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How do banks make the trade-offs among risks? The role of corporate governance

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ABSTRACT

This study analyzes the role of corporate governance in the relationship among credit, interest rate, and liquidity risks encountered by banks. In particular, the study investigates how banks make the trade-offs among these risks under the maturity transformation business model. The sample consists of banks in 43 countries over the period of 2002–2010. Results show that credit, interest rate, and liquidity risks are related to one another, and that the interactions among them can be reduced by corporate governance and regulations. During the regular yield curve spread (YCS) period, management-controlled banks take less credit risk and even less liquidity risk whereas shareholder-controlled banks encounter more liquidity risk as they pursue more interest rate risk. During the inverted YCS period, management-controlled banks still opt for less credit risk-taking, but shareholder-controlled banks are greatly exposed to risks and should thus be monitored by concerned authorities.

1. Introduction

Banks mainly play the role of risk transformation to earn profits by issuing riskless deposits and liquid liabilities to finance risky illiquid assets or off-balance-sheet activities in the financial markets (Bryant, 1980; Diamond and Dybvig, 1983; Holmstrom and Tirole, 1998; Kashyap et al., 2002). However, this undertaking comes at the cost of increased risk. Banks often face or take various risks, such as credit, interest rate, or liquidity risks.[1] Although each of these risks may occur independently, they are often interdependent in reality. Insolvency risk is a consequence of one or more kinds of risk when the capital of a bank is driven to, or near to, zero because of losses incurred. The Material Loss Reports issued by the Federal Deposit Insurance Corporation on bank defaults prove that U.S. banks failed during the recent crisis because of loan loss, interest rate risk, and illiquidity. Some banks even failed because of the joint occurrence of credit, interest rate, and liquidity risks.

What is the relationship among credit, interest rate, and liquidity risks for banks? The Diamond-Dybvig framework (Diamond and Dybvig, 1983) implies that theoretically, credit risk is related to liquidity risk through borrower defaults and fund withdrawals. However, the empirical results obtained by Imbierowicz and Rauch (2014) show that these risks do not have an economically meaningful, reciprocal, contemporaneous, or time-lagged relationship for banks. Aside from liquidity risk, interest rate risk also causes the maturity mismatch of a bank in the banking book. According to Carling et al. (2007), interest rate changes influence the credit quality of assets. Drehmann et al. (2010) further prove that a risk assessment should jointly measure the integrated effect of credit and interest rate risks. Baldan et al. (2012) demonstrate that reducing a bank's liquidity risk would lower its interest rate risk. Even though the linkage of any two risk categories among credit, interest rate, and liquidity risks has been examined, no study has analyzed the relation among these risks in the banking sector. Consequently, many important questions regarding this topic remain unanswered, such as "What are the interactions among credit risk, interest rate risk, and liquidity risk for banks?" and "Which risk do banks take more when they face the trade-offs among these risks?"

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[1] Foreign exchange risk, market risk, off-balance-sheet risk, technology and operational risk or country risk are also incurred by a bank.

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Each bank adopts different risk management strategies. Some banks focus on the issue of credit risk (for an overview see Cole and Gunther, 1998; Logan, 2001), whereas others concentrate on liquidity risk exposure (for an overview see Diamond and Rajan, 2001; Berger and Bouwman, 2009). Moreover, some banks regard insolvency risk due to the change of interest rate as an important consideration (for an overview see Flannery, 1981; Flannery and James, 1984; Choi et al., 1992; Angbazo, 1997; Fraser et al., 2002). During the period of positive yield curve spreads (YCS), a bank may earn a huge amount of money from the spreads because it holds several long-term assets and short-term deposits when its maturity transformation from deposits to loans is great. In other words, a bank increases its profits by taking further interest rate risk, which in turn, reduces its insolvency risk. However, this strategy may increase the liquidity and credit risks of the bank. To alleviate these risks, banks could either hold a sufficient portion of liquid assets or choose high credit rating securities or customers although doing so could lower their profits. In times of tightening or inverting YCS, the transformation margins of banks narrow and even become negative. This occurrence forces a bank to make a decision, that is, to either accept the narrow spreads and lower their profits, even loss, or increase the volume of their maturity transformation. Either option poses a threat to banks. The first option may cause a bank to take further interest rate risk, resulting in insolvency, while the second option may induce a bank to approve loans from subprime rating borrowers, increasing their credit risk and illiquidity. How do banks deal with this kind of trade-off? What is the determinant of bank risk-taking?

The topic of bank risk-taking has been drawing the interest of regulators, bank managers, customers, and academics because of the high leverage and great opacity of banks, especially after the occurrence of a crisis. Although considerable literature cited several factors that could affect bank risk-taking, many aspects remained unresolved, for example, why were some financial institutions more affected than others during the global financial crisis? Substantial anecdotal evidence[2] from distressed financial institutions during the recent financial crisis reveals that corporate governance may affect bank risk-taking. The Organization for Economic Co-operation and Development (OECD) reports that "the financial crisis can be, to an important extent, attributed to failures and weakness in corporate governance arrangements" (Kirkpatrick, 2009). In other words, banks with poor governance may engage in excessive risk-taking, causing large losses during a crisis. Kashyap et al. (2008) suggest that governance problems in banks are at the core of the recent financial crisis, but the reforms are the results of cost-benefit trade-offs made by the corporate boards and shareholders. Therefore, improved bank governance could reduce bank fragility.

Corporate governance broadly refers to the mechanisms employed to address agency problems and control risks within the firm (Peni and Vähämaa, 2012). This concept largely falls into two categories: motivate and constraint mechanisms. Motivate mechanisms are related to firm executives and their compensation, whereas constraint mechanisms are based on the roles of shareholders or board of directors (hereafter referred to as "board" for brevity) of the firm. Some studies have tested the influence of corporate governance factors (e.g., incentive of managers, executive compensation, ownership structure, and board characteristics) on bank risk-taking. These studies obtained varying results, and they all focused on individual risk rather than the interactions among risks. Credit, liquidity, and interest rate risks may be interdependent with one another, and as such, banks should consider the joint occurrence of these risks in their risk management, which depends on their corporate governance. Therefore, the issue of whether and how corporate governance influences the trade-offs among various risks is worthy of further investigation. However, to the best of our knowledge, no research has looked into this topic in detail.

To fill this gap in the literature, we provide empirical evidence on the role of corporate governance in the relationship among credit, interest rate, and liquidity risks. In addition, we compare how banks deal with the trade-offs when they face such risks during the regular and inverted YCS periods. In this study, we do not only look into the firm-level governance mechanisms (e.g., roles of bank managers, shareholders, and boards), but also examine how the country-level regulations affect bank risk-taking while considering the integrated effects of credit, interest rate, and liquidity risks on banks. By employing the three-stage least squares method, we perform our investigation using data from banks across 43 countries over the period 2002–2010.

This study contributes to an emerging body of literature that attempts to identify the mechanisms affecting the relationship among credit, interest rate, and liquidity risks in two approaches. First, the existing studies on bank risk exposure have mostly focused on a single risk item or on the relation between any two risk categories. To our knowledge, the current study is among the first to examine the linkage among credit, interest rate, and liquidity risks using a global and long-term sample. Second, most papers about the interactions between risks either provide theoretical views or examine a hypothetical bank. Only a few studies control for the effects of bank-specific characteristics and the prevailing macroeconomic conditions. In comparison, our empirical models consider several corporate governance characteristics and regulations. This study is closely related to the works of Laeven and Levine (2009), Erkens et al. (2012), and Imbierowicz and Rauch (2014). Laeven and Levine (2009) were the first to analyze bank risk-taking, ownership structure, and national bank regulations, Erkens et al. (2012) investigated the influence of corporate governance on the performance of financial firms during the 2007–2008 financial crisis, and Imbierowicz and Rauch (2014) examined the relationship between liquidity and credit risks for all U.S. commercial banks from 1998 to 2010. We complement the findings of these previous studies by documenting whether and how corporate governance and regulations influence the risk-taking behaviors of banks when they face the trade-offs among credit, interest rate, and liquidity risks.

The empirical results of this study show that credit, interest rate, and liquidity risks are related to one another, and that the interactions among them could be reduced through corporate governance and regulations. During the regular YCS period, management-controlled banks take less credit risk and even less liquidity risk whereas shareholder-controlled banks are exposed to liquidity risk as they pursue several interest rate risks. During the inverted YCS period, management-controlled banks still take less credit risk, but shareholder-controlled banks are greatly exposed to risks and should thus be monitored by the authorities. The types of ultimate owner of banks also influence bank risk-taking. The impacts of the same capital regulations on bank's risk depends on each bank's governance characteristics.

The remainder of the paper is organized into six sections. Following the Introduction, Section 2 reviews the literature and provides the theoretical background for our analysis. Section 3 describes the sample, variables, and methodology. Section 4 explores and analyzes the empirical results. Section 5 addresses the robustness issues, and finally, Section 6 concludes the study.

[2] The New York Times Magazine on April 18, 2010 described Stan O'Neal, the chief executive of Merrill Lynch, as one of the "feckless dolts" who helped precipitate the financial crisis of 2007. Bear Stearns were determined to fail because of their increasing exposure to mortgage-backed assets and insufficient monitoring in the subprime mortgage crisis.

2. Theoretical background

2.1. The relationship among credit, interest rate and liquidity risks

Over the past 30–40 years, a considerable number of studies have looked into bank credit risk,[3] interest rate risk,[4] or liquidity risk[5] separately. In the classic financial intermediation theory, Diamond and Dybvig (1983) develop a theoretical model to show how banks' mix of illiquid (long maturity) assets and liquid (short-term) liabilities may lead to self-fulfilling panic among depositors, which may be manifested through borrower defaults and fund withdrawals. Holmstrom and Tirole (1998) and Kashyap et al. (2002) assert that this model does not only hold true for the balance sheet business of banks, but also for the lending and funding businesses conducted by off-balance sheet items. In particular, these researchers suggest that at least in theory, a relationship exists between credit and liquidity risks. Diamond and Rajan (2005) construct a model based on their earlier work (Diamond and Rajan, 2001) to argue that if many risky projects funded with loans are delayed, then a bank cannot meet the demand of its depositors. In this case, the bank can either increase the real interest rate of fresh deposits, sell late project loans, or call loans. However, if the asset values of the bank are reduced with the increase of the real rates, then many depositors of the bank will claim back their money. Therefore, a high credit risk is accompanied by high liquidity risk.

Meanwhile, Acharya and Viswanathan (2011) assume that financial firms raise short-term debts, which should be rolled over constantly to finance assets. These researchers argue that during a crisis, deteriorated asset values not only make it hard for financial firms to roll over debts, but they also lead to the exhaustion of market and funding liquidity. This result implies that the credit and liquidity risks faced by banks are related. However, Imbierowicz and Rauch (2014) show that a reliable direct interdependency does not exist between liquidity and credit risks. Each of the risk categories significantly increases banks' probability of default; however, the influence of their interaction depends on the overall level of risk and can either aggravate or mitigate default risk.

The maturity mismatch of a bank not only results in liquidity risk exposure, but also causes an interest rate risk in the banking book (Resti and Sironi, 2007). Although the literature has thoroughly debated on both liquidity and interest rate risks, only Baldan et al. (2012) have shed light on the integrated management of these risks. In particular, they demonstrate that when a bank reduces its liquidity risk, its interest margin is also reduced. In turn, this event decreases the amount of capital absorbed by the interest rate risk, indicating that liquidity risk is positively correlated with interest rate risk (Baldan et al., 2012).

Following credit risk, interest rate risk is the second most important risk for the capital adequacy or risk decomposition of banks (Basel Committee, 2006; IFRI-CRO, 2007; Kuritzkes and Schuermann, 2007). Despite this condition, only a few studies have collectively analyzed credit and interest rate risks. The work of Jarrow and Turnbull (2000) is the first to show how interest rate and credit risks can be integrated by using a factor modeling approach. Carling et al. (2007) argue that interest rate changes affect the credit quality of assets, while Drehmann et al. (2010) report that a risk assessment should measure the integrated effect of credit and interest rate risks by using a stress test judged by the economic value and capital adequacy of banks. The results obtained by Alessandri and Drehmann (2010) confirm that the interaction between credit and interest rate risks matters. The simulations of this previous study show that great interest rate risk exposure would increase the credit risk encountered by a bank, which borrows short and lends long at the beginning, because the yield curve shifts upwards and the asset prices worsen. Nevertheless, the bank can progressively reprise its exposures over time, thereby boosting its net interest income and offsetting the effects of high funding costs and high default rates. For this reason, when a bank ignores the integrated effects of such risks, this can lead to a risk overstatement.

Based on the assumptions and outcomes of the studies discussed in the preceding paragraphs, we present the following hypotheses concerning the relationship among credit, interest rate, and liquidity risks.

$\boldsymbol{H_1}$: A relationship exists among credit, interest rate, and liquidity risks.

H_{1a}: Credit and liquidity risks increase or decrease jointly.
H_{1b}: Liquidity and interest rate risks increase or decrease jointly.
H_{1c}: Interest rate and credit risks increase or decrease jointly.

2.2. The influence of corporate governance on bank risk-taking

From the theoretical perspective or based on the empirical results of previous studies, the relationship among credit, interest rate, and liquidity risks seems to be clearly established. The follow-up question then is "Which factor affects the choice of a bank when it faces the trade-offs among these risks?" Considering that the risk management of banks is ultimately the result of the cost-benefit trade-offs made by their corporate boards and shareholders (Kashyap et al., 2008), we draw on the literature in order to examine the influence of corporate governance on bank risk-taking, after which we formulate a testable hypothesis to resolve the above question.

The mechanisms of corporate governance include motivate and constraint mechanisms. Motivate mechanisms are related to the firm executives and their compensation. Several studies have examined how the risk-taking behaviors of banks are affected by the incentive of managers. Amihud and Lev (1981), Demsetz and Lehn (1985), Saunders et al. (1990), Hirshleifer and Thakor

[3] Most empirical studies examine the effects of accounting-, market-, or macroeconomic factors on bank credit risk. Kolari et al. (2002) and Kraft and Jankov (2005) demonstrate that bank credit risk is driven by low capitalization, low earnings, overexposure to certain types of loans, and low GDP. Aubuchon and Wheelock (2010) and DeYoung and Torna (2013) both focus on bank defaults during the recent financial crisis. These researchers identify that excessive investment banking activities, bad regional macroeconomic conditions, and heavy concentrations in commercial real estate loans substantially increase bank credit risk. Correspondingly, all these researchers prove that credit risk plays a crucial role for bank stability. Duffie and Singleton (2003) also provide an overview of credit risk pricing, measurement, and management.

[4] Concurrent literature has concentrated on analyzing the various approaches used to assess interest rate exposure of banks. These approaches can be classified into two types (i.e., current earnings or economic value perspective). The former is based on "gap management models" to control the variability of a bank's interest margin on a short-term time horizon, and its target variable is represented by the operating interest margin (Resti and Sironi, 2007). The latter is based on "financial models" to control the effects of variations in the interest rate on the global market value of a bank's financial assets and liabilities on a long-term time horizon, and its target variable is the market value of the bank's capital (Staikouras, 2006).

[5] Some studies have investigated the liquidity implications of a bank's maturity transformation function from a theoretical perspective (e.g., Goldstein and Pauzner, 2005; Wagner, 2007; Acharya et al., 2010). Goldstein and Pauzner (2005) provide a modified version of the model initially developed by Diamond and Dybvig (1983) to compute the ex ante probability of panic-based bank runs. These researchers determine that banks increase their overall welfare and construct a demand-deposit contract that trades off the benefits from liquidity against the costs of runs. Wagner (2007) reports that high asset liquidity causes banks to have an incentive to take on new risk that offsets the positive direct effect on their stability. As a result, an increased liquidity of bank assets paradoxically increases banking instability. Acharya et al. (2010) present an evidence that bank liquidity is countercyclical. In other words, bank liquidity is inefficiently low during economic booms, but is excessively high during crises because the gains from acquiring assets at fire-sale prices make it attractive for banks to hold liquid assets. Gatev et al. (2009) conduct an empirical study on liquidity risk and learn that transaction deposits help banks hedge liquidity risk from unused loan commitments, especially during the period of tight liquidity. Acharya and Mora (2015) argue that because of large support from the government and government-sponsored agencies, banks maintained their advantage as liquidity providers during the 2007 to 2009 crisis.

(1992), John et al. (2008), and Laeven and Levine (2009) show that bank managers are likely to be more risk-averse than shareholders because of career concerns and undiversifiable employment risk. Contrarily, Gorton and Rosen (1995) and Knopf and Teall (1996) empirically determine that, compared with shareholder-controlled banks, management-controlled banks tend to take riskier investments and those that make the least profit. With regard to executive compensation, Houston and James (1995) report that, in the 1980s, the bank CEO compensation policies did not encourage excessive risk-taking. John et al. (2000), Palia and Porter (2004), and Chen et al. (2006) assert that CEO compensation is negatively related to bank risk. In contrast, Balachandran et al. (2010), and Guo et al. (2015) believe that the relation between executive compensation and risk is positive and significant. Hence, no consensus has been reached in the literature.

The constraint mechanisms in corporate governance emphasize the degree to which the management is controlled by shareholders, and are thus related to the roles played by shareholders or boards. Several studies have examined the relationship between bank ownership structure and risk. The majority of the bank shareholders have a tendency to monitor and control the bank managers to protect their private benefits (Morck et al., 2005; Stulz, 2005) because they can hardly diversify their own holdings[6] (Shleifer and Vishny, 1986, 1997). Therefore, concentrated ownership may help control bank management. For large blockholders, the ability to control management seems to be empirically more important than to reduce the risk effect of insufficient diversification (Gropp and Köhler, 2010). However, the opacity of banks makes it difficult for the majority shareholders to intervene because their information costs are high (Kahn and Winton, 1998), thus further worsening the agency problems of banks. Levine (2004) clarifies that concentrated ownership is associated with high risk-taking, whereas dispersed ownership can reduce the risk. Gropp and Köhler (2010) state that, compared with the management-controlled banks, shareholder-controlled banks yielded higher profits in the years before the crisis, but incurred larger losses and required government assistance during the crisis. Contrarily, Iannotta et al. (2007) argue that banks with high ownership concentration have low asset and insolvency risks. Dispersed ownership and restrictions on shareholder rights in the form of voting and ownership ceilings cause a bank to be ineffectively monitored by its shareholders and disciplined by the market, and thereby leads a bank CEO to become powerful (Bechmann and Raaballe, 2010). In relation to this, improving shareholder rights may enable dispersed shareholders to control bank managers and change their degree of risk-taking (La Porta et al., 1998, 1999). Consequently, the effect of ownership concentration on bank risk-taking is ambiguous ex ante.

As regards the board characteristics, Pathan (2009) learns that for large U.S. bank holding companies, their strong boards,[7] which reflect the interests of shareholders, positively affect bank risk-taking because of the improved monitoring of managers (Jensen and Meckling, 1976; Merton, 1977). In contrast, the CEO power that controls board decisions negatively affects bank risk-taking because of risk aversion (Smith and Stulz, 1985; Pathan, 2009). In addition, increasing the outside directors of banks seems to be useful for monitoring the selfish behaviors of managers (Fama, 1980; Fama and Jensen, 1983) and increasing the survival rate of financial institutions during crisis (Byrd et al., 2001). However, Erkens et al. (2012) find that firms with more independent boards experienced worse stock returns during the crisis period because they raised more equity capital and thereby resulted in a wealth transfer from existing shareholders to debtholders.

According to the studies discussed above, banks can be classified into owner- and manager-controlled banks through a set of corporate governance variables related to shareholders and management. A manager-controlled bank tends to have dispersed ownership and a large-sized board, whereas an owner-controlled bank is inclined to have concentrated ownership, a small board, and numerous independent directors. If a bank is largely managed by its shareholders, it may suffer from increased risk-taking. However, when a bank is weakly controlled by its shareholders, it would face reduced risks.

During the period of positive YCS, a bank can earn a huge amount of profit from the YCS because it holds several long-term assets and short-term deposits when its maturity transformation from deposits to loans is great. In other words, a bank increases its profits by taking further interest rate risk, which in turn, reduces its insolvency risk. Nevertheless, this strategy may be accompanied by increased liquidity and credit risks. To alleviate these risks, banks could either hold a sufficient portion of liquid assets or choose high credit rating securities or customers, although doing so could reduce their profits. Compared with an owner-controlled bank, a manager-controlled bank may adjust the composition of its assets and liabilities to avoid taking numerous credit and liquidity risks because of career concerns and undiversifiable employment risks.

In times of tightening or inverting YCS, the transformation margins of banks narrow and even become negative at some point. The banks that are insufficiently or improperly hedged will lose money in the process because their short-term liabilities become costlier than their long-term assets. These banks also face a dilemma as to whether they should accept narrow spreads and lower profits, even loss, or increase the volume of their maturity transformation. The former option may cause banks to experience insolvency, whereas the latter may induce banks to increase their credit risk and illiquidity. A manager-controlled bank may struggle for volume effects to obtain high short-term profits; it may also take additional credit and liquidity risks because of bonus payments that have to be issued at the end of the year. Therefore, the risk appetite, volume of maturity transformation, and no hedging due to cost of these banks may be stronger than those of the owner-controlled ones. Consequently, the amount of maturity transformation and the risk hedging of banks may depend on their corporate governance structures. Based on such information, we present the following hypotheses.

H₂: Corporate governance affects the trade-offs among risks.

H_{2a}: During the period of positive YCS, a manager-controlled bank avoids taking more credit and liquidity risks than a shareholder-controlled bank.

H_{2b}: During the period of tightening or inverting YCS, a manager-controlled bank broadens the volume of its maturity transformation and takes more credit and liquidity risks than a shareholder-controlled bank.

3. Data and empirical design

3.1. Sample and data source

The data for this study are collected from banks in 43 countries from 2002 to 2010. The sample countries consist of Taiwan and the G20 countries, including all European Union (EU) countries at the end of 2010. The main reason for taking this sample is the fact that, although the G20 economies account for approximately 85% of the gross world product and two-thirds of the world population, not all EU countries are among the top 20 economies in the world.[8]

[6] However, the majority of shareholders may often gain their private interests by sacrificing the benefits of the minority ones.

[7] Strong bank boards have small board size, numerous independent directors, and non-restrictive shareholder rights.

[8] These data are measured with the gross domestic product (GDP) at purchasing-power-parity (PPP) rates by the Intrnational Monetary Fund (IMF).

Taiwan has been ranked among the top 20 economies[9] in the world since 2002, but it does not belong to any international forum group because of political reasons. Still, we infer that the risk-taking behaviors of banks located in the above countries greatly influence the global economy and financial system.

Our sample period is set from 2002 to 2010 because the economic boom or recession may have changed the term structure of yield curve, thus affecting banks' risk-taking behaviors. The IMF regarded 2002 as the global recovery period from the downturns in 2000 to 2001 (IMF, 2002). However, the U.S. subprime mortgage crisis has led to the global recession and contributed to the European sovereign debt crisis.[10] In 2010, the European debt crisis was temporarily controlled through sovereign bailout programs,[11] which were provided jointly by the IMF, the European Commission (EC), and the European Central Bank (ECB). Therefore, we end our investigation period in 2010 and further examine whether the risk-taking behaviors of banks are different when they face different YCS in this period.

Our sample consists of 1604 banks across 43 countries. Among these banks, only 701 were listed at the end of December 2010; the others were either unlisted or delisted. We divide the banks by specialization based on *Bankscope* and came up with the following numbers: 399 bank holding companies, 998 commercial banks, 134 cooperative banks, and 73 savings banks. A set of criteria is adopted for the data collection. First, we restrict our sample to bank holding companies, commercial banks, and cooperative and savings banks covered by *Bankscope*. These banks commonly play the role of risk transformation by dealing with deposits and loans for individuals or businesses. Considering this criterion, we have 25,373 banks. Second, we exclude a bank from our sample if it has (1) no outstanding loans and (2) zero deposits, thus reducing our sample to 17,388 banks. Third, to perform the cross-country analysis and avoid data overlapping, we use consolidated financial statements for parent banks and exclude their subsidiaries from the sample.[12] Only 3203 banks meet this criterion. Although *Bankscope* provides information on annual financial statement and governance characteristics, some data about asset quality, maturity, ownership, and board structure are not available for some unlisted banks. Finally, we remove from our sample a total of 1599 banks that do not have necessary data on risk categories and governance characteristics.

Among the sample banks, 398 are from the U.S., 434 are from Europe, 405 are from Russia, and 367 are from other regions/countries. Hence, the sample is relatively balanced in different regions.[13] Although our sample represents only a small fraction of the number of banks covered by *Bankscope*, it is economically important and represents 70.51% of the aggregate banking industry assets on average.[14] Our sample contains 8663 bank-year observations (i.e., 2527 for large banks, 4236 for medium banks, and 1900 for small banks).[15] In addition, we do not exclude the banks that are involved in mergers and acquisitions, liquidation, or failures during our observation period because of two reasons. First, we could observe the effects of mergers on bank risk-taking for acquiring banks. Second, prior to liquidation, failures or becoming targets, these banks are treated as normal banks to lessen the survivorship bias. Therefore, 172 banks have a merger status in the lagged year, and 41 banks do not survive continuously during or after the sample period.[16]

To classify the whole period into regular and inverse YCS, this study uses the treasury bill and treasury bond rates provided by the *International Financial Statistics* database of the IMF and the statistical database of the OECD. For robustness tests, we divide this time period into two, namely, pre-financial crisis period as well as during and post-financial crisis period.[17] This setup allows us to account for a possible substantial shock. We also split the sample countries into developed and developing economies according to the classification of the World Bank.[18] Table 1 provides an overview of all the countries included in our sample, specifically the sample distribution, period classification, and whether each country is classified as developed or developing.

3.2. Risk proxy variables

This study aims to investigate the role of corporate governance in the relationship among credit, interest rate, and liquidity risks. Furthermore, this study intends to compare how banks deal with the trade-offs when they face these risks during the regular and inverted YCS periods. Three main variables are used to measure bank risk.

(1) Credit risk (CR): non-performing loans (NPL) ratio[19] is a timely source of information about loan default (Liu and Ryan, 2006) because most banks are required to disclose it. Wahlen (1994) and Fonseca and González (2008) report that

[9] Iran is also among the top 20 economies worldwide since 2002, but it is not included in our sample because all banks in Iran provided by *Bankscope* are Islamic banks with different operating procedures from other types of banks. Islamic banks adhere to the concepts of Islamic law, and all their banking activities must avoid interest, a concept that is forbidden in Islam. Instead, Islamic banks earn profit and fees on the financing facilities that they extend to their customers.

[10] Since the beginning of 2010, the Euro region has faced a severe sovereign debt crisis because of the overly high government deficits and debt levels.

[11] In May 2010, the EC, ECB, and IMF agreed with the Greek government to take out a three-year €110 billion bailout loan. The European Financial Stability Facility (EFSF) was then established to provide financial assistance to eurozone states in difficulty. A financial safety net up to €750 billion was composed of €440 billion lending capacity from EFSF, loans up to €60 billion from the European Financial Stabilisation Mechanism (EFSM), which is reliant on funds raised by the EC using the EU budget as collateral, and up to €250 billion from the IMF. In November 2010, Ireland obtained a €85 billion rescue deal, which was made up of €67.5 billion from the EFSF, EFSM, and IMF.

[12] If the consolidated financial statements for parent banks are not obtained, then we use the unconsolidated financial statements for these banks and their subsidiaries.

[13] We also examine whether geographical differences exist for the U.S., the Europe, the Russian and other regions. The results support our main analyses.

[14] In some countries, the top 3 banks may be owned by another foreign parent banks. For instance, in Estonia, the total market share of the top 2 banks (i.e. Swedbank AS and SEB Pank) by total assets in 2010 is 97.15% according to *Bankscope*. But both of their owners are the Swedish banks. Based on using consolidated financial statements of parent banks, the top 2 banks in Estonia become the subsidiaries of the parent banks in Sweden and are excluded from our sample. As a result, the market share of our sample banks in Estonia is reduced to 2.85% while that in Sweden is increased to more than 100% as the banking industry assets are calculated by unconsolidated financial statements of all banks in each country. Hence, we disclose the representativeness of our sample banks from the overall view rather than a country view.

[15] We use the 25th and the 75th percentile of total assets of this sample as the threshold to divide all banks into small, medium, and large banks. The size classification of some banks will be changed due to asset growth or mergers.

[16] Among these banks, 19 were acquired, three went into liquidation, and four defaulted during the sample period. In 2011, 14 banks were acquired, and one bank went into liquidation. Note that if a subsidiary of a sample parent bank was acquired, we could not obtain this information because *Bankscope* does not disclose it in the history of the parent bank. Hence, we will record a bank as a target bank only a sample parent bank was acquired. On the other hand, if a sample parent bank acquired another bank (i.e. an independent bank or a subsidiary of another (sample) parent bank), we will obtain this information and regard this event as a merger. The above cases are also applied to bank liquidation and failures.

[17] Ryan (2008) reports that the market first realized the severity of the losses related to subprime mortgage from 2007. Therefore, we split the whole sample period by 2007. The period before 2007 is defined as the pre-financial crisis period, and the other is during and post-financial crisis period. The number of banks in the period subsample is different due to bank establishment, mergers, or failures.

[18] Some countries such as Czech, Estonia, Hungary, Latvia, Poland, Saudi Arabia, and Slovakia are classified as developed countries since or during a certain year.

[19] Non-performing loans are loans that are 90 days or more past due. Many German banks in *Bankscope* do not report their loan quality information; thus, only six of them are included in our sample. We do not further collect the loan quality information from other database to avoid different definition.

Table 1
Sample covered.

	Country	Developed Economies	N of banks	Regular YCS Period	Inverted YCS Period		Country	Developed Economies	N of banks	Regular YCS Period	Inverted YCS Period
1.	Argentina	0	22	NA	NA	23.	Korea Rep. of	1	5	2001 ~ 2007, 2009 ~ 2010	2008
2.	Australia	1	9	2001 ~ 2004, 2009 ~ 2010	2005 ~ 2008	24.	Latvia	1 (2009)	12	2001 ~ 2005, 2010	2006 ~ 2009
3.	Austria	1	9	2001 ~ 2007, 2009 ~ 2010	2008	25.	Lithuania	0	5	2001 ~ 2010	
4.	Belgium	1	4	2001 ~ 2007, 2009 ~ 2010	2008	26.	Luxembourg	1	2	2001 ~ 2006	NA
5.	Brazil	0	39	NA	NA	27.	Malta	1	2	2001 ~ 2007, 2009 ~ 2010	2008
6.	Bulgaria	0	9	2001 ~ 2010		28.	Mexico	0	16	2002 ~ 2004, 2006, 2008 ~ 2010	2001, 2005, 2007
7.	Canada	1	17	2001 ~ 2006, 2008 ~ 2010	2007	29.	Netherlands	1	12	2001 ~ 2007, 2009 ~ 2010	2008
8.	China	0	55	NA	NA	30.	Poland	1 (2009~)	5	2003 ~ 2007, 2009 ~ 2010	2001 ~ 2002, 2008
9.	Cyprus	1	5	2001 ~ 2010		31.	Portugal	1	12	2001 ~ 2007, 2009 ~ 2010	2008
10.	Czech Republic	1 (2006~)	6	2001 ~ 2010		32.	Romania	0	3	2006 ~ 2007, 2010	2008 ~ 2009
11.	Denmark	1	28	2001 ~ 2006, 2009 ~ 2010	2007 ~ 2008	33.	Russian Federation	0	405	2001 ~ 2007, 2010	2008 ~ 2009
12.	Estonia	1 (2006~)	3	2001 ~ 2007, 2009 ~ 2010	2008	34.	Saudi Arabia	1 (2004~)	9	NA	NA
13.	Finland	1	2	2001 ~ 2007, 2009 ~ 2010	2008	35.	Slovakia	1 (2007~)	3	2001, 2004 ~ 2010	2002 ~ 2003
14.	France	1	68	2001 ~ 2007, 2009 ~ 2010	2008	36.	Slovenia	1	8	2004, 2006 ~ 2007, 2009 ~ 2010	2003, 2005, 2008
15.	Germany	1	6	2001 ~ 2006, 2009 ~ 2010	2007 ~ 2008	37.	South Africa	0	10	2001 ~ 2002, 2004 ~ 2006, 2009 ~ 2010	2003, 2007 ~ 2008
16.	Greece	1	12	2001 ~ 2007, 2009 ~ 2010	2008	38.	Spain	1	20	2001 ~ 2007, 2009 ~ 2010	2008
17.	Hungary	1 (2007~)	1	2006, 2009 ~ 2010	2001 ~ 2005, 2007 ~ 2008	39.	Sweden	1	14	2001 ~ 2007, 2009 ~ 2010	2008
18.	India	0	31	NA	NA	40.	Taiwan	1	33	2001 ~ 2005, 2008 ~ 2010	2006 ~ 2007
19.	Indonesia	0	27	NA	NA	41.	Turkey	0	16	NA	NA
20.	Ireland	1	5	2001 ~ 2007, 2009 ~ 2010	2008	42.	United Kingdom	1	33	2002 ~ 2004, 2009 ~ 2010	2001, 2005–2008
21.	Italy	1	129	2001 ~ 2010		43.	United States	1	398	2001 ~ 2005, 2008 ~ 2010	2006 ~ 2007
22.	Japan	1	94	2001 ~ 2010							

This table lists the 1604 banks in 43 countries included in our sample. It indicates for each country whether the country is classified as developed (=1) or developing (=0) economies according to the classification of the World Bank. If this country is not always classified as a developed economy during the sample period, the year(s) during which it holds such classification will be listed in parenthesis. The period of regular YCS and that of inverted YCS in some countries cannot be distinguished because of lack of both/either T-bill and T-bonds data.
Source: *IFS* database of the IMF, the OECD, the World Bank and the authors.

high NPL is associated with low loan quality. Cole and Gunther (1998), Logan (2001), and Bennett and Unal (2010) use the indicators on the bank balance sheet (e.g., capitalization or NPL ratio) to predict the probability of bankruptcy. Accordingly, we adopt the NPL ratio as our main credit risk proxy. This variable is assumed to be positively related to whether a bank subsequently fails, that is, when the value of this ratio is large, the bank faces great credit risk. We also include the LLP and NCO measures, which are discussed in the robustness checks.

(2) Interest rate risk (IR): reprising mismatches between assets and liabilities is one of the most important sources of interest rate risk. This risk can either be measured with the earnings at risk (EaR) or through an economic value approach. EaR is a measure that assesses the effects of the interest rate shocks on the net interest income of banks. The economic value approach measures the effects of shocks on the value of assets and liabilities. Flannery (1981), Flannery and James (1984), Choi et al. (1992), Angbazo (1997), and Fraser et al. (2002) analyze the effects of interest rate changes on the operation of a bank. In particular, these researchers report that banks strongly depend on the YCS if they focus on maturity transformation-type businesses. We follow the traditional EaR approach[20] and use the ratio of cumulative one-year repricing gap[21] (CGAP) to total assets, CGAP_A, to measure interest rate risk. This method is commonly used in the banking industry and for regulatory purposes (see Basel Committee, 2008) though an economic value perspective could capture the market value effects as interest rates change. From maturity transformation perspective, a bank is exposed to refinancing risk by holding longer-term assets relative to liabilities while it is exposed to reinvestment risk by holding shorter-term assets relative to liabilities. Moreover, according to the unbiased expectations theory, a upward-sloping yield curve reflects the market's expectation of rising short-term interest rates in the future while a downward-sloping yield curve reveals the market's expectation that short-term rates will drop in the future. Thus, a bank would want its CGAP to be positive (negative) when interest rates are expected to rise (fall). We assume that banks

[20] We do not use an economic value approach because our dataset includes unlisted banks whose market values cannot be captured.

[21] The repricing gap is the difference between assets whose interest rates will be repriced or changed over some future period (rate-sensitive assets, RSAs) and liabilities whose interest rates will be repriced or changed over some future period (rate-sensitive liabilities, RSLs).

are exposed to interest rate risk if their CGAP_A ratio is not equal to zero. During positive YCS period, a bank will generate great profits from their large maturity transformation derived from positive YCS and positive CGAP effects originated from expected rising short-term rate. To increase a positive CGAP_A ratio would reduce bank's insolvency risk. During tight or inverted YCS period, a positive CGAP_A ratio may further cause a bank's profits to be worsen because of expected declining short-term rate when a bank's maturity transformation margins narrow even become negative. Hence, to improve a bank's profit is to enlarge an absolute negative CGAP_A ratio.

(3) Liquidity risk (LR): Banks issue riskless deposits and liquid liabilities to finance risky illiquid assets (Bryant, 1980 and Diamond and Dybvig, 1983) or off-balance-sheet activities such as loan commitment (Holmstrom and Tirole, 1998 and Kashyap et al., 2002) to create liquidity for the economy. In other words, banks are pools of liquidity which provide long-term availability of cash to borrowers and short-term availability of cash to depositors. Excessive liquidity creation can lead to financial fragility (Diamond and Rajan, 2001; Berger and Bouwman, 2009). Berger and Bouwman (2008) also find that banking crises were preceded by positive abnormal[22] liquidity creation, whereas the market-related crises were generally preceded by negative abnormal liquidity creation. Hence, a high amount of liquidity creation is associated with high liquidity risk for a bank. Deep and Schaefer (2004) are the first to measure bank liquidity creation by constructing a measure of liquidity transformation gap[23] (LT gap). Correspondingly, Deep and Schaefer (2004) show that the 200 largest U.S. banks failed to create substantial liquidity from 1997 to 2001.[24] Meanwhile, instead of using the maturity category proposed by Deep and Schaefer (2004), Berger and Bouwman (2008, 2009) use the product category to classify all bank assets, liabilities, equity, and off-balance sheet activities as liquid, semi-liquid, or illiquid according to ease, cost, and time for the banks or customers and to estimate the amount of bank liquidity creation.[25] This measure is the preferred index[26] of Berger and Bouwman (2009), who also identify that the U.S. bank liquidity creation increased annually, even exceeding $5.7 trillion in the early 2008. Imbierowicz and Rauch (2014) further use the calculated liquidity values in U.S. dollars provided by Berger and Bouwman normalized by a bank's total assets as their liquidity risk proxy. Given that the current study performs a cross-country analysis, we need to calculate the value of liquidity creation rather than use the Berger's and Bouwman's publicly available dataset[27]. Similarly, the dollar amount of bank liquidity creation is normalized by a bank's total assets.[28] We use this ratio (LC_A) as our liquidity risk proxy. The Basel Committee on Banking Supervision of the Bank for International Settlement (BIS) developed two new liquidity ratios, liquidity coverage ratio (LCR) and the net stable funds ratio (NSFR), for liquidity risk supervision. These ratios are included in the robustness checks and are discussed in the latter part of the paper.

3.3. Internal corporate governance mechanisms

Four types of corporate governance characteristics are listed below.

3.3.1. Ownership structure

We use two variables to reflect the ownership structure, namely, shareholder independence (IND_S) and the degree of ownership concentration (OC). Shareholder independence (IND_S) is measured by BvD independence indicators in *Bankscope*. These indicators include A, B, C, D, and U,[29] which are further signified by "+" or "−"[30] to denote their degree of reliability. This study assigns the values 4, 3, 2, and 1 to A, B, C and D, respectively, according to their definitions. When shareholders of a bank have a high degree of independence, the bank exhibits a high degree of separation between ownership and control, making it a management-controlled bank. Several studies argue that bank managers are inclined to be risk averse because of career concerns and undiversifiable employment risk (e.g., Amihud and Lev, 1981; Saunders et al., 1990; Hirshleifer and Thakor, 1992; John et al., 2008; Laeven and Levine, 2009). However, Demsetz and Lehn (1985), Gorton and Rosen (1995), Knopf and Teall (1996), and Esty (1998) report that management-controlled banks take riskier investments because of managerial entrenchment effects based on corporate control considerations. No consensus has been reached, so we intend to examine the relationship between shareholder independence and bank

[22] Abnormal is based on a time trend and seasonal factors.

[23] Liquidity transformation gap is equal to (liquid liabilities – liquid assets)/total assets. According to Deep and Schaefer (2004), all loans with a maturity period of one year or less are considered to be liquid, excluding loan commitments and other off-balance sheet activities because of their contingent nature.

[24] The LT gap is nearly 20% of the total assets on average.

[25] Berger and Bouwman (2009) perform a three-step procedure to estimate the amount of bank liquidity creation. The first step is classification using product category. In step 2, the researchers assign weights equal to 1/2, 0, and −1/2 to liquid, semi-liquid, and illiquid liabilities plus equity, respectively. Moreover, these researchers assign weights equal to −1/2, 0, and 1/2 to liquid, semi-liquid, and illiquid assets, respectively, and they apply the same principle to off-balance sheet activities that is consistent with the functional similarities to on-balance sheet items discussed in step 1. This procedure is consistent with the theory, which holds that maximum liquidity is created when liquid liabilities are used to finance illiquid assets, and maximum liquidity is destroyed when illiquid liabilities or equity are used to finance liquid assets. In step 3, the researchers combine the activities classified in step 1and subsequently weighted in step 2 to calculate the amount of liquidity creation. In the robustness issues of Berger and Bouwman (2009), they use a different weight to measure off-balance sheet liquidity creation and an alternative way to classify loans, respectively. The results show that both patterns of liquidity creation are fairly similar to their preferred index pattern.

[26] Berger and Bouwman (2009) consider this measure (named as "cat fat" by Berger and Bouwman (2009)) to be the preferred index because it captures the ease, cost, and time for banks to dispose of their assets to obtain liquid funds and takes account of liquidity supply function of off-balance-sheet activities.

[27] Note that some of the on-balance-sheet and off-balance-sheet items are not the same because the data of this study are collected from *Bankscope* , whereas those employed by Berger and Bouwman (2009) come from *Call Reports*. We follow the same principles and concepts of liquidity creation to evaluate each item for all bank activities. Liquidity classification of bank activities is listed in Appendix 1. Additionally, off-balance-sheet items recorded in *Bankscope* mostly consist of financial guarantees (e.g. loan commitments) and financial derivatives are accidentally included though we focus on the notional values of guarantees and the gross fair values of derivatives. Hence, the measure of this study may overstate liquidity creation.

[28] This method could render the amount of liquidity creation meaningful and comparable across banks and avoid assigning undue weight to the largest institutions.

[29] Note that the three types of shareholders are "public," "unnamed private shareholders (aggregated)," and "other unnamed shareholders (aggregated)" in *Bankscope* are excluded because they are considered unable to exert control over a company. "A" indicates that no known or recorded shareholders of a company have more than 25% of direct or total ownership, that is, A companies are classified as independent companies. "B" implies that one or more shareholders of a company has/have an ownership exceeding 25%. However, no known or recorded shareholders have direct or total ownership of more than 50%. "C" means that a recorded shareholder of a company has a total or a calculated total ownership exceeding 50%. Similarly, a C company has an ultimate owner, whether or not the percentage of its ownership is unknown. "D" indicates that a recorded shareholder of a company has a direct ownership of more than 50%. Finally, "U" is assigned to companies that are not categorized as A, B, C or D, indicating an unknown degree of independence. Therefore, these companies have been excluded from the sample.

[30] The "+" notation is assigned to a company with six or more identified shareholders whose ownership percentages are known. Alternatively, the "-" notation is assigned to a company with one to three identified shareholders, whose ownership/s percentage is/are known, or a company that is the ultimate owner of another company even when its shareholders are not mentioned.

risk-taking. We expect a positive (negative) coefficient of this variable in the regression model to imply that a management-controlled bank tends to take more (less) risks.

The degree of ownership concentration (OC) refers to "the maximum of the direct or total shareholding for a shareholder." Shareholders typically have a larger incentive to increase their risk-taking than managers and debtholders. Moreover, majority shareholders are more likely to monitor and control managers than minority shareholders, thus inducing managers to increase their risk-taking behaviors (Shleifer and Vishny, 1986; Morck et al., 2005; Stulz, 2005). Therefore, banks with a high degree of ownership concentration tend to be shareholder-controlled banks, and are thus expected to take more risks.

3.3.2. Board structure

The effectiveness of a board in monitoring its managers and limiting their opportunistic behaviors depends on board size (Board) and board independence (IND_B). Strong bank boards that reflect most of the bank shareholders' interests positively affect bank risk-taking (Jensen and Meckling, 1976; Merton, 1977; Pathan, 2009). Board size (Board) refers to the number of directors on the board. Cheng (2008) suggests that a larger board is less efficient and slower in decision-making because arranging meetings and reaching a consensus are more difficult for the board. An individual director's incentive to acquire information and monitor managers is low in a large board; therefore, the CEO can easily dominate the board and increase his or her decision-making power (Jensen, 1993; Cheng, 2008). This finding is consistent with the argument of Smith and Stulz (1985) that controlling board decisions by CEO power negatively affects bank risk-taking because of risk aversion. Hence, board size can affect bank risk-taking.

In a one-tier board (e.g., UK and U.S.), all of the directors, including executive and non-executive directors (i.e., independent or outside directors) form the board of directors. Independent directors can monitor managers well if they prioritize maintaining reputation in directorship market. Numerous studies indicate that firms have better stock returns and operating performance when their independent directors hold a significant number of board seats (e.g., Rosenstein and Wyatt, 1990; Byrd and Hickman, 1992; Cornett et al., 2008; Ravina and Sapienza, 2010). Evidence suggests that a higher number of independent directors results in better monitoring. However, in a two-tier board (e.g., Germany, China, Taiwan, and certain continental European countries) the supervisory boards resemble a board that consists of all non-executive directors. They are responsible for promoting their shareholders' interests by monitoring the executive directors and managers. Thus, board independence (IND_B) is measured by the percentage of independent board members. A high level of board independence is associated with boards that can presumably monitor and control managers well. We expect that a bank with a smaller board or a higher degree of board independence tends to be a shareholder-controlled bank and takes more risks because of a strong board.

3.3.3. CEO duality (Dual)

If the CEO is also the chairman of the board, this dummy variable equals one, and zero otherwise. Chairmen exert a tremendous amount of control over the operating business of a bank, which is run by the officers. When a bank's CEO is also its major supervisor, an important control tool for principal-agent conflicts is lost, and thus, such bank has a low degree of separation between ownership and control, making it a shareholder-controlled bank. Moreover, when the CEO of a bank is also the chairman of the board, we expect the bank to take more risks.

3.3.4. Ultimate owner

We classify the ultimate owner of a bank into four types: state (U_S), bank (U_B), enterprise (U_E), and others. Three dummy variables (i.e., U_S, U_B, U_E) are used in this study. La Porta et al. (1999) provide a pioneer contribution through their investigation to identify the ultimate owners of corporations from the 27 richest countries. Claessens et al. (1999, 2000) follow the method of La Porta et al. (1999) to explore ownership structures in nine East Asian countries. However, these studies do not discuss the effect of the type of the ultimate owner on bank risk-taking. Compared with a bank that is ultimately owned by an enterprise, a bank that is ultimately owned by the government or bank is expected to take fewer risks owing to regulatory constraints. Therefore, a positive (negative) coefficient of each dummy variable means a bank with such ultimate owner is inclined to take more (less) risks.

3.4. Regulations

Prowse (1997), Macey and O'Hara (2003), and Levine (2004) argue that principal-agent problems may be more severe in the banking sector than in other sectors because of the high level of regulation. Existing management tends to be protected by banking regulations upon entry and during mergers, takeovers, and administrative rule changes (Cheng et al., 1989; Prowse, 1997). This situation may restrict the ability of the market for corporate control to discipline banks (Prowse, 1995), and hostile takeovers in numerous countries are explicitly discouraged. In addition, deposit insurance may aggravate agency problems because it increases the incentive of shareholders to engage in excessive risk taking (Prowse, 1997; Macey and O'Hara, 2003). However, Laeven and Levine (2009) demonstrate that bank risk-taking varies positively with the comparative power of shareholders within the corporate governance structure of each bank. Stricter capital regulations are associated with greater risk when a bank has a sufficiently powerful owner, but such regulations tend to have the opposite effect in widely held banks. Hence, the same regulation can have different effects on bank risk-taking depending on the bank's corporate governance structure. Gropp and Köhler (2010) also reveal that regulation does not seem to mitigate risk-taking by bank owners.

To investigate the relationship between bank risk-taking and regulations, this study further adds three regulation indicators to the main empirical model.

(1). Deposit insurance (DI)

This dummy variable equals one if a country has explicit deposit insurance and zero otherwise (Demirgüç-Kunt et al., 2005). From a moral hazard perspective, deposit insurance intensifies the incentive of stockholders to increase their risk-taking (Merton, 1977; Keeley, 1990). Hence, we expect a bank in a country with deposit insurance to take more risks.

(2). Capital regulations (Capital)[31]

Capital regulations is an index of regulatory oversight of bank capital from the *Bank Regulation and Supervision* database provided

[31] During the sample period, the main regulatory changes for our sample countries are Basel Agreement (Basel). In 2001, the BIS issued a Consultative Document, "The New Basel Capital Accord," that proposed the incorporation of operational risk into capital requirements and updated the credit risk assessments in the Basel I. Basel II that was implemented in the years prior to 2008 consisted of three mutually reinforcing pillars which contribute to the safety and soundness of the financial system. Basel 2.5 that updated capital requirements on market risk from banks' trading operations was passed in 2009 (effective in 2013) to improve the weaknesses with Basel II. Basel III was passed in 2010 (fully effectively in 2019) and it's goal is to raise the quality, consistency, and transparency of the capital base of banks to withstand credit risk and to strengthen the risk coverage of the capital framework. We use this capital regulations index provided by World Bank to capture regulatory changes in capital requirements.

by the World Bank. It released in 2001 and updated in 2003, 2007, and 2012 respectively to capture regulatory changes in capital requirements. This index provides information on whether the source of funds that count as capital can include assets other than cash, government securities, or borrowed funds and whether the authorities verify the sources of capital. Such an index, whose values range from 0 to 9, also include information on the extent of the regulatory requirements regarding the amount of capital that banks must hold. Higher values indicate greater stringency. To induce prudent risk-taking, capital regulations require bank owners to increase the amount of capital as a bank's assets become riskier. Nevertheless, binding capital regulations reduce the utility of owning a bank, and in response, bank owners may seek to increase risk-taking (Koehn and Santomero, 1980; Buser et al., 1981). We expect a bank in a country with strict capital regulations to take more risks.

(3). Shareholder rights (SR)

We use an anti-director index that aggregates shareholder rights to measure legal protections of investors (Caprio et al., 2007; Laeven and Levine, 2009). The index, whose values range from 0 to 6 (where the higher values represent greater shareholder rights), is calculated by La Porta et al. (1999). Gropp and Köhler (2010) report that stronger shareholder rights enable dispersed shareholders to exercise better control over management. Thus, minority shareholders also have incentive to increase risk-taking. We expect a bank in a country with better shareholder protection to take greater risks.

All of the variables are described in detail in Table 2.

3.5. Methodology

Credit, interest rate, and liquidity risks may interrelate simultaneously; hence, we employ a structural equation approach in which a system of equations is estimated via generalized least squares:

$$CR_{i,j,t} = \alpha_{1i,j} + \beta_1' CR_{i,j,t-1} + \beta_2' IR_{i,j,t} + \beta_3' LR_{i,j,t} + \beta_4' Merger_{i,j,t-1} + \eta_1' Governance_{i,j,t-1} + \gamma_1' X_{i,j,t-1} + \varepsilon_{1i,j,t} \quad (1.1)$$

$$IR_{i,j,t} = \alpha_{2i,j} + \delta_1' IR_{i,j,t-1} + \delta_2' CR_{i,j,t} + \delta_3' LR_{i,j,t} + \delta_4' Merger_{i,j,t-1} + \eta_2' Governance_{i,j,t-1} + \gamma_2' X_{i,j,t-1} + \varepsilon_{2i,j,t} \quad (1.2)$$

$$LR_{i,j,t} = \alpha_{3i,j} + \lambda_1' LR_{i,j,t-1} + \lambda_2' CR_{i,j,t} + \lambda_3' IR_{i,j,t} + \lambda_4' Merger_{i,j,t-1} + \eta_3' Governance_{i,j,t-1} + \gamma_3' X_{i,j,t-1} + \varepsilon_{3i,j,t} \quad (1.3)$$

where $i = 1,2,\ldots, n$, $j = 1,2,\ldots,k$, $t = 1,2,\ldots, T$; and $Merger_{i,j,t-1}$ is a dummy variable, which equals 1 if bank i in country j at time $t-1$ is involved in one or more mergers.[32] Controlling for mergers is important because banks may substantially alter their risk-taking behavior following such events. In addition, *Governance* is a matrix of corporate governance variables; X is a matrix of control variables; and ε_1, ε_2, and ε_3 are error terms[33] in Eqs. (1.1), (1.2) and (1.3), respectively. It is noted that some of the right-hand side variables in each equation are endogenous (i.e. IR and LR in Eqs. (1.1), CR and LR in Eqs. (1.2), and CR and IR in Eqs. (1.3)), and there is both heteroskedasticity and contemporaneous correlation in the residuals.[34]

In econometrics, the simultaneous equation model is formed with a set of linear simultaneous equations and one or more of the explanatory variables are endogenous. Although the two-stage least squares (2SLS) method, which is an equation-by-equation technique, is the simplest and the most common estimation method for the simultaneous equation model, we do not use it because 2SLS method does not take account of the covariances between residuals. The seemingly unrelated regressions (SUR) model is a generalization of a linear regression model that consists of several regression equations. Each equation can be estimated separately, and the error terms are correlated across the equations. However, SUR method assumes that all of the explanatory variables in each equation are exogenous. Since the three-stage least squares (3SLS) method combines 2SLS with SUR, it is an appropriate technique for this study. Therefore, these equations are estimated simultaneously, controlling for the possible endogeneity of the respective independent risk variable in a 3SLS approach.

A one-year lagged value of the dependent variable is included in each equation. All of the governance and control variables also have one-year lagged values to minimize any unintentional feedback from the potential endogenous variables and reflect earlier decisions. The coefficients and statistical significance levels of any governance variables not only indicate the degree of risk appetite for banks under different governance structures but also reveal how banks handle the trade-offs among the three types of risk.

Control variables include one country-specific variable[35] and bank-specific variables, which consist of the log of total assets (Ln (TA)), the capital ratio (EA), real gross domestic product growth (RGDPG), and annual time fixed effects. The first two variables reflect the bank size and bank structure, the third one represents a country's economy, and the time fixed effects account for features distinct to specific years. These variables have been well established by the recent literature on bank risk-taking, such as Berger and Bouwman (2009), Erkens et al. (2012), and Imbierowicz and Rauch (2014).

The IND_S and OC variables reflect the ownership structure, whereas Board and IND_B variables signify strong bank board proxies. Both pairs are either highly correlated or identical proxies, so we do not include them simultaneously in the regression model to avoid problems of multicollinearity.

We extend the analysis by testing whether the relationship between corporate governance structure and bank risk-taking varies with national regulations when controlling for the interactions among credit, interest rate, and liquidity risks. Thus, the following system of equations is estimated:

$$CR_{i,j,t} = \alpha_{1i,j} + \beta_1' CR_{i,j,t-1} + \beta_2' IR_{i,j,t} + \beta_3' LR_{i,j,t} + \beta_4' Merger_{i,j,t-1} + \eta_1' Governance_{i,j,t-1} + \theta_1' R_{j,t-1} + \rho_1' Governance_{i,j,t-1} \times R_{j,t-1} + \gamma_1' X_{i,j,t-1} + \varepsilon_{1i,j,t} \quad (2.1)$$

$$IR_{i,j,t} = \alpha_{2i,j} + \delta_1' IR_{i,j,t-1} + \delta_2' CR_{i,j,t} + \delta_3' LR_{i,j,t} + \delta_4' Merger_{i,j,t-1} + \eta_2' Governance_{i,j,t-1} + \theta_2' R_{j,t-1} + \rho_2' Governance_{i,j,t-1} \times R_{j,t-1} + \gamma_2' X_{i,j,t-1} + \varepsilon_{2i,j,t} \quad (2.2)$$

$$LR_{i,j,t} = \alpha_{3i,j} + \lambda_1' LR_{i,j,t-1} + \lambda_2' CR_{i,j,t} + \lambda_3' IR_{i,j,t} + \lambda_4' Merger_{i,j,t-1} + \eta_3' Governance_{i,j,t-1} + \theta_3' R_{j,t-1} + \rho_3' Governance_{i,j,t-1} \times R_{j,t-1} + \gamma_3' X_{i,j,t-1} + \varepsilon_{3i,j,t} \quad (2.3)$$

where *Governance* is changed to an indicator of corporate governance structure, R is a matrix of country-level measures of

[32] Merger is defined as the combination of bank charters into an institution with a single set of books. We obtain this data by surveying the history of each sample bank.

[33] To control for dependence in the error terms for banks within the same country, we use robust standard errors clustered by country.

[34] We use the hausman test to examine whether some right-hand side variables in each equation are not exogenous. The results show that contemporaneous risk variables in each equation indeed are correlated with the error term at the 1% significance level. We also test if there are heteroskedasticity and contemporaneous correlation in the errors across equations. Similarly, the evidence is found that we need to account for heteroskedasticity and contemporaneous correlation in the errors across equations.

[35] To control for the possibility that the relationship between corporate governance characteristics and bank risk-taking primarily reflects cross-country differences, instead of cross-bank differences, in corporate governance characteristics, we follow Laeven and Levine (2009) and include a country-specific variable.

Table 2
Description of variables.

Variables	Definitions	Data sources
Credit Risk (CR) Proxy		
NPL ratio (%)	Non-performing Loans/Gross Loans	*Bankscope*
LLP measure (%)	Loan Loss Provisioning/Average Gross Loans	*Bankscope*
NCO measure (%)	Net Charge-offs$_t$/Loan Loss Allowance$_{t-1}$	*Bankscope*
Interest Rate Risk (IR) Proxy		
CGAP_A (%)	Cumulative One-year Repricing Gap/Total Assets	*Bankscope*
Liquidity Risk (LR) Proxy		
LC_A (%)	The Amount of Liquidity Creation/Total Assets	*Bankscope*
Inverse of LCR (%)	Total Net Cash Outflows over the Next 30 Calender Days/Stock of High-quality Liquidity Assets	*Bankscope*
Inverse of NSFR (%)	Required Amount of Stable Funding/Available Amount of Stable Funding	*Bankscope*
Corporate Governance Characteristics		
IND_S	BvD independence indicators. The values 4 to 1 are assigned to A, B, C, and D, respectively. Higher value exhibits that bank shareholders have higher degree of independence and this bank tends to be a management-controlled bank	*Bankscope*
OC (%)	The maximum of the direct or total shareholding for a shareholder. Higher value represents that a bank tends to be a shareholder-controlled bank	*Bankscope*
Board	The number of directors on the board. A bank with a small board is inclined to be a shareholder-controlled bank	*Bankscope*
IND_B	The percentage of board members who are independent. A bank with a larger degree of board independence is inclined to be a shareholder-controlled bank	*Bankscope*
Dual	Dummy variable indicating whether the CEO is also the chairman of the board. A bank with CEO duality tends to be a shareholder-controlled bank	*Bankscope*
U_S	Dummy variable indicating whether the ultimate owner of a bank is the state	*Bankscope*
U_B	Dummy variable indicating whether the ultimate owner of a bank is the bank	*Bankscope*
U_E	Dummy variable indicating whether the ultimate owner of a bank is the enterprise	*Bankscope*
Regulations		
DI	Dummy variable indicating whether a country has explicit deposit insurance	Demirgüç-Kunt et al. (2005)
Capital	Capital Regulatory Index. The index that includes information on the following questions: (1) Is the minimum capital-asset ratio requirement risk weighted in line with the Basel guidelines? (2) Does the minimum ratio vary as a function of market risk? (3) Are market value of loan losses not realized in accounting books deducted from capital? (4) Are unrealized losses in securities portfolios deducted? (5) Are unrealized foreign exchange losses deducted? (6) What fraction of revaluation gains is allowed as part of capital? (7) Are the sources of funds to be used as capital verified by the regulatory/supervisory authorities? (8) Can the initial disbursement or subsequent injections of capital be done with assets other than cash or government securities? (9) Can initial disbursement of capital be done with borrowed funds? The index ranges from 0 to 9 with higher values indicating greater stringency	*Bank Regulation and Supervision* of the World Bank
SR	The La Porta et al. (1999) index of the statutory rights of shareholders. The index is formed by adding one when: (1) the country allows shareholders to mail their proxy vote to the firm; (2) shareholders are not required to deposit their shares prior to a General Shareholder's Meeting; (3) cumulative voting or proportional representation of minorities in the board of directors is allowed; (4) an oppressed minorities mechanism is in place; (5) the minimum percentage of share capital that entitles a shareholder to call an Extraordinary Shareholders Meeting is less than or equal to 10%; or (6) shareholders have preemptive rights that can only be waved by a shareholders' vote. It ranges from 0 to 6, where larger values indicate greater shareholder rights	La Porta et al. (1999)
Control and Other Variables		
Ln (TA)	Natural log of total assets	*Bankscope*
EA (%)	Capital ratio: Total equity capital as a proportion of total assets	*Bankscope*
RGDPG (%)	Real gross domestic product growth rate	*IFS* of the IMF
Merger	Dummy variable indicating whether a bank was involved in one or more mergers	*Bankscope*

This table contains description of all observed and analyzed variables of the paper's analyses.

regulation variables, and *Governance* × *R* are the interactions between bank-level governance structure and national regulations. The governance variable *Dual* is a dummy variable, so we do not include its interaction term in each equation.

4. Empirical Results

4.1. Descriptive statistics

The descriptive statistics on all observed and analyzed variables for the sample are presented in Table 3. This table also reports the results of size subsample including small, medium, and large banks by using the 25th and the 75th percentiles of total assets of this sample as the threshold. The standard deviation is indicated in the parentheses below each variable. For the total sample, the results indicate an average CR-NPL ratio of approximately 3.5%, an average IR-CGAP_A of nearly −1.2%, and an average LR-LC_A of around 23.9%. Although medium banks have the worst asset quality according to NPL ratio, their LLP measure, which signals future troubles, is the lowest. The IR value and all LR values change by bank size, signifying that most of the large banks take more interest rate risks by using negative CGAP and have more fragile balance sheet structures. Several differences exist in the risk categories for small or medium banks because of the large standard deviation.

As regards the corporate governance variables, large banks tend to be management-controlled banks because they have the highest degree of shareholder independence (IND_S) and the largest board (Board). The CEO duality (i.e., the CEO is also the chairman) (Dual) also occurs frequently in large banks. Small banks have the highest degree of ownership concentration (OC), whereas their board independence (IND_B) is the lowest. The states (U_S) or the banks (U_B) are more likely to become the ultimate owners of large banks, but

Table 3
Descriptive statistics.

	Whole period				Regular YCS Period	Inverted YCS Period	Pre-Financial Crisis Period	During and Post Financial Crisis Period	Developed Economies	Developing Economies
	Small	Medium	Large	Total						
Number of observations	1900	4236	2527	8663	5711	1759	3304	5359	5714	2949
Number of banks	560	819	476	1604	1388	975	1007	1588	964	667
CR-NPL Ratio (%)	3.40	3.63	3.50	3.50	3.60	2.00	3.10	3.80	3.20	4.00
	(6.03)	(6.03)	(3.60)	(5.40)	(5.00)	(5.30)	(5.40)	(5.40)	(4.40)	(6.80)
CR-LLP measure (%)	3.86	1.05	1.30	1.10	1.00	0.90	1.60	1.80	1.80	1.60
	(35.73)	(4.09)	(12.30)	(2.80)	(2.00)	(2.10)	(18.80)	(17.80)	(21.40)	(5.20)
CR-NCO measure (%)	13.37	21.71	30.70	27.60	26.70	29.30	12.50	19.50	18.50	10.80
	(438.84)	(313.04)	(99.00)	(275.40)	(78.80)	(585.50)	(253.60)	(281.80)	(239.20)	(306.60)
IR-CGAP_A (%)	1.12	−1.70	−3.80	−1.20	−1.10	−1.50	0.00	−2.60	−1.30	−0.90
	(14.15)	(16.24)	(14.10)	(13.00)	(11.50)	(9.70)	(11.40)	(15.10)	(13.30)	(13.20)
LR-LC_A (%)	20.69	31.17	33.10	23.90	24.10	18.50	18.30	27.50	27.20	14.50
	(30.80)	(64.15)	(35.40)	(29.10)	(29.90)	(27.10)	(50.20)	(38.80)	(54.00)	(24.60)
LR-Inverse of LCR (%)	1004.58	2758.59	2843.90	1074.80	735.40	1325.90	1641.50	1990.60	2266.10	1017.50
	(3890.35)	(38700.99)	(50140.20)	(13376.70)	(12712.40)	(10210.30)	(33204.90)	(29224.50)	(39249.40)	(8999.40)
LR-Inverse of NSFR (%)	148.66	298.84	486.50	330.20	360.70	253.70	206.80	277.20	299.10	136.80
	(200.75)	(654.54)	(1074.40)	(829.50)	(981.00)	(353.00)	(351.20)	(888.20)	(783.10)	(289.40)
IND_S	2.66	2.82	3.20	3.10	3.30	3.20	3.10	2.80	3.00	2.60
	(1.19)	(1.25)	(1.20)	(1.20)	(1.10)	(1.20)	(0.90)	(1.40)	(1.20)	(1.20)
OC(%)	53.76	45.68	34.30	34.00	28.50	33.40	46.70	42.50	40.40	55.80
	(35.25)	(37.35)	(33.70)	(33.30)	(31.80)	(32.70)	(37.90)	(35.40)	(37.50)	(31.40)
Board	1.21	4.49	7.80	5.10	5.10	5.40	1.50	5.80	4.50	1.60
	(3.00)	(5.60)	(8.10)	(6.40)	(6.50)	(6.70)	(4.40)	(6.50)	(6.50)	(3.90)
IND_B	0.05	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
	(0.22)	(0.30)	(0.30)	(0.30)	(0.20)	(0.30)	(0.20)	(0.30)	(0.30)	(0.20)
Dual	0.02	0.14	0.20	0.20	0.20	0.20	0.00	0.10	0.10	0.00
	(0.15)	(0.34)	(0.40)	(0.40)	(0.40)	(0.40)	(0.20)	(0.30)	(0.30)	(0.10)
U_S	0.04	0.07	0.10	0.10	0.00	0.00	0.10	0.10	0.00	0.20
	(0.19)	(0.25)	(0.30)	(0.20)	(0.20)	(0.20)	(0.30)	(0.20)	(0.20)	(0.40)
U_B	0.11	0.22	0.30	0.20	0.30	0.20	0.30	0.20	0.30	0.10
	(0.32)	(0.42)	(0.50)	(0.40)	(0.40)	(0.40)	(0.40)	(0.40)	(0.50)	(0.30)
U_E	0.18	0.16	0.10	0.10	0.10	0.10	0.10	0.20	0.10	0.20
	(0.39)	(0.37)	(0.30)	(0.30)	(0.30)	(0.30)	(0.30)	(0.40)	(0.30)	(0.40)
DI	0.99	0.97	0.90	1.00	1.00	1.00	1.00	1.00	1.00	0.90
	(0.10)	(0.18)	(0.30)	(0.20)	(0.10)	(0.10)	(0.20)	(0.20)	(0.10)	(0.30)
Capital	6.43	5.94	5.70	6.00	6.00	6.40	5.80	6.10	5.80	6.10
	(1.30)	(1.66)	(2.20)	(1.70)	(1.60)	(1.00)	(1.70)	(1.80)	(1.70)	(1.80)
SR	2.80	3.29	2.90	3.60	3.60	4.30	2.90	2.90	3.00	2.40
	(1.73)	(1.76)	(1.40)	(1.60)	(1.70)	(1.20)	(1.70)	(1.70)	(1.80)	(1.10)
Total Assets (mil. USD)	125.09	2256.34	131546.38	43778.53	44706.14	43867.57	23777.30	41588.87	43588.19	13403.81
	(94.03)	(1997.83)	(328154.52)	(198245.23)	(200074.98)	(222173.06)	(114567.31)	(205933.08)	(201613.26)	(81353.86)
EA (%)	19.65	10.42	7.30	11.10	10.60	12.60	11.30	12.40	10.20	15.70
	(15.42)	(7.36)	(4.50)	(7.90)	(7.50)	(8.80)	(10.30)	(10.90)	(9.40)	(12.10)
RGDPG (%)	2.88	2.16	2.00	2.20	0.70	4.70	3.50	1.90	1.40	5.20
	(5.22)	(3.71)	(3.70)	(4.30)	(4.00)	(2.30)	(2.70)	(4.90)	(2.40)	(4.70)
Merger	0.002	0.02	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(0.04)	(0.15)	(0.22)	(0.20)	(0.20)	(0.20)	(0.10)	(0.10)	(0.20)	(0.10)

This table provides a descriptive overview of the data. We report the results for all variables described in Table 2 and used in subsequent analyses. All variables are shown for all banks during the sample period and split by size ("Small", "Medium" and "Large") employing the 25th and the 75th percentiles of total assets of this sample as the threshold. The whole period is further divided into the regular YCS period and the inverted YCS period by using the treasury bill and treasury bond rates provided by *International Financial Statistics (IFS)* database of the IMF and statistical database of the OECD. For robustness tests, the whole period is also subdivided by 2007. The period before 2007 is the pre-financial crisis period and the other is the during and post-financial crisis period. Additionally, the total sample is classified into the developed economies and the developing economies according to the classification of the World Bank. The descriptive statistics for all of the subsamples are provided. The standard deviation is shown in parentheses below each variable. The number of observations and the number of banks are not applicable to CR-LLP measure, CR-NCO measure, LR-Inverse of LCR, and SR due to partial data unavailable. Note that bank establishment, mergers, or failures would affect the the number of banks in the subsamples. The size classification of some banks will be changed due to asset growth or mergers. Because of lack of both/either T-bill and T-bonds data, the period of regular YCS and that of inverted YCS in some countries cannot be distinguished. This leads our observations to be reduced to 7470. Moreover, some countries such as Czech, Estonia, Hungary, Latvia, Poland, Saudi Arabia, and Slovakia are classified as developed countries since or during a certain year.

the enterprises (U_E) tend to invest in small banks. Compared with medium and large banks, the average DI, Capital, SR, and RGDPG for small banks are 0.99, 6.43, 2.8 and 2.88%, respectively, indicating that most of the small banks are in countries with explicit deposit insurance, stricter capital regulations, weaker shareholder rights, and better economies. The total banks have an average asset size of US$43.78 billion and an average capital ratio (EA) of 11.1%. Large banks tend to be involved in mergers in the one-year lagged year.

We further divide the whole period into the regular and inverted YCS periods. During the inverted YCS period, banks take more interest rate risks. The average LR-Inverse of LCR increases from 735.4% to 1325.9%, but the mean of other two LR proxies exhibits a downward trend from the regular to the inverted YCS period. This evidence explains that although banks have more liquidity risk exposure in the short term, they take fewer liquidity risks in the long term during the inverted YCS period. The governance characteristics in these two periods are similar except for shareholder independence (IND_S), ownership concentration (OC), and board size (Board).

Next, we split the whole sample period into the pre-financial crisis and the during and post-financial crisis periods. Results show that all of the risk exposures are raised during and post-financial crisis period. The total sample is also classified into developed and developing economies. Banks in developing countries take fewer interest rate risks and liquidity risks, but they take more credit risks than those in developed countries in terms of NPL ratio. However, the results change when the LLP or NCO measures are used as credit risk proxy. Instead, banks in developed countries have more expected and unexpected loan losses. Additionally, most of the banks in developing economies have a lower degree of shareholder independence (IND_S), more concentrated ownership (OC), and small boards (Board), whereas the phenomenon of the CEO duality (Dual) often occurs in developed countries. In contrast to developed economies, the states (U_S) and the enterprises (U_E) often become the ultimate owners of banks in developing economies.

The simple correlation matrix for the total sample in Table 4 indicates that credit, interest rate, and liquidity risks are interrelated. The CR and the LR are positively correlated with a statistically significant correlation coefficient of 7%, whereas the correlation between the IR and the CR or the IR and the LR are −3% and −9% at the 1% significance level, respectively. Hence, there is a relationship among credit, interest rate, and liquidity risks. For total sample, a shareholder-controlled bank (as measured by higher OC or IND_B) takes more risks. A bank in a country with explicit deposit insurance, stricter capital regulations, and better shareholder rights takes more interest rate risks, but it has less liquidity risk exposure. Furthermore, credit risk decreases after a bank acquired one or more banks in the one-year lagged year. The correlation matrix of other credit risk or liquidity risk proxies are similar to the results of Table 4 although their statistically significance levels are weak or unavailable. We do not display the results here for brevity.

4.2. Relationship among credit, interest rate, and liquidity risks

The results of the linkage among credit, interest rate, and liquidity risks without controlling for the bank-level governance characteristics are shown in Table 5. All equations include one-year lagged value of the dependent variable and control for bank size (Ln(TA)), bank structure (EA), a country's economy (RGDPG), and annual time fixed effects. For brevity, we do not show them in the table.[36] We split the sample period into the regular YCS period and the inverted YCS period. We also subdivide banks by size to observe if size effects exist.

For the whole period and in the inverted YCS period, a relationship among credit, interest rate, and liquidity risks exists for all banks. Increased liquidity risk not only worsens bank loan quality but also decreases the cumulative one-year repricing gap (CGAP). Thus, banks take more credit and interest rate risks as their liquidity risk increases. Similarly, more credit risks also coincide with more interest rate risks. All of these results indicate that banks have increased interest rate risks because of taking liquidity and credit risks in the inverted YCS period. However, interest rate risk does not significantly affect contemporaneous credit or liquidity risk-taking. During the regular YCS period, increased credit risk is also associated with greater interest rate and liquidity risks. Although interest rate risk increases as banks expose more liquidity risks, the magnitude and significance level of the coefficient on LR become weaker than those in the whole period and the inverted YCS period for all banks. This also indicates that banks tend to adopt a negative CGAP strategy in the period of inverted YCS.

For small banks, panel A and B of Table 5 illustrate that LR enters positively and significantly at the 5% level in the equation of interest rate risk. Therefore, more liquidity risks are related to more interest rate risks, but banks are safer in terms of insolvency because of positive CGAP. The liquidity risk exposure of small banks decreases when the interest rate risk increases by owning positive CGAP during the regular YCS period. This result demonstrates that adopting a positive CGAP strategy during the regular YCS period is beneficial to lower bank liquidity risk for small banks. Specifically, during the inverted YCS period, the interaction between LR and CR is statistically significant positive for small banks. This evidence demonstrates that credit and liquidity risks increase or decrease jointly for small banks, consisting with the arguments of Diamond and Rajan (2005) and Acharya and Viswanathan (2011). In addition, credit risk increases considerably if small banks acquire other banks in the one-year lagged year during the whole period and positive YCS period. During the inverted YCS period, we do not include the *Merger* variable into the equations because no small banks are involved in these events.

For medium banks, the results suggest that banks with more credit risks can decrease their liquidity risk exposure significantly only for the whole period though this evidence is not consistent with our expectation. Liquidity risk influences bank credit risk simultaneously during the regular YCS period. Moreover, liquidity and credit risks both affect the contemporaneous interest rate risk exposure during the inverted YCS period. Hence, the relationship among credit, interest rate, and liquidity risks is slightly weak in medium banks.

For large banks, the interactions among credit, interest rate, and liquidity risks become obvious; they are similar to the results of all banks during the inverted YCS period. In addition, the credit risk exposure is reduced when large banks take more positive CGAP. Only large banks tend to have increased liquidity risk as they merge with other banks in the inverted YCS period.

In sum, the results support our hypothesis H_1, that is, a relationship among credit risk, interest rate risk, and liquidity risk exists. However, these risks do not always interact simultaneously. Banks take more credit and interest rate risks as their liquidity risk increases. More credit risks also coincide with more interest rate risks. Particularly, in the inverted YCS period, all of these influences are statistically and economically meaningful. Nevertheless, interest rate risk does not significantly affect contemporaneous credit or liquidity risk-taking except for large banks. Hence, banks pursue more profits by using negative CGAP to avoid insolvency at the cost of default and illiquidity in the period of inverted YCS. Additionally, the interaction between LR and CR in small banks as well as that between CR and IR in large banks both exist during the inverted

[36] We also examine the relationship among credit, interest-rate, and liquidity risks without any control variables or without the macro-level variable. The results remain unchanged.

Table 4
Correlation matrix of main regression variables.

	CR-NPL	IR	LR-LC_A	IND_S	OC	Board	IND_B	Dual	U_S	U_B	U_E	DI	Capital	SR	Ln(TA)	EA	RGDPG	Merger
CR-NPL	1.00***																	
IR	−0.03***	1.00***																
LR-LC_A	0.07***	−0.09***	1.00***															
IND_S	−0.13***	0.07***	−0.12***	1.00***														
OC	0.13***	−0.08***	0.13***	−0.80***	1.00***													
Board	0.01	−0.06***	0.13***	0.14***	−0.17***	1.00***												
IND_B	0.03***	−0.15***	0.09***	−0.09***	0.10***	0.14***	1.00***											
Dual	−0.08***	0.03***	−0.06***	0.20***	−0.25***	0.43***	−0.04***	1.00***										
U_S	0.10***	−0.11***	0.04***	−0.31***	0.31***	0.01	0.13***	−0.08***	1.00***									
U_B	−0.02	−0.01	0.12***	0.01	−0.05***	0.08***	−0.002	0.05***	−0.14***	1.00***								
U_E	0.04***	0.01	0.02	−0.09***	0.05***	0.05***	0.05***	−0.08***	−0.10***	−0.2***	1.00***							
DI	0.02	0.11***	−0.09***	−0.002	−0.08***	−0.01	−0.13***	0.06***	−0.11***	0.03**	0.002	1.00***						
Capital	0.02	0.05***	−0.06***	−0.02	−0.01	−0.09***	−0.02**	0.04***	−0.01	−0.07***	−0.03***	0.21***	1.00***					
SR	−0.29***	0.06***	−0.24***	0.16***	−0.27***	−0.13***	−0.11***	0.33***	−0.11***	0.01	−0.26***	−0.03**	0.18***	1.00***				
Ln(TA)	−0.02	−0.07***	0.02*	0.07***	−0.05***	0.16***	0.15***	0.08***	0.05***	0.05***	−0.03**	−0.08***	−0.06***	−0.07***	1.00***			
EA	0.02	0.09***	−0.14***	−0.17***	0.17***	−0.18***	−0.08***	−0.11***	−0.03***	−0.13***	0.10***	0.07***	0.14***	0.02	−0.15***	1.00***		
RGDPG	−0.19***	0.01	−0.005	−0.03***	0.09***	−0.1***	0.08***	−0.09***	0.12***	−0.08***	−0.02	−0.31***	−0.01	0.06***	−0.02*	0.04***	1.00***	
Merger	−0.03***	0.01	0.01	0.04***	−0.05***	0.07***	−0.01	0.12***	−0.02*	0.05***	−0.02	0.03**	0.01	0.07***	0.08***	−0.03**	−0.004	1.00***

This table reports the correlations between the main regression variables. The total sample consists of 1604 banks and 8663 bank-year observations across 43 countries. *CR-NPL* is the credit risk measured by non-performing loan (NPL) ratio. *IR* is the interest rate risk measured by the ratio of cumulative one-year repricing gap to total assets (CGAP_A). *LR-LC_A* is the liquidity risk measured by the ratio of the dollar amount of bank liquidity creation to total assets. *IND_S* is the shareholder independence measured by BvD independence indicators in *Bankscope*. The values 4 to 1 are assigned to A, B, C, and D, respectively. Higher value exhibits that bank shareholders have higher degree of independence and this bank tends to be a management-controlled bank. *OC* is the degree of ownership concentration. It is defined as "the maximum of the direct or total shareholding for a shareholder". Higher value represents that a bank tends to be a shareholder-controlled bank. *Board* reflects the board size and refers to the number of directors on the board. A bank with a small board is inclined to be a shareholder-controlled bank. *IND_B* is the board independence measured by the percentage of board members who are independent. A bank with a larger degree of board independence is inclined to be a shareholder-controlled bank. *Dual* is a dummy variable indicating whether the CEO is also the chairman of the board. A bank with CEO duality tends to be a shareholder-controlled bank. *U_S*, *U_B*, and *U_E* are the dummy variables indicating whether the ultimate owner of a bank is the state, the bank, and the enterprise, respectively. *DI* takes a value of one if the country has explicit deposit insurance, and zero otherwise. *Capital* is an index of regulatory oversight of bank capital from the *Bank Regulation and Supervision* database provided by the World Bank. It released in 2001 and updated in 2003, 2007, and 2012 respectively to capture regulatory changes in capital requirements. The range for the index is from 0 to 9. Higher values indicates greater stringency. *SR* is the anti-director index calculated by La Porta et al. (1999) and ranges from 0 to 6. Higher values represent greater shareholder rights. *Ln(TA)* is the natural log of total assets. *EA* is the capital ratio calculated by the ratio of total equity to total assets. *RGDPG* is the growth rate of real gross domestic product and represents a country's economy. *Merger* is a dummy variable indicating whether a bank was involved in one or more mergers. *,**,*** indicate significance at the 10%, 5%, and 1% levels, respectively.

Table 5
The relationship among credit, interest rate, and liquidity risks.

	Credit Risk (CR)					Interest Rate Risk (IR)					Liquidity Risk (LR)			
	All Banks	Bank Size				All Banks	Bank Size				All Banks	Bank Size		
		Small	Medium	Large			Small	Medium	Large			Small	Medium	Large
Panel A: Whole period														
Constant	1.9603	−0.3789	3.2995	2.4896	Constant	2.7201	0.4084	−0.8017	4.4118	Constant	−3.7376	−10.1792	9.4554	9.8040
	(5.86)***	(−0.23)	(1.71)*	(4.45)***		(3.12)***	(0.16)	(−0.12)	(1.48)		(−2.84)***	(−1.81)*	(1.68)*	(2.86)***
IR(t)	−0.0013	−0.0072	0.0002	−0.0070	CR(t)	−0.0654	−0.2047	−0.0273	−0.0974	CR(t)	0.0552	0.3438	−0.2579	−0.0837
	(−0.29)	(−0.42)	(0.02)	(−1.57)		(−2.59)***	(−3.95)***	(−0.34)	(−1.26)		(1.45)	(3.10)***	(−3.68)***	(−0.94)
LR(t)	0.0035	−0.0004	0.0018	0.0002	LR(t)	−0.0135	0.0220	−0.0415	−0.0133	IR(t)	0.0153	−0.0288	0.0004	0.0180
	(2.23)**	(−0.06)	(0.34)	(0.17)		(−3.33)***	(1.98)**	(−2.39)**	(−2.22)**		(0.91)	(−0.50)	(0.02)	(0.66)
Merger	−0.3120	5.5130	−1.8164	−0.0581	Merger	0.4837	9.2154	1.2646	0.1810	Merger	0.3610	−14.0848	2.7219	0.5309
	(−1.32)	(2.01)**	(−1.62)	(−0.34)		(0.79)	(2.11)**	(0.34)	(0.20)		(0.39)	(−1.50)	(0.84)	(0.51)
CR(t-1)	YES	YES	YES	YES	IR(t-1)	YES	YES	YES	YES	LR(t-1)	YES	YES	YES	YES
Control Var.	YES	YES	YES	YES	Control Var.	YES	YES	YES	YES	Control Var.	YES	YES	YES	YES
Adj. *R*-squared	0.57	0.41	0.49	0.48	Adj. *R*-squared	0.50	0.44	0.45	0.45	Adj. *R*-squared	0.77	0.57	0.57	0.59
N of observations	8663	1900	4236	2527	N of observations	8663	1900	4236	2527	N of observations	8663	1900	4236	2527
Panel B: Regular YCS Period														
Constant	1.8515	−4.8642	0.1344	3.1353	Constant	1.0291	0.0100	10.3763	0.1809	Constant	−0.9808	3.8197	2.3001	7.6877
	(5.06)***	(−2.25)**	(0.07)	(4.36)***		(1.19)	(0.003)	(1.51)	(0.06)		(−0.59)	(0.48)	(0.44)	(1.80)*
IR(t)	−0.0002	−0.0005	−0.0035	−0.0177	CR(t)	−0.0711	−0.2250	0.0151	−0.0880	CR(t)	0.1079	0.4008	−0.0684	−0.0331
	(−0.04)	(−0.03)	(−0.47)	(−3.05)***		(−2.61)***	(−3.88)***	(0.20)	(−1.07)		(2.05)**	(2.95)***	(−1.22)	(−0.28)
LR(t)	0.0018	0.0024	0.0090	−0.0002	LR(t)	−0.0066	0.0306	−0.0278	−0.0089	IR(t)	−0.0115	−0.1454	0.0020	−0.0192
	(1.05)	(0.30)	(1.65)*	(−0.11)		(−1.67)*	(2.46)**	(−1.35)	(−1.62)		(−0.51)	(−2.13)**	(0.09)	(−0.57)
Merger	−0.0765	9.8899	−0.4374	0.1859	Merger	0.5319	−4.3404	2.2353	0.5504	Merger	0.6784	−14.4519	−0.2577	1.2573
	(−0.29)	(3.01)***	(−0.43)	(0.74)		(0.84)	(−0.82)	(0.58)	(0.54)		(0.56)	(−1.16)	(−0.09)	(0.86)
CR(t-1)	YES	YES	YES	YES	IR(t-1)	YES	YES	YES	YES	LR(t-1)	YES	YES	YES	YES
Control Var.	YES	YES	YES	YES	Control Var.	YES	YES	YES	YES	Control Var.	YES	YES	YES	YES
Adj. *R*-squared	0.60	0.47	0.48	0.56	Adj. *R*-squared	0.58	0.53	0.54	0.54	Adj. *R*-squared	0.77	0.56	0.54	0.51
N of observations	5711	1104	2819	1788	N of observations	5711	1104	2819	1788	N of observations	5711	1104	2819	1788
Panel C: Inverted YCS Period														
Constant	1.3451	0.3846	6.4199	2.1682	Constant	0.9949	−3.5635	−6.1055	0.2042	Constant	−4.4226	18.7496	−1.7775	−3.9201
	(3.89)***	(0.15)	(6.00)***	(4.14)***		(1.29)	(−1.55)	(−2.40)**	(0.10)		(−2.98)***	(1.53)	(−0.46)	(−1.24)
IR(t)	−0.0031	0.0082	−0.0202	−0.0225	CR(t)	−0.0962	0.0041	−0.1353	−0.0871	CR(t)	0.0711	0.6519	−0.0390	−0.0322
	(−0.51)	(0.14)	(−1.64)	(−2.63)***		(−4.11)***	(0.06)	(−3.20)***	(−2.08)**		(1.58)	(1.90)*	(−0.60)	(−0.48)
LR(t)	0.0032	0.0130	0.0012	−0.0005	LR(t)	−0.0156	0.0052	−0.0107	−0.0072	IR(t)	−0.0318	0.0474	0.0236	0.0287
	(2.06)**	(1.82)*	(0.53)	(−0.39)		(−4.50)***	(0.80)	(−2.10)**	(−1.66)*		(−1.22)	(0.17)	(0.54)	(0.56)
Merger	−0.1028		0.1865	0.1247	Merger	−0.1453		0.7364	−0.5119	Merger	1.0079		1.3094	1.9183
	(−0.45)		(0.48)	(0.68)		(−0.29)		(0.82)	(−0.73)		(1.03)		(0.96)	(1.74)*
CR(t-1)	YES	YES	YES	YES	IR(t-1)	YES	YES	YES	YES	LR(t-1)	YES	YES	YES	YES
Control Var.	YES	YES	YES	YES	Control Var.	YES	YES	YES	YES	Control Var.	YES	YES	YES	YES
Adj. *R*-squared	0.61	0.26	0.59	0.59	Adj. *R*-squared	0.45	0.37	0.47	0.38	Adj. *R*-squared	0.78	0.50	0.51	0.52
N of observations	1759	650	770	339	N of observations	1759	650	770	339	N of observations	1759	650	770	339

This table shows the results of a regression analysis which estimates a system of equations (simultaneous equations) via three-stage least squares without controlling for the bank-level governance characteristics. We report the results of all banks and size subsamples including small banks, medium banks, and large banks during the whole period, regular YCS period, and inverted YCS period. All equations include one-year lagged value of the dependent variable as well as control variables covering the log of total assets (Ln(TA)), capital ratio (EA), the growth rate of real gross domestic product (RGDPG), and annual time fixed effects. We do not show them in the table for reasons of brevity. Because of lack of both/either T-bill and T-bonds data, the period of regular YCS and that of inverted YCS in some countries cannot be distinguished. This leads the number of observations to be becomed 7470. *CR* is the credit risk measured by non-performing loan (NPL) ratio. A high ratio is associated with high credit risk. *IR* is the interest rate risk measured by the ratio of cumulative one-year repricing gap to total assets (CGAP_A). Banks are exposed to interest rate risk if their CGAP_A ratio is not equal to zero. *LR* is the liquidity risk measured by the ratio of the dollar amount of bank liquidity creation to total assets. A high ratio is associated with high liquidity risk. *Merger* is a dummy variable indicating whether a bank was involved in one or more mergers. *t*-Statistics based on robust standard errors clustered by country are reported in parentheses. ***, **, and * denote significant levels at the 1%, 5%, and 10% levels respectively.

YCS period, supporting the hypotheses H_{1a} and H_{1c}, respectively. The authorities should monitor the credit risk of small banks when these banks acquired other banks in the previous year.

4.3. Effects of corporate governance structure on the relationship among credit, interest rate, and liquidity risks

Based on the relationship among credit, interest rate, and liquidity risks, we further investigate the role of corporate governance and compare how banks deal with the trade-offs when they face these risks during the regular and inverted YCS periods. In the following section, we only analyze all banks because the linkage among these risks is slightly weak and no size effect exists in the size subsample. The results are listed in Table 6.

The relationship among credit, interest rate, and liquidity risks become weak when controlling for corporate governance characteristics (see Table 6). Hence, the interactions among the three risks can be weakened through corporate governance mechanisms. Panel A of Table 6 illustrates that IND_S enters negatively and significantly at the 1% level only in the CR equation. Therefore, a higher degree of shareholder independence improves loan quality and thus reduces bank credit risk exposure. Shareholder-controlled banks that are measured by OC or IND_B have more credit risk exposure and take more interest rate risks. The magnitude of the coefficients on IND_B is larger than that of those on OC in the CR and IR equations. Hence, board independence reinforces the incentives of shareholder-controlled banks to pursue more risks. Banks with greater ownership concentration (OC), larger board (Board), or a CEO as the chairman (Dual) take more liquidity risks. Banks take more liquidity risks only when their ultimate owner is the bank (U_B).

During the regular YCS period (see panel B of Table 6), only liquidity risk increases with credit risk when controlling for the governance characteristics. Therefore, banks can lower their credit risk-taking directly through governance characteristics. These effects also indirectly reduce their liquidity risk exposure via the interdependency between CR and LR. The effective methods are to increase shareholder independence (IND_S) or encourage the enterprises (U_E) to be ultimate owners. Banks also mitigate their liquidity risk exposure when their ultimate owners are the state (U_S). Although shareholder-controlled banks that are measured by OC, IND_B, or Dual take more interest rate risks, their strategies of CGAP vary. Banks with more concentrated ownership (OC) and/or higher board independence (IND_B) tend to adopt small or even negative CGAP strategies, whereas banks with a CEO as the chairman (Dual) operate with a positive CGAP during the regular YCS period. The results in panel B of Table 6 also demonstrate that a higher degree of board independence (IND_B) induces a bank to take more credit risks. This indicates that independent boards is useful for shareholders to monitor and control managers (Fama, 1980; Fama and Jensen, 1983). On the contrary, banks have more liquidity risk exposure when their board is large (Board), their CEO is the chairman (Dual), or the ultimate owner is the bank (U_B). Hence, these results suggest that during the regular YCS period, shareholder-controlled banks would pursue more profits to avoid insolvency at the cost of illiquidity as their CEO is the chairman, however, management-controlled banks tend to decrease credit risk and liquidity risk under hedging against interest rate risk as they have higher degree of shareholder independence. These findings are consistent with the arguments that bank managers are more risk-averse than shareholders (Amihud and Lev, 1981; Demsetz and Lehn, 1985; Saunders et al., 1990; Hirshleifer and Thakor, 1992; John et al., 2008, and Laeven and Levine, 2009).

In the inverted YCS period (see panel C of Table 6), interest rate risk increases with credit and/or liquidity risks when controlling for the governance characteristics. The magnitude of the coefficient on IND_S in the CR and IR equations become larger than that of those in the regular YCS period. All of these are statistically significant, indicating that management-controlled banks continue to take fewer credit risks although they take interest rate risk by using positive CGAP. Hence, management-controlled banks value credit risk management beyond all things. The Board only enters positively and significantly at the 1% level in the LR equation for any period, but its effect on the other risks is similar to that of IND_S. This evidence suggests that a large board is near to the proxy of management-controlled bank. Compared with the results in the regular YCS period, shareholder-controlled banks that are measured by OC or IND_B not only take more interest rate risks but also have larger credit and liquidity risk exposure. The magnitude of the coefficient on OC in each equation is intensified; thus, shareholder-controlled banks are risky during the inverted YCS period. Similarly, banks that enterprises control tend to take fewer credit risks although the effect is slightly smaller compared with those in the regular YCS period. In addition, banks reduce credit risk exposure significantly when they are the ultimate owner only during the inverted YCS period.

Thus, the results support our second hypothesis H_2, that is, corporate governance affects the trade-offs among credit, interest rate, and liquidity risks. During the regular YCS period, management-controlled banks reduce credit risk (directly) and even liquidity risk (indirectly) through increasing their degree of shareholder independence. However, shareholder-controlled banks raise liquidity risk by using CEO duality or increasing board independence. The former is a direct approach, whereas the latter is an indirect method that influences credit risk-taking first and then changes the bank's liquidity risk exposure. Hence, our hypothesis H_{2a} is also supported. During the inverted YCS period, management-controlled banks continue take fewer credit risks although they take interest rate risks. However, the authorities should monitor shareholder-controlled banks because of their great risk exposure. Therefore, our hypothesis H_{2b} is partially supported. In addition, banks that are owned ultimately by enterprises tend to take fewer credit risks. On the contrary, governments induce their ultimately owned banks to increase credit risk exposure because of policy-related lending, especially in the regular YCS period. When banks are the ultimate owner, they remain responsible for generating more liquidity for the economy and thus have a larger liquidity risk exposure, but they take fewer credit risks during the inverted YCS period. The abovementioned findings about ultimate owners contradict our expectations. We suggest that the authorities should limit the state ownership.

4.4. Effects of regulations

Certain sample countries[37] do not have the anti-director index provided by La Porta et al. (1999), so our bank-year observations for the whole period is further reduced to 6502. Table 7 presents the results of the direct and interactive associations among corporate governance characteristics, regulations, and bank risk. All equations include contemporaneous independent risk variables, one-year lagged value of the dependent variable, and control variables, including bank size (Ln(TA)), bank structure (EA), a country's economy (RGDPG), and annual time fixed effects. Similarly, we do not show them in the table for brevity.

First, we check the relationship among credit, interest rate, and liquidity risks when controlling for corporate governance characteristics, regulations, and interaction terms. The results are similar to those shown in Table 6 for the whole period and the inverted

[37] These countries are Bulgaria, China, Cyprus, Czech, Estonia, Hungary, Latvia, Lithuania, Luxembourg, Malta, Poland, Romania, Russian, Saudi Arabia, Slovakia, and Slovenia.

Table 6
The impacts of corporate governance structure on the relationship among credit, interest rate, and liquidity risks.

	Credit Risk (CR)					Interest Rate Risk (IR)					Liquidity Risk (LR)			
	(1)	(2)	(3)	(4)		(1)	(2)	(3)	(4)		(1)	(2)	(3)	(4)
Panel A: Whole period														
Constant	2.7307	2.3012	2.9778	2.5784	Constant	2.5015	3.2939	1.7076	2.4856	Constant	3.4602	1.1117	1.6071	−0.3359
	(6.10)***	(5.23)***	(6.89)***	(6.00)***		(1.86)*	(2.51)**	(1.31)	(1.93)*		(1.95)*	(0.64)	(0.93)	(−0.20)
IR(t)	−0.0003	−0.0003	0.0010	0.0010	CR(t)	−0.0441	−0.0405	−0.0392	−0.0356	CR(t)	0.0544	0.0524	0.0580	0.0555
	(−0.07)	(−0.07)	(0.22)	(0.23)		(−1.32)	(−1.19)	(−1.17)	(−1.05)		(1.23)	(1.17)	(1.31)	(1.24)
LR(t)	0.0025	0.0025	0.0023	0.0023	LR(t)	−0.0180	−0.0168	−0.0171	−0.0159	IR(t)	0.0152	0.0136	0.0181	0.0168
	(1.34)	(1.30)	(1.21)	(1.17)		(−3.22)***	(−2.93)***	(−3.07)***	(−2.78)***		(0.86)	(0.76)	(1.01)	(0.93)
Merger	−0.3523	−0.3574	−0.3272	−0.3301	Merger	0.4137	0.4101	0.3140	0.3119	Merger	0.3036	0.2236	0.2484	0.1698
	(−1.49)	(−1.48)	(−1.38)	(−1.37)		(0.59)	(0.57)	(0.45)	(0.44)		(0.33)	(0.24)	(0.27)	(0.18)
IND_S	−0.1076		−0.1088		IND_S	0.1039		0.0937		IND_S	−0.2373		−0.1415	
	(−2.65)***		(−2.70)***			(0.86)		(0.78)			(−1.48)		(−0.89)	
OC		0.0026		0.0026	OC		−0.0105		−0.0099	OC		0.0155		0.0130
		(1.75)*		(1.78)*			(−2.38)**		(−2.26)**			(2.68)***		(2.25)**
Board	−0.0090	−0.0117			Board	0.0161	0.0151			Board	0.1411	0.1353		
	(−1.09)	(−1.38)				(0.65)	(0.60)				(4.33)***	(4.09)***		
IND_B			0.4507	0.4674	IND_B			−2.0686	−2.0768	IND_B			0.7855	0.7762
			(2.83)***	(2.87)***				(−4.39)***	(−4.32)***				(1.25)	(1.21)
Dual	−0.0144	−0.0166	−0.0239	−0.0364	Dual	0.7421	0.6869	0.6648	0.6021	Dual	0.7602	0.9928	1.4653	1.6669
	(−0.12)	(−0.14)	(−0.21)	(−0.31)		(2.10)**	(1.89)*	(1.98)**	(1.75)*		(1.62)	(2.07)**	(3.28)***	(3.65)***
U_S	0.0885	0.1404	0.0619	0.1142	U_S	−1.1058	−0.8450	−0.9973	−0.7393	U_S	−0.2210	−0.5110	−0.1444	−0.4908
	(0.48)	(0.75)	(0.33)	(0.61)		(−2.01)**	(−1.52)	(−1.81)*	(−1.34)		(−0.30)	(−0.70)	(−0.20)	(−0.67)
U_B	−0.1797	−0.1783	−0.1665	−0.1625	U_B	0.0988	0.1263	0.0470	0.0763	U_B	0.8846	0.7941	0.8566	0.7374
	(−1.69)*	(−1.65)*	(−1.57)	(−1.51)		(0.31)	(0.39)	(0.15)	(0.24)		(2.12)**	(1.88)*	(2.05)**	(1.74)*
U_E	−0.1939	−0.1802	−0.2076	−0.1922	U_E	0.2483	0.2843	0.2944	0.3209	U_E	−0.2801	−0.1454	−0.2042	−0.0986
	(−1.48)	(−1.36)	(−1.58)	(−1.45)		(0.64)	(0.72)	(0.76)	(0.81)		(−0.54)	(−0.28)	(−0.40)	(−0.19)
CR(t-1)	YES	YES	YES	YES	IR(t-1)	YES	YES	YES	YES	LR(t-1)	YES	YES	YES	YES
Control Var.	YES	YES	YES	YES	Control Var.	YES	YES	YES	YES	Control Var.	YES	YES	YES	YES
Adj. *R*-squared	0.60	0.60	0.60	0.60	Adj. *R*-squared	0.50	0.50	0.50	0.50	Adj. *R*-squared	0.77	0.77	0.77	0.77
N of observations	8663	8663	8663	8663	N of observations	8663	8663	8663	8663	N of observations	8663	8663	8663	8663
Panel B: Regular YCS Period														
Constant	2.3975	1.8524	2.5990	2.1521	Constant	−0.1018	0.9455	0.0516	0.8756	Constant	6.3716	4.9860	3.9003	2.9422
	(5.02)***	(3.94)***	(5.66)***	(4.71)***		(−0.07)	(0.71)	(0.04)	(0.67)		(2.80)***	(2.24)**	(1.78)*	(1.35)
IR(t)	0.0025	0.0025	0.0048	0.0049	CR(t)	−0.0221	−0.0257	−0.0154	−0.0172	CR(t)	0.1607	0.1520	0.1650	0.1540
	(0.52)	(0.50)	(0.97)	(0.96)		(−0.55)	(−0.63)	(−0.38)	(−0.42)		(2.40)**	(2.25)**	(2.45)**	(2.27)**
LR(t)	0.0012	0.0013	0.0009	0.0010	LR(t)	−0.0076	−0.0062	−0.0075	−0.0059	IR(t)	−0.0134	−0.0123	−0.0120	−0.0105
	(0.57)	(0.62)	(0.46)	(0.49)		(−1.31)	(−1.02)	(−1.30)	(−0.99)		(−0.57)	(−0.52)	(−0.51)	(−0.44)
Merger	−0.1832	−0.1815	−0.1635	−0.1587	Merger	0.5760	0.5830	0.5313	0.5383	Merger	0.7115	0.5365	0.6333	0.4619
	(−0.70)	(−0.68)	(−0.63)	(−0.60)		(0.78)	(0.77)	(0.72)	(0.72)		(0.57)	(0.43)	(0.51)	(0.37)
IND_S	−0.1338		−0.1230		IND_S	0.1683		0.0962		IND_S	0.0379		0.1331	
	(−3.03)***		(−2.81)***			(1.34)		(0.77)			(0.18)		(0.64)	
OC		0.0023		0.0019	OC		−0.0119		−0.0095	OC		0.0110		0.0091
		(1.44)		(1.18)			(−2.61)***		(−2.09)**			(1.44)		(1.19)
Board	−0.0069	−0.0111			Board	−0.0342	−0.0364			Board	0.1634	0.1560		
	(−0.77)	(−1.21)				(−1.35)	(−1.40)				(3.86)***	(3.62)***		
IND_B			0.6957	0.7480	IND_B			−2.2827	−2.3134	IND_B			−0.4701	−0.4111
			(3.65)***	(3.81)***				(−4.26)***	(−4.19)***				(−0.52)	(−0.44)
Dual	0.0772	0.0781	0.0779	0.0610	Dual	0.9599	0.8999	0.6750	0.6012	Dual	1.4151	1.7188	2.1896	2.4640
	(0.60)	(0.59)	(0.65)	(0.49)		(2.65)***	(2.42)**	(1.98)**	(1.72)*		(2.32)**	(2.76)***	(3.81)***	(4.19)***
U_S	0.5887	0.6609	0.5091	0.5761	U_S	−0.3061	−0.0824	−0.0796	0.1589	U_S	−1.7231	−2.2892	−1.5814	−2.2132
	(2.32)**	(2.56)**	(2.01)**	(2.23)**		(−0.42)	(−0.11)	(−0.11)	(0.22)		(−1.43)	(−1.88)*	(−1.31)	(−1.81)*
U_B	−0.1608	−0.1496	−0.1571	−0.1450	U_B	0.3143	0.3050	0.3044	0.3130	U_B	0.8877	0.6845	0.8773	0.6327
	(−1.49)	(−1.36)	(−1.46)	(−1.32)		(1.03)	(0.98)	(1.00)	(1.01)		(1.74)*	(1.32)	(1.71)*	(1.22)

U_E	−0.3712	−0.3631	−0.3962	−0.3886	U_E	0.1097	0.0993	0.1256	0.1072	U_E	−0.5802	−0.4278	−0.3731	−0.2577
	(−2.53)**	(−2.43)**	(−2.71)***	(−2.61)***		(0.26)	(0.23)	(0.30)	(0.25)		(−0.84)	(−0.61)	(−0.54)	(−0.37)
CR(t-1)	YES	YES	YES	YES	IR(t-1)	YES	YES	YES	YES	LR(t-1)	YES	YES	YES	YES
Control Var.	YES	YES	YES	YES	Control Var.	YES	YES	YES	YES	Control Var.	YES	YES	YES	YES
Adj. *R*-squared	0.60	0.60	0.60	0.60	Adj. *R*-squared	0.58	0.57	0.58	0.57	Adj. *R*-squared	0.75	0.74	0.75	0.74
N of observations	5711	5711	5711	5711	N of observations	5711	5711	5711	5711	N of observations	5711	5711	5711	5711
Panel C: Inverted YCS Period														
Constant	2.1708	1.4204	2.4498	1.7493	Constant	−0.4910	0.9753	−1.2970	0.1666	Constant	2.4775	0.3368	−0.1110	−1.6646
	(4.44)***	(2.97)***	(5.24)***	(3.77)***		(−0.39)	(0.80)	(−1.08)	(0.14)		(1.19)	(0.17)	(−0.06)	(−0.85)
IR(t)	0.0036	0.0036	0.0053	0.0054	CR(t)	−0.0718	−0.0729	−0.0710	−0.0717	CR(t)	0.0701	0.0657	0.0743	0.0682
	(0.55)	(0.55)	(0.81)	(0.81)		(−2.24)**	(−2.26)**	(−2.22)**	(−2.23)**		(1.33)	(1.24)	(1.40)	(1.28)
LR(t)	0.0025	0.0026	0.0023	0.0023	LR(t)	−0.0179	−0.0165	−0.0171	−0.0156	IR(t)	−0.0156	−0.0158	−0.0096	−0.0089
	(1.28)	(1.26)	(1.18)	(1.15)		(−3.57)***	(−3.21)***	(−3.42)***	(−3.05)***		(−0.57)	(−0.57)	(−0.35)	(−0.32)
Merger	−0.1144	−0.1119	−0.0882	−0.0814	Merger	−0.3387	−0.3475	−0.4410	−0.4464	Merger	0.8512	0.7236	0.7537	0.6298
	(−0.49)	(−0.46)	(−0.37)	(−0.34)		(−0.56)	(−0.56)	(−0.73)	(−0.73)		(0.85)	(0.72)	(0.76)	(0.62)
IND_S	−0.1676		−0.1719		IND_S	0.2404		0.2292		IND_S	−0.1523		−0.0059	
	(−3.79)***		(−3.94)***			(2.12)**		(2.06)**			(−0.82)		(−0.03)	
OC		0.0045		0.0046	OC		−0.0169		−0.0161	OC		0.0135		0.0100
		(2.71)***		(2.79)***			(−4.04)***		(−3.88)***			(1.96)**		(1.45)
Board	−0.0098	−0.0143			Board	0.0122	0.0113			Board	0.1704	0.1631		
	(−1.10)	(−1.57)				(0.53)	(0.49)				(4.55)***	(4.28)***		
IND_B			0.4427	0.4635	IND_B			−2.3672	−2.3809	IND_B			1.1880	1.2531
			(2.44)**	(2.48)**				(−5.17)***	(−5.07)***				(1.55)	(1.60)
Dual	0.0202	0.0325	0.0095	0.0041	Dual	0.7763	0.6957	0.6484	0.5626	Dual	0.8825	1.1032	1.7224	1.9107
	(0.17)	(0.27)	(0.09)	(0.04)		(2.57)**	(2.25)**	(2.27)**	(1.92)*		(1.77)*	(2.17)**	(3.63)***	(3.94)***
U_S	0.2124	0.2563	0.1692	0.2147	U_S	−0.9385	−0.5609	−0.7347	−0.3684	U_S	0.0118	−0.3968	0.0728	−0.4237
	(0.88)	(1.05)	(0.70)	(0.88)		(−1.52)	(−0.90)	(−1.19)	(−0.59)		(0.01)	(−0.39)	(0.07)	(−0.41)
U_B	−0.2665	−0.2628	−0.2575	−0.2499	U_B	0.3207	0.3735	0.2807	0.3374	U_B	1.2229	1.0987	1.1956	1.0257
	(−2.44)**	(−2.36)**	(−2.36)**	(−2.25)**		(1.15)	(1.32)	(1.01)	(1.19)		(2.66)***	(2.36)**	(2.60)***	(2.20)**
U_E	−0.3091	−0.2935	−0.3261	−0.3080	U_E	−0.0943	−0.0552	−0.0222	0.0021	U_E	−0.6000	−0.4463	−0.5500	−0.4288
	(−2.19)**	(−2.05)**	(−2.31)**	(−2.15)**		(−0.26)	(−0.15)	(−0.06)	0.0058		(−1.01)	(−0.74)	(−0.92)	(−0.71)
CR(t-1)	YES	YES	YES	YES	IR(t-1)	YES	YES	YES	YES	LR(t-1)	YES	YES	YES	YES
Control Var.	YES	YES	YES	YES	Control Var.	YES	YES	YES	YES	Control Var.	YES	YES	YES	YES
Adj. *R*-squared	0.62	0.62	0.62	0.62	Adj. *R*-squared	0.45	0.46	0.46	0.46	Adj. *R*-squared	0.78	0.78	0.78	0.78
N of observations	1759	1759	1759	1759	N of observations	1759	1759	1759	1759	N of observations	1759	1759	1759	1759

This table shows the results of a regression analysis which estimates a system of equations (simultaneous equations) via three-stage least squares when controlling for corporate governance characteristics. We report the results of all 1604 banks during the whole period, regular YCS period, and inverted YCS period. All equations include one-year lagged value of the dependent variable as well as control variables covering the log of total assets (Ln(TA)), capital ratio (EA), the growth rate of real gross domestic product (RGDPG), and annual time fixed effects. We do not show them in the table for reasons of brevity. Because of lack of both/either T-bill and T-bonds data, the period of regular YCS and that of inverted YCS in some countries cannot be distinguished. This leads the number of observations to be becomed 7470. *CR* is the credit risk measured by non-performing loan (NPL) ratio. A high ratio is associated with high credit risk. *IR* is the interest rate risk measured by the ratio of cumulative one-year repricing gap to total assets (CGAP_A). Banks are exposed to interest rate risk if their CGAP_A ratio is not equal to zero. *LR* is the liquidity risk measured by the ratio of the dollar amount of bank liquidity creation to total assets. A high ratio is associated with high liquidity risk. *Merger* is a dummy variable indicating whether a bank was involved in one or more mergers. *IND_S* is the shareholder independence measured by BvD independence indicators in *Bankscope*. The values 4 to 1 are assigned to A, B, C, and D, respectively. Higher value exhibits that bank shareholders have higher degree of independence and this bank tends to be a management-controlled bank. *OC* is the degree of ownership concentration. It is defined as "the maximum of the direct or total shareholding for a shareholder". Higher value represents that a bank tends to be a shareholder-controlled bank. *Board* reflects the board size and refers to the number of directors on the board. A bank with a small board is inclined to be a shareholder-controlled bank. *IND_B* is the board independence measured by the percentage of board members who are independent. A bank with a larger degree of board independence is inclined to be a shareholder-controlled bank. *Dual* is a dummy variable indicating whether the CEO is also the chairman of the board. A bank with CEO duality tends to be a shareholder-controlled bank. *U_S, U_B,* and *U_E* are the dummy variables indicating whether the ultimate owner of a bank is the state, the bank, and the enterprise, respectively. *t*-Statistics based on robust standard errors clustered by country are reported in parentheses. ***, **, and * denote significant levels at the 1%, 5%, and 10% levels respectively.

Table 7
Bank governance, regulations, and risk taking.

	Credit Risk (CR)					Interest Rate Risk (IR)					Liquidity Risk (LR)				
	IND_S	OC	Board	IND_B	Dual	IND_S	OC	Board	IND_B	Dual	IND_S	OC	Board	IND_B	Dual
Panel A: Whole period (6502 bank-year observations)															
Constant	3.00	0.94	2.03	1.80	2.22	−12.26	2.65	−10.79	−6.10	−1.94	14.00	−1.61	8.94	1.88	3.53
	(2.71)***	(1.29)	(2.48)**	(2.95)***	(3.81)***	(−3.17)***	(1.04)	(−4.35)***	(−3.29)***	(−1.09)	(2.42)**	(−0.42)	(2.36)**	(0.66)	(1.30)
Merger	−0.31	−0.33	−0.19	−0.19	−0.20	0.16	0.14	0.01	0.005	−0.07	0.42	0.34	0.68	0.76	0.62
	(−1.67)*	(−1.71)	(−0.96)	(−0.93)	(−0.99)	(0.24)	(0.22)	(0.02)	(0.01)	(−0.12)	(0.43)	(0.34)	(0.73)	(0.81)	(0.67)
G_Index	−0.41	0.02	0.03	1.79	0.11	3.47	−0.11	0.94	18.15	0.64	−3.68	0.08	−0.53	4.92	1.23
	(−1.32)	(2.03)***	(0.48)	(1.30)	(1.06)	(3.23)***	(−3.00)***	(4.93)***	(4.36)***	(2.02)**	(−2.29)**	(1.48)	(−1.82)*	(0.77)	(2.54)**
DI	−1.05	0.51	0.66	0.11	−0.10	5.17	−0.97	9.63	4.98	1.68	3.92	1.99	1.64	3.29	2.46
	(−1.18)	(1.05)	(1.03)	(0.26)	(−0.28)	(1.67)*	(−0.57)	(4.96)***	(4.03)***	(1.58)	(0.85)	(0.78)	(0.55)	(1.73)*	(1.52)
Capital	−0.03	0.17	0.10	0.13	0.11	1.10	−0.26	0.21	0.15	0.08	−1.24	1.15	0.07	0.37	0.36
	(−0.55)	(5.45)***	(3.28)***	(5.70)***	(5.04)***	(5.80)***	(−2.29)**	(2.25)**	(2.24)**	(1.30)	(−4.37)***	(7.01)***	(0.51)	(3.62)***	(3.60)***
SR	0.11	−0.12	−0.23	−0.16	−0.16	0.08	0.25	0.09	0.05	0.04	−0.60	−0.62	−0.81	−0.39	−0.52
	(1.62)	(−3.01)***	(−6.02)***	(−6.17)***	(−5.78)***	(0.34)	(1.83)*	(0.74)	(0.56)	(0.41)	(−1.69)*	(−3.04)***	(−4.47)***	(−3.08)***	(−3.99)***
G*DI	0.33	−0.01	−0.08	−0.82		−1.25	0.06	−0.82	−14.17		−0.26	0.03	0.14	−2.08	
	(1.23)	(−1.47)	(−1.33)	(−0.87)		(−1.33)	(1.73)*	(−4.75)***	(−4.94)***		(−0.18)	(0.71)	(0.54)	(−0.47)	
G*Capital	0.04	−0.002	0.001	−0.26		−0.32	0.01	−0.02	−0.94		0.55	−0.02	0.04	−0.11	
	(2.48)**	(−3.36)***	(0.38)	(−2.51)**		(−5.48)***	(4.71)***	(−1.82)*	(−2.99)***		(6.27)***	(−5.97)***	(2.94)***	(−0.24)	
G*SR	−0.06	0.001	0.01	0.17		0.02	0.00	0.002	0.40		0.03	0.004	0.05	−0.42	
	(−2.76)***	(1.87)	(2.82)***	(1.46)		(0.23)	(−1.44)	(0.15)	(1.11)		(0.28)	(1.12)	(2.87)***	(−0.76)	
Risk	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control Var.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. *R*-squared	0.63	0.62	0.60	0.60	0.60	0.48	0.48	0.50	0.50	0.49	0.78	0.77	0.80	0.80	0.80
Panel B: Regular YCS Period (4630 bank-year observations)															
Constant	0.98	−0.56	1.25	1.20	1.53	−15.08	−1.06	−20.97	−9.00	−3.95	12.25	−5.91	5.85	−3.14	0.53
	(0.93)	(−0.80)	(1.48)	(2.09)**	(2.81)***	(−4.13)***	(−0.43)	(−8.68)***	(−5.43)***	(−2.47)**	(1.65)*	(−1.21)	(1.14)	(−0.89)	(0.16)
Merger	−0.10	−0.10	−0.07	−0.08	−0.08	0.50	0.51	0.27	0.24	0.21	0.74	0.59	0.85	0.81	0.73
	(−0.54)	(−0.56)	(−0.39)	(−0.39)	(−0.42)	(0.80)	(0.79)	(0.50)	(0.44)	(0.37)	(0.58)	(0.46)	(0.73)	(0.70)	(0.63)
G_Index	−0.25	0.02	0.04	1.25	0.14	3.50	−0.08	1.68	13.43	0.13	−4.26	0.11	−0.44	7.65	2.17
	(−0.83)	(2.04)**	(0.62)	(0.86)	(1.44)	(3.43)***	(−2.21)**	(9.01)***	(3.18)***	(0.47)	(−2.05)**	(1.39)	(−1.12)	(0.86)	(3.70)
DI	−0.99	0.08	−0.05	−0.72	−0.82	3.25	0.97	18.53	7.17	2.38	6.30	5.82	4.92	6.01	4.70
	(−1.18)	(0.15)	(−0.07)	(−1.71)*	(−2.25)**	(1.11)	(0.54)	(9.22)***	(5.93)***	(2.24)**	(1.07)	(1.61)	(1.15)	(2.34)**	(2.11)
Capital	0.13	0.22	0.11	0.17	0.15	1.72	−0.11	0.38	0.21	0.20	−1.32	1.42	0.34	0.71	0.63
	(1.86)*	(7.82)***	(3.56)***	(7.88)***	(7.07)***	(7.49)***	(−1.16)	(4.17)***	(3.33)***	(3.18)***	(−2.78)***	(7.27)***	(1.72)*	(5.27)***	(4.84)
SR	0.12	0.02	−0.08	−0.06	−0.06	0.17	0.30	0.07	0.09	0.13	−0.44	−0.52	−0.75	−0.23	−0.39
	(1.88)*	(0.57)	(−2.21)**	(−2.53)**	(−2.36)**	(0.81)	(2.48)**	(0.65)	(1.28)	(1.79)*	(−1.01)	(−2.14)**	(−3.48)***	(−1.53)	(−2.50)**
G*DI	0.21	−0.01	−0.07	0.06		−0.56	0.01	−1.62	−20.58		0.20	0.02	0.08	−3.22	
	(0.83)	(−1.24)	(−1.20)	(0.06)		(− 0.63)	(0.44)	(−9.35)***	(−7.26)***		(0.11)	(0.37)	(0.21)	(−0.54)	
G*Capital	0.01	−0.002	0.005	−0.30		−0.45	0.01	−0.02	0.36		0.62	−0.02	0.04	−0.59	
	(0.62)	(−2.62)	(1.66)*	(−3.12)***		(−6.94)***	(5.20)***	(−2.40)**	(1.28)		(4.68)***	(−4.85)***	(2.17)**	(−1.00)	
G*SR	−0.02	0.001	0.003	0.21		0.01	−0.002	0.01	0.72		0.03	0.01	0.06	−0.41	
	(−1.36)	(1.01)***	(1.08)	(1.29)		(0.12)	(−1.00)	(0.87)	(1.50)		(0.22)	(1.34)	(3.43)***	(−0.41)	
Risk	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control Var.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. *R*-squared	0.73	0.73	0.72	0.72	0.72	0.59	0.59	0.61	0.61	0.60	0.75	0.75	0.81	0.80	0.81
Panel C: Inverted YCS Period (1014 bank-year observations)															
Constant	1.99	−0.63	0.84	0.71	1.03	−21.78	0.24	−15.47	−9.68	−4.05	7.82	−6.17	2.68	−4.82	−2.71
	(1.98)**	(−1.03)	(1.24)	(1.40)	(2.16)**	(−6.11)***	(0.11)	(−7.36)***	(−6.15)***	(−2.70)***	(1.11)	(−1.44)	(0.63)	(−1.51)	(−0.91)
Merger	−0.04	−0.04	−0.01	−0.01	−0.02	−0.49	−0.50	−0.53	−0.57	−0.60	0.98	0.85	1.06	1.09	1.00
	(−0.28)	(−0.29)	(−0.07)	(−0.05)	(−0.13)	(−0.91)	(−0.92)	(−1.10)	(−1.19)	(−1.25)	(0.95)	(0.81)	(1.11)	(1.13)	(1.05)
G_Index	−0.51	0.03	0.03	1.75	0.11	4.98	−0.17	1.06	21.31	0.47	−3.37	0.06	−0.47	9.13	1.07
	(−1.87)*	(3.10)***	(0.57)	(1.57)	(1.37)	(5.08)***	(−4.97)***	(6.94)***	(6.10)***	(1.91)*	(−1.75)*	(0.85)	(−1.52)	(1.30)	(2.15)**
DI	−1.80	0.12	0.07	−0.56	−0.65	4.36	−0.92	12.26	6.74	1.87	6.53	0.99	1.54	4.12	3.17
	(−2.31)**	(0.28)	(0.14)	(−1.57)	(−2.22)**	(1.54)	(−0.57)	(7.46)***	(6.11)***	(2.03)**	(1.19)	(0.32)	(0.46)	(1.85)*	(1.72)*

Capital	0.09	0.23	0.14	0.19	0.17	2.52	−0.20	0.18	0.28	0.21	−1.56	1.45	0.41	0.80	0.75
	(1.28)	(8.55)***	(4.10)***	(8.72)***	(7.96)***	(10.42)***	(−2.03)**	(1.68)*	(4.04)***	(3.16)***	(−3.12)***	(7.55)***	(1.95)*	(5.75)***	(5.59)***
SR	0.10	−0.0004	−0.09	−0.06	−0.06	−0.10	0.36	0.35	0.11	0.13	−0.13	−0.64	−0.50	−0.32	−0.42
	(1.76)*	(−0.01)	(−2.80)***	(−2.83)***	(−2.61)***	(−0.49)	(3.15)***	(3.36)***	(1.58)	(1.79)*	(−0.31)	(−2.90)***	(−2.41)**	(−2.31)**	(−2.98)***
G*DI	0.41	−0.02	−0.07	−0.20		−0.88	0.06	−1.00	−17.76		−0.97	0.07	0.22	−3.03	
	(1.71)*	(−2.17)**	(−1.52)	(−0.27)		(−1.01)	(2.00)**	(−7.42)***	(−7.59)***		(−0.58)	(1.12)	(0.82)	(−0.64)	
G*Capital	0.02	−0.002	0.003	−0.31		−0.66	0.02	0.004	−0.91		0.70	−0.02	0.04	−0.60	
	(1.25)	(−3.13)***	(1.15)	(−3.28)***		(−9.83)***	(7.63)***	(0.42)	(−3.08)***		(5.11)***	(−4.58)***	(2.11)**	(−1.01)	
G*SR	−0.03	0.001	0.005	0.15		0.10	−0.004	−0.02	0.43		−0.09	0.01	0.02	−0.50	
	(−1.47)	(1.31)	(1.74)*	(1.67)*		(1.66)*	(−1.98)**	(−2.20)**	(1.49)		(−0.76)	(1.94)*	(1.12)	(−0.85)	
Risk	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control Var.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R-squared	0.73	0.73	0.73	0.73	0.73	0.42	0.42	0.43	0.43	0.42	0.79	0.78	0.82	0.82	0.82

This table shows the results of a regression analysis which estimates a system of equations (simultaneous equations) with controlling for corporate governance characteristics, regulations, and interaction terms via three-stage least squares. We report the results of all banks during the whole period, regular YCS period, and inverted YCS period. All equations include contemporaneous independent risk variables, one-year lagged value of the dependent variable as well as control variables covering the log of total assets (Ln(TA)), capital ratio (EA), the growth rate of real gross domestic product (RGDPG), and annual time fixed effects. We do not show them in the table for reasons of brevity. Because some sample countries do not have the anti-director index provided by La Porta et al. (1999), our bank-year observations for the whole period reduce to 6502. Similarly, since the period of regular YCS and that of inverted YCS in some countries cannot be distinguished based on lacking of both/either T-bill and T-bonds data, the number of observations further be becomed 5644. *CR* is the credit risk measured by non-performing loan (NPL) ratio. *IR* is the interest rate risk measured by the ratio of cumulative one-year repricing gap to total assets (CGAP_A). *LR* is the liquidity risk measured by the ratio of the dollar amount of bank liquidity creation to total assets. *Merger* is a dummy variable indicating whether a bank was involved in one or more mergers. *IND_S* is the shareholder independence measured by BvD independence indicators in *Bankscope*. The values 4 to 1 are assigned to A, B, C, and D, respectively. Higher value exhibits that bank shareholders have higher degree of independence and this bank tends to be a management-controlled bank. *OC* is the degree of ownership concentration. It is defined as "the maximum of the direct or total shareholding for a shareholder". Higher value represents that a bank tends to be a shareholder-controlled bank. *Board* reflects the board size and refers to the number of directors on the board. A bank with a small board is inclined to be a shareholder-controlled bank. *IND_B* is the board independence measured by the percentage of board members who are independent. A bank with a larger degree of board independence is inclined to be a shareholder-controlled bank. *Dual* is a dummy variable indicating whether the CEO is also the chairman of the board. A bank with CEO duality tends to be a shareholder-controlled bank. *U_S*, *U_B*, and *U_E* are the dummy variables indicating whether the ultimate owner of a bank is the state, the bank, and the enterprise, respectively. *DI* takes a value of one if the country has explicit deposit insurance, and zero otherwise. *Capital* is an index of regulatory oversight of bank capital from the *Bank Regulation and Supervision* database provided by the World Bank. It released in 2001 and updated in 2003, 2007, and 2012 respectively to capture regulatory changes in capital requirements. The range for the index is from 0 to 9. Higher values indicates greater stringency. *SR* is the anti-director index calculated by La Porta et al. (1999) and ranges from 0 to 6. Higher values represent greater shareholder rights. t-statistics based on robust standard errors clustered by country are reported in parentheses. ***, **, and * denote significant levels at the 1%, 5%, and 10% levels respectively.

YCS period, but the interactions among risks disappear in the regular YCS period. Therefore, corporate governance structure and regulations alleviate the interactions among risks.

Second, the results shown in Table 7 exhibit that all governance indicators have statistically significant effects on interest rate risk. Management-controlled banks measured by IND_S directly exert negative effects on bank liquidity risk, whereas shareholder-controlled banks measured by Dual tend to increase liquidity risk exposure. The magnitude and significant level of the coefficient of IND_S or Dual become weaker in the inverted YCS period. Only banks with a more concentrated ownership (OC) raise credit risks. In terms of regulations, all of the regulation variables induce banks to increase interest rate risk. The direct effect of explicit deposit insurance (DI) is to raise bank liquidity risk exposure, especially during the regular YCS period. Additionally, Stricter capital regulations (Capital) induce banks to boost all types of risks,[38] whereas stronger shareholder rights (SR) tend to reduce bank liquidity risk. Most of the direct effects of both regulation variables (i.e., Capital and SR) are larger in the inverted YCS period.

The abovementioned results confirm our expectations except for the effects of SR. Hence, deposit insurance and capital regulations intensify the incentive of banks to pursue risk. The DI in the CR equation when controlling for Dual enters negatively and significantly, indicating that banks reduce credit risk exposure under explicit deposit insurance, especially during the regular YCS period. This may be related to deposit insurance premium that is linked to asset quality. Comparing the effect of Capital with the effect of SR in the CR equation (see panel B and C of Table 7), the risk-enhancing effect of stricter capital regulations is larger than the risk-reducing effect of better shareholder rights. In the LR equation, this evidence is obtained as well, except for controlling for IND_S and Board.

Third, with respect to the interaction terms, during the regular YCS period, Board $\times$ Capital enters positively and significantly in the CR and LR equations. Therefore, capital regulations enhance a bank's incentive and power to increase credit and liquidity risks when the bank has a large board. Board $\times$ SR in the LR equation also has a similar positive effect although the direct effect of SR is negative. We further compare the total effects of Capital with the total effects of SR. Bank liquidity risk can *rise* by 0.87 standard deviations if one standard deviation increases in Capital (1.6) when the bank has 5.1 directors (i.e., the mean of Board). However, if we do not change the number of directors, bank liquidity risk can *fall* by 0.75 standard deviations if there one standard deviation increases in SR (1.7). The regulation effect break-even is about 4.4 directors. Both the increase and reduction in risk are statistically significant. Hence, banks can raise liquidity risk if their board directors are more than 4.4, considering only the effects of capital regulations and shareholder rights. This evidence also indicates that the impacts of regulations depend on bank boards.

Capital regulations have significantly different implications for the risk-taking behaviors of shareholder-controlled banks compared with those of management-controlled banks. For instance, during the inverted YCS period, although the coefficient of OC $\times$ Capital in the CR equation is negative and significant, the total effects of Capital remain positive because the magnitude of the coefficient of the interaction term is exceedingly small. However, the risk-enhancing effect of capital regulations in a management-controlled bank (i.e. a widely held bank) is larger than that in a shareholder-controlled bank. This finding is not

38 An exception exists in the LR equation, that is, the direct effect of capital regulations is to reduce bank liquidity risk as we control for shareholder independence (IND_S).

consistent with Laeven and Levine (2009). We also find the same evidence in the LR equation when we control for shareholder independence[39] (IND_S). The results show that capital regulations induce management-controlled banks to increase their liquidity risk-taking. Indeed, with a sufficiently independent shareholder, capital regulations will increase bank liquidity risk though the direct effect of capital regulations is negative. On the contrary, same regulations lead shareholder-controlled banks to decrease their credit and liquidity risk-taking.

Overall, corporate governance structure and regulations jointly alleviate the interactions among risks. Explicit deposit insurance raises bank liquidity risk exposure, and stricter capital regulations also increase bank risk-taking, however, stronger shareholder rights reduce bank liquidity risk. Moreover, the risk-enhancing effect of stricter capital regulations is larger than the risk-reducing effect of better shareholder rights. Additionally, management-controlled banks increase their incentive of taking liquidity risk, whereas shareholder-controlled banks decrease their credit and liquidity risk-taking when they are located in countries with tighter capital regulations. Hence, the impact of capital regulations on bank risk depends critically on each bank's governance characteristics.

5. Robustness tests

5.1. Credit and liquidity risk proxies

First, *ceteris paribus,* we replace our original main variable CR with two proxy variables for credit risk: the LLP measure and the NCO measure. NPL ratio is blamed for a backward-looking measure of credit risk owing to the nature of loan quality although it is a timely source of information about loan default. Recent studies (e.g., Covitz and Downing, 2007; Erkens et al., 2012) begin to use expected default probability (EDF) provided by Moody's KMV CreditMonitor to capture credit risk. EDF is estimated by financial statement data, equity market information, and proprietary data on the empirical distribution of defaults. It represents the probability that a firm will default within one year. However, we cannot use this forward-looking measure because our dataset includes unlisted banks.

Barth and Landsman (2010) argue that loan loss provisioning (LLP) is most likely a critical factor in determining the health of a bank. LLP represents that bank managers' prediction of loans at risk of default for the current period. Higher LLP signals future trouble because managers have private information on loan quality and default risk (Jin et al., 2011). LLP is an income statement item, so it is applicable to all sample banks. An important caveat of LLP, however, is that bank managers may be more conservative in their estimates or they are more prompt in recognizing loan losses (Jin et al., 2011). We use the ratio of LLP to average gross loan[40] as our second credit risk proxy (i.e., LLP measure). We also refer to the approach of Imbierowicz and Rauch (2014) to measure the third credit risk proxy (i.e., NCO measure), which is the ratio of net charge-offs in the current year to loan loss allowance[41] recorded in the previous year. This measure describes a bank's ability to cover near-term future loan losses. If this ratio is above 100%, the bank has unanticipated loan losses. Thus, a higher ratio implies a higher credit risk.

The LLP and the NCO measures are used as the forward-looking measures of credit risk. The former represents the anticipated loan losses, whereas the latter only reflects unanticipated loan losses.

Second, *ceteris paribus,* we replace our original main variable LR with two proxy variables for liquidity risk: the inverse of LCR and the inverse of NSFR. The BIS's Basel Committee on Banking Supervision developed two new liquidity ratios, which are the liquidity coverage ratio (LCR) and the net stable funds ratio (NSFR), to improve banks' liquidity risk management and control banks' liquidity risk exposure after the financial crisis of 2007–2008. The LCR is defined as dividing stock of high-quality liquid assets by total net cash outflows over the next 30 calendar days.[42] It ensures that a bank maintains an adequate level of high-quality assets that can be converted into cash to meet liquidity needs for a 30-day time horizon. This ratio has been reported to the supervisors since 2015, and the minimum ratio is 100%.

The NSFR is the ratio of available amount of stable funding to required amount of stable funding.[43] Such ratio considers liquidity on a bank's balance sheet in a longer term. This ratio requires a minimum amount of stable funding to be held over a one-year time horizon based on liquidity risk factors assigned to liquidity exposure of on- and off-balance-sheet assets. The NSFR ratio limits reliance on short-term wholesale funding, which is the major problem in the financial crisis. It will be reported to supervisors starting in 2018, and it is required to be more than 100%.

In this study, we calculate the inverse of LCR and the inverse of NSFR to measure the short-term and long-term bank liquidity risk exposure, respectively. Higher ratios imply higher liquidity risk. The necessary information, such as security rating, maturity, transaction counterparty, or financial derivatives provided by *Bankscope*, are not applicable or even available when the LCR or NSFR is calculated. Consequently, the LCR or the NSFR ratio is underestimated, and then their reciprocals that measure liquidity risk exposure are overestimated.

To ensure the validity of the NPL and the LC_A ratio as a solid proxy for credit and liquidity risks, respectively, we only examine the relationship among credit, interest rate, and liquidity risks[44] without controlling for the bank-level governance characteristics. Then, we replace one type of risk proxy; other types of risk categories continue to use their original proxy variables in each test. The results are displayed in Table 8. In panel A of Table 8, we replace CR proxy with the LLP measure. Based on this alternative method of measuring credit risk, we obtain consistent results: a relationship among credit, interest rate, and liquidity risks exists for the whole period and the regular YCS period. Nevertheless, we detect statistically insignificant relationship among risks during the inverted YCS period. Similarly, in panel B of Table 8, the NCO measure is used as a substitute for the original CR proxy, that is, NPL ratio. The effects of NCO are consistent with our prior findings and the impacts of other risk categories on NCO are larger than those on NPL in our prior findings. However, the interactions between NCO and other risk categories are not statistically significant. NPL ratio can therefore be seen as a valid proxy for credit risk from a statistically or economically meaningful view.

In panel C of Table 8, we replace LR proxy with the inverse of LCR. In panel D, the inverse of NSFR substitutes for the original

[39] Bank liquidity risk can rise by 1.86 standard deviations if one standard deviation increases in Capital (1.6) when the IND_S is 4 (i.e., a management-controlled bank). However, bank liquidity risk can fall by 1.12 standard deviations if one standard deviation increases in Capital when the IND_S is 1 (i.e., a shareholder-controlled bank).

[40] The observations are further reduced to 7404 because the LLP data of several banks are not available in *Bankscope*.

[41] Net charge-offs refers to the value of loans and leases removed from the books and charged against loss reserves, minus recoveries on delinquent debt. It reflects the actual losses on loans. Loan loss allowance is a cumulative estimate by the bank manager of the gross loans that will not be repaid to the bank. The observations are further reduced to 5675 because some banks' data in *Bankscope* is unavailable.

[42] The definitions of stock of high-quality liquid assets and total net cash outflows are described in Basel Committee on Banking Supervision (2013). This publication is available on the BIS website (www.bis.org).

[43] The definitions of available stable funding and required stable funding are described in Basel Committee on Banking Supervision (2014). This publication is available on the BIS website (www.bis.org).

[44] We also examine the results by replacing the CR and LR proxies simultaneously. Our prior findings are supported from a statistically or economically meaningful view.

Table 8
Robustness test – the credit and liquidity risk proxies.

	Credit Risk (CR)				Interest Rate Risk (IR)				Liquidity Risk (LR)		
	Whole period	Regular YCS Period	Inverted YCS Period		Whole period	Regular YCS Period	Inverted YCS Period		Whole period	Regular YCS Period	Inverted YCS Period
Panel A: Credit Risk Proxy–LLP											
Constant	0.3827	1.2112	−1.3907	Constant	2.0966	1.2123	−8.5155	Constant	2.1703	8.1221	−7.3670
	(0.37)	(0.86)	(−0.50)		(2.18)**	(1.22)	(−1.73)*		(1.10)	(3.33)***	(−0.78)
IR(t)	−0.0143	−0.0170	−0.0246	CR(t)	−0.0054	−0.0050	0.0207	CR(t)	0.0381	0.0323	0.1099
	(−1.34)	(−1.18)	(−1.06)		(−0.64)	(−0.68)	(0.54)		(2.19)**	(1.77)*	(1.49)
LR(t)	0.0051	0.0070	0.0007	LR(t)	−0.0042	−0.0001	−0.0079	IR(t)	0.0168	−0.0015	0.1009
	(2.15)**	(2.32)**	(0.20)		(−1.88)**	(−0.04)	(−1.33)		(0.82)	(−0.06)	(1.29)
Merger	0.0523	0.0091	0.1863	Merger	0.4998	0.4070	−1.2212	Merger	−0.3007	0.4095	−0.0742
	(0.07)	(0.01)	(0.23)		(0.73)	(0.56)	(−0.86)		(−0.22)	(0.23)	(−0.03)
CR(t-1) & Control	YES	YES	YES	IR(t-1) & Control	YES	YES	YES	LR(t-1) & Control	YES	YES	YES
Adj. R-squared	0.24	0.37	0.37	Adj. R-squared	0.50	0.50	0.31	Adj. R-squared	0.79	0.79	0.62
N of observations	7404	4970	1327	N of observations	7404	4970	1327	N of observations	7404	4970	1327
Panel B: Credit Risk Proxy—NCO											
Constant	0.1204	−37.4121	332.9586	Constant	2.4644	0.7119	191.9313	Constant	−3.5186	−0.2661	6.1195
	(0.005)	(−4.24)***	(0.77)		(2.71)***	(0.76)	(0.10)		(−2.66)***	(−0.15)	(0.09)
IR(t)	−0.1872	−0.0655	−5.3966	CR(t)	0.0111	−0.0039	−0.5368	CR(t)	0.0084	0.0123	0.0376
	(−0.56)	(−0.55)	(−1.72)		(0.57)	(−0.40)	(−0.11)		(0.30)	(0.65)	(0.20)
LR(t)	0.1902	−0.0435	0.9535	LR(t)	−0.0168	−0.0077	0.5780	IR(t)	0.0167	−0.0110	0.3008
	(1.58)	(−1.08)	(1.64)		(−2.94)**	(−1.95)*	(0.10)		(0.94)	(−0.49)	(0.30)
Merger	−2.1000	−0.0127	−17.3788	Merger	0.5700	0.5702	−8.4448	Merger	0.3268	0.6193	2.0945
	(−0.11)	(−0.002)	(−0.24)		(0.88)	(0.90)	(−0.10)		(0.35)	(0.51)	(0.50)
CR(t-1) & Control	YES	YES	YES	IR(t-1) & Control	YES	YES	YES	LR(t-1) & Control	YES	YES	YES
Adj. R-squared	0.10	0.15	0.10	Adj. R-squared	0.54	0.48	0.10	Adj. R-squared	0.73	0.60	0.50
N of observations	5675	3896	951	N of observations	5675	3896	951	N of observations	5675	3896	951
Panel C: Liquidity Risk Proxy-Inverse of LCR											
Constant	1.9378	1.8934	−0.8995	Constant	2.9205	1.0560	−6.9773	Constant	−488.5514	−1535.5609	1977.2552
	(5.80)***	(5.18)***	(−0.41)		(3.35)***	(1.22)	(−1.16)		(−0.57)	(−2.13)**	(0.35)
IR(t)	−0.0016	−0.0008	−0.0193	CR(t)	−0.0749	−0.0757	−0.1892	CR(t)	43.8951	43.8928	38.4698
	(−0.38)	(−0.16)	(−1.16)		(−2.97)***	(−2.78)***	(−4.05)***		(1.77)*	(1.93)*	(0.83)
LR(t)	0.00001	0.00001	0.00002	LR(t)	0.00001	0.000001	−0.00001	IR(t)	0.53531	5.18409	−65.43692
	(2.28)**	(2.78)***	(2.10)**		(1.39)	(0.09)	(−0.19)		(0.05)	(0.53)	(−1.50)
Merger	−0.3128	−0.0708	−0.2549	Merger	0.5063	0.5339	−0.6137	Merger	−58.1375	−187.2057	−124.4476
	(−1.32)	(−0.26)	(−0.71)		(0.82)	(0.85)	(−0.62)		(−0.10)	(−0.35)	(−0.13)
CR(t-1) & Control	YES	YES	YES	IR(t-1) & Control	YES	YES	YES	LR(t-1) & Control	YES	YES	YES
Adj. R-squared	0.57	0.60	0.60	Adj. R-squared	0.50	0.58	0.30	Adj. R-squared	0.54	0.66	0.42
N of observations	8187	5270	1753	N of observations	8187	5270	1753	N of observations	8187	5270	1753
Panel D: Liquidity Risk Proxy-Inverse of NSFR											
Constant	1.6273	1.7083	−1.0834	Constant	0.4448	0.6308	−6.8912	Constant	−207.0868	−287.7711	−131.6489
	(2.78)***	(4.05)***	(−0.49)		(0.19)	(0.62)	(−1.15)		(−2.70)***	(−2.59)***	(−0.75)
IR(t)	0.0052	0.0022	−0.0191	CR(t)	−0.0085	−0.0692	−0.1903	CR(t)	5.4551	4.5142	−3.7856
	(0.46)	(0.36)	(−1.14)		(−0.14)	(−2.39)**	(−4.09)***		(2.46)**	(1.29)	(−2.66)***
LR(t)	−0.0015	−0.0005	−0.0003	LR(t)	−0.0130	−0.0016	0.0004	IR(t)	4.4469	5.2389	−5.7622
	(−0.63)	(−0.70)	(−1.01)		(−1.33)	(−0.87)	(0.39)		(4.52)***	(3.49)***	(−4.23)***
Merger	−0.4462	−0.1384	−0.2743	Merger	−0.5411	0.3544	−0.5753	Merger	−83.9665	−117.9650	−27.2814
	(−1.37)	(−0.48)	(−0.76)		(−0.44)	(0.52)	(−0.58)		(−1.56)	(−1.45)	(−0.94)
CR(t-1) & Control	YES	YES	YES	IR(t-1) & Control	YES	YES	YES	LR(t-1) & Control	YES	YES	YES
Adj. R-squared	0.51	0.59	0.49	Adj. R-squared	0.23	0.55	0.31	Adj. R-squared	0.65	0.64	0.55
N of observations	8663	5711	1759	N of observations	8663	5711	1759	N of observations	8663	5711	1759

In order to check the validity of the NPL ratio and the LC_A ratio as a solid proxy for credit risk and liquidity risk respectively, we only examine the relationship among credit, interest rate, and liquidity risks without controlling for the bank-level governance characteristics. In panel A, we replace our original variable CR with the LLP measure. The LLP measure is the ratio of loan loss provisioning (LLP) to average gross loan. It signals future trouble since managers have private information on loan quality and default risk. A higher ratio indicates higher credit risk. In panel B, we replace our original variable CR with the NCO measure. The NCO measure is the ratio of net charge-offs in the current year to loan loss allowance recorded in the previous year. It describes a bank's ability to cover near-term future loan losses. A higher ratio denotes higher credit risk. In panel C, we replace our original variable LR with the inverse of LCR. The inverse of LCR is defined as dividing total net cash outflows over the next 30 calendar days by stock of high-quality liquid assets. A higher ratio reflects higher liquidity risk. In panel D, we replace our original variable LR with the inverse of NSFR. The inverse of NSFR is the ratio of required amount of stable funding to available amount of stable funding. A higher ratio implies higher liquidity risk. The original CR is measured by non-performing loan (NPL) ratio. *IR* is the interest rate risk measured by the ratio of cumulative one-year repricing gap to total assets (CGAP_A). The original LR is the liquidity risk measured by the ratio of the dollar amount of bank liquidity creation to total assets. The total observations for the LLP measure, the NCO measure, and the inverse of LCR are reduced to 7404, 5675, and 8187 due to data unavailable. t-statistics based on robust standard errors clustered by country are reported in parentheses. ***, **, and * denote significant levels at the 1%, 5%, and 10% levels respectively.

LR proxy, that is, LC_A. All of the results confirm our prior findings, but the economic effects of the new LR proxy on credit and interest rate risks become negligible and even statistically unmeaningful. Therefore, LC_A can be seen as a valid proxy for liquidity risk from a statistically or economically meaningful view.

5.2. Relationship among credit, interest rate and liquidity risks

To examine if any two risks jointly have an impact on another risk, we add the interaction terms between the different types of risk in the system of equations without controlling for the bank-level governance characteristics. For brevity, we only report the coefficients of the interaction terms in Panel A of Table 9. We find that our main analyses are still supported though the significant levels are slightly weak. The interaction term, CR × LR, is highly significant and negative at the 5% level across all sample period specifications while other interaction terms (i.e. IR × LR and CR × IR) are insignificant. The results suggest that there is a joint and negative influence of the interaction between credit risk and liquidity risk on CGAP, thereby increasing bank interest rate risk, however, a joint occurrence of IR and LR (or CR and IR) has no impact on credit risk (or on liquidity risk). The adjusted *R*-squared of each equation that adds the interaction term is also not substantially improved. Hence, our hypothesis H_1 that a relationship exists among credit, interest rate, and liquidity risks is confirmed. Moreover, only credit risk and liquidity risk jointly contribute to bank interest rate risk. This also demonstrates that our empirical model indeed captures the linkage among credit, interest rate, and liquidity risks.

Since the recent financial crisis started in developed countries, we divide the sample into developed and developing economies according to the classification of the World Bank to investigate whether the relationship among risks is different by the level of economic development. The results shown in panel B and C of Table 9 reinforce our main analyses. That is, a relationship among credit, interest rate, and liquidity risks exists in developed and developing economies. The economic effects of the interactions among risks are also magnified. Banks in developed economies take more interest rate risks as their credit and liquidity risks increase; however, their interest rate risk-taking does not significantly affect contemporaneous credit or liquidity risk-taking. In addition, the CR and LR or the IR and LR change jointly in developing economies. The authorities in developed economies should monitor the liquidity risk exposure of acquiring banks when mergers occurred in the previous year.

We also subdivide the sample period by 2007. The period before 2007 is the pre-financial crisis period, whereas the remaining period is during and post-financial crisis. The results in panel D and E of Table 9 confirm our prior findings; moreover, the effects are considerable for the during and post-financial crisis period although only credit risk increases with interest rate risk in the inverted YCS period before 2007.

5.3. Effects of corporate governance structure on the relationship among credit, interest rate, and liquidity risks

The linkage among risks is slightly weak in the pre-financial crisis period,[45] so we only examine the effects of corporate governance structure in developed and developing economies. The relationship among credit, interest rate, and liquidity risks continues to exist in developed and developing economies (see Table 10). Compared with the results of Table 6, the economic effect of the relationship become more considerable and statistically significant for developing economies. Hence, to consider the integrated impacts of risks is necessary. During the regular YCS period, management-controlled banks take fewer credit risks, whereas shareholder-controlled banks take more credit and interest rate risks. Most of the economic impacts of governance characteristics are higher in developing countries than those in developed countries. During the inverted YCS period, management-controlled banks continue to take fewer credit risks even though their CGAP strategy would lower their profits or result in loss at taking interest rate risk, whereas shareholder-controlled banks take more risk through direct or indirect effects that are combined the interactive effects of risks. In addition, banks that are owned ultimately by banks and enterprises tend to take fewer credit risks in developed economies. These effects are more significant and larger in the inverted YCS period than those in the regular YCS period. On the contrary, governments in developed countries induce their ultimately owned banks to increase credit risk exposure during the inverted YCS period, however, this same effects occur in the regular YCS period for banks in developing countries. Hence, the authorities should limit the state ownership in a bank. Only banks in developed countries will take more liquidity risks during the inverted YCS period when their ultimate owner is the bank. The risk-taking behavior of a management-controlled bank is more consistent and statistically significant in developing economies than that in developed economies. The authorities in the developed countries should monitor the liquidity risk and interest rate risk exposure of acquiring banks during the inverted YCS period when they were involved in mergers in the previous year. Therefore, our main findings are robust in developed and developing economies.

5.4. Effects of regulations

We further examine the effects of regulations in developed and developing economies. The results are shown in Table 11 and are qualitatively similar to our main results although the statistically significant effects of governance indicators become weak during the regular YCS period. In developing economies, explicit deposit insurance enhances bank interest rate and liquidity risk-taking and stricter capital regulations induce banks to boost all types of risks. But stronger shareholder rights reduce bank risk exposure regardless of economy. In terms of liquidity risk, the risk-enhancing effects of stricter capital regulations are smaller than the risk-reducing effects of better shareholder rights in developed countries during the inverted YCS period. However, with regard to credit risk, the result is the opposite. In addition, capital regulations have different implications for banks in developed countries compared with banks in developing ones. In developed countries, stricter capital regulations induce a shareholder-controlled bank to take more interest rate risk by using positive CGAP and decrease credit and liquidity risks. However, the same regulations strengthen a management-controlled bank's incentive to increase its interest rate and liquidity risk exposure. On the contrary, in developing economies, stricter capital regulations and stronger shareholder rights enhance a shareholder-controlled bank's incentive and power to increase credit and interest rate risks, especially during the regular YCS period, whereas these regulations induce a management-controlled bank to decrease its credit risk exposure. Hence, stricter capital regulations are applicable to shareholder-controlled banks in developed economies.

[45] We examine the effects of corporate governance structure and the effects of regulations for the during and post-financial crisis period. All of the results hold.

Table 9
Robustness test – the relationship among credit, interest rate, and liquidity risks.

	Credit Risk (CR)				Interest Rate Risk (IR)				Liquidity Risk (LR)		
	Whole period	Regular YCS Periods	Inverted YCS Periods		Whole period	Regular YCS Periods	Inverted YCS Periods		Whole period	Regular YCS Periods	Inverted YCS Periods
Panel A: Interaction terms between the different types of risk included											
IR × LR	−0.0001	0.0001	−0.0002	CR × LR	−0.0058	−0.0043	−0.0089	CR × IR	0.0010	−0.0014	0.019
	(−0.53)	(0.38)	(−0.25)		(−4.65)***	(−4.76)***	(−2.27)**		(0.31)	(−0.42)	(1.45)
Adj. *R*-squared	0.57	0.60	0.65	Adj. *R*-squared	0.50	0.53	0.31	Adj. *R*-squared	0.77	0.77	0.80
N of observations	8663	5711	1759	N of observations	8663	5711	1759	N of observations	8663	5711	1759
Panel B: Developed Economies											
Constant	1.7202	2.6951	3.5911	Constant	7.8828	2.5011	−0.2566	Constant	7.9793	9.4625	−2.3107
	(2.49)**	(5.07)***	(4.96)***		(3.19)***	(1.32)	(−0.16)		(4.54)***	(5.55)***	(−1.59)
IR(t)	0.0028	0.0037	−0.0042	CR(t)	−0.1612	−0.1086	−0.0280	CR(t)	−0.0258	−0.0358	0.0930
	(0.47)	(0.78)	(−0.40)		(−2.96)***	(−2.36)**	(−0.57)		(−0.66)	(−0.85)	(2.10)**
LR(t)	0.0079	0.0016	0.0124	LR(t)	−0.0662	−0.0201	−0.0274	IR(t)	0.0067	−0.0043	0.0079
	(2.37)**	(0.64)	(3.94)***		(−5.66)***	(−2.32)**	(−3.97)***		(0.44)	(−0.28)	(0.39)
Merger	0.0104	0.3591	−0.0858	Merger	−0.8897	0.7973	−1.1433	Merger	0.9654	1.6336	1.4241
	(0.02)	(0.94)	(−0.21)		(−0.55)	(0.59)	(−1.30)		(0.84)	(1.33)	(1.79)*
CR(t-1) & Control	YES	YES	YES	IR(t-1) & Control	YES	YES	YES	LR(t-1) & Control	YES	YES	YES
Adj. *R*-squared	0.70	0.72	0.49	Adj. *R*-squared	0.54	0.61	0.42	Adj. *R*-squared	0.88	0.88	0.90
N of observations	5714	4636	1007	N of observations	5714	4636	1007	N of observations	5714	4636	1007
Panel C: Developing Economies											
Constant	2.9440	3.2118	1.5949	Constant	4.4615	0.7645	3.0444	Constant	−11.3603	−6.4355	−4.7733
	(3.42)***	(3.96)***	(2.21)**		(2.30)**	(0.50)	(2.35)**		(−4.32)***	(−2.75)***	(−3.10)***
IR(t)	−0.0094	−0.0143	−0.0055	CR(t)	−0.1012	−0.0788	−0.0917	CR(t)	0.0646	0.2020	0.1425
	(−1.05)	(−1.44)	(−0.48)		(−2.13)**	(−1.75)*	(−2.74)***		(1.00)	(2.98)***	(3.61)***
LR(t)	0.0062	0.0196	0.0301	LR(t)	−0.0172	−0.0378	−0.0450	IR(t)	0.0030	−0.0487	0.0143
	(1.10)	(3.73)***	(6.13)***		(−1.36)	(−3.82)***	(−5.04)***		(0.11)	(−1.73)*	(0.59)
Merger	−1.4989	0.1039	−0.0379	Merger	2.4544	0.7395	1.1675	Merger	−3.9586	0.2063	0.1335
	(−1.34)	(0.11)	(−0.04)		(0.98)	(0.44)	(0.75)		(−1.16)	(0.08)	(0.07)
CR(t-1) & Control	YES	YES	YES	IR(t-1) & Control	YES	YES	YES	LR(t-1) & Control	YES	YES	YES
Adj. *R*-squared	0.49	0.46	0.54	Adj. *R*-squared	0.49	0.55	0.46	Adj. *R*-squared	0.61	0.68	0.80
N of observations	2949	1075	752	N of observations	2949	1075	752	N of observations	2949	1075	752
Panel D: Pre-Financial Crisis Period (2002 ∼ 2006)											
Constant	1.0329	0.9614	−0.1390	Constant	3.2316	1.6707	3.9707	Constant	−2.9599	−1.4017	22.4710
	(1.77)*	(1.93)*	(−0.16)		(2.59)***	(1.63)	(0.79)		(−1.80)*	(−0.84)	(4.45)***
IR(t)	−0.0067	−0.0084	0.0293	CR(t)	−0.0773	−0.1429	−0.0364	CR(t)	0.0018	0.0214	0.0712
	(−0.79)	(−1.09)	(1.72)*		(−2.25)**	(−4.64)***	(−0.31)		(0.04)	(0.43)	(0.60)
LR(t)	0.0018	0.0016	0.0009	LR(t)	0.0072	0.0107	0.0133	IR(t)	0.0884	0.0503	−0.0778
	(0.85)	(0.95)	(0.57)		(1.57)	(3.11)***	(1.57)		(3.71)***	(1.95)*	(−0.80)
Merger	−0.4183	0.1090	−0.0292	Merger	1.0840	0.6878	−0.2198	Merger	0.6970	0.9755	0.5608
	(−1.07)	(0.31)	(−0.15)		(1.29)	(0.96)	(−0.19)		(0.63)	(0.84)	(0.50)
CR(t-1) & Control	YES	YES	YES	IR(t-1) & Control	YES	YES	YES	LR(t-1) & Control	YES	YES	YES
Adj. *R*-squared	0.56	0.57	0.57	Adj. *R*-squared	0.50	0.64	0.29	Adj. *R*-squared	0.70	0.63	0.67
N of observations	3304	2368	426	N of observations	3304	2368	426	N of observations	3304	2368	426
Panel E: During and Post Financial Crisis Period (2007 ∼ 2010)											
Constant	1.3793	2.3860	1.5642	Constant	1.6887	−0.2076	1.9724	Constant	−3.0460	2.6681	−9.5607
	(4.79)***	(4.73)***	(3.38)***		(2.04)**	(−0.17)	(1.90)*		(−2.27)**	(1.09)	(−4.47)***
IR(t)	0.0010	0.0025	−0.0070	CR(t)	−0.0730	−0.0159	−0.1441	CR(t)	0.0459	0.1727	0.1592
	(0.22)	(0.38)	(−0.75)		(−2.40)**	(−0.39)	(−3.94)***		(0.93)	(2.15)**	(2.09)**
LR(t)	0.0038	0.0020	0.0045	LR(t)	−0.0226	−0.0322	−0.0365	IR(t)	−0.0165	−0.0867	−0.0504
	(2.61)***	(0.60)	(1.33)		(−5.41)***	(−4.03)***	(−4.90)***		(−0.81)	(−2.73)***	(−1.18)
Merger	−0.1991	−0.2188	−0.4103	Merger	0.3234	0.5932	0.2764	Merger	0.5727	0.6871	0.5992
	(−0.92)	(−0.57)	(−1.13)		(0.52)	(0.63)	(0.34)		(0.57)	(0.37)	(0.36)

(*continued on next page*)

Table 9 (*continued*)

	Credit Risk (CR)				Interest Rate Risk (IR)				Liquidity Risk (LR)			
	Whole period	Regular YCS Periods	Inverted YCS Periods		Whole period	Regular YCS Periods	Inverted YCS Periods		Whole period	Regular YCS Periods	Inverted YCS Periods	
CR(t-1) & Control	YES	YES	YES	IR(t-1) & Control	YES	YES	YES	LR(t-1) & Control	YES	YES	YES	
Adj. *R*-squared	0.61	0.55	0.56	Adj. *R*-squared	0.50	0.55	0.52	Adj. *R*-squared	0.78	0.78	0.71	
N of observations	5359	3343	1333	N of observations	5359	3343	1333	N of observations	5359	3343	1333	

This table shows the results of a regression analysis which estimates a system of equations (simultaneous equations) via three-stage least squares without controlling for the bank-level governance characteristics. In Panel A, we only report the coefficients of interaction terms when we include the interaction terms between the different types of risk in the system of equations. In panel B and C, we report the results of all banks in developed and developing economies respectively during the whole period, regular YCS period, and inverted YCS period. In panel D and E, we also report the results of all banks during the pre-financial crisis period and during and post-financial crisis period respectively. All equations include one-year lagged value of the dependent variable as well as control variables covering the log of total assets (Ln(TA)), capital ratio (EA), the growth rate of real gross domestic product (RGDPG), and annual time fixed effects. We do not show them in the table for reasons of brevity. Because of lack of both/either T-bill and T-bonds data, the period of regular YCS and that of inverted YCS in some countries cannot be distinguished. This will reduce the number of observations. *CR* is the credit risk measured by non-performing loan (NPL) ratio. A high ratio is associated with high credit risk. *IR* is the interest rate risk measured by the ratio of cumulative one-year repricing gap to total assets (CGAP_A). Banks are exposed to interest rate risk if their CGAP_A ratio is not equal to zero. *LR* is the liquidity risk measured by the ratio of the dollar amount of bank liquidity creation to total assets. A high ratio is associated with high liquidity risk. *Merger* is a dummy variable indicating whether a bank was involved in one or more mergers. t-statistics based on robust standard errors clustered by country are reported in parentheses. ***, **, and * denote significant levels at the 1%, 5%, and 10% levels respectively.

Table 10
Robustness test – The impacts of corporate governance structure on the relationship among credit, interest rate, and liquidity risks.

	Credit Risk (CR)					Interest Rate Risk (IR)					Liquidity Risk (LR)			
Panel A: Developed Economies-Regular YCS Periods														
Constant	1.6732	1.2900	1.7167	1.4225	Constant	0.0848	1.5933	0.1568	1.3444	Constant	9.0300	8.2222	8.4915	7.8477
	(2.99)***	(2.29)**	(3.11)***	(2.55)**		(0.03)	(0.64)	(0.06)	(0.54)		(4.39)***	(4.01)***	(4.16)***	(3.85)***
IR(t)	0.0007	0.0008	0.0024	0.0026	CR(t)	−0.0464	−0.0525	−0.0323	−0.0347	CR(t)	0.0510	0.0360	0.0474	0.0327
	(0.16)	(0.17)	(0.54)	(0.56)		(−0.74)	(−0.81)	(−0.51)	(−0.54)		(0.96)	(0.67)	(0.89)	(0.61)
LR(t)	0.0001	−0.0005	0.0001	−0.0007	LR(t)	−0.0188	−0.0203	−0.0193	−0.0200	IR(t)	−0.0197	−0.0181	−0.0187	−0.0170
	(0.04)	(−0.19)	(0.04)	(−0.26)		(−1.72)*	(−1.76)*	(−1.78)*	(−1.74)*		(−1.18)	(−1.08)	(−1.11)	(−1.00)
Merger	0.1106	0.1156	0.1116	0.1264	Merger	1.3500	1.4006	1.3215	1.3092	Merger	1.3802	1.0847	1.4022	1.1093
	(0.29)	(0.29)	(0.29)	(0.32)		(0.80)	(0.81)	(0.79)	(0.76)		(0.98)	(0.75)	(0.99)	(0.77)
IND_S	−0.1133		−0.0924		IND_S	0.3577		0.2544		IND_S	−0.0087		0.00003	
	(−2.37)**		(−1.93)*			(1.70)*		(1.21)			(−0.05)		(0.0001)	
OC		0.0036		0.0030	OC		−0.0103		−0.0075	OC		0.0042		0.0042
		(2.21)**		(1.85)*			(−1.43)		(−1.04)			(0.70)		(0.69)
Board	0.0069	0.0044			Board	−0.0586	−0.0618			Board	0.0487	0.0380		
	(0.82)	(0.50)				(−1.58)	(−1.60)				(1.57)	(1.19)		
IND_B			0.5861	0.6158	IND_B			−2.6090	−2.7629	IND_B			−0.2058	−0.1158
			(3.48)***	(3.52)***				(−3.55)***	(−3.61)***				(−0.33)	(−0.18)
Dual	0.1115	0.1257	0.1614	0.1717	Dual	1.1347	1.2535	0.7831	0.8506	Dual	0.3237	0.5610	0.5277	0.7237
	(0.68)	(0.74)	(1.02)	(1.04)		(1.58)	(1.67)*	(1.13)	(1.17)		(0.54)	(0.90)	(0.90)	(1.19)
U_S	−0.1062	−0.0783	−0.1571	−0.1402	U_S	1.1917	1.1725	1.3843	1.4133	U_S	−1.7525	−2.0076	−1.6902	−1.9726
	(−0.41)	(−0.30)	(−0.61)	(−0.53)		(1.05)	(1.01)	(1.22)	(1.22)		(−1.83)*	(−2.08)**	(−1.76)*	(−2.04)**
U_B	−0.2563	−0.2478	−0.2590	−0.2534	U_B	−0.4236	−0.5149	−0.4024	−0.4658	U_B	0.0477	−0.0859	0.0441	−0.0995
	(−2.33)**	(−2.18)**	(−2.36)**	(−2.23)**		(−0.88)	(−1.03)	(−0.84)	(−0.93)		(0.12)	(−0.21)	(0.11)	(−0.24)
U_E	−0.2448	−0.2358	−0.2460	−0.2372	U_E	0.2091	0.2112	0.1601	0.1413	U_E	0.0492	0.1501	0.1535	0.2230
	(−1.66)*	(−1.55)	(−1.68)*	(−1.57)		(0.32)	(0.31)	(0.25)	(0.21)		(0.09)	(0.27)	(0.28)	(0.40)

CR(t-1) & Control	YES	YES	YES	YES	IR(t-1) & Control	YES	YES	YES	YES	LR(t-1) & Control	YES	YES	YES	YES
Adj. *R*-squared	0.74	0.74	0.74	0.74	Adj. *R*-squared	0.59	0.58	0.59	0.59	Adj. *R*-squared	0.87	0.87	0.87	0.87
N of observations	4636	4636	4636	4636	N of observations	4636	4636	4636	4636	N of observations	4636	4636	4636	4636
Panel B: Developed Economies- Inverted YCS Periods														
Constant	5.2008	4.1111	5.6571	4.6466	Constant	−3.3156	−0.2188	−4.7108	−1.6187	Constant	2.5642	−1.2567	0.9251	−2.5564
	(5.83)***	(4.68)***	(6.60)***	(5.48)***		(−1.46)	(−0.10)	(−2.15)**	(−0.75)		(1.34)	(−0.68)	(0.50)	(−1.43)
IR(t)	0.0100	0.0093	0.0133	0.0125	CR(t)	−0.1174	−0.1182	−0.1085	−0.1087	CR(t)	0.1055	0.0960	0.1153	0.1039
	(0.93)	(0.86)	(1.23)	(1.15)		(−1.55)	(−1.55)	(−1.43)	(−1.42)		(1.66)*	(1.50)	(1.81)*	(1.62)
LR(t)	0.0089	0.0091	0.0088	0.0089	LR(t)	−0.0260	−0.0246	−0.0253	−0.0239	IR(t)	0.0055	−0.0016	0.0064	0.00001
	(2.59)**	(2.54)**	(2.58)***	(2.49)**		(−3.06)***	(−2.83)***	(−2.99)***	(−2.76)***		(0.25)	(−0.08)	(0.29)	
Merger	0.0761	0.0650	0.1322	0.1279	Merger	−2.0432	−2.0205	−2.1812	−2.1619	Merger	1.6470	1.6033	1.5239	1.4855
	(0.18)	(0.15)	(0.32)	(0.30)		(−2.00)**	(−1.95)*	(−2.14)**	(−2.09)**		(1.92)*	(1.85)*	(1.77)*	(1.71)*
IND_S	−0.2451		−0.2529		IND_S	0.5914		0.6225		IND_S	−0.6445		−0.5775	
	(−3.15)***		(−3.28)***			(3.14)***		(3.34)***			(−4.06)***		(−3.66)***	
OC		0.0070		0.0071	OC		−0.0270		−0.0274	OC		0.0241		0.0231
		(2.59)***		(2.65)***			(−4.21)***		(−4.28)***			(4.47)***		(4.29)***
Board	−0.0161	−0.0234			Board	0.0578	0.0664			Board	0.0919	0.0838		
	(−1.17)	(−1.66)*				(1.73)*	(1.95)*				(3.28)***	(2.95)***		
IND_B			0.8419	0.8642	IND_B			−1.6577	−1.6206	IND_B			0.5585	0.5047
			(3.24)***	(3.24)***				(−2.61)***	(−2.51)**				(1.04)	(0.93)
Dual	−0.2836	−0.2615	−0.2228	−0.2116	Dual	−0.0775	−0.0831	−0.1117	−0.1009	Dual	−0.1410	0.0210	0.2296	0.3711
	(−1.34)	(−1.20)	(−1.07)	(−0.98)		(−0.15)	(−0.16)	(−0.22)	(−0.19)		(−0.32)	(0.05)	(0.53)	(0.84)
U_S	1.6311	1.7280	1.6159	1.7314	U_S	−0.1454	0.1913	−0.1329	0.1491	U_S	−0.6735	−0.6998	−0.7214	−0.7976
	(3.92)***	(4.12)***	(3.89)***	(4.14)***		(−0.14)	(0.18)	(−0.13)	(0.14)		(−0.77)	(−0.81)	(−0.82)	(−0.92)
U_B	−0.4825	−0.4855	−0.4509	−0.4465	U_B	−0.0626	−0.0681	−0.1311	−0.1516	U_B	0.8222	0.8622	0.8071	0.8241
	(−2.76)***	(−2.73)***	(−2.59)***	(−2.51)**		(−0.15)	(−0.16)	(−0.31)	(−0.35)		(2.30)**	(2.39)**	(2.25)**	(2.28)**
U_E	−0.5961	−0.5631	−0.6152	−0.5704	U_E	−0.0654	−0.0480	−0.0051	−0.0190	U_E	0.2996	0.6058	0.3625	0.6502
	(−2.66)***	(−2.46)**	(−2.75)***	(−2.49)**		(−0.12)	(−0.09)	(−0.01)	(−0.03)		(0.65)	(1.31)	(0.79)	(1.40)
CR(t-1) & Control	YES	YES	YES	YES	IR(t-1) & Control	YES	YES	YES	YES	LR(t-1) & Control	YES	YES	YES	YES
Adj. *R*-squared	0.47	0.47	0.47	0.47	Adj. *R*-squared	0.44	0.45	0.44	0.45	Adj. *R*-squared	0.91	0.91	0.91	0.91
N of observations	1007	1007	1007	1007	N of observations	1007	1007	1007	1007	N of observations	1007	1007	1007	1007
Panel C: Developing Economies- Regular YCS Periods														
Constant	4.8491	3.7896	5.7606	4.9176	Constant	−2.7701	2.1598	−3.4433	1.3340	Constant	−0.2014	−4.1888	−3.0746	−6.6317
	(4.06)***	(3.22)***	(5.18)***	(4.45)***		(−1.02)	(0.81)	(−1.35)	(0.53)		(−0.08)	(−1.77)*	(−1.33)	(−2.94)***
IR(t)	−0.0015	−0.0035	0.0027	0.0005	CR(t)	−0.0888	−0.1028	−0.0818	−0.0951	CR(t)	0.1571	0.1531	0.1668	0.1602
	(−0.14)	(−0.33)	(0.26)	(0.05)		(−1.25)	(−1.42)	(−1.14)	(−1.31)		(2.46)**	(2.40)**	(2.58)***	(2.48)**
LR(t)	0.0213	0.0236	0.0192	0.0209	LR(t)	−0.0385	−0.0394	−0.0371	−0.0375	IR(t)	−0.0121	−0.0182	−0.0103	−0.0153
	(3.26)***	(3.37)***	(3.02)***	(3.04)***		(−2.62)***	(−2.52)**	(−2.58)***	(−2.44)**		(−0.58)	(−0.88)	(−0.49)	(−0.73)
Merger	0.5674	0.5744	0.6843	0.7039	Merger	−1.0471	−1.0106	−1.1312	−1.0922	Merger	0.2848	0.0354	−0.0695	−0.2937
	(0.53)	(0.53)	(0.64)	(0.65)		(−0.44)	(−0.42)	(−0.47)	(−0.45)		(0.13)	(0.02)	(−0.03)	(−0.14)
IND_S	−0.2601		−0.2383		IND_S	0.9147		0.8848		IND_S	−0.5288		−0.5017	
	(−2.56)**		(−2.35)**			(4.10)***		(3.97)***			(−2.61)***		(−2.47)**	
OC		0.0038		0.0032	OC		−0.0308		−0.0300	OC		0.0165		0.0163
		(1.09)		(0.90)			(−4.05)***		(−3.94)***			(2.42)**		(2.38)**
Board	−0.0374	−0.0440			Board	0.0248	0.0262			Board	0.1300	0.1188		
	(−1.88)*	(−2.15)**				(0.56)	(0.58)				(3.29)***	(2.97)***		
IND_B			1.3575	1.4059	IND_B			−1.4259	−1.4439	IND_B			−0.4635	−0.1761
			(3.56)***	(3.58)***				(−1.67)*	(−1.64)				(−0.60)	(−0.22)
Dual	−0.3354	−0.3687	−0.4449	−0.4704	Dual	1.1125	1.3814	1.1898	1.4285	Dual	0.1487	0.7201	0.4780	1.0652
	(−0.80)	(−0.83)	(−1.07)	(−1.07)		(1.19)	(1.40)	(1.28)	(1.47)		(0.18)	(0.82)	(0.57)	(1.23)
U_S	1.5279	1.7588	1.4740	1.6996	U_S	0.0869	−0.1237	0.1352	−0.0644	U_S	−2.8496	−2.7662	−2.8841	−2.8501
	(3.09)***	(3.54)***	(2.99)***	(3.43)***		(0.08)	(−0.11)	(0.12)	(−0.06)		(−2.85)***	(−2.79)***	(−2.87)***	(−2.87)***
U_B	−0.4802	−0.4948	−0.4704	−0.4800	U_B	0.0728	−0.1424	0.0648	−0.1491	U_B	0.5467	0.5560	0.5573	0.5342
	(−2.05)**	(−2.04)**	(−2.01)**	(−1.98)**		(0.14)	(−0.26)	(0.12)	(−0.28)		(1.16)	(1.16)	(1.18)	(1.11)
U_E	−0.6941	−0.7333	−0.7690	−0.7947	U_E	−0.1806	−0.3690	−0.1194	−0.3266	U_E	0.1876	0.5609	0.4118	0.7449
	(−2.50)**	(−2.54)**	(−2.80)***	(−2.78)***		(−0.29)	(−0.58)	(−0.19)	(−0.51)		(0.34)	(0.99)	(0.74)	(1.31)
CR(t-1) & Control	YES	YES	YES	YES	IR(t-1) & Control	YES	YES	YES	YES	LR(t-1) & Control	YES	YES	YES	YES
Adj. *R*-squared	0.45	0.45	0.45	0.45	Adj. *R*-squared	0.57	0.57	0.57	0.57	Adj. *R*-squared	0.81	0.80	0.81	0.80

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Table 10 (*continued*)

	Credit Risk (CR)					Interest Rate Risk (IR)					Liquidity Risk (LR)			
N of observations	1075	1075	1075	1075	N of observations	1075	1075	1075	1075	N of observations	1075	1075	1075	1075
Panel D: Developing Economies- Inverted YCS Periods														
Constant	1.8769	0.9079	3.2123	2.4319	Constant	1.9207	6.1614	0.4630	4.4566	Constant	4.1433	0.7612	1.7040	−1.2110
	(1.58)	(0.77)	(2.93)***	(2.25)**		(0.79)	(2.62)***	(0.21)	(2.04)**		(1.96)*	(0.37)	(0.86)	(−0.63)
IR(t)	0.0132	0.0122	0.0162	0.0149	CR(t)	−0.1364	−0.1420	−0.1387	−0.1443	CR(t)	0.0853	0.0795	0.0934	0.0875
	(0.99)	(0.90)	(1.19)	(1.09)		(−2.84)***	(−2.93)***	(−2.90)***	(−2.99)***		(2.02)**	(1.87)*	(2.20)**	(2.05)**
LR(t)	0.0285	0.0317	0.0247	0.0275	LR(t)	−0.0555	−0.0573	−0.0510	−0.0518	IR(t)	0.0065	0.0017	0.0101	0.0065
	(4.25)***	(4.43)***	(3.79)***	(3.91)***		(−4.06)***	(−3.95)***	(−3.84)***	(−3.64)***		(0.27)	(0.07)	(0.42)	(0.27)
Merger	−0.0140	0.0178	−0.0177	0.0147	Merger	−0.3040	−0.3836	−0.2009	−0.2600	Merger	1.3010	1.1820	1.1041	0.9674
	(−0.01)	(0.02)	(−0.02)	(0.01)		(−0.13)	(−0.17)	(−0.09)	(−0.11)		(0.64)	(0.58)	(0.54)	(0.48)
IND_S	−0.2204		−0.2038		IND_S	0.7935		0.7397		IND_S	−0.5617		−0.5304	
	(−2.16)**		(−2.00)**			(3.91)***		(3.64)***			(−3.12)***		(−2.93)***	
OC		0.0035		0.0027	OC		−0.0294		−0.0277	OC		0.0177		0.0175
		(0.98)		(0.77)			(−4.18)***		(−3.94)***			(2.85)***		(2.80)***
Board	−0.0473	−0.0521			Board	0.0402	0.0399			Board	0.1115	0.0997		
	(−2.36)**	(−2.52)**				(0.99)	(0.96)				(3.14)***	(2.75)***		
IND_B			1.1619	1.1903	IND_B			−2.4917	−2.5583	IND_B			0.5683	0.8640
			(2.75)***	(2.73)***				(−2.95)***	(−2.96)***				(0.75)	(1.12)
Dual	−0.4359	−0.5248	−0.5685	−0.6570	Dual	1.4633	1.7920	1.5800	1.8484	Dual	0.1586	0.7251	0.4401	1.0425
	(−1.01)	(−1.15)	(−1.32)	(−1.46)		(1.67)*	(1.96)**	(1.82)*	(2.05)**		(0.21)	(0.90)	(0.57)	(1.31)
U_S	0.7736	1.0200	0.7380	0.9803	U_S	0.1775	−0.1190	0.2368	−0.0254	U_S	−1.4776	−1.3404	−1.4713	−1.3905
	(1.54)	(2.04)**	(1.47)	(1.96)**		(0.17)	(−0.12)	(0.23)	(−0.03)		(−1.65)*	(−1.52)	(−1.64)	(−1.57)
U_B	−0.5037	−0.4924	−0.4861	−0.4701	U_B	−0.4130	−0.6526	−0.4517	−0.6842	U_B	0.5555	0.5176	0.5767	0.5147
	(−2.10)**	(−1.99)**	(−2.02)**	(−1.90)*		(−0.85)	(−1.30)	(−0.93)	(−1.37)		(1.29)	(1.18)	(1.34)	(1.17)
U_E	−0.3387	−0.3615	−0.4407	−0.4567	U_E	−1.0561	−1.2205	−0.9295	−1.1205	U_E	0.3375	0.6183	0.5095	0.7686
	(−1.23)	(−1.27)	(−1.62)	(−1.61)		(−1.91)*	(−2.14)**	(−1.69)*	(−1.98)**		(0.69)	(1.23)	(1.04)	(1.54)
CR(t-1) & Control	YES	YES	YES	YES	IR(t-1) & Control	YES	YES	YES	YES	LR(t-1) & Control	YES	YES	YES	YES
Adj. *R*-squared	0.53	0.53	0.53	0.53	Adj. *R*-squared	0.48	0.49	0.48	0.49	Adj. *R*-squared	0.84	0.83	0.84	0.83
N of observations	752	752	752	752	N of observations	752	752	752	752	N of observations	752	752	752	752

This table shows the results of a regression analysis which estimates a system of equations (simultaneous equations) via three-stage least squares when controlling for corporate governance characteristics. We report the results of all banks in developed and developing economies respectively during the regular YCS period and the inverted YCS period. All equations include one-year lagged value of the dependent variable as well as control variables covering the log of total assets (Ln(TA)), capital ratio (EA), the growth rate of real gross domestic product (RGDPG), and annual time fixed effects. We do not show them in the table for reasons of brevity. Because of lack of both/either T-bill and T-bonds data, the period of regular YCS and that of inverted YCS in some countries cannot be distinguished. This will reduce the number of observations. *CR* is the credit risk measured by non-performing loan (NPL) ratio. A high ratio is associated with high credit risk. *IR* is the interest rate risk measured by the ratio of cumulative one-year repricing gap to total assets (CGAP_A). Banks are exposed to interest rate risk if their CGAP_A ratio is not equal to zero. *LR* is the liquidity risk measured by the ratio of the dollar amount of bank liquidity creation to total assets. A high ratio is associated with high liquidity risk. *Merger* is a dummy variable indicating whether a bank was involved in one or more mergers. *IND_S* is the shareholder independence measured by BvD independence indicators in *Bankscope*. The values 4 to 1 are assigned to A, B, C, and D, respectively. Higher value exhibits that bank shareholders have higher degree of independence and this bank tends to be a management-controlled bank. *OC* is the degree of ownership concentration. It is defined as "the maximum of the direct or total shareholding for a shareholder". Higher value represents that a bank tends to be a shareholder-controlled bank. *Board* reflects the board size and refers to the number of directors on the board. A bank with a small board is inclined to be a shareholder-controlled bank. *IND_B* is the board independence measured by the percentage of board members who are independent. A bank with a larger degree of board independence is inclined to be a shareholder-controlled bank. *Dual* is a dummy variable indicating whether the CEO is also the chairman of the board. A bank with CEO duality tends to be a shareholder-controlled bank. *U_S, U_B,* and *U_E* are the dummy variables indicating whether the ultimate owner of a bank is the state, the bank, and the enterprise, respectively. t-statistics based on robust standard errors clustered by country are reported in parentheses. ***, **, and * denote significant levels at the 1%, 5%, and 10% levels respectively.

Table 11
Robustness test – Bank governance, regulations, and risk taking.

	Credit Risk (CR)					Interest Rate Risk (IR)					Liquidity Risk (LR)				
	IND_S	OC	Board	IND_B	Dual	IND_S	OC	Board	IND_B	Dual	IND_S	OC	Board	IND_B	Dual
Panel A: Developed Economies-Regular YCS Period (4530 bank-year observations)															
Constant	−0.915	0.042	3.397	1.873	2.112	−10.337	8.449	3.587	4.437	6.096	14.316	4.427	9.259	7.998	8.867
	(−0.57)	(0.04)	(2.36)**	(2.23)**	(2.58)***	(−1.52)	(2.08)**	(0.72)	(1.53)	(2.17)**	(2.28)**	(1.20)	(1.89)*	(2.80)***	(3.19)***
Merger	−0.028	−0.046	0.310	0.285	0.282	1.424	1.391	0.517	0.535	0.525	0.933	0.660	1.402	1.376	1.438
	(−0.08)	(−0.13)	(0.89)	(0.82)	(0.81)	(0.97)	(0.92)	(0.43)	(0.45)	(0.44)	(0.69)	(0.48)	(1.18)	(1.16)	(1.21)
G_Index	0.271	−0.001	−0.142	1.489	0.018	4.579	−0.113	0.201	−2.629	0.586	−2.145	0.057	−0.099	4.635	0.869
	(0.62)	(−0.05)	(−0.88)	(0.68)	(0.10)	(2.45)**	(−1.74)*	(0.36)	(−0.35)	(1.01)	(−1.24)	(0.95)	(−0.18)	(0.62)	(1.51)
DI	1.569	−0.322	−0.728	0.061	−0.043	1.901	−3.908	−1.919	−2.188	−2.988	1.886	2.142	0.785	1.744	1.490
	(1.15)	(−0.48)	(−0.58)	(0.10)	(−0.07)	(0.32)	(−1.37)	(−0.44)	(−1.04)	(−1.49)	(0.35)	(0.83)	(0.18)	(0.83)	(0.75)
Capital	0.065	0.196	0.080	0.153	0.132	1.741	−0.259	0.284	0.124	0.102	−0.714	0.543	0.155	0.242	0.226
	(0.89)	(6.58)***	(2.26)**	(6.22)***	(5.54)***	(5.74)***	(−2.00)**	(2.34)**	(1.45)	(1.25)	(−2.47)**	(4.63)***	(1.29)	(2.87)***	(2.79)***
SR	−0.061	−0.089	−0.214	−0.192	−0.175	−0.075	0.029	−0.234	−0.212	−0.207	−0.679	−0.405	−0.275	−0.422	−0.492
	(−0.67)	(−1.87)*	(−3.57)***	(−5.03)***	(−4.54)***	(−0.19)	(0.14)	(−1.12)	(−1.59)	(−1.55)	(−1.87)*	(−2.17)**	(−1.34)	(−3.22)***	(−3.75)***
G*DI	−0.439	0.013	0.093	−0.378		−1.384	0.037	−0.108	−1.248		0.127	0.007	0.135	−0.316	
	(−1.15)	(1.00)	(0.59)	(−0.21)		(−0.85)	(0.65)	(−0.20)	(−0.20)		(0.08)	(0.13)	(0.25)	(−0.05)	
G*Capital	0.021	−0.002	0.007	−0.314		−0.479	0.013	−0.024	0.100		0.288	−0.010	0.011	−0.269	
	(1.04)	(−2.68)***	(2.05)**	(−3.06)***		(−5.65)***	(4.49)***	(−2.17)**	(0.28)		(3.58)***	(−3.52)***	(1.01)	(−0.77)	
G*SR	−0.006	0.001	0.005	0.327		0.004	−0.003	0.003	0.345		0.079	−0.0005	−0.015	−0.795	
	(−0.21)	(0.55)	(0.95)	(1.76)*		(0.03)	(−0.76)	(0.16)	(0.54)		(0.74)	(−0.13)	(−0.86)	(−1.25)	
Risk	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Control Var.	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Adj. R-squared	0.75	0.75	0.73	0.73	0.73	0.63	0.62	0.65	0.65	0.65	0.88	0.88	0.89	0.89	0.89
Panel B: Developed Economies-Inverted YCS Period (984 bank-year observations)															
Constant	1.987	−0.604	0.393	0.650	0.755	−4.396	9.068	−5.759	−0.512	5.466	9.115	1.947	3.704	3.554	3.742
	(1.76)*	(−0.84)	(0.54)	(1.09)	(1.30)	(−0.79)	(2.60)***	(−1.72)*	(−0.18)	(2.02)**	(2.01)**	(0.69)	(1.33)	(1.54)	(1.67)*
Merger	0.047	0.033	0.012	0.019	0.002	−1.407	−1.399	−0.473	−0.615	−0.844	1.902	1.903	1.683	1.623	1.635
	(0.23)	(0.16)	(0.06)	(0.10)	(0.01)	(−1.41)	(−1.38)	(−0.54)	(−0.70)	(−0.95)	(2.34)**	(2.33)**	(2.30)**	(2.22)**	(2.23)**
G_Index	−0.512	0.029	0.046	0.013	0.034	2.730	−0.132	1.355	25.302	1.324	−1.772	0.028	0.037	2.916	−0.004
	(−1.76)*	(2.85)***	(0.91)	(0.01)	(0.34)	(1.92)*	(−2.72)***	(5.88)***	(5.28)***	(2.81)***	(−1.52)	(0.70)	(0.19)	(0.73)	(−0.01)
DI	−1.797	0.439	0.026	−0.491	−0.379	−4.294	−0.905	13.237	5.880	0.178	2.208	1.122	1.160	1.620	1.406
	(−2.16)**	(1.00)	(0.05)	(−1.44)	(−1.27)	(−1.05)	(−0.42)	(5.77)***	(3.74)***	(0.13)	(0.66)	(0.65)	(0.60)	(1.24)	(1.23)
Capital	0.284	0.296	0.237	0.255	0.239	2.455	−0.541	−0.444	−0.093	−0.122	−0.796	0.376	0.237	0.292	0.283
	(3.15)***	(9.43)***	(6.62)***	(10.94)***	(10.58)***	(5.80)***	(−3.53)***	(−2.68)***	(−0.84)	(−1.14)	(−2.18)**	(2.99)***	(1.72)*	(3.19)***	(3.20)***
SR	−0.031	−0.017	−0.033	−0.053	−0.041	−1.777	−0.741	−0.459	−0.864	−0.916	−0.354	−0.882	−0.474	−0.670	−0.684
	(−0.43)	(−0.41)	(−0.74)	(−1.80)*	(−1.40)	(−5.14)***	(−3.77)***	(−2.20)**	(−6.44)***	(−6.87)***	(−1.23)	(−5.54)***	(−2.73)***	(−5.89)***	(−6.06)***
G*DI	0.497	−0.018	−0.044	0.856		1.064	−0.013	−1.389	−23.145		−0.193	0.013	0.032	−1.093	
	(2.00)**	(−2.13)**	(−0.97)	(1.13)		(0.87)	(−0.31)	(−6.77)***	(−6.69)***		(−0.19)	(0.39)	(0.19)	(−0.38)	
G*Capital	−0.006	−0.001	0.0003	−0.237		−0.698	0.024	0.035	−0.463		0.272	−0.008	0.005	−0.154	
	(−0.23)	(−1.49)	(0.09)	(−2.39)**		(−6.11)***	(6.20)***	(2.57)**	(−1.01)		(2.76)***	(−2.32)**	(0.44)	(−0.40)	
G*SR	−0.003	−0.0003	−0.0005	0.169		0.273	−0.008	−0.037	0.108		−0.085	0.008	−0.019	−0.192	
	(−0.13)	(−0.45)	(−0.14)	(1.98)**		(2.76)***	(−2.21)**	(−2.37)**	(0.28)		(−1.05)	(2.65)***	(−1.45)	(−0.59)	
Risk	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Control Var.	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Adj. R-squared	0.78	0.78	0.79	0.79	0.79	0.37	0.39	0.38	0.37	0.36	0.92	0.92	0.93	0.93	0.93
Panel C: Developing Economies- Regular YCS Period (200 bank-year observation)															
Constant	−2.141	−1.313	−2.989	−2.204	−2.872	14.180	−0.614	−30.998	−12.954	−0.296	4.091	2.416	2.617	2.496	4.642
	(−1.21)	(−1.14)	(−2.05)**	(−2.09)**	(−2.93)***	(2.08)**	(−0.14)	(−7.25)***	(−4.11)***	(−0.10)	(0.67)	(0.63)	(0.62)	(0.82)	(1.64)
Merger	−0.515	−0.466	−0.327	−0.353	−0.338	−1.809	−2.129	0.303	0.380	−0.010	0.771	0.577	0.540	0.300	0.331
	(−0.87)	(−0.77)	(−0.60)	(−0.65)	(−0.62)	(−0.78)	(−0.91)	(0.19)	(0.23)	(−0.01)	(0.38)	(0.29)	(0.34)	(0.19)	(0.21)
G_Index	0.515	0.021	0.022	−2.461	−0.173	−4.350	0.043	2.719	38.596	1.170	−0.344	−0.018	0.310	10.419	0.688
	(1.07)	(1.24)	(0.23)	(−1.17)	(−0.71)	(−2.34)**	(0.64)	(9.81)***	(6.19)***	(1.54)	(−0.21)	(−0.31)	(1.11)	(1.70)*	(0.96)
DI	−2.568	0.660	0.358	−0.270	0.098	−12.391	5.529	36.024	15.598	3.157	5.798	2.594	6.555	4.484	3.322

(*continued on next page*)

Table 11 (*continued*)

	Credit Risk (CR)					Interest Rate Risk (IR)					Liquidity Risk (LR)				
	IND_S	OC	Board	IND_B	Dual	IND_S	OC	Board	IND_B	Dual	IND_S	OC	Board	IND_B	Dual
	(−2.05)**	(0.77)	(0.30)	(−0.37)	(0.17)	(−2.54)**	(1.68)*	(10.80)***	(7.26)***	(1.75)*	(1.32)	(0.91)	(1.92)*	(2.11)**	(1.96)**
Capital	0.733	0.208	0.225	0.206	0.216	0.832	−0.185	−0.129	−0.027	−0.054	−0.325	0.325	0.124	0.364	0.311
	(6.12)***	(5.24)***	(4.04)***	(5.91)***	(6.42)***	(1.77)*	(−1.17)	(−0.77)	(−0.25)	(−0.50)	(−0.77)	(2.38)**	(0.76)	(3.51)***	(3.10)***
SR	0.363	−0.265	−0.057	−0.054	−0.029	−2.982	−0.813	−0.809	−0.845	−1.064	0.044	−0.616	0.078	−0.338	−0.394
	(2.87)***	(−3.51)***	(−0.65)	(−0.93)	(−0.50)	(−6.43)***	(−2.80)***	(−3.13)***	(−4.92)***	(−6.18)***	(0.10)	(−2.47)**	(0.31)	(−2.00)**	(−2.37)**
G*DI	0.552	−0.039	−0.026	1.654		4.828	−0.106	−2.738	−39.552		−0.652	0.031	−0.200	−4.612	
	(1.37)	(−2.62)***	(−0.30)	(1.17)		(3.10)***	(−1.80)*	(−11.48)***	(−9.69)***		(−0.46)	(0.62)	(−0.82)	(−1.12)	
G*Capital	−0.136	0.002	−0.001	−0.016		−0.206	0.012	0.010	0.707		0.153	−0.004	0.019	−0.681	
	(−4.20)***	(2.04)**	(−0.22)	(−0.09)		(−1.64)	(2.91)***	(0.74)	(1.33)		(1.35)	(−0.99)	(1.37)	(−1.32)	
G*SR	−0.167	0.003	0.003	0.412		0.602	−0.012	−0.018	−1.603		−0.138	0.007	−0.041	−0.714	
	(−4.40)***	(2.67)***	(0.43)	(1.80) (0.07)		(4.21)***	(−2.64)***	(−0.89)	(−2.33)**		(−1.06)	(1.68)*	(−2.04)**	(−1.07)	
Risk	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Control Var.	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Adj. R-squared	0.72	0.71	0.69	0.69	0.69	0.47	0.49	0.51	0.50	0.47	0.85	0.84	0.85	0.85	0.85
Panel D: Developing Economies- Inverted YCS Period (130 bank-year observations)															
Constant	−3.222	−1.373	−0.927	0.059	−0.756	14.067	3.847	−17.612	−7.614	2.986	7.338	4.173	1.957	1.510	3.899
	(−1.81)*	(−1.27)	(−0.77)	(0.06)	(−0.88)	(2.00)**	(0.91)	(−4.15)***	(−2.32)**	(0.96)	(1.30)	(1.25)	(0.55)	(0.55)	(1.52)
Merger	−0.629	−0.551	−0.252	−0.273	−0.260	−1.839	−2.194	0.305	0.279	−0.052	0.799	0.635	0.296	0.072	0.070
	(−1.06)	(−0.92)	(−0.53)	(−0.57)	(−0.54)	(−0.78)	(−0.92)	(0.18)	(0.16)	(−0.03)	(0.42)	(0.34)	(0.21)	(0.05)	(0.05)
G_Index	0.759	0.012	0.026	−2.422	−0.294	−3.386	−0.019	1.772	29.943	1.127	−0.802	0.015	0.249	10.736	0.656
	(1.62)	(0.75)	(0.35)	(−1.38)	(−1.38)	(−1.83)*	(−0.29)	(6.74)***	(4.83)***	(1.45)	(−0.54)	(0.30)	(1.10)	(2.05)**	(1.02)
DI	−0.519	0.355	0.279	−0.867	−0.415	−13.122	1.535	22.765	10.563	0.430	2.375	2.151	4.850	3.888	2.359
	(−0.44)	(0.49)	(0.32)	(−1.49)	(−0.92)	(−2.83)***	(0.53)	(7.55)***	(5.13)***	(0.26)	(0.63)	(0.94)	(1.87)*	(2.24)**	(1.74)*
Capital	0.592	0.213	0.228	0.212	0.222	1.050	−0.177	−0.008	0.016	−0.015	−0.288	0.333	0.140	0.361	0.313
	(4.80)***	(5.34)***	(4.70)***	(6.95)***	(7.54)***	(2.13)**	(−1.09)	(−0.04)	(0.14)	(−0.13)	(−0.72)	(2.60)***	(0.95)	(3.84)***	(3.44)***
SR	0.249	−0.250	−0.247	−0.153	−0.126	−2.879	−0.927	−0.927	−0.944	−1.168	0.054	−0.672	0.199	−0.286	−0.353
	(1.91)*	(−3.25)***	(−2.86)***	(−2.91)***	(−2.43)**	(−5.80)***	(−3.07)***	(−3.02)***	(−5.13)***	(−6.41)***	(0.13)	(−2.83)***	(0.76)	(−1.81)*	(−2.28)**
G*DI	0.012	−0.020	−0.066	1.665		4.321	−0.055	−1.755	−27.699		−0.131	−0.002	−0.137	−5.804	
	(0.03)	(−1.52)	(−1.12)	(1.56)		(3.02)***	(−1.02)	(−8.61)***	(−7.47)***		(−0.11)	(−0.05)	(−0.78)	(−1.82)*	
G*Capital	−0.103	0.001	−0.001	−0.023		−0.256	0.013	−0.00001	0.108		0.147	−0.003	0.018	−0.531	
	(−3.07)***	(1.07)	(−0.17)	(−0.16)		(−1.94)*	(3.04)***	(0.00)	(0.21)		(1.37)	(−0.92)	(1.43)	(−1.23)	
G*SR	−0.141	0.002	0.011	0.413		0.540	−0.011	−0.012	−1.466		−0.138	0.007	−0.045	−0.732	
	(−3.58)***	(1.81)*	(1.73)*	(2.10)**		(3.52)***	(−2.20)**	(−0.52)	(−2.09)**		(−1.10)	(1.71)*	(−2.25)**	(−1.24)	
Risk	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Control Var.	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Adj. R-squared	0.72	0.71	0.71	0.71	0.71	0.47	0.49	0.49	0.48	0.47	0.87	0.86	0.88	0.88	0.88

This table shows the results of a regression analysis which estimates a system of equations (simultaneous equations) with controlling for corporate governance characteristics, regulations, and interaction terms via three-stage least squares. We report the results of all banks in developed and developing economies respectively during the regular YCS period and the inverted YCS period. All equations include contemporaneous independent risk variables, one-year lagged value of the dependent variable as well as control variables covering the log of total assets (Ln(TA)), capital ratio (EA), the growth rate of real gross domestic product (RGDPG), and annual time fixed effects. We do not show them in the table for reasons of brevity. Our bank-year observations will be reduced because some sample countries do not have the anti-director index provided by La Porta et al. (1999) or lack both/either T-bill and T-bonds data. *CR* is the credit risk measured by non-performing loan (NPL) ratio. *IR* is the interest rate risk measured by the ratio of cumulative one-year repricing gap to total assets (CGAP_A). *LR* is the liquidity risk measured by the ratio of the dollar amount of bank liquidity creation to total assets. *Merger* is a dummy variable indicating whether a bank was involved in one or more mergers. *IND_S* is the shareholder independence measured by BvD independence indicators in *Bankscope*. The values 4 to 1 are assigned to A, B, C, and D, respectively. Higher value exhibits that bank shareholders have higher degree of independence and this bank tends to be a management-controlled bank. *OC* is the degree of ownership concentration. It is defined as "the maximum of the direct or total shareholding for a shareholder". Higher value represents that a bank tends to be a shareholder-controlled bank. *Board* reflects the board size and refers to the number of directors on the board. A bank with a small board is inclined to be a shareholder-controlled bank. *IND_B* is the board independence measured by the percentage of board members who are independent. A bank with a larger degree of board independence is inclined to be a shareholder-controlled bank. *Dual* is a dummy variable indicating whether the CEO is also the chairman of the board. A bank with CEO duality tends to be a shareholder-controlled bank. *U_S, U_B,* and *U_E* are the dummy variables indicating whether the ultimate owner of a bank is the state, the bank, and the enterprise, respectively. *DI* takes a value of one if the country has explicit deposit insurance, and zero otherwise. *Capital* is an index of regulatory oversight of bank capital from the *Bank Regulation and Supervision* database provided by the World Bank. It released in 2001 and updated in 2003, 2007, and 2012 respectively to capture regulatory changes in capital requirements. The range for the index is from 0 to 9. Higher values indicates greater stringency. *SR* is the anti-director index calculated by La Porta et al. (1999) and ranges from 0 to 6. Higher values represent greater shareholder rights. t-statistics based on robust standard errors clustered by country are reported in parentheses. ***, **, and * denote significant levels at the 1%, 5%, and 10% levels respectively.

6. Conclusion

This paper discusses the role of corporate governance in the relationship among credit, interest rate and liquidity risks as well as compares how banks handle the trade-offs when they face these risks during the regular and inverted YCS period. We not only focus on firm-level governance mechanisms but also examine the effects of country-level regulations on banks' risk-taking behaviors when considering the integrated effects of credit, interest rate, and liquidity risks. We perform our investigation on banks across 43 countries over 2002–2010 by using three-stage least squares method.

The empirical results indicate that a relationship among credit, interest rate, and liquidity risks exists, although these risks do not always interact simultaneously. The interactions among risks can be weakened through corporate governance and regulations. Corporate governance also affects the trade-offs among credit, interest rate, and liquidity risks. During the regular YCS period, management-controlled banks reduce credit risk and even liquidity risk whereas shareholder-controlled banks increase liquidity risk exposure as they pursue more interest rate risk. During the inverted YCS period, management-controlled banks continue to take less credit risk even though they take more interest rate risk. However, shareholder-controlled banks should be monitored by the authorities because of their great risk exposure.

The types of ultimate owner of banks also influence bank risk-taking. To reduce bank credit risk exposure, the authorities should encourage the enterprises and the banks to be the ultimate owner. However, they should decrease the ownership of the governments to refrain them from becoming the ultimate owner of banks. In addition, stricter capital regulations enhance bank risk-taking, but stronger shareholder rights reduce bank liquidity risk. The risk-enhancing effect of stricter capital regulations is larger than the risk-reducing effect of better shareholder rights. Management-controlled banks increase their incentive of taking liquidity risk, whereas shareholder-controlled banks decrease their credit and liquidity risk-taking when they are located in countries with tighter capital regulations.

Hence, we suggest that the authorities should call for a joint management of credit, interest rate, and liquidity risks. When banks face these risks, a management-controlled bank regards credit risk management as important, whereas a shareholder-controlled bank takes more interest rate risk to generate more profits at the cost of illiquidity and even default. To lessen the exposure of banks to credit or liquidity risks, the authorities should avoid ownership concentration and the CEO duality, encourage enterprises to be the ultimate owners, and reduce the state ownership. In addition, the effects of the same capital regulations on bank's risk critically depends on each bank's governance characteristics.

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Appendix A

See Appendix 1.

Appendix 1
Liquidity classification of bank activities.

Assets			
Illiquid assets (weight = 1/2)		Semi-liquid assets (weight = 0)	Liquid assets (weight = −1/2)
Customer loans of all maturities	Assets leased	Loans to municipalities and government entities	Total securities minus nonlisted securities
Commercial real estate loans (CRE)	Lease receivables	Loans to state and local governments	Treasury bills
Commercial and industrial loans (C&I)	Overdrafts	Loans to foreign governments	Other bills
Mortgages	Nonlisted securities	Loans to banks	Bonds
Business loans	Long-term investments	Loans to depository institutions	Cash and due from other institutions
Loans to finance agricultural production	Other investments	Lending to other financial institutions	Cash and due from banks
Loans to group companies/associates	Other earning assets	Loans and advances to banks	Short-term investments
Loans to other corporates	Total nonearning assets minus cash and due from banks	Loans and advances (short-term)	Open market investments
Loans and advances (long term)	Total fixed assets	Residential real estate loans (RRE)	Trading assets
Loans to non-residents	Customers' liability on bankers acceptances	Residential mortgages	Fed funds sold
Other loans	Investment in unconsolidated subsidiaries	Deposits with banks	
Other loans and lease financing receivables	Intangible assets	Due from central banks	
Other real estate owned (OREO)	Premises	Due from other banks	
Hire purchase/lease	Other assets	Due from other credit institutions	
		Certificates of deposit	
		Equity investments	

Liabilities plus equity				
Liquid liabilities (weight = 1/2)		Semi-liquid liabilities (weight = 0)		Illiquid liabilities plus equity (weight = −1/2)
Demand deposits	Inter-bank deposits	Time deposits	Other deposits	Bank's liability on bankers acceptances
Customer deposits – demand	Deposits from banks	Commercial deposits	Other short-term borrowing	Subordinated debt
Savings deposits	Transactions deposits	Municipalities/government deposits	Open market funding	Other liabilities

(continued on next page)

Appendix 1 (*continued*)

Liabilities plus equity				
Liquid liabilities (weight = 1/2)		Semi-liquid liabilities (weight = 0)		Illiquid liabilities plus equity (weight = −1/2)
Deposits-no split available	Due to customers (<1 year)	Foreign deposits	Short-term securities issued	Total other funding
Short-term demand and deposits	Sale & repurchase transactions	Fixed deposits	Debt securities in issue	Total loan loss and other reserves
Short-term customer deposits	Overnight federal funds purchased	Special deposits	Other borrowed money	Total equity
Bank deposits	Trading liabilities	Long-term deposits	Due to customers (>1 year)	
		Long-term customer deposits	Due to customers, no breakdown	
		Other customer deposits	Total money market funding	

Off-balance sheet guarantees (notional values)			
Illiquid guarantees (weight = 1/2)		Semi-liquid guarantees (weight = 0)	Liquid guarantees (weight = −1/2)
Unused commitments	Acceptances	Net credit derivatives	Net participations acquired
Commercial and similar letters of credit	Outstanding acceptances	Net securities lent	
Net standby letters of credit	Other commitments and contingent liabilities		
Committed credit lines	Contingent liabilities		
Documentary credits	All other off-balance sheet liabilities		
Guarantees			

Off-balance sheet derivatives (gross fair values)
Liquid derivatives (weight = −1/2)
Interest rate derivatives
Foreign exchange derivatives
Equity and commodity derivatives
Derivatives
Interest rate swaps
Foreign currency swaps
Forward purchases of assets

Source: the authors.

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