those banks listed on the Amman stock exchange, we collected the data from Bloomberg and Bankscope; however, for the banks not listed on the Amman stock exchange, the data were obtained manually from annual reports of those banks. For macroeconomic factors, we collect the data from World Bank and the global economic databases. Table 1 shows the descriptive data for the variables. We have 204 observations from 17 banks between 2005 and 2016.

Table 4 displays the evaluation of the mean values for the variables within the sample duration. The outcomes for Z-score, Return on Asset (ROA), Liquidity, Lerner Index and HHI (loan) fluctuated during the sample period. In addition, NPL decreased from 2005 until 2008, however following the financial crisis in 2008 the NPL started to increase until 2011 when it began to decreased. Meanwhile, HHI (assets) and Concentration ratio for assets decreased during the sample period. However, while the Concentration ratio (loan) decreased every year from 2005 to 2016, expect for an increase in 2007 only.\(^5\)

2.1 Measurement of variables

2.1.1 Concentration

This research used three different measurements to measure concentration: Concentration ratio (CCR), Herfindahl-Hirschman index (HHI) and Lerner Index. Concentration ratio is a measure representing the sum of the combined market shares of the three/five/seven largest banks in the loans/assets market. While, Concentration ratio is a measure of the market share of the largest banks only. HHI focuses on the market shares (Total Loan or assets) of all the banks in the sample.

Herfindahl-Hirschman index is measured as follows:

\[ HHI = \sum_{i=1}^{N} A_i^2 \]

\(^5\) Figure 1, Figure 2 and Figure 3 display a visual representation of the evolution of the Lerner index, Concentration ratio and the HHI respectively, during sample period.
Where $A_i$ is the market share (total assets or loan) of bank $i$ and $n$ represent the total number of banks in the sample.

Lerner index is one of most popular measurements for market power. When the value is close to one, it means a monopoly as price diverges from marginal cost. Simply put, a low value for the Lerner index will increase the degree of competitiveness in the banking industry.

$$Lerner_{st} = \frac{P_{st} - mc_{st}}{P_{st}}$$

Where $P_{st}$ is the price of total assets for bank $s$ at time $t$; proxy by the ratio of total revenues divided by total assets. The marginal cost is $mc_{st}$. As in previous studies, the following equation is used to estimate marginal cost on the basis of a translog cost function with three input prices (price of deposit, labor and fixed capital) and one output (total assets) (i.e., Demirguc-Kunt and Martinez Peria, 2010). The cost function is as follows:

$$LnCost_{st} = \beta_0 + \beta_1 LnQ_{st} + \frac{\beta_2}{2} LnQ_{st}^2 + \sum_{k=1}^{3} \gamma_{kst} LnW_{kst} + \sum_{k=1}^{3} \phi_{kst} LnQ_{st} LnW_{kst}$$

$$+ \sum_{k=1}^{3} \sum_{j=1}^{3} LnW_{kst} LnW_{jst} + e_{st}$$

Where $LnCost_{st}$ is lag of total cost of the bank and includes all interest and noninterest expenses, $s$ is bank and $t$ is years, $Q_{st}$ is total earning assets, and $W_{kst}$ are the three input prices. $W_d$ is the price of deposit (interest expenses divided by total deposits), $W_l$ is the price of labour (total salaries expenses divided by total assets), and $W_f$ is the price of fixed capital (measured by dividing other operating and administrative expenses to total assets). Marginal cost is calculated as follows:

$$MC_{st} = \frac{Cost_{st}}{Q_{st}} \left[ \beta_1 + \beta_2 LnQ_{st} + \sum_{k=1}^{3} \phi_{kst} LnW_{kst} \right]$$

### 2.1.2 Dependent variable

Following González, Razia, Búa, and Sestayo, 2017 and Kasman and Kasman, 2015, this study has employed two different measures of banking risk, namely Z-score and Non-performing loan. Z-score is an inverse measure of overall bank risk. Z-score is one of the most popular ratios to test entry into bankruptcy or the probability of insolvency of individual banks. Z-score is an absolute and balanced indicator of bank vulnerability, combining accounting measures of profitability, volatility and leverage. Z-score is measured as follows:

$$Z_{it} = \frac{\text{ROA}_{it} + \left( \frac{E}{TA} \right)_{it}}{\sigma(\text{ROA})_{it}}$$

Where $i$ is the bank, $t$ is the year, ROA is the return on assets, $E/TA$ is the equity to total assets ratio, and $\sigma(\text{ROA})$ denotes the standard deviation of ROA. Thus, a greater Z-score value indicates a higher bank stability and a smaller risk profile for a bank (Berger et al., 2009). The second measurement for bank risk is non-performing loans ratio which is used as the common measurement of credit risk or loan portfolio (Berger et al., 2009). Since non-performing loans damage the assets market values, profitability and the stability of the bank, having a high value of non-performing loan will lead to high risk and instability in the banking industry. The measurement of NPL is as follows:

$$NPL = \frac{\text{Non performing loans}}{\text{total loan}}$$
2.1.3 Control variable

Banks with high profitability face less pressure for revenue creation and are thus under less compulsion to engage in credit risk. In this study, the Return on Assets (ROA) after-tax is considered as a bank profitability indicator. This study measured the ROA using the following equation:

\[
\text{Return on Asset} = \frac{\text{Net Income}}{\text{Total Assets}}
\]

Return on Assets shows bank efficiency in assets employment as well as the net income generated from assets. A high value of ROA indicates better performance and gives rise to profit. Bank liquidity can simply be explained as the capability of a bank to meet its short-term obligations as well as maintaining it solvency. The measurement of the liquidity is as follows:

\[
\text{liquidity} = \frac{\text{liquid assets}}{\text{total assets}}
\]

The above equation considers liquid assets to be those assets that can be converted to cash easily in any circumstances or at any time. One of the vital properties of this ratio is that it shows the accessibility of liquidity by which a bank is able to fulfill its short-term obligations. The measure of the remaining bank-specific factor, Bank size, is calculated by taking the lags of total assets for each bank in each year (Kasman and Kasman, 2015). Meanwhile, measures of macro-economic factors, which are growth of GDP and Inflation, were obtained through the Worldbank and global economic databases.

Table 1. Descriptive Analysis

| Variables          | Mean     | Standard deviation | Coefficient of variation |
|--------------------|----------|--------------------|--------------------------|
| Dependent Variable |          |                    |                          |
| Z-score            | 3.97768  | 2.727202           | 0.685625                 |
| NPL                | 8.54384  | 5.968919           | 0.6986221                |
|                    |          |                    |                          |
| Independent Variables |       |                    |                          |
| HHI (Loan)         | 2445.10  | 400.9052           | 0.1639627                |
| CCR7 (Loan)        | 81.4678  | 2.341461           | 0.0287409                |
| CCR5 (Loan)        | 71.9143  | 4.258402           | 0.059215                 |
| CCR3 (Loan)        | 63.4808  | 2.87452            | 0.045282                 |
| HHI (Assets)       | 2715.01  | 622.4942           | 0.229278                 |
| CCR7 (Assets)      | 82.8590  | 3.679114           | 0.044402                 |
| CCR5 (Assets)      | 75.4024  | 4.242993           | 0.056271                 |
| CCR3 (Assets)      | 66.5651  | 4.676846           | 0.0702596                |
| Lerner Index       | 0.93162  | 0.014724           | 0.0158052                |
| Translog cost function |       |                    |                          |
| Marginal Cost      | 0.45142  | 0.128430           | 0.2845008                |
| W1= Price of deposit | 0.03092 | 0.013944           | 0.4509125                |
| W2= Price of labour| 0.00998  | 0.003292           | 0.3296761                |
| W3= Price of fixed capital | 0.01350 | 0.005938           | 0.4398779                |
| Q = Total assets   | 2942.79  | 5467.561           | 1.857947                 |
| TC= Total cost     | 120.446  | 202.9643           | 1.685106                 |
| Control variables  |          |                    |                          |
| Earnings           | 1.29944  | 0.634883           | 0.4885817                |
| Liquidity          | 13.8643  | 7.751816           | 0.5591172                |
| Bank size          | 7.24059  | 1.078348           | 0.1489309                |
| Inflation          | 4.09464  | 4.075629           | 0.995356                 |
| Growth of GDP      | 1.37241  | 0.545172           | 0.3972356                |

Notes: NPL is Non-performing loan, HHI is Herfindahl-Hirschman index (loan or assets), and CCR is Concentration ratio for the largest 3, 5 or 7 banks (loan or assets).
3. RESULTS AND DISCUSSION

Table 2 and Table 3 show the main results of this paper. We used two dependent variables to proxy financial risk (Z-score and Non-performing loan) and used different measurements of bank concentration. Moreover, we added a specification test provided through the GMM system. The lagged endogenous variable showed positive and significant results in two regressions in all the models. Model 1 in Table 2 points out the impact of HHI (loan) on risk, controlling for bank specifics and macroeconomics. The results show that the relationship between HHI (loan) and Z-score is significant and negative at the 1% level, suggesting that a decrease in market power will result in more stability. In terms of HHI (assets), the result also support the concentration-fragility view, meaning that concentration in the banking industry will lead to an unstable and risky banking environment. Moreover, the concentration ratio for the biggest 3, 5 and 7 banks in the banking industry, whether from the aspect of loans or assets, is significantly negative, and therefore support the concentration-fragility view. Furthermore, the results show a significant negative relationship between the Lerner Index and Z-score. Suggesting that high market power in the banking industry will result in instability.

The outcomes, as presented in Table 2 show that the coefficients of Earnings and Inflation are positive and significant in all models, proposing that an increase in inflation and profit will increase the Z-score and will lead towards more stability. In other words, the biggest banks are gaining a high proportion of profitability and that amount will drive them to a more stable environment. Moreover, during periods of high inflation a bank will increase its interest rate which will result in higher profits causing the banks to experience less risk. Liquidity is shown to be positive and significant in Models 1, 5, 7 and 9. Therefore, it is proposed that banks with high liquidity will become less risky. However, Bank size shows a negative and significant relationship with Z-score in Model 7 only, while all other models shows the relationship to be insignificant. This suggests that an increase of the total assets will cause an unstable environment. Growth of GDP shows a negative relationship with Z-score in Model 2 and Models 5 through 9. This outcome proposes that an increase in the rate of growth of GDP will decrease stability in the banking industry.

The second dependent variable is Non-performing loan, shown in Table 3. Model 1 in Table 3 displays the outcomes of the relationship between concentration measures calculated using HHI (loan) and Non-performing loan; this result is positive and significant, suggesting an increase in market power will lead to an increase in credit risk. Similarly, results presented in Table 3 show a positive coefficient, significant at 1% level between market power of assets (HHI assets) and Non-performing loan. Furthermore, CCR 3, 5 and 3 (loan) and CCR 3, 5 and 7 (assets) show a significantly positive relationship with credit risk. However, Model 9, which presents the Lerner Index, supports the concentration-stability view as an increase in market power will negatively relate to credit risk. The findings of this research support those of Kasman and Kasman (2015) and Nguyen et al. (2018) and show the existence of a U-shaped relationship between bank concentration and bank risk. In addition, in Table 3, profitability in all Models displays a negative relationship with non-performing loan, suggesting that an increase in profit will causes a decrease in credit risk. However, the probability value of earning was insignificant in Model 9. Inflation and growth of GDP displays a negative and significant relationship with NPL in all models except Model 9 where Growth of GDP is shown to be insignificant. To reduce inflation and money circulation, the central bank will increase the interest rate, which will cause the banks to gain more revenue from the loans thereby leading to bank stability; this result matches that of Fofack (2005). Moreover, an increase in the growth of GDP will lead to an increase in income enabling borrowers to meet their obligations and resulting in less credit risk. Bank size shows a significant positive relationship with NPL in Model 5, suggesting that an increase in bank size will increase bank non-performing loan. Furthermore, Liquidity shows no relationship with non-performing loan in Models 3, 4 and 6. How-

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6 AR(1) and AR(2) are autoregressive; where AR(1) test require a significant serial correlation. However, AR(2) test require a lack serial correlation. In addition, Hansen J-test (p-value) point to whether the instruments are unrelated to the error term.
ever, liquidity shows a significantly positive relationship with NPL in HHI (loan), CCR7 (loan), and Lerner Index, proposing that an increase in liquidity will increase the credit risk. Meanwhile, Liquidity displays a negative relationship with NPL in Models 5, 7 and 8, suggesting banks with more liquid assets will face low credit risk.

Table 2. Estimation results of the main model, dependent variables: Z-score

| Dependent Variable | Model 1       | Model 2       | Model 3       | Model 4       | Model 5       | Model 6       | Model 7       | Model 8       | Model 9       |
|-------------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| Z-score,1         | (0.0415)**    | (0.0824)**    | (0.0535)**    | (0.0547)**    | (0.0742)**    | (0.0934)**    | (0.0791)**    | (0.0757)**    | (0.0684)**    |
|                   | 0.0692        | 0.5431        | 0.1222        | 0.1623        | 0.6317        | 0.5147        | 0.5489        | 0.6131        | 0.61421       |
|                   | (0.0001)***   | -0.0006       |               |               |               |               |               |               |               |
| HHI(Loan)         | (0.0466)**    | (0.0113)**    |               |               |               |               |               |               |               |
|                   | -0.1128       | -0.0269       |               |               |               |               |               |               |               |
| CCR5(Loan)        | (0.0271)**    |               |               |               |               |               |               |               |               |
|                   | -0.0598       |               |               |               |               |               |               |               |               |
| CCR3(Loan)        |               |               |               |               |               |               |               |               |               |
|                   |               |               |               |               |               |               |               |               |               |
| HHI(Assets)       | (0.0002)***** |               |               |               |               |               |               |               |               |
|                   |               | (0.0007)***   |               |               |               |               |               |               |               |
| CCR7 (Assets)     | (0.0179)**    |               |               |               |               |               |               |               |               |
|                   | -0.0380       |               |               |               |               |               |               |               |               |
| CCR5 (Assets)     |               |               |               |               |               |               |               |               |               |
|                   |               |               |               |               |               |               |               |               |               |
| CCR3 (Assets)     |               |               |               |               |               |               |               |               |               |
|                   | (0.0088)**    |               |               |               |               |               |               |               |               |
|                   | -0.0684       |               |               |               |               |               |               |               |               |
| Lerner Index      | (0.1926)**    |               |               |               |               |               |               |               |               |
|                   | -0.6368       |               |               |               |               |               |               |               |               |
| Earnings          | (0.2325)**    | (0.2128)**    | (0.1891)**    | (0.2327)**    | (0.2418)**    | (0.2242)**    | (0.2183)**    | (0.2221)**    | (0.1729)**    |
|                   | 2.3911        | 1.6025        | 2.2979        | 2.2719        | 1.6758        | 1.4539        | 1.6263        | 1.386         | 2.2706        |
|                   | (0.0076)***   | (0.0245)***   | (0.0068)***   | (0.0069)***   | (0.0093)***   | (0.0082)***   | (0.0101)***   | (0.0026)***   | (0.0066)***   |
|                   | 0.0147        | -0.0087       | 0.0069        | 0.0107        | 0.0162        | -0.0003       | 0.0246        | 0.3262        | 0.02416       |
|                   | (0.3597)***   | (0.1563)***   | (0.1393)***   | (0.1221)***   | (0.1852)***   | (0.0807)***   | (0.1466)***   | (0.1374)***   | (0.2164)***   |
|                   | -0.3881       | 0.08221       | -0.0117       | 0.02482       | -0.0514       | 0.07576       | -0.49797      | -0.1029       | -0.1067       |
| Inflation         | (0.0069)**    | (0.0081)***   | (0.0084)***   | (0.0080)***   | (0.0081)***   | (0.0164)***   | (0.0097)***   | (0.0075)***   | (0.0089)***   |
|                   | 0.0240        | 0.07181       | 0.03362       | 0.03355       | 0.0529        | 0.03877       | 0.06399       | 0.05806       | 0.0576        |
|                   | 0.1436        |               |               |               |               |               |               |               |               |
| LnGDP             | (0.1012)***   | (0.1475)***   | (0.1605)***   | (0.1754)***   | (0.1467)***   | (0.1197)***   | (0.0983)***   | (0.1093)***   | (0.1376)***   |
|                   | 0.1436        | -0.2552       | -0.0373       | -0.1417       | -0.2969       | -0.2609       | -0.5080       | -0.2982       | -0.8860       |
|                   | (0.053)       | 0.010         | 0.020         | 0.024         | 0.023         | 0.057         | 0.009         | 0.013         | 0.018         |
|                   | 0.999         | 0.223         | 0.747         | 0.756         | 0.580         | 0.392         | 0.389         | 0.429         | 0.779         |
| Hansen-J-test     | 0.662         | 0.909         | 0.374         | 0.883         | 0.896         | 0.942         | 0.890         | 0.873         | 0.825         |
|                   | (0.817)       | 0.600         | 0.401         | 0.551         | 0.646         | 0.580         | 0.489         | 0.482         | 0.467         |
|                   | (0.000)       | 0.000         | 0.000         | 0.000         | 0.000         | 0.000         | 0.000         | 0.000         | 0.000         |
| Prob > chi2       | 187/204       | 187/204       | 187/204       | 187/204       | 187/204       | 187/204       | 187/204       | 187/204       | 187/204       |
| Wald chi2         | 6239.27       | 2606.53       | 502.69        | 973.81        | 9549.53       | 1932.43       | 8084.42       | 4390.02       | 1636.61       |
| Number of Observation | 204/204     | 204/204       | 204/204       | 204/204       | 204/204       | 204/204       | 204/204       | 204/204       | 204/204       |

Notes: Z-score,1 is the lag of Z-score, HHI is Herfindahl-Hirschman index (loan or assets), CCR is Concentration ratio for the largest 3, 5 or 7 banks (loan or assets) and LnGDP is the lag of growth of GDP. *** is significant at 1%, ** is significant at 5%, * is significant at 10%. Standard error appears in the brackets above estimated coefficients.
**Table 3.** Estimation results of the main model, dependent variables: NPL

| Dependent Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 | Model 9 |
|--------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| NPLt               | (0.018)** | (0.024)** | (0.021)** | (0.022)** | (0.035)** | (0.021)** | (0.022)** | (0.024)** | (0.019)** |
| HHI(Loan)          | (0.0006)** |          |         |         |         |         |         |         |         |
| CCR7(Loan)         | (0.176)** | (0.079)** |         |         |         |         |         |         |         |
| CCR5(Loan)         |          | (0.079)** | (0.40142) |         |         |         |         |         |         |
| CCR3(Loan)         |          |         | (0.177)** | (0.7427) |         |         |         |         |         |
| HHI(Assets)        |          |          |         | (0.0007)** |         |         |         |         |         |
| CCR7(Assets)       |          |          |         | (0.080)** |         |         |         |         |         |
| CCR5(Assets)       |          |          |         | (0.075)** | (0.5235) |         |         |         |         |
| CCR3(Assets)       |          |          |         | (0.0792)** | (0.5994) |         |         |         |         |
| Lerner Index       |          |         |         |         |         | (0.045)** | (0.5994) |         |         |
| Earnings           | (0.176)** | (0.272)** | (0.262)** | (0.2938)** | (0.366)** | (0.273)** | (0.278)** | (0.2999)** | (0.6270)** |
| Liquidity          | (0.015)** | (0.009)** | (0.0095) | (0.0158) | (0.014)** | (0.0087) | (0.009)** | (0.0123)** | (0.010)** |
| Bank Size          | (0.1286) | (0.3565) | (0.3937) | (0.4787) | (0.455)** | (0.235)** | (0.215)** | (0.3494)** | (0.130)** |
| Inflation          | (0.013)** | (0.025)** | (0.018)** | (0.0224)** | (0.005)** | (0.013)** | (0.012)** | (0.0076)** | (0.011)** |
| LnGDP              | (0.376)** | (0.544)** | (0.415)** | (0.665)** | (0.507)** | (0.399)** | (0.406)** | (0.4664)** | (0.2384)** |
| AR(1) Test (p-value) | 0.001   | 0.001   | 0.002   | 0.002   | 0.005   | 0.003   | 0.004   | 0.005   | 0.001   |
| AR(2) Test (p-value) | 0.628   | 0.632   | 0.914   | 0.936   | 0.489   | 0.911   | 0.961   | 0.838   | 0.951   |
| Hansen J Test (p-value) | 0.129   | 0.179   | 0.129   | 0.118   | 0.134   | 0.233   | 0.193   | 0.168   | 0.309   |
| Difference-in-Hansen Test (p-value) | 0.833   | 0.446   | 0.377   | 0.116   | 0.342   | 0.320   | 0.339   | 0.437   | 0.910   |
| Prob > chi2         | 0.000   | 0.000   | 0.000   | 0.000   | 0.000   | 0.000   | 0.000   | 0.000   | 0.000   |
| Wald chi2          | 16166.8 | 9850.87 | 6665.95 | 6064.96 | 5025.15 | 6001.84 | 6965.21 | 6078.92 | 25944.7 |
| Number of Observation | 186/204 | 186/204 | 186/204 | 186/204 | 186/204 | 186/204 | 186/204 | 186/204 | 186/204 |

Notes: NPLt-1 is the lag of non-performing loan ratio, HHI is Herfindahl-Hirschman index (loan or assets), CCR is Concentration ratio for largest 3, 5 or 7 banks (loan or assets) and LnGDP is the lag of growth of GDP. *** is significant at 1%, ** is significant at 5%, * is significant at 10%. Standard error appears in the brackets above estimated coefficients.

**CONCLUSION**

This research investigates the association between bank concentration and risk, based on data from banks in Jordan for the period 2005–2016. We used two measures to calculate financial risk: Z-score (whole risk) and Non-performing loan (credit risk), and nine proxies for bank concentration with controlling bank specifics and macro-economics.

Our main results are consistent with the concentration-fragility view; when the dependent variable is Z-score, the outcome shows a negative and significant relationship between concentration and bank stability (Z-score), indicating that an increase in market power will result in increased risks. Meanwhile, by using Non-performing loan as a dependent variable, the outcome displays a positive and significant relationship with concentration, proposing that an increase in market power will positively increase credit risk. Moreover, this supports the argument that when there is a drop in the market power rate, there is a lower interest loan rate, which, in turn, will result in bor-
rowers paying back their loans. When this happens, credit risk will be decreased, leading to greater stability in the banking sector. The conclusion of these findings is that banks engage in less risky behaviours in a low concentrated environment. The conclusion also supports the concentration-fragility view, which can be applied to the Jordanian banking sector.

The data obtained through this research provides a number of significant implications for policymakers. Our empirical evidence proposes that a less concentrated environment contributes to less risk in the banking sector. The results support a recommendation to the Central Bank of Jordan to increase the number of banks by making changes to market entry restrictions, thereby increasing competition in the banking industry, because high market power in the banking industry will lead to greater risk. Concerning bank specifics, Earnings show a significant relationship with bank stability, and this research recommends that banks have moderate earnings as this would ensure those banks are less volatile. Additionally, as liquidity shows a positive relationship with bank stability, regulators should continue to strengthen bank liquidity.

Every research has limitations and the current research is no exception. The main limitation is poor availability of data, especially for foreign banks; it would therefore be beneficial for future research to collect more data in the Jordanian banking industry, particularly from foreign banks. Additionally, future research can assess financial risk using data from non-bank financial institutions such as insurance companies. This study did not use all the available measurements of bank concentration, such as the Boone indicator and the efficiency-adjusted Lerner index. Thus, future research can use these other measurements to determine whether similar findings can be achieved for banks operating in Jordan. The highest risk facing the Jordanian banking industry is credit risk, which may be affected by a number of factors such as Investment rate, Return to Shareholders Ratio, Net Interest Margin, and sensitivity to market risk. Future research could use these variables in addition to bank concentration. While this research only applied Z-score and non-performing loan to determine bank risk, future studies may attempt to examine other measurement of the financial risk, such as the capitalization ratio as a measure of a bank’s level of capitalization (Berger et al., 2009).

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Appendix

**Figure 1.** Evaluation of Lerner Index

**Figure 2.** Evaluation of Concentration Ratio

**Figure 3.** Evaluation of HHI
Table 4. Mean values of measures of variables

| Year | Z-score | NPL (Assets) | HHI (Assets) | CCR7 (Assets) | CCR5 (Assets) | CCR3 (Assets) | HHI (Loan) | CCR7 (Loan) | CCR5 (Loan) | CCR3 (Loan) | Lerner Index | ROA | Liquidity |
|------|---------|--------------|--------------|---------------|---------------|---------------|-------------|-------------|-------------|-------------|-------------|-----|-----------|
| 2005 | 5.1306  | 11.341       | 3985.327     | 88.973        | 82.453        | 75.021        | 3019.878    | 84.908      | 77.497      | 68.012      | 0.9486282   | 1.913| 19.499    |
| 2006 | 4.557   | 9.052        | 3855.029     | 87.838        | 81.804        | 74.454        | 2880.835    | 83.854      | 76.610      | 66.235      | 0.9404316   | 1.576| 14.542    |
| 2007 | 4.170   | 7.899        | 3023.899     | 85.620        | 78.754        | 69.810        | 3059.77     | 85.130      | 78.116      | 68.094      | 0.9315591   | 1.437| 13.601    |
| 2008 | 4.333   | 6.461        | 2931.25      | 85.036        | 77.868        | 66.962        | 2854.25     | 83.739      | 76.370      | 66.614      | 0.9310187   | 1.417| 13.355    |
| 2009 | 3.463   | 8.470        | 2735.452     | 84.287        | 76.473        | 67.232        | 2560.882    | 81.765      | 73.387      | 64.081      | 0.9263222   | 1.067| 15.961    |
| 2010 | 3.868   | 9.708        | 2576.849     | 83.555        | 78.789        | 66.411        | 2406.969    | 81.094      | 72.128      | 62.521      | 0.9324544   | 1.234| 13.724    |
| 2011 | 3.483   | 10.527       | 2515.687     | 83.424        | 75.611        | 66.043        | 2286.893    | 80.914      | 71.474      | 61.340      | 0.9261557   | 1.043| 10.755    |
| 2012 | 3.708   | 10.044       | 2386.324     | 81.807        | 74.142        | 64.543        | 2098.699    | 80.776      | 68.703      | 61.351      | 0.9262963   | 1.156| 11.156    |
| 2013 | 3.658   | 8.673        | 2271.443     | 80.182        | 72.468        | 63.019        | 2129.739    | 79.590      | 68.111      | 61.324      | 0.9262736   | 1.111| 11.678    |
| 2014 | 4.173   | 7.405        | 2223.501     | 78.537        | 70.761        | 62.436        | 2151.698    | 78.937      | 67.662      | 61.074      | 0.9306396   | 1.377| 15.107    |
| 2015 | 3.700   | 7.002        | 2106.187     | 77.924        | 69.908        | 61.211        | 2015.874    | 78.792      | 68.712      | 61.435      | 0.9299977   | 1.190| 15.423    |
| 2016 | 3.483   | 6.103        | 1949.272     | 77.119        | 68.793        | 59.634        | 1875.924    | 78.112      | 66.198      | 59.683      | 0.9295561   | 1.102| 12.166    |

Notes: NPL is non-performing loan ratio, HHI is Herfindahl-Hirschman index (loan or assets), CCR is Concentration ratio for the largest 3, 5 or 7 banks (loan and assets), and ROA is Return of Assets after tax.