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Examining the Association between Bank Competition, Regulatory Capital, and Bank Risk-Taking*

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Abstract

Using a sample of 27 banks in Egypt covering the period from 2011 till 2017, the results suggest that the banking sector in Egypt is characterized by monopolistic competition. The findings provide empirical evidence that a higher level of competition increases bank risk-taking and contributes to financial fragility in the absence of banking capital regulations. Further, larger regulatory capital adequacy has the potential to discipline the risk-shifting incentives of banks and protect them against default. Finally, the tradeoff between bank competition and financial stability does not indicate that bank regulators shall give up trying to improve it. In fact, the findings prove that it is possible to maintain a larger regulatory capital ratio to ensure effective competition and financial stability at the same time. This represents the main challenge for bank supervisors and regulators. The findings are robust to alternative measures of bank risk-taking.

Keywords

Bank competition; Regulatory capital; Bank risk-taking; Financial stability

Article history

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1. Introduction

The banking sector is one of the main forces affecting economic stability. It has a crucial role in controlling the monetary transactions through the efficient allocation of funds "from surplus to deficit spending units". Given their intermediation function, banks provide investment services and financing activities for households, corporations, and governments (Ayaydin and Karakaya, 2014; Bessler and Kurmann, 2014). On that account, it is important to have a strong banking system that can face financial problems.

In the recent phases of deregulation, the policymakers have taken steps towards the privatization programs and engaged in the liberalization of financial markets. These promote financial innovation and bank competition which are essential for market efficiency and overall economic growth (Keeley, 1990). Bank competition denotes that there is a rivalry between banks seeking superiority. The goal of each bank is to expand its customer base and increase its market share. Banks compete successfully on setting prices and enhancing the quality of products to enlarge their market shares. Such competition may have real consequences on banks' profitability and risk-taking in the future (Bushman *et al.*, 2016).

The evolution of financial liberalization was followed by financial crises, which have raised suspicion of whether bank competition has been one of the factors that exacerbate bank risk-taking behavior and contribute to financial fragility. Two views are posited in the prior literature (the so-called competition fragility and competition stability). The dominant view emphasizes that a higher level of competition erodes banks' franchise values and the buffer of profits. This induces banks to undertake excessive risks, which in turn increase systemic instability (e.g. Jiménez *et al.*, 2013; Zaghdoudi *et al.*, 2016). Another school of thought concludes that increased bank competition improves the investment level; thus, reducing economic recessions and boosting financial stability (e.g. Fiordelisi and Mare, 2014; Akins *et al.*, 2016).

Additionally, the Latin American debt crisis in the 1980s, which had a negative impact at the global level and led to many banking failures, had shed light on the overriding necessity for setting international banking regulations to strengthen banks' solvency. This led to the establishment of the Basel Capital Accord which required banks to maintain a minimum ratio of capital to risk-weighted assets.[1] These capital regulations absorb banks' losses and enable banks to withstand economic shocks (e.g. Naceur and Kandil, 2009; Belanes and Hajiba, 2012; Adesina and Mwamba, 2016). Nevertheless, some banks that maintained the regulatory capital adequacy ratio collapsed during the financial crisis of 2007-2009 (e.g. Linsmeier, 2011; Cole and White, 2012; Poczter, 2016).

[1] Bank for International Settlements. (n.d.). *History of the Basel committee*. Retrieved from https://www.bis.org/bcbs/history.html.

The financial distress and banks' failure highlighted the tendency of banks to undertake excessive risks.[2] Bank risk-taking behavior has raised widespread attention for bank regulators over the last years. This motivated researchers to express increased interest in understanding the factors affecting bank risk-taking. The current research intends to complement empirically the prior literature by examining the association between bank competition and bank risk-taking and among regulatory capital and bank risk-taking since they are more topical, and the findings are inconclusive. Most importantly, they are even a central issue for bank regulators to formulate proper policies. Additionally, very few studies tackle the association between bank competition, regulatory capital, and bank risk-taking. Therefore, this research attempts to investigate the role of banking capital regulations on the association between bank competition and bank risk-taking in the Egyptian context.

The Egyptian banking sector is an interesting case study of an emerging market since it has experienced fundamental changes in the last decade. The Central Bank of Egypt (CBE) started to enact reform programs and regulations to achieve financial stability and sustain economic growth. The first reform program took place from 2004 till 2008. This reform program was the cornerstone to strengthen the vitality of Egyptian banks to effectively face regional and global competition.[3] In February 2005, Egypt's competition law was ratified to protect competition and to prevent monopoly practices that had negative impacts on the national economy. The law stressed the importance of practicing competition freely without any barriers to improve market efficiency. In 2006, the Egyptian Competition Authority (ECA) was established. The ECA represents a government advisory body that focuses primarily on issues concerning the privatization process and the competition law.[4]

The second reform program took place from 2009 till 2011 and was intended to apply Basel II regulations in the Egyptian banking sector. Basel II regulations were chosen to represent part of the regulatory framework of the CBE for three main reasons. First, Basel II enhances managing different types of risks, which in turn lowers the bankruptcy risk and boosts banks' financial stability. Second, Basel II tends to efficiently manage banks' capital, to ensure that "capital will be mobilized where real risks are located". Third, Basel II improves the competitiveness of Egyptian banks. Therefore, the implementation of Basel II regulations is the logical continuation of the reform programs which the CBE has undertaken since 2004.[5]

The current paper poses three main research questions. The first research question: how bank competition affects bank risk-taking? The second research

[2] See the G20 meeting statement of finance ministers and governors of central banks, held in Sao Paulo, on 9 November 2008. Retrieved from http://www.g20.utoronto.ca/2008/2008communique1109.html.

[3] Central Bank of Egypt. (n.d.). *Banking sector and supervisory framework in Egypt – reform and present situation*. Retrieved from http://www.cbe.org.eg/en/BankingSupervision/Pages/Strategy.aspx.

[4] American chamber of commerce in Egypt. (2006). *Report on the seminar "competition law and policy in Egypt"*. Retrieved from http://www.amchamegypt.org/Trac/reports/Competition_Law_Dec_2006.pdf.

[5] Central Bank of Egypt. (n.d.) *Banking sector and supervisory framework in Egypt – reform and present situation*. op.cit.

question: how regulatory capital adequacy impacts bank risk-taking? The third research question: how the interaction term of bank competition and regulatory capital affects bank risk-taking? These questions do not only concern banking regulatory authorities and government in Egypt, but also provide further future research implications to other banking systems over the world.

The remainder of this paper proceeds as follows. Section 2 reviews the relevant prior literature on bank competition, regulatory capital, and bank risk-taking and develops the research hypotheses. Section 3 discusses the data and methodology undertaken in the paper. Section 4 reports the descriptive statistics and empirical regression results. Finally, Section 5 concludes and offers implications for further work in the future.

2. Literature Review and Hypotheses Development

This section begins by reviewing the prior literature on the association between bank competition and bank risk-taking to develop the first research hypothesis. Then, it is followed by a discussion on the association between regulatory capital and bank risk-taking to develop the second research hypothesis. Finally, the association among bank competition, regulatory capital, and bank risk-taking is tackled to develop the third research hypothesis.

2.1. Bank Competition and Bank Risk-Taking

Several attempts are made to identify how bank competition impacts bank risk-taking. Many prior studies provide evidence consistent with the competition-fragility view, stating that there is a positive association between bank competition and bank risk-taking. The conventional wisdom indicates that a higher level of competition erodes banks' franchise values and monopoly rents. Consequently, banks are more likely to participate in risky investments to compensate the negative impact of increased competition (e.g. Cipollini and Fiordelisi, 2012; Fungacova and Weill, 2013; Jiménez *et al.*, 2013; Fernández *et al.*, 2016; Fungácová *et al.*, 2017).

Moreover, prior research findings prove that during periods of high competition, banks are forced to offer higher deposit rates, which in turn increase their cost of funding and chances of financial distress (e.g. Craig and Dinger, 2013; Zaghdoudi *et al.*, 2016; Kabir and Worthington, 2017). Other lines of evidence reveal that highly competitive banks are not adopting enough monitoring and screening strategies. Thus, deteriorating the quality of loans and increasing the likelihood of credit risks (e.g. Beck *et al.*, 2013; Bushman *et al.*, 2016; Jiang *et al.*, 2018).

On the contrary, other studies find a negative association between bank competition and bank risk-taking, supporting the competition-stability view. The premise is that lower degrees of competition in the market are associated with higher loan rates, which increase the possibility of banks' default, in-line with the "risk shifting" paradigm (Boyd and Nicolo, 2005). Increased competition has the advantage of diminishing risky loan portfolios by lowering loan rates and lending restrictions as

well. Thus, such competition facilitates the payment of borrowers and provides access for new borrowers to lend from banks (e.g. Schaeck *et al.*, 2009; Mirzaei *et al.*, 2013; Akins *et al.*, 2016). Additionally, prior studies conclude that at times of high competition, banks tend to diversify their products and services, which increase the scale of investments and improve banks' performance (e.g. Amidu and Wolfe, 2013; Fiordelisi and Mare, 2014; Samantas, 2017).

According to prior literature, most of the studies deduce that bank competition is positively associated with bank risk-taking (e.g. Cipollini and Fiordelisi, 2012; Beck *et al.*, 2013; Craig and Dinger, 2013; Fungacova and Weill, 2013; Jiménez *et al.*, 2013; Bushman *et al.*, 2016; Fernández *et al.*, 2016; Zaghdoudi *et al.*, 2016; Fungácová *et al.*, 2017; Kabir and Worthington, 2017; Jiang *et al.*, 2018). Thus, the first research hypothesis is developed as follows:

H_1. There is a positive association between bank competition in one year and bank risk-taking in the subsequent year.

2.2. Regulatory Capital and Bank Risk-Taking

Concerning the nexus between regulatory capital and bank risk-taking, several studies provide evidence that regulatory capital adequacy is negatively associated with bank risk-taking. This indicates that maintaining a higher capital ratio regulates a bank's risky behavior. Besides, the findings reveal that a larger regulatory capital base is a defensive tool against a bank's default since it covers credit, market, and operational losses (e.g. Belanes and Hajiba, 2012; Berger and Bouwman, 2013; Lee and Hsieh, 2013; Nguyen, 2013; Adesina and Mwamba, 2016; Fratzscher *et al.*, 2016; Laeven *et al.*, 2016).

The findings of other prior studies confirm the buffer role of higher regulatory capital adequacy during the crisis periods (e.g. Guidara *et al.*, 2013; Holod *et al.*, 2017; Khan *et al.*, 2017). Furthermore, previous research findings prove that a higher level of regulatory capital boosts a bank's liquidity, profits, quality of assets, and stock market performance (e.g. Naceur and Kandil, 2009; Demirguc-Kunt *et al.*, 2013; Bitar *et al.*, 2016).

On the other hand, some studies prove a positive association between regulatory capital and bank risk-taking. The findings reveal that higher regulatory capital adequacy ratios harm banks' liquidity, which weakens their funding activities and financial growth. Banks are thus encouraged to undertake excessive risks to offset the costs of maintaining these capital requirements (e.g. Heuvel, 2008; Laeven and Levine, 2009; Shim, 2013; Poczter, 2016). Furthermore, Linsmeier (2011) and Cole and White (2012) find that some banks failed in 2009 during the global financial crisis although maintaining larger regulatory capital ratios. This contradicts the premise stating that a higher regulatory capital base serves as a "buffer" at times of crisis.

The findings of several studies agree on the negative association between regulatory capital and bank risk-taking (e.g. Belanes and Hajiba, 2012; Berger and

Bouwman, 2013; Guidara *et al*., 2013; Lee and Hsieh, 2013; Nguyen, 2013; Adesina and Mwamba, 2016; Bitar *et al*., 2016; Fratzscher *et al*., 2016; Laeven *et al*., 2016; Holod *et al*., 2017). Hence, the second research hypothesis is stated as follows:

H_2. There is a negative association between regulatory capital in one year and bank risk-taking in the subsequent year.

2.3. Bank Competition, Regulatory Capital, and Bank Risk-Taking

Although there is an increasing interest in examining the association between bank competition and bank risk-taking and between regulatory capital and bank risk-taking, very little attention is paid to examining the association between bank competition, regulatory capital, and bank risk-taking. According to Behr *et al*. (2010), banks undertake more risky investments to make up for the erosion of franchise values and profits at times of high competition in the market. The study proves that larger regulatory capital has an effective role in attenuating excessive bank risk-taking during increased competition. Similarly, Tabak *et al*. (2012) highlight the importance of maintaining higher regulatory capital adequacy ratios to ensure more conservative behavior of larger banks at periods of high competition.

On the contrary, Agoraki *et al*. (2011) and Tabak *et al*. (2015) find that the positive association between bank competition and bank risk-taking is not affected by regulatory capital. This suggests that larger regulatory capital is not sufficient to lessen the detrimental impact of high competition on banks' risky behavior. Thus, bank competition has a greater influence on risks compared to regulatory capital.

Based on the few prior studies which tackle the association between bank competition, regulatory capital, and bank risk-taking (e.g. Behr *et al*., 2010; Tabak *et al*., 2012). And consistently with the current research hypotheses, assuming that there is a positive association between bank competition and bank risk-taking and a negative association between regulatory capital and bank risk-taking. It can be claimed that the association between bank competition and bank risk-taking may become less positive when adding a larger regulatory capital base. Therefore, the third research hypothesis is established as follows:

H_3. There is a negative association between the interaction term of bank competition and regulatory capital in one year and bank risk-taking in the subsequent year.

3. Data and Methodology

This section describes the data collection sources and provides some details concerning the sample composition. Then, it focuses on discussing the measurements of bank risk-taking, bank competition, and regulatory capital along with other determinants of risk-taking.

3.1. Data

The sample consists of banks registered at the Central Bank of Egypt (CBE) for the period 2011-2017. The data are collected from the annual reports (i.e. non-consolidated financial statements) of banks through the official websites and databases of different banks. The initial sample encompasses 38 banks listed at the CBE.[6] Some banks are excluded due to difficulties in data collection, the unavailability of non-consolidated financial statements, and the availability of fewer observations. The final sample consists of 27 banks with 189 bank-year observations. **Appendix 1** presents the list of banks along with their classifications, these classifications are conducted according to the website of Mubasher and the official websites of banks.[7] Market data about the monthly closing prices of banks listed at the Egyptian Stock Exchange (EGX) are gathered from the website of Mubasher.[8] The initial sample comprises 14 banks listed at the EGX. Societe Arabe International Du Banque (SAIB) and Bank Du Caire are excluded due to the unavailability of monthly closing prices. Therefore, the final sample of banks listed at the EGX consists of 12 banks with 84 bank-year observations.

3.2. Methodology

The following regression model is used to examine the developed hypotheses:

$$RISKTAKING_{it} = \beta_0 + \beta_1 PR_{it-1} + \beta_2 CAR_{it-1} + \beta_3 PR_{it-1} \times CAR_{it-1} + \sum_{J=1}^{N} \beta_J Controls_{Jit-1} + \epsilon_{it-1}$$

Where $RISKTAKING_{it}$ = the dependent variable that proxies for risk-taking for bank i at year t, proxied by: RWA_{it} = the ratio of risk-weighted assets to average assets, $Z-SCORE_{it}$ = the natural logarithm of the simplified Z-score, $STDV_{it}$ = the annualized standard deviation of monthly stock returns, PR_{it-1} = bank competition using P&R model, CAR_{it-1} = the regulatory capital adequacy ratio, $PR_{it-1} \times CAR_{it-1}$ = the interaction term between bank competition and regulatory capital, $SIZE_{it-1}$ = the natural logarithm of total assets, $PROF_{it-1}$ = the ratio of net income after taxes scaled by average assets, LEV_{it-1} = the ratio of total liabilities to total assets, DIV_{it-1} = the ratio of non-interest income to the total income, D_REV_{it-1} = a dummy variable that equals one if the year is 2011, 2012 or 2013 and zero otherwise, D_GOV_{it-1} = a dummy variable that equals one if the banks are governmental and zero otherwise.[9]

3.2.1 Risk-Taking

We use accounting and market-based measures to proxy for bank risk-taking. The accounting-based measures are the risk-weighted assets ratio and the simplified Z-

[6] Retrieved from http://www.cbe.org.eg/ar/BankingSupervision/Pages/LicenseLists.aspx .
[7] Retrieved from https://www.mubasher.info/markets/EGX/indices/BAN.
[8] https://www.mubasher.info/countries/eg
[9] To avoid "endogeneity" problems that are caused by "reverse causality" issues, prior research models suggest lagging of independent variables by one year (e.g. Haq and Heaney, 2012).

score, and the market-based measure is the annualized standard deviation of monthly stock returns. Some studies argue that accounting measures are viewed as backward-looking proxies since they require historical accounting data. While market measures rely on market data; consequently, they are considered forward-looking proxies (e.g. Leroy and Lucotte, 2017). Other studies conclude that one of the main privileges of using accounting-based measures is that they are used for both listed and unlisted banks at the Stock Exchange. However, market-based measures are computed for only listed banks at the Stock Exchange (e.g. Kabir and Worthington, 2017).

3.2.1.1. Risk-Weighted Assets (RWA) Ratio

The ratio of RWA to average assets is a widely used proxy to capture the actual risky behavior of banks. Prior studies strengthen that the proportions of risky assets to average assets in banks' portfolios reflect the behavior of banks' managers towards the choice of projects and the overall assets' risks (e.g. Jeitschko and Jeung, 2007). According to Francis and Osborne (2012) and Shim (2013), banks report the values of their RWA depending on banking regulations, they allocate different risk weights to each group of assets. Additionally, prior studies claim that the RWA ratio is considered a credit risk measure under the accords of Basel (e.g. Khan *et al.*, 2017). As a result, this research uses the ratio of RWA to average assets of bank i at year t to reflect the quality of bank assets and in turn risk-taking behavior.

3.2.1.2. The Simplified Z-score

The simplified Z-score is a multifaceted measure since it encompasses indicators of bank profitability, the strength of capital, and the volatility of returns into a single measure. This proxy captures the extent to which banks have cushions to absorb their losses (e.g. Ariss, 2010; Papanikolaou and Wolff, 2010; Liu *et al.*, 2013). According to Chiaramonte *et al.* (2016), Z-score is the most widely accounting-based measure used to show the distance of a bank from the probability of default. The probability of default increases when the capital falls below the negative return on assets "losses". Additionally, the Z-score results in transparent calculations and can predict bank failure three years in advance with a percentage of 76%.

A higher value of Z-score implies that a bank owns higher levels of profitability and capitalization, and lower earnings volatility. This indicates more financial stability and a lower possibility of default. Thus, Z-score is a direct indicator of bank stability and is inversely proportional to the possibility of default (e.g. Tabak *et al.*, 2012; Amidu and Wolfe, 2013; Beck *et al.*, 2013; Adesina and Mwamba, 2016; Leroy and Lucotte, 2017). Further, it is argued that Z-score is a broad measure of risks since it captures both credit and market risks (Marques *et al.*, 2013).

Following the methodologies of prior studies, we rely on the Z-score to capture bank risk-taking and the possibility of default. Moreover, we use the natural logarithm of Z-score to diminish the high skewness (e.g. Laeven and Levine, 2009; Nguyen, 2013; Soedarmonoa *et al.*, 2013; Fernández *et al.*, 2016; Samantas, 2017; Mohsni and Otchere, 2018). The Z-score of bank i at year t is calculated as follows:

$$lnZscore_{it} = \frac{ROA_{it} + TE_{it}/TA_{it}}{\sigma\ ROA_{it}}$$

Where $lnZscore_{it}$ is the natural logarithm of the Z-score of bank i at year t. ROA_{it} is the return on assets, it is computed as the ratio of net income after taxes to average assets of bank i at year t, average $assets_{it} = \frac{(Assets_{it} + Assets_{it-1})}{2}$. TE_{it}/TA_{it} is total equity to total assets ratio of bank i at year t. $\sigma\ ROA_{it}$ is the standard deviation of return on assets of bank i at year t, to capture the volatility of bank returns. This research employs the rolling standard deviation technique to compute the value of the standard deviation of ROA.

3.2.1.3. Volatility of Stock Returns

Concerning the market-based measure, considerable prior studies employ the annualized standard deviation of stock returns to proxy for bank risk-taking. Such market-based measure incorporates three different types of risks namely credit risk, liquidity risk, and interest rate risk (Papanikolaou and Wolff, 2010). Further, the standard deviation of stock returns is based on a market premise stating that it reveals information about the risk inherent in the bank's activities, which in turn reflects the risky behavior of the bank (Craig and Dinger, 2013).

According to Bennett *et al.* (2015), the main reason behind using the standard deviation of stock returns is that such a measure captures the expected bank risks. It is positively associated with financial and operational risks. Additionally, the possibility of a bank's default increases when the bank has a higher standard deviation of stock returns. Most importantly, it is argued that the market-based measures reflect bank risks in a fairly transparent and timely manner compared to accounting measures. The intuition is that accounting-based measures may be subject to manipulations and the accounting regulations change over time (Jiang *et al.*, 2018).

Following the approaches of the previous studies, this proxy is computed using two steps (e.g. Laeven and Levine, 2009; Guidara *et al.*, 2013; Bennett *et al.*, 2015; Holod *et al.*, 2017; Jiang *et al.*, 2018). The first step is to use the monthly closing stock prices of each bank to compute the monthly stock returns:

$$\mathrm{R_{im}} = lnP_{im} - lnP_{im-1}$$

Where R_{im} is the stock returns, i and m denote for bank and month respectively; lnP_{im} refers to the natural logarithm of the monthly closing stock price of $bank_i$. The second step is to calculate the annualized standard deviation of monthly stock returns:

$$\sigma_{it} = \sqrt{\frac{\sum(R_{im} - \bar{R}_{it})^2}{12}}$$

Where σ_{it} is the standard deviation of stock returns, i and t indicate bank and year respectively; R_{im} is the stock returns, i and m represent bank and month; $\bar{R}_{it}$ is the annual mean of the monthly stock returns of bank i at year t.

3.2.2 Bank Competition

According to prior studies, bank competition is captured through traditional "structure" approaches and new industrial organization "non-structure" approaches. The traditional approaches are consistent with the structure conduct performance (SCP) theory assuming that there is a negative association between concentration and competition.[10] Herfindahl–Hirschman Index (HHI), concentration ratios, and the market share of banks (based on loans, deposits, assets) are counted as structure measures. Higher values of these measures are interpreted as higher bank concentration and lower market competition. Then, the traditional approaches are direct proxies of concentration and are not exact measures of bank competition because a higher level of concentration does not always imply lower competition in the market.

On the contrary, the new industrial organization approaches are direct indicators of bank competition. They rely on recent methodologies that effectively reflect the behavior of banks and assess the nature of competition in the market. The P&R model and Lerner index represent non-structure measures and are superior since they overcome the shortcomings of the structure measures (e.g. Schaeck *et al.*, 2009; Fungácová *et al.*, 2017).

3.2.2.1. Panzar and Rosse Model

Panzar and Rosse (1987) introduce the P&R model which is also known as H-Statistic. The model builds an assumption that banks are seeking to maximize their profits. Thereafter, the model examines to what extent changes in the input prices are reflected in banks' revenues. In the case of perfect competition, the marginal costs and banks' revenues increase by the same proportion due to the increase in input prices. Perfect competition exists when there is a higher degree of elasticity in the market. However, if the market is monopolistic, the elasticity will be low or negative (Claessens and Laeven, 2004; Poshakwale and Qian, 2011; Amidu and Wolfe, 2013; Tabak *et al.*, 2015; Bushman *et al.*, 2016). According to Mwega (2011) and Mulyaningsih *et al.* (2015), the P&R model is advantageous for three main reasons. First, this model represents a straightforward measure of bank competition compared to other proxies. Second, it relies on data from the bank level. Third, it considers the differences between banks. While one of the disadvantages of using the P&R model is that it assumes banks are operating in an equilibrium market.

Following the methodology of Claessens and Laeven (2004), we employ the P&R "reduced-form revenue" model for the bank (i) at year (t-1). The subsequent model is computed for 27 banks during 7 years-period starting from 2010 till 2016, to evaluate the competitive behavior of the Egyptian banks:

$$ln(R_{it-1}) = \alpha + \beta_1\, ln(\mathrm{I}_{1,it-1}) + \beta_2\, ln(\mathrm{I}_{2,it-1}) + \beta_3\, ln(\mathrm{I}_{3,it-1}) + \mathrm{Y}_1\, ln(\mathrm{C}_{1,it-1}) + \mathrm{Y}_2\, ln(\mathrm{C}_{2,it-1}) + \mathrm{Y}_3\, ln(\mathrm{C}_{3,it-1}) + \epsilon_{it-1}$$

[10] The SCP posits that highly concentrated banks exploit their greater market power in setting unfavorable terms to gain more profits (Hannan, 1991; Tabak *et al.*, 2012).

Where R_{it-1} is the ratio of gross interest revenue to average assets of bank i at year t-1 to capture the output price of bank's loans. Three input prices are included in the P&R model. $I_{1,it-1}$ is interest expense to average deposits ratio to reflect the input price of the bank's deposits. $I_{2,it-1}$ is the ratio of personnel expenses to average assets to proxy for the input price of labor. $I_{3,it-1}$ is other operating and administrative expenses to average assets ratio to represent the input price of capital. Additionally, three control variables are incorporated into the model. $C_{1,it-1}$ is the ratio of gross loans to average assets. $C_{2,it-1}$ is equity to average assets ratio, and $C_{3,it-1}$ is total assets to control bank's size. The natural logarithm is taken for all the variables in the P&R model.

The H-statistic is calculated as the summation of the coefficients $\beta_1, \beta_2,$ and β_3. A higher value of the H-statistic indicates a more competitive market. The market is thus characterized by perfect competition when H-statistic equals one. However, if H-statistic equals to or is less than zero, there is a monopoly (collusion) in the market. Finally, there is monopolistic competition in the market when H-statistic is less than one and is greater than zero. We employ the ordinary least square (OLS) regression using the Statistical Package for Social Sciences (SPSS) software (version 22) to estimate the following parameters $\beta_1, \beta_2,$ and β_3 for each bank every year.

3.2.3 Regulatory Capital

Regulatory capital adequacy ratios are used extensively in prior research to measure banks' capital in relation to their risk-weighted assets. These capital ratios strengthen the idea of having enough capital in banks to cover all possible losses and shocks arising from credit, market, and operational risks. Thus, protecting banks' depositors and promoting the financial stability and efficiency of the banking system. (e.g. Soedarmonoa *et al*., 2013; Poczter, 2016; Chiaramonte and Casu, 2017).

3.2.4 Other Determinants of Bank Risk-Taking

The model also employs $SIZE_{it-1}$, $PROF_{it-1}$, LEV_{it-1}, DIV_{it-1}, D_REV_{it-1}, D_GOV_{it-1} as control variables that can influence the actual behavior of banks towards risks. $SIZE_{it-1}$ is measured by the natural logarithm of total assets. Larger banks are less prone to risks and are more financially stabilized compared to smaller banks. Larger banks own better resources that enable them to extend their businesses geographically. Therefore, they have better chances to invest in loans and other activities broadly, thus building up higher buffers of capital. Such capital enables larger banks to cover unexpected obligations and liquidity shocks. Further, larger banks diversify their portfolio efficiently and apply effective monitoring policies (e.g. Konishi and Yasuda, 2004; Liu et al., 2013; Kabir and Worthington, 2017). Likewise, Agoraki *et al*. (2011) and Sarkar and Sensarma (2016) find that larger banks have better credit quality and risk management systems, which are considered the main reasons behind lower ratios of non-performing loans in their loans' portfolios. It is expected to find a negative association between bank size in one year and subsequent year risk-taking.

$PROF_{it-1}$ denotes net income after taxes scaled by average assets.[11] Banks with larger profits are conservative since they have more to lose if they undertake excessive risks. Further, they are more likely to survive during the financial crises compared to their counterparts with fewer profits. The intuition is that larger profits absorb banks' losses and are cushions against sudden shocks (e.g. Berger and Bouwman, 2013; Chiaramonte and Casu, 2017; Holod *et al*., 2017; Mohsni and Otchere, 2018). Bank profitability is expected to be negatively associated with subsequent year risk-taking. The third covariate is the ratio of total liabilities to total assets (LEV_{it-1}) as a proxy for bank leverage. Banks with excessive leverage are less likely to absorb losses and to cover liquidity shocks, and thus they tend to invest in profitable though more risky assets (e.g. Haq and Heaney, 2012; Kato and Tsuruga, 2016). Further, other studies confirm that increased leverage forces banks to experience default, contributes to systemic risk, and exposes the economy to greater crises. Accordingly, banks shall sustain lower levels of leverage to enable their equity capital to serve as buffers, protecting banks against losses on risky assets and triggering banks to continue their operations in case of a financial turmoil (Papanikolaou and Wolff, 2010; Bhagat *et al*., 2015; Clark *et al*., 2018). We expect a positive association between bank leverage and risk-taking.

Following Kabir and Worthington (2017) and Leroy and Lucotte (2017) among others, we also employ the ratio of non-interest income to total income (DIV_{it-1}) to control for bank diversification. A higher value indicates that a bank's portfolio is well diversified.[12] Nowadays, banks are encouraged to diversify their portfolio and to rely on sources of income beyond traditional interest-generating activities to enhance their performance. They expand their operations to comprehend non-traditional and off-balance sheet activities to generate more profits, grow rapidly, and become more efficient. Thereby, well-diversified banks are less likely to experience systemic shocks and risks compared to less diversified banks (Cipollini and Fiordelisi, 2012; Liu and Wilson, 2013; Chiaramonte and Casu, 2017; Holod *et al*., 2017; Samantas, 2017). It is expected to find a negative association between bank diversification in one year and subsequent year risk-taking.

Furthermore, we include a revolution dummy variable (D_REV_{it-1}), that takes the value of one if the year is 2011, 2012 or 2013 and zero otherwise. As such, it is possible to capture the uniqueness of the political and economic instability three-year period of 2011-2013 in recent Egyptian history. Revolution is also expected to be negatively associated with subsequent year risk-taking. The negative association is attributed to the fact that banks are more likely to experience a massive decline in their capital ratios in times of stress, which in turn curbs their appetite and ability to invest in imprudent lending activities and other risky positions. As such, the degree of banks'

[11] This ratio is preferable since it captures how a bank's management can effectively generate profits from its assets (e.g., Tabak *et al*., 2015; Khan *et al*., 2017).

[12] The non-interest revenues are exemplified from: fee and commission income, net gains (losses) from trading, net gains (losses) from sales of financial investments or securities, dividends income, net gains (losses) from assets at fair value, net gains (losses) from the transactions of foreign currency exchange, net insurance income, dividends from subsidiaries and associates, gains from housing projects, and other non-interest income.

risk aversion increases after the crisis period to reduce distress and to maintain the stability of the financial system (Soedarmonoa *et al.*, 2013). According to the prior studies, the structure of ownership shall also be considered in the empirical study to provide a comprehensive analysis of bank risk-taking (e.g. Laeven and Levine, 2009; Schaeck *et al.*, 2009). Thus, we consider a governmental dummy variable (D_GOV_{it-1}), which takes the value of 1 for governmental banks and 0 otherwise.[13] **Appendix 2** defines the research variables and summarizes their measurements.

4. Results

This section presents the descriptive statistics concerning the accounting and market-based measures and then discusses the main regression results of the cross-sectional time-series feasible generalized least squares method within the banking industry in Egypt.[14]

4.1Descriptive Statistics

Table 1 provides summary statistics for the main research variables we use in the regressions. It reports the number of observations (N), mean, median, standard deviation (Std.), minimum (Min.) and maximum (Max.) for the total sample of banks and for banks listed at the EGX. In panel A, the mean (median) of risk-weighted assets to average assets ratio is 58% (57%). The average natural logarithm of the Z-score for the sample of banks is 3.37 with a minimum of 0.00 and a maximum value of 6.52. The measure of bank competition (PR_{it-1}) has a mean (median) of 1% (0%). On average, the regulatory capital adequacy ratio is 16% and has shown little variation across the years. This result shows that banks are motivated to maintain a capital cushion above the minimum requirements of the Basel Capital Accord. The mean result for the interaction term ($PR_{it-1} \times CAR_{it-1}$) is 0%. In panel B, the mean (median) ratio of the market-based risk-taking measure ($STDV_{it}$) is 10% (9%). The size of listed banks constitutes 99% of the total sample. On average, the profitability of sample banks listed at the EGX represents 1%, while leverage is 90%. Mean bank diversification is 28% with a standard deviation of 14%.

[13] Banks are governmental when the portions of the governmental shareholdings and rights are 50% or more of the ownership. Examples of governmental banks in Egypt are National Bank of Egypt, Banque Misr, Banque Du Caire, Export Development Bank of Egypt, Housing and Development Bank, and Industrial Development and Workers Bank of Egypt. The Industrial Development and Workers Bank of Egypt is excluded from the final sample due to the unavailability of annual non-consolidated financial statements.

[14] The results of the Modified Wald test prove that the three research models (RWA, Z-score, and STDV) have heteroskedasticity problems since the p-values are less than 5%. Further, the Wooldridge test confirms that the residuals in the RWA and Z-score models are serially correlated since the p-values are less than 5%. However, the residuals in the STDV model are not serially correlated. In such cases, the GLS is the best linear unbiased method since it obtains more efficient and consistent estimators when the error term is heteroskedastic and/or serially correlated (Gujarati, 2003; Baum, 2006; Hill *et al*., 2010; Baltagi, 2013).

Table 1: Descriptive Statistics

Panel A: Summary Statistics - Banks – n=27 (2011-2017)							
	Variables	**N.**	**Mean**	**Median**	**Std.**	**Min.**	**Max.**
	$RISKTAKING_{it}$: RWA	189	0.58	0.57	0.14	0.25	1.28
	$RISKTAKING_{it}$: Z-SCORE	189	3.37	3.25	1.24	0.00	6.52
	PR_{it-1}	189	0.01	0.00	0.11	-0.27	1.16
	CAR_{it-1}	189	0.16	0.15	0.06	0.07	0.49
	$PR_{it-1} \times CAR_{it-1}$	189	0.00	0.00	0.02	-0.05	0.14
	$SIZE_{it-1}$	189	24.07	23.90	1.08	22.23	27.28
	$PROF_{it-1}$	189	0.01	0.01	0.01	-0.06	0.11
	LEV_{it-1}	189	0.90	0.90	0.04	0.75	0.96
	DIV_{it-1}	189	0.28	0.26	0.12	-0.04	0.88
Panel B: Summary Statistics - Banks Listed at the EGX – n=12 (2011-2017)							
	$RISKTAKING_{it}$: STDV	84	0.10	0.09	0.04	0.02	0.22
	PR_{it-1}	84	-0.02	-0.00	0.06	-0.24	0.18
	CAR_{it-1}	84	0.16	0.15	0.05	0.09	0.29
	$PR_{it-1} \times CAR_{it-1}$	84	-0.00	-0.00	0.01	-0.05	0.02
	$SIZE_{it-1}$	84	23.97	23.87	0.86	22.23	26.30
	$PROF_{it-1}$	84	0.01	0.02	0.02	-0.06	0.04
	LEV_{it-1}	84	0.90	0.90	0.04	0.81	0.96
	DIV_{it-1}	84	0.28	0.26	0.14	-0.04	0.60

4.2. Regression Results

Table 2 presents the regression results using the three measures of $RISKTAKING_{it}$, *RWA*, *Z-score*, and *STDV* in each of the three main columns. As reported in the first column, PR_{it-1} is positively associated with RWA_{it} with a coefficient of 0.229 and is statistically significant at conventional levels. One possible explanation for the positive association is that high competition erodes the franchise values and the market power of banks, causing a drop in their solvency. Thus, banks become more willing to undertake excessive risky projects in the subsequent year to make up the losses caused by high competition, supporting the competition-fragility view (Ariss, 2010; Cipollini and Fiordelisi, 2012; Fungacova and Weill, 2013; Jiménez *et al.*, 2013; Ayaydin and Karakaya, 2014; Bushman *et al.*, 2016).

The coefficient of CAR_{it-1} -0.240, is negative and significant at conventional levels. The negative association agrees with the prior studies which derive that excessively risk-taking behaviors of banks are restricted since banks are maintaining higher levels of regulatory capital. Thus, higher regulatory capital adequacy is an effective tool in disciplining "the risk-return frontier of a bank" and enhancing the financial stability of banks (e.g. Konishi and Yasuda, 2004; Belanes and Hajiba, 2012; Lee and Hsieh, 2013; Nguyen, 2013; Adesina and Mwamba, 2016). The coefficient of $PR_{it-1} \times CAR_{it-1}$ -2.478, is also negative and significant at conventional levels. The findings can be explained in the light of (Behr *et al.*, 2010; Tabak *et al.*, 2012). They conclude that larger regulatory capital is a sufficient assurance to attenuate the unsound risk-taking practices of banks during times of high competition, and thus preserving

the overall financial stability. Tabak *et al.* (2012) confirm the previous findings for large banks in 10 Latin American countries between 2003 and 2008.

Table 2: Main Results Using Cross-sectional Time-series Feasible Generalized Least Squares Regression – Banks (2011-2017)

Variables	$RISKTAKING_{it}$								
	RWA_{it}			$Z-SCORE_{it}$			$STDV_{it}$		
	Pred.	**Coef.**	**Z**	**Pred.**	**Coef.**	**Z**	**Pred.**	**Coef.**	**Z**
Intercept	+/-	-0.435	-3.13***	+/-	0.823	0.55	+/-	0.055	0.47
PR_{it-1}	+	0.229	3.23***	-	-1.866	-8.24***	+	0.839	2.43**
CAR_{it-1}	-	-0.240	-2.17**	+	2.685	2.89***	-	-0.108	-2.27**
$PR_{it-1} \times CAR_{it-1}$	-	-2.478	-3.80***	+	4.152	4.53***	-	-4.958	-2.54**
$SIZE_{it-1}$	-	-0.057	-1.58	+	0.362	6.67***	-	-0.019	-2.50**
$PROF_{it-1}$	-	0.504	1.82*	+	-11.442	-3.95***	-	1.046	2.06**
LEV_{it-1}	+	0.504	3.45***	-	-8.047	-11.81***	+	0.424	2.47**
DIV_{it-1}	-	-0.100	-2.24**	+	1.703	4.61***	-	-0.007	-0.49
D_REV_{it-1}	-	-0.031	-3.40***	+	0.371	7.17***	-	-0.024	-3.38***
D_GOV_{it-1}	+/-	-0.008	-0.75	+/-	-0.114	-1.00	+/-	-0.002	-0.25
Year fixed effects	YES			YES			NO		
Firm fixed effects	YES			YES			YES		
P-value	0.0000			0.0000			0.0000		
Observations	189			189			84		
Number of banks	27			27			12		

Notes:

1. *, **, and *** represent significance at the 10%, 5%, and 1% level respectively.
2. A year and firm fixed effects are used to control for serial correlation and heteroskedasticity in regression residuals respectively.
3. A differencing transformation technique is used.

In the second column, the regression results of the explanatory variables with the $Z-SCORE_{it}$ as the dependent variable are presented. In general, higher levels of bank competition in one year drive banks to fund risky projects in the subsequent year, which in turn deteriorate the financial stability, as evident by the significant negative coefficient of PR_{it-1} -1.866. Stringent regulatory capital in one year absorbs banks' losses and guards banks against default, which includes improved financial stability in the subsequent year as shown by the significant positive coefficient of CAR_{it-1} 2.685. The significant positive coefficient of the interaction term, $PR_{it-1} \times CAR_{it-1}$, 4.152 shows the larger is the regulatory capital adequacy ratio, the less negative is the association between bank competition in one year and subsequent year financial stability.

Coefficients in the third column are the main results of the model regressing risk-taking within the market-based measure. With respect to the variable PR_{it-1}, the result suggests that when competition intensifies in one year, banks are prone to higher volatility of stock returns in the subsequent year due to taking on excessive risks as apparent by the significant positive coefficient of 0.839. CAR_{it-1} is negatively associated with $STDV_{it}$ with a coefficient of -0.108 and is statistically significant at conventional levels. This implies that stricter regulatory capital in one year disciplines the behavior of banks towards risks, thus lowering the volatility of stock returns in the subsequent year. The coefficient of the interaction term $PR_{it-1} \times CAR_{it-1}$ -4.958, is also negative significant at conventional levels, showing that there is a negative association between the interaction variable at year t-1 and the standard deviation of stock returns at year t.

Concerning bank-specific and macro-economic control variables, the results show that bank size in one year is positively associated with the subsequent year financial stability as measured by the $Z-SCORE_{it}$ and is negatively associated with the subsequent year risk-taking as measured by the $STDV_{it}$. It is consistent with the findings that larger banks are less inclined to take risky investments since they possess better resources and higher buffers of capital that enable them to face any sudden shocks. Furthermore, larger banks diversify their portfolio and apply better screening policies, which eventually undermine the overall risks and the financial fragility (e.g. Konishi and Yasuda, 2004; Liu *et al.*, 2013; Kabir and Worthington, 2017). However, the result indicates that bank size at one year is statistically insignificant with the subsequent year risk-taking when the RWA_{it} is used as a proxy for bank risk-taking.

Contrary to the expectations, the findings reveal that there is a significant positive association between bank profitability in one year and bank risk-taking in the subsequent year. The results agree with the prior literature (e.g. Delis and Kouretas, 2011; Sarkar and Sensarma, 2016). These studies conclude that higher lagged profitability drives banks to undertake more asset risk; thus, they are more likely to experience financial fragility. Regarding bank leverage, as expected the findings for all specifications confirm that there is a significant positive association between bank leverage in one year and subsequent year risk-taking. The results can be explained in the light of (Haq and Heaney, 2012; Bhagat *et al*., 2015; Kato and Tsuruga, 2016; Clark *et al*., 2018). They argue that banks with excessive leverage are financially distressed. Hence, they tend to participate in profitable though more risky assets to be able to cover losses and to withstand liquidity shocks.

As for bank diversification, the results show that bank diversification is significantly negatively associated with the RWA_{it} and is significantly positively associated with the $Z-SCORE_{it}$. It is consistent with the prior work of (Cipollini and Fiordelisi, 2012; Liu and Wilson, 2013; Chiaramonte and Casu, 2017; Holod *et al*., 2017; Samantas, 2017). The aforementioned studies reveal that well-diversified banks are not incited to engage in risky activities due to diversification benefits. Thereby, they have more stable performance compared to their less diversified counterparts. However, the finding is statistically insignificant when considering the $STDV_{it}$.

Collectively, the coefficients of the dummy variable for revolution at one year are significantly negatively associated with bank risk-taking in the subsequent year as expected. This indicates the tendency of banks to invest in relatively lower risky positions during times of revolutions, supporting the findings of (Soedarmonoa *et al.*, 2013; Ayaydin and Karakaya, 2014; Khan *et al.*, 2017). According to Soedarmonoa *et al.* (2013), banks experience a decline in their capital ratios during periods of instability, thus investing in low-risk activities. Further, the evidence reported by Khan *et al.* (2017) suggests that banks are more actively disciplined and monitored for risk-taking during crises to behave less aggressively. Finally, the coefficients of the dummy variable for bank ownership are statistically insignificant with bank risk-taking for all specifications.

5. Conclusion

In response to the financial crisis of 2007-2008, studies on bank risk-taking are expanded due to the major concern among policymakers. In this regard, this paper examines the impact of bank competition on bank risk-taking and how regulatory capital influences the behavior of banks towards risks. Furthermore, the paper contributes to the very few investigations through examining the association between the interacting effect of bank competition and regulatory capital on bank risk-taking. Most importantly, accounting-based and market-based measures are employed to capture bank risk-taking.

Using a sample comprising 27 banks registered at the CBE covering the period from 2011 till 2017, we provide empirical evidence that bank competition in one year is positively associated with subsequent year risk-taking. The result agrees with the findings of (Jiménez *et al.*, 2013; Fernández *et al.*, 2016; Fungácová *et al.*, 2017). The evidence suggests that higher competition drives banks to undertake risky projects. One possible explanation is that a higher level of competition erodes banks' franchise values and monopoly rents, supporting the competition-fragility hypothesis (Cipollini and Fiordelisi, 2012; Fungacova and Weill, 2013). In addition, the result can be explained by the fact that increased competition deteriorates the quality of loans. The premise is that highly competitive banks do not apply sufficient monitoring and screening technologies (Beck *et al.*, 2013; Jiang *et al.*, 2018). Other possible explanation for the result is that intensive competition increases banks' costs due to offering higher deposit rates (Craig and Dinger, 2013; Zaghdoudi *et al.*, 2016).

Another important finding is that there is a negative association between regulatory capital in one year and subsequent year risk-taking. The result highlights the importance of maintaining a larger regulatory capital base to discipline bank risk-taking behavior. This entails that higher regulatory capital restricts the "risk-return frontier of banks", consistently with the findings of (Belanes and Hajiba, 2012; Nguyen, 2013; Adesina and Mwamba, 2016). The result strengthens the idea that stringent regulatory capital acts as a "first loss absorber" and guards banks against default (Guidara *et al.*, 2013; Fratzscher *et al.*, 2016; Holod *et al.*, 2017). Additionally,

the finding is in accordance with the previous studies revealing that a higher level of regulatory capital improves banks' assets' quality,and stock market performance (e.g. Demirguc-Kunt *et al*., 2013; Bitar *et al*., 2016).

One of the most significant findings to emerge from this paper is that regulatory capital is an essential factor in explaining the association between bank competition and bank risk-taking. This result indicates that the interaction term in one year is negatively associated with subsequent year risk-taking. It supports the conceptual premise stating that larger regulatory capital lessens the positive association between bank competition in one year and bank risk-taking in the subsequent year. Such finding agrees with the studies concluding that a higher level of regulatory capital impedes highly competitive banks to undertake excessive risks, thus regulatory capital ensures more cautious bank behavior (e.g. Behr *et al*., 2010; Tabak *et al*., 2012). Tabak *et al.* (2012) find that the effective role of higher regulatory capital is evident for large banks only.

Overall, the findings are of interest to academics in this field and policymakers. The main contribution of this paper confirms that increased competition needs to be upheld with stronger capital regulations to maintain the financial stability of banks in Egypt. This entails that the recent initiative of the CBE to enhance bank competition appears to be a good step only when banks are maintaining larger regulatory capital. Additionally, optimal competition policies (such as deposit rate ceilings and restrictions on certain activities) can also be complementary tools to banking capital regulations to improve social welfare. Such social welfare is achieved through effective competition and financial stability at the same time. Most importantly, the paper supports the ongoing efforts of bank regulators and policymakers in reinforcing the regulations and reform programs of the financial sector in Egypt.

The generalizability of the results is subject to certain limitations. First, the sample comprises 27 Egyptian banks only due to the unavailability of data. Therefore, this study cannot generalize the results to the Egyptian banking system. Second, the study relies on the risk-weighted assets ratio, the Z-score, and the standard deviation of stock returns to capture bank risk-taking and does not take into consideration other proxies such as loan loss provision, the ratio of non-performing loans. Third, the study does not examine the validity of the long-run equilibrium market assumption while using the P&R model. Fourth, this study is limited to studying one element of corporate governance structure (bank ownership). Fifth, the study does not consider how the economic conditions (such as inflation rate and gross domestic product "GDP" growth rate) influence the behavior of banks towards risks. Finally, the study does not provide comparative studies.

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Appendix 1: Final sample of banks registered at the CBE

Number of Banks	Name of Banks	Classification	
		Listed or Un-listed Banks in the Egyptian Stock Exchange	**Ownership structure**
1	National Bank of Egypt (NBE)	Un-listed	Governmental
2	Banque Misr	Un-listed	Governmental
3	Banque Du Caire	Listed starting from February 2017	Governmental
4	Export Development Bank of Egypt (EBE)	Listed	Governmental
5	Housing and Development Bank (HDB)	Listed	Governmental
6	Commercial International Bank (CIB)	Listed	Non-Governmental
7	Qatar National Bank (QNB) Al Ahli	Listed	Non-Governmental
8	Credit Agricole Egypt	Listed	Non-Governmental
9	Union National Bank (UNB) Egypt	Listed	Non-Governmental
10	National Bank of Kuwait (NBK) Egypt	Listed	Non-Governmental
11	Egyptian Gulf (EG) Bank	Listed	Non-Governmental
12	Suez Canal Bank	Listed	Non-Governmental
13	Abu Dhabi Islamic Bank (ADIB)	Listed	Non-Governmental
14	Al Barka Bank	Listed	Non-Governmental
15	Faisal Islamic Bank of Egypt	Listed	Non-Governmental
16	Societe Arabe International Du Banque (SAIB)	Listed	Non-Governmental
17	Arab African International Bank (AAIB)	Un-Listed	Non-Governmental
18	HSBC Bank Egypt	Un-listed	Non-Governmental
19	Audi Bank	Un-listed	Non-Governmental
20	Emirates National Bank of Dubai (NBD) Egypt	Un-listed	Non-Governmental
21	Alex Bank	Un-listed	Non-Governmental
22	Blom Bank Egypt	Un-listed	Non-Governmental
23	Misr Iran Development Bank	Un-listed	Non-Governmental
24	Al Ahli Bank of Kuwait (ABK) Egypt	Un-listed	Non-Governmental
25	Arab Banking Corporation (ABC) Egypt	Un-listed	Non-Governmental
26	Arab Investment Bank (AIBK)	Un-listed	Non-Governmental
27	Arab International Bank (AIB)	Un-listed	Non-Governmental

Appendix 2: Summary of the Research Variables

Type	Variable	Measurement	Notation
Dependent variable	Bank risk-taking	Computed as the ratio of risk-weighted assets to average assets of bank i at year t	RWA_{it}
		Measured using the natural logarithm of the simplified Z-score of bank i at year t	$Z - SCORE_{it}$
		Calculated as the annualized standard deviation of monthly stock returns of bank i at year t	$STDV_{it}$
Independent variable	Bank competition	Computed using P&R model of bank i at year t-1	PR_{it-1}
	Regulatory capital	Regulatory capital ratio of bank i at year t-1	CAR_{it-1}
	Interaction term between bank competition and regulatory capital	Calculated by multiplying bank competition and regulatory capital of bank i at year t-1	$PR_{it-1} \times CAR_{it-1}$
Control variable	Size	Computed as the natural logarithm of total assets of bank i at year t-1	$SIZE_{it-1}$
	Profitability	Measured as the ratio of net income after taxes scaled by average assets of bank i at year t-1	$PROF_{it-1}$
	Leverage	Calculated as the ratio of total liabilities to total assets of bank i at year t-1	LEV_{it-1}
	Diversification	Computed as the ratio of non-interest income to the total income of bank i at year t-1	DIV_{it-1}
	Revolution	Represented by a dummy variable that equals one if the year is 2011, 2012 or 2013 and zero otherwise.	D_REV_{it-1}
	Bank ownership	Represented by a dummy variable that equals one if the banks are governmental and zero otherwise.	D_GOV_{it-1}