Common Ownership and Bank Stability: Evidence from the U.S. Banking Industry*

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Abstract

We empirically test competing theoretical arguments about the impact of common ownership on bank stability: the *common ownership hypothesis,* where banks decrease risk-taking by internalizing risk externalities on commonly held banks, and the *diversification hypothesis,* where banks increase risk-taking incentivized by the common owners who diversify away idiosyncratic risks. Using data from the U.S. banking industry from 1991 to 2016, we find that banks with more common ownership linkages undertake less risk, as predicted by the common ownership hypothesis. This relation is statistically significant and economically sizable, which is consistent across alternative measures of common ownership and bank risk and robust to potential endogeneity. Our study adds the financial stability perspective to the ongoing discussions on common ownership and antitrust regulations.

JEL Classifications: G21, G32

Keywords: banking industry, common ownership, financial stability, risk-taking externalities

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1 Introduction

We examine whether common ownership linkages affect bank risk-taking behavior. Despite the policymakers' need for study on common ownership from a financial stability perspective (OECD, 2017), this subject has not been well explored. Theories make different prediction for the relation between common ownership and financial stability, leaving it as an empirical question. The *common ownership hypothesis* argues that banks decrease risk-taking by internalizing risk externalities on commonly held banks, while the *diversification hypothesis* claims that banks increase risk-taking incentivized by the common owners who diversify away idiosyncratic risks. Using data from the U.S. banking industry from 1991 to 2016, we find that common ownership linkages across banks reduce risk-taking incentives, and thus improve financial stability, as predicted by the common ownership hypothesis.

Common ownership refers to overlapping shareholders across firms, who seek to maximize their portfolio payoffs by increasing the combined profits of firms that they hold simultaneously, rather than the profit of a single firm. The common ownership phenomenon is increasingly prevalent due to the popularity of diversified portfolios (e.g., index funds, mutual funds, and ETFs) and the growth of mergers and acquisitions in the asset management industry (FTC, 2018). Figure 1 presents common ownership trends over time in the U.S. banking industry. The percentage of banks commonly held by institutional blockholders was low around 20% in the 1990s, but then it began increasing in the 2000s to reach 81.1% in 2016.[1] This indicates that the majority of the listed U.S. banks and bank holding companies nowadays share common owners. Banks with such ownership interconnectedness would make different decisions from those that only consider their own profits.

Since theoretical predictions are inconclusive, we aim to test which argument is dominant in the banking industry. According to the common ownership hypothesis, firms

[1]Following He and Huang (2017), we use institutional blockholders, i.e., shareholders who own more than 5% of a company's shares as the proxy of shareholders that can exercise effective control. Currently, common ownership driven by 3%–5% shareholdings of asset managers is drawing regulatory attention (Franks and Vig, 2018). When we relax the ownership threshold from 5% to 3%, similar common ownership trends and empirical results are observed.

that share common owners internalize negative externalities to maximize their joint profits (e.g., Reynolds and Snapp, 1986; Hansen and Lott, 1996; Azar et al., 2018). In the banking sector, one bank's risk-taking entails negative externalities onto other banks, which are exposed to it directly through financial transactions (Allen and Gale, 2000) and indirectly through expectation channels (Diamond and Dybvig, 1983). As for common owners, their portfolio values are maximized when banks that they hold together internalize the contagion effects. Therefore, banks with common ownership linkages are expected to choose lower risk profile compared to those without such considerations. Based on this theoretical argument, Siciliani and Norris (2017) also anticipate that common ownership would improve financial stability.

However, the diversification hypothesis argues that banks increase risk-taking to maximize portfolio payoffs of the common owners who diversify away idiosyncratic risks. Many have documented that the increasing popularity of passive investments formulated to benefit portfolio diversification has contributed to a rise in common ownership (e.g., OECD, 2017; Backus et al., 2019). Therefore, shareholders may have become common owners of multiple banks as they achieve portfolio diversification. In this case, the diversified common owners have incentives to demand each bank to undertake riskier investments. Jensen and Meckling (1976) claim that diversified owners are less risk averse than undiversified owners because they can diversify away idiosyncratic risks and reduce the overall riskiness of their portfolios. Building on this argument, several studies have shown the possibility that portfolio diversification intensifies corporate risk-taking (e.g., Parrino et al., 2005; Faccio et al., 2011; García-Kuhnert et al., 2015).

Depending on which of the two hypotheses is dominant, our findings suggest different policy implications for the recent discussions on common ownership. Upon its increasing trends and intensity, policymakers have begun scrutinizing the potential impact of common ownership on industries, especially concerning institutional investors that are blockholding multiple firms (FTC, 2018; EC, 2018). There are discussions whether to regulate cross-shareholdings of the large shareholders so as to reduce common ownership concentration and mitigate their anticompetitive effects (e.g., Posner et al., 2017; Rock and Rubinfeld, 2017). However, policymakers underline the need for alternative policy

perspectives, particularly regarding financial stability (OECD, 2017), before they take any regulatory action against common ownership. If common ownership reduces bank risk-taking incentives, policymakers who have stronger financial stability objectives would take cautious steps in regulating cross-shareholdings in the banking industry. Conversely, if common ownership harms financial stability in addition to market competition, the recommendations on antitrust enforcement actions would gain more support.

For our empirical analysis, first, we measure common ownership linkages and bank risk in diverse ways and check if our findings are consistent across alternative proxy variables. Using quarterly shareholding, accounting, and stock market data of banks, we construct seven proxies of common ownership, ranging from a dummy variable that indicates the existence of common owners to a model-implied variable that reflects the degree of internalization of risk-taking externalities due to common owners, and four proxies of bank risk including the market-based default probability and the accounting-based Z-score. Each of them demonstrates a slightly different aspect of common ownership or bank risk. By employing these different measures, we confirm that our results are not limited to a particular choice of measurement.

Second, we control for the potential indirect effect of common ownership on bank stability to get a more direct relation between them. The existing banking literature reveals that market competition is closely related to bank risk-taking incentives (e.g., Keeley, 1990; Hellmann et al., 2000; Boyd and De Nicolo, 2005). Although its direction is still contentious, a considerable amount of empirical studies have assured the existence of the competition-stability relation (e.g., Beck et al., 2013; Goetz, 2018). Given this competition-stability relation, the literature on anticompetitive effects of common ownership (e.g., Azar et al., 2018) in turn suggests the possibility that common ownership linkages indirectly influence bank risk-taking by altering competitive incentives. In this regard, we disentangle the direct effect of common ownership on bank stability by explicitly controlling for bank-level market power proxied by the Lerner index, along with other bank-specific characteristics and macroeconomic variations.

Third, we exploit the exogenous shareholding variations generated by mergers between institutional shareholders and carry out difference-in-difference (DiD) estimation in

addition to panel regressions. The panel regression analysis allows us to examine the average effect of common ownership on bank stability across more than 300 banks along 26 years. However, this approach poses two limitations. One is a potential endogeneity concern in common ownership coefficients arising from unobservable bank characteristics such as corporate culture and managerial reputation that might affect both investor shareholding and bank risk-taking decisions. The other is that it does not rule out the possibility that interbank common ownership could have resulted from concentrated shareholdings in the banking industry rather than portfolio diversification, in which case we cannot properly test the diversification hypothesis.[2] To complement our panel regression results, we select mergers between institutional shareholders that result in more diversified portfolios across industries and more common ownership within the banking industry,[3] and then test the differential effects on bank risk between banks that are likely to experience an increase in common ownership after the mergers and those that are not.

Our results show that banks with more common ownership linkages undertake less risk, which are consistent across alternative proxy variables and empirical models. The coefficients on common ownership are significantly negative in the panel regressions, in which we regress different bank risk measures on each of the seven alternative common ownership proxies. This indicates that, in line with the common ownership hypothesis, banks take into account risk-taking externalities because of their common owners, and thus choose lower risk profile. The degree of such internalization gets stronger with the extent to which a bank is connected to other banks by common ownership. In our baseline model, the default probability and the (negative) Z-score are approximately 1% and 5% lower, respectively, when a bank faces common ownership. The DiD analysis also reveals that banks significantly decrease risk-taking after they have a higher degree of common

[2]For example, if investors are exposed more specifically to the banking industry by holding more banks (increasing common ownership) and decreasing cross-industry diversification (decreasing portfolio diversification), they could incentivize their portfolio banks to decrease risk-taking.

[3]In a merger between asset managers, the acquirer generally takes over the target's existing portfolio and holds it for an extended period of time because of transaction costs (Holthausen et al., 1990; He and Huang, 2017). Therefore, the acquirer's portfolio is likely to be more diversified with more cross-shareholdings across firms and industries in the post-merger period. For instance, BlackRock held shares in 1246 firms and 46 industries in 2009Q1, but the numbers increased to 4373 firms and 48 industries when it acquired Barclays Global Investors in 2009Q4, which remained at the similar levels for a year before an adjustment to about 3500 firms and 48 industries in 2011Q1.

ownership linkages due to the institution mergers, further confirming the causal impact of common ownership on bank stability.

The main contribution of this paper to the literature is the empirical identification of the effect of common ownership on bank stability. To the best of our knowledge, it is the first to test the related hypotheses suggested by the existing theoretical arguments. We complement a long strand of literature arguing that cross-shareholdings incentivize firms to maximize joint profits and reduce market competition (e.g., Reynolds and Snapp, 1986; Hansen and Lott, 1996; Azar et al., 2018) by turning focus to risk-taking externalities and stability in the banking industry. García-Kuhnert et al. (2015) provide evidence of a positive link between cross-shareholdings in the form of portfolio diversification and bank risk using data from European banks; however, they only consider the largest shareholders and the diversification explanation about risk-taking incentives. In contrast, we assume more generally that shareholders with more than 5% (3% for robustness) influence bank risk-taking decisions, and study more detailed ownership linkages across banks arising from portfolio diversification in order to test conflicting theoretical arguments. We relate our results to the recent discussions on common ownership and provide alternative policy implications regarding financial stability.

Our study also contributes to the literature on determinants of bank risk-taking. Previous studies in the banking literature have shown that bank risk-taking incentives can be affected by market competition (e.g., Keeley, 1990; Hellmann et al., 2000; Martinez-Miera and Repullo, 2010) and ownership structure (e.g., Saunders et al., 1990; Laeven and Levine, 2009; Faccio et al., 2011). We provide empirical evidence that bank risk-taking incentives are closely related to interbank ownership connectedness after controlling for their positive link with market competition. Specifically, we show that interconnectedness through common ownership can mitigate bank risk-taking because common owners care about negative risk-taking externalities that could reduce their portfolio payoffs.

The remainder of the paper is structured as follows. We discuss the literature used to elaborate the main hypotheses in Section 2, and describe data and empirical methodology in Section 3. We analyze the effect of common ownership on bank stability in Section 4 and provide concluding remarks in Section 5.

2 Two Conflicting Theories and Hypotheses

In this section, we review the related literature and theoretical arguments about common ownership and financial stability. There are two competing hypotheses—the common ownership hypothesis and the diversification hypothesis—, which make different predictions about the impact of ownership linkages across banks on risk-taking incentives.

2.1 Common Ownership Hypothesis

The common ownership hypothesis argues that investors with cross-shareholdings pursue joint profit maximization, thereby incentivizing the internalization of between-firm externalities. Because of cross-shareholdings, Gordon (1990) explains that shareholders can be negatively affected if firms act for their own profits as assumed in the traditional models of corporate behavior. Hansen and Lott (1996) show that commonly held firms behave differently from solely held firms in the presence of externalities. Shareholder portfolio values are maximized if firms make choices after accounting for between-firm externalities. Therefore, commonly held firms would internalize the shareholder interests in their decision-making. Previous studies criticize that common ownership could reduce competitive incentives, resulting in socially inefficient market outcomes (e.g., Reynolds and Snapp, 1986; Parker and Röller, 1997; Gilo et al., 2006; Azar et al., 2018), while several others suggest that they also promote collaboration between firms, leading to new business activities and innovation (e.g., He and Huang, 2017; Vives, 2019).

Considering risk-taking externalities in the banking industry, the common ownership hypothesis predicts a positive relation between common ownership and financial stability. Banks are inter-related directly through financial transactions particularly in interbank markets (Allen and Gale, 2000) and payment systems (Freixas and Parigi, 1998). Even if a bank finds one more unit of risk-taking profitable after accounting for an increase in its default probability, other banks always become exposed to more credit and liquidity risks as a consequence. If a bank bankrupts due to excessive risk-taking, other banks linked to it become troubled with defaulted credit claims and liquidity deficits. Without direct channels, the remaining banks can also be affected indirectly in the form of

bank runs because a bank failure changes investors' expectations about the banking system (Diamond and Dybvig, 1983). Accordingly, if banks take into account these risk-taking externalities, they would choose lower risk levels than they would do without such considerations. Common owners seek for the internalization of the between-bank externalities to maximize their portfolio values, which makes banks undertake less risk and improves bank stability. Therefore, this leads to our first hypothesis:

H1: Common ownership increases bank stability.

2.2 Diversification Hypothesis

Contrary to the common ownership hypothesis, the diversification hypothesis argues that investors with cross-shareholdings from diversified portfolios are less concerned with firm-specific risks and have stronger incentives to undertake riskier projects. Jensen and Meckling (1976) claim that diversified owners are less risk averse than undiversified owners because they can diversify away idiosyncratic risks and reduce the overall riskiness of their portfolios. In this aspect, several studies have shown the possibility that the level of portfolio diversification affects corporate risk-taking. Parrino et al. (2005) present simulated results that diversified agents are more concerned about firm value than risk when they make investment decisions. Faccio et al. (2011) and García-Kuhnert et al. (2015) provide empirical evidence that diversification of the ultimate largest shareholder increases risk-taking in European non-financial companies and banks, respectively. In addition, considering institutional investors as diversified shareholders, Barry et al. (2011) find a positive relation between institutional ownership and bank risk.

Given the fact that common ownership is largely driven by portfolio diversification, the diversification hypothesis predicts a negative relation between common ownership and financial stability. Previous studies have noted that the recent common ownership phenomenon is closely associated with portfolio diversification. OECD (2017) explains that the spread of passive investment strategy, i.e., buying a market diversified portfolio, has contributed to an increase in common ownership linkages. Backus et al. (2019) document a concurrent growth in assets under management by passive equity index funds

and common ownership. Azar et al. (2018) express concerns that common ownership may cause social costs that accompany private benefits of diversification. Overall, overlapping shareholders across banks seem to be generated by portfolio diversification. Then, the diversified common owners have incentives to demand banks to take riskier investments to maximize their portfolio values, which suggests our second hypothesis that:

H2: Common ownership decreases bank stability.

3 Data and Methodology

For our empirical analysis, we combine quarterly shareholdings data and financial statements of the U.S. banks and bank holding companies for the period of 1991–2016. More than 300 banks are publicly listed in the U.S., and the ownership structure of the listed banks has become increasingly interconnected because of the popularity of passive investments, and mergers and acquisitions among asset managers. As depicted in Figure 1, the proportion of banks that were commonly held by institutional blockholders was merely 15.9% in 1991, but rapidly raised to 81.1% in 2016. These unique properties of the U.S. banking industry—cross-sectional variations and common ownership intensity—help identify the relation between common ownership and bank stability, in addition to 26-year long variations.

3.1 Institutional Shareholdings and Mergers

Using institutional shareholdings from Thomson Reuters database[4] of the U.S. Securities and Exchange Commission (SEC) 13F reports, we compute seven proxy variables of common ownership: (1) an indicator variable that equals one if the bank has overlapping shareholders with other banks (*CODummy*), (2) the number of peer banks that are commonly held by the shareholders (*COBank1*), (3) the average number of peer banks held by each of the shareholders (*COBank2*), (4) the number of the common shareholders

[4]Backus et al. (2019) report an undercoverage issue in the Thomson Reuters 13F dataset. Therefore, we complement our sample using the data provided by Azar et al. (2018), who hand-collected missing reports of large institutional investors from the SEC. In this study, we used the Thomson Reuters 13F dataset downloaded on June 9, 2019, and corrected shareholdings of BlackRock in 2010Q1–Q2, JPMorgan Chase in 2008Q3, and Barclays in 2003Q4.

(*COInvestor*), (5) the sum of percentage shares held by the common shareholders (*COShare*), (6) the average of model-implied weights that the bank places on the profits of other commonly held banks relative to its own profit (*COWeight1*), and (7) the market share weighted average version of the sixth variable (*COWeight2*).

Since there is not a conventional measure for firm-level common ownership, we try to calculate common ownership across banks in diverse ways possible using the methods and ideas presented in previous studies on common ownership (e.g., He and Huang, 2017; Azar et al., 2018; Gramlich and Grundl, 2018). We derive the structural profit weights used in the sixth and seventh proxies from the bank's profit maximization where common ownership is allowed. The detailed derivation is in Appendix C. As in He and Huang (2017), we measure ownership linkages generated by institutional blockholders that have more than 5% of outstanding shares, and thus implicitly assume that blockholders are shareholders that can influence managerial decisions.[5]

In addition, we construct our sample of mergers between institutional shareholders using the Security Data Company (SDC) database of mergers and acquisitions. We select mergers that satisfy the following criteria. First, mergers are completed within one year after the initial announcement and the target institution stops filing 13F reports within one year after the completion.[6] Second, interbank mergers are excluded. Third, one of merging institutions is a blockholder of at least one sample bank in the quarter before the merger event. Appendix B lists institution mergers used in our DiD analysis.

It is unlikely that the merger decisions were made because of riskiness of individual banks in the merging portfolios, thereby generating plausibly exogenous variations in ownership linkages across banks. In the 1990s, mergers by commercial banks acquiring asset management firms were taken place to create their own mutual fund products in response to competitive threats from mutual funds (Markham, 2000).[7] From the mid-

[5]The shareholding threshold of 5% has been used in previous finance literature to proxy beneficial owners (e.g., Gilson, 1990; Villalonga and Amit, 2006). As noted by Franks and Vig (2018), 3%–5% shareholdings by asset managers are currently drawing regulatory attention regarding the common ownership phenomenon. For robustness, we adopt alternative thresholds of 4% and 3%, respectively, and find similar empirical results to those presented in Section 4.

[6]The first selection rule is adopted from Huang (2013) and He and Huang (2017).

[7]Markham (2000) documents that funds managed by mutual funds exceeded deposits held by commercial banks in 1993, which placed competitive threats to commercial banks.

2000s, mergers in the asset management industry (e.g., the BlackRock's acquisition of Barclays Global Investors) have become active in searching for bigger market power amid a shift in demand for cheap passive funds (Moody's, 2018). To ensure the exogeneity further, in cases of a merger between a bank and a non-bank, we only use the merger event to calculate implied shareholding changes in other non-merging banks and exclude the merging bank from the actual DiD analysis.

The merger decisions also result in more diversified portfolios as the acquirer institutions take over the existing portfolios of the target institutions. Because of transaction costs, the acquirer institutions usually maintain the target's portfolios for an extended period of time (Holthausen et al., 1990; He and Huang, 2017). Therefore, the acquirers are expected to hold more diversified portfolios in the post-merger period. As shown in Appendix B, the acquirer institutions have obtained more cross-shareholdings in terms of firms and industries after the completion of the mergers. For instance, BlackRock held shares in 1246 firms and 36 industries in 2009Q1, but the numbers increased to 4273 firms and 48 industries when it acquired Barclays Global Investors in 2009Q4, which remained at the similar levels for a year before a minor adjustment to about 3500 firms and 48 industries in 2011Q1.

3.2 Bank Risk and Characteristics

Using stock prices from the Center for Research in Security Prices (CRSP) and financial reports filed into the Federal Reserve Bank of Chicago by commercial banks and bank holding companies, we construct four proxy variables of bank risk: (1) the default probability, (2) the Z-score, (3) the stock return volatility, and (4) the risk-weighted asset ratio. As the market-based risk measure, we compute default probabilities using the method of Bharath and Shumway (2008) based on the distance to default model of Merton (1974), where equity is viewed as a call option on the assets with a strike price equal to the face value of the liabilities. The default probability that the value of assets becomes less than the face value of liabilities at the end of the holding period is given by:

$$P(Default) = N\left(-\frac{ln(\frac{V_A}{D}) + (\mu - \delta - \frac{\sigma_A^2}{2})T}{\sigma_A\sqrt{T}}\right),$$

where $N(\cdot)$ is the cumulative normal density function, V_A is the value of assets, D is the face value of liabilities, μ is the expected return proxied by stock returns over the previous year, δ is the dividend rate proxied by the ratio of dividends to the sum of liabilities and market value of equity, σ_A is asset volatility, and T is the time to expiration taken to be one year. Unobservable V_A and σ_A are estimated using the following equations: $V_A = V_E + D$, $\sigma_A = \frac{V_E}{V_A}\sigma_E + \frac{D}{V_A}\sigma_D$, and $\sigma_D = 0.05 + 0.25 * \sigma_E$, where V_E is the market value of common equity, and σ_E is the standard deviation of daily stock returns multiplied by the square root of the trading days (taken to be 252 days). As the accounting-based risk measure, we employ the Z-score (Roy, 1952):

$$Z\text{-}score = \frac{ROA + \frac{E}{A}}{\sigma(ROA)},$$

where ROA is the return on assets, $\frac{E}{A}$ is the equity to assets, and $\sigma(ROA)$ is the standard deviation of ROA. The Z-score measures bank soundness, reflecting a number of negative shocks a bank can endure with the existing profitability and equity buffer. For interpretation to be comparable to other bank risk measures, we use the negative value of the Z-score so that high value means high risk. While the Z-score has been widely used as a stability indicator in the literature (e.g., Boyd and Runkle, 1993; Laeven and Levine, 2009; Beck et al., 2013), the default probability is updated more frequently using the daily stock market data that also contains forward looking information. Because of these distinct advantages, the market-based risk measure has been recently adopted in the banking literature (e.g., Bongini et al., 2002; Fu et al., 2014). Alternatively, we use the stock return volatility and the risk-weighted asset ratio as additional bank risk measures as in Ignatowski and Korte (2014) and Khan et al. (2017).

In addition, we employ bank-specific characteristics as control variables. The existing banking literature reveals that market competition is closely related to bank risk-taking (e.g., Keeley, 1990; Hellmann et al., 2000; Boyd and De Nicolo, 2005), while the recent work of Azar et al. (2018) provides evidence on the anticompetitive effects of common

ownership. These two strands of literature suggest that common ownership may indirectly affect bank stability by changing competitive incentives. Accordingly, we explicitly control for bank-level market power proxied by the Lerner index:

$$Lerner = \frac{P - MC}{P},$$

where P is the price proxied by the ratio of total operating income to total assets and MC is the marginal cost estimated from a translog cost function (See Appendix D for further details of marginal costs and cost estimates). Moreover, we additionally control for bank size proxied by total assets, asset composition proxied by total loans to total assets, credit quality proxied by loan loss provisions to interest income, liquidity risk proxied by total deposits to total assets, non-interest activity proxied by non-interest income to total operating income, profitability proxied by net income to total assets, and leverage proxied by total equity to total assets. As the Z-score is a function of ROA and equity-to-asset ratio, we exclude the last two control variables in model specifications with the Z-score as an independent variable.

Table 1 reports the descriptive statistics for our sample of the U.S. listed banks and bank holding companies. The number of bank-quarter observations is 42,680. About a one-third of the bank-quarters are commonly held by at least one institutional blockholder, and the commonly held banks on average share ownership linkages with 23 banks. The average banks in the sample have the default probability of 0.18, the logged Z-score of 3.42, and the Lerner index of 0.24, which are similar to the values reported in previous banking literature (e.g., Beck et al., 2013; Anginer et al., 2014; Fu et al., 2014). We winsorize all continuous variables at the 1% and 99% levels to minimize the effects of outliers. Table 2 provides the pairwise correlation coefficients of the variables used in this study. The Z-score, the proxy of bank soundness, is negatively related to other bank risk measures—the default probability, the stock return volatility, and the risk-weighted asset ratio.[8] The common ownership proxies have relatively strong correlations with each other, exhibiting complementarity. The bank-specific control variables are

[8]We use the negative values of the Z-score in our analysis and results in Section 4 for interpretation to be comparable to other bank risk measures.

not highly intercorrelated, relieving the multicollinearity concern. The variables are also listed along with definitions and data sources in Appendix A.

3.3 Empirical Methodology

We adopt two main approaches to examine the empirical relation between common ownership and bank stability. The first approach is a panel analysis using the following two-way fixed-effects panel regression model:

$$Risk_{j,t} = \alpha_1 CO_{j,t-1} + \alpha_2 Controls_{j,t-1} + \alpha_3 \nu_j + \alpha_4 \mu_t + \varepsilon_{j,t}, \tag{1}$$

where $Risk_{j,t}$ is the risk-taking level of bank j in time t, $CO_{j,t}$ is the common ownership that bank j has because of overlapping shareholders with other banks in time t, $Controls_{j,t}$ is a vector of control variables specific to bank j in time t, ν_j is a bank dummy, and μ_t is a time dummy. We capture unobservable bank-specific characteristics with the bank fixed effect and macroeconomic variations with the time fixed effect. Our main interest lies in the common ownership coefficient, α_1, which reflects how a bank changes its risk-taking with the degree of common ownership linkages. The common ownership hypothesis predicts that the common ownership coefficient to be negative because joint financial interests promote the internalization of risk-taking externalities. On the contrary, the diversification hypothesis predicts that the common ownership coefficient to be positive because diversified shareholders less sensitive to idiosyncratic risks incentivize corporate risk-taking.

The second approach is a DiD analysis based on common ownership changes induced by mergers between institutional shareholders. We estimate the differential effect of the institution mergers on bank risk between the treatment and control groups by adopting the following two-way fixed-effects panel regression model:

$$Risk_{i,j,t} = \beta_1 Treat * Post + \beta_2 Post + \beta_3 Controls_{j,t-1} + \beta_4 \delta_{i,j} + \beta_5 \mu_t + \varepsilon_{i,j,t}, \tag{2}$$

where $Risk_{i,j,t}$ is the risk-taking level of bank j in time t prior or post merger event i, $Treat$ is a treatment group dummy, $Post$ is a dummy for post-merger period, $Controls_{j,t}$ is a vector of control variables specific to bank j in time t, $\delta_{i,j}$ is a bank-merger dummy, and μ_t is a time dummy. We use the two-year window around the merger event.[9] The bank-merger fixed effect that absorbs both time-invariant bank characteristics within the same merger and time trends across mergers.

We assign treatment using the intention-to-treat (ITT) method. We calculate counterfactual ownership linkages by treating the shareholdings of merging institutions in the quarter of the announcement date as if they were held by a single entity. Among banks held by one of the merging institutions, we define the treatment group as those that have higher implied common ownership and the control group as those that do not. The treatment banks are likely to experience an increase in common ownership in the post-merger. This ITT method helps randomized treatment assignment based on the initial ownership structures of banks prior to the merger event and mitigate the influence of unobserved demand in the stock market after the merger event, which is also adopted in He and Huang (2017) and Azar et al. (2018). If the estimate of β_1, the coefficient of the interaction term between the treatment dummy and the post-merger dummy, is significantly negative, banks undertake less risk as mergers between institutional shareholders produce more interbank ownership linkages, which supports the common ownership hypothesis.

The DiD analysis complements the panel regressions in that it identifies a causal link between common ownership and bank stability by exploiting institution mergers that result in more diversified portfolios and common ownership. Although the panel regression analysis allows us to examine the average effect of common ownership on bank stability across more than 300 banks along 26 years, it has two limitations. One is a potential endogeneity concern in common ownership coefficients arising from unobservable characteristics that are not captured with the bank and time fixed effects but might affect both investor shareholding and bank risk-taking decisions. The other is

[9]For robustness, we adopt alternative time windows, i.e., one-year and three-year, and find similar results to those in Section 4.

that it does not rule out the possibility that interbank common ownership results from concentrated shareholdings in the banking industry rather than portfolio diversification, in which case we cannot properly test the diversification hypothesis. For example, if investors are exposed more specifically to the banking industry by holding more banks (increasing common ownership) and decreasing cross-industry diversification (decreasing portfolio diversification), they could incentivize their portfolio banks to decrease risk-taking. However, the DiD analysis mitigates these concerns by studying exogenous ownership changes in banks from mergers that lead to more diversified portfolios for acquirer institutions.

4 Results

In this section, we present and discuss our estimates. First, we estimate the two-way fixed effects panel regression models to analyze how common ownership linkages are related with bank stability. For robustness, we employ alternative measures of common ownership and bank risk-taking. Second, to further identify the causal impact of common ownership on bank stability, we carry out the DiD analysis by exploiting exogenous variations in common ownership generated by mergers between institutional shareholders. The sample includes 42,680 bank-quarter observations in the U.S. banking industry from 1991 to 2016.

4.1 Panel Regression Results

Table 3 reports the results from the panel regression model in equation 1, where the dependent variable is bank risk and the key explanatory variable is common ownership. We use different measures of bank risk in each panel and alternative proxies of common ownership in each column, as explained in Section 3. The bank risk measures include the default probability in Panel A, the Z-score in Panel B, the stock return volatility in Panel C, and the risk-weighted asset ratio in Panel D. The common ownership proxies are the common ownership indicator variable (*CODummy* in Column (1)), the number of commonly held banks (*COBank1* in Column (2)), the average number of commonly held banks across shareholders (*COBank2* in Column (3)), the number of common

shareholders (*COInvestor* in Column (4)), the percentage share of common ownership (*COShare* in Column (5)), the average of model-implied profit weights on commonly held banks (*COWeight1* in Column (6)), and the market share average of the model-implied profit weights (*COWeight2* in Column (7)). In addition, we control for bank-specific characteristics that might affect risk-taking behavior as well as bank- and time- fixed effects.

The common ownership coefficients are significantly negative in all columns of Table 3, Panel A with bank risk measured by the default probability. The negative common ownership coefficients are consistently significant at one percent level across alternative proxies of common ownership while the economic magnitude differs slightly depending on the measurement method used. The coefficient estimate of common ownership in Column (1) shows that the default probability decreases by about one percent if a bank shares at least one common owner with other banks. Columns (2) to (4) represent that a bank has a lower default probability as it faces a large number of commonly held banks and common owners. Column (5) indicates that one percentage point increase in the common ownership portion of issued shares leads to an approximately six percent decrease in the default probability. Columns (6) and (7) also show this negative relation between common ownership and the default probability even when we adopt the common ownership proxies derived from structural models.

The results imply that banks have more incentives to internalize risk-taking externalities when they have more common owners with other banks, which is consistent with the prediction of the common ownership hypothesis. The common ownership hypothesis argues that commonly held firms internalize negative externalities for joint profit maximization promoted by common owners. In the banking industry, one bank's risk-taking entails negative externalities onto other banks through financial transactions especially in interbank markets (Allen and Gale, 2000) or through expectation channels in the form of bank runs (Diamond and Dybvig, 1983). Without common ownership linkages, a bank chooses the optimal risk level that balances the benefit of revenue and the cost of default risk upon an additional risk-taking. In the presence of shareholders that also hold shares in other banks, a bank needs to take into account its influence on

the commonly held banks because its risk-taking further decreases the profits of the peer banks and their common owners. Thus, the risk choice of a bank would be lower when it is engaged with more common ownership linkages.

We find that the negative empirical relation between common ownership and bank risk exists after controlling for other possible confounding and explanatory factors as well as bank- and time-specific fixed effects. The existing literature on common ownership (e.g., Reynolds and Snapp, 1986; Azar et al., 2018) and bank stability (e.g., Keeley, 1990; Hellmann et al., 2000; Boyd and De Nicolo, 2005) can be taken together to suggest the indirect channel in which common ownership affects bank risk-taking by altering competitive incentives. Apart from this indirect effect, we confirm the existence of a direct effect of common ownership on bank risk by explicitly controlling for bank-specific market power with the Lerner index. As shown in Table 3, Panel A, the coefficient estimates of the remaining control and explanatory variables are in expected signs and indicate that a bank undertakes lower risk profile when it has larger market power, smaller assets, and lower exposure to risky operating activities, in consistent with previous empirical banking literature (e.g., Beck et al., 2013; Fu et al., 2014; Khan et al., 2017).

For further robustness, we redo the estimation with alternative measures of bank risk along with the seven different proxies of common ownership, and show that the previous panel regression results are not driven by a particular measurement choice. Table 3, Panel B, provides the results from panel regressions with the (negative) Z-score as the bank risk measure. Consistent with the previous results, the common ownership coefficients are significantly negative in all columns with different proxies of common ownership. This implies that if a bank is associated with common ownership, it is likely to reduce risk-taking, which subsequently decreases the (negative) Z-score by approximately five percent relative to those without common ownership linkages. In terms of the stock return volatility and the risk-weighted asset ratio, the riskiness of commonly held banks is on average about one standard deviation lower, as presented in Table 3, Panel C and D, respectively. Overall, our findings indicate that common ownership is related to lower bank risk in the following quarter, which is not confined to specific measures of common ownership and bank risk.

4.2 DiD Regression Results

Using the institution mergers, we conduct the DiD analysis to mitigate the concerns arising from the panel regressions. The panel regression results reveal that common ownership linkages are closely related with bank risk-taking incentives based on relatively large cross-sectional and time variations. Nevertheless, the panel analysis poses challenges in studying the causal relation. As discussed in Section 3.3, common ownership might be correlated with unobservable qualitative traits which are not captured fully by the two-way fixed effects, resulting in estimation bias. Moreover, if common ownership in the banking industry had emerged from factors other than portfolio diversification, the diversification hypothesis cannot be tested properly in the panel regression model. The mergers between institutional shareholders, however, produce more diversified portfolios by contract, which in turn generate exogenous changes in common ownership.

To identify the causal impact of common ownership on bank stability, we examine the differential effect of institution mergers on bank risk between the treatment and control bank groups. As explained in Section 3.3, the treatment banks are those that are likely to experience an increase in common ownership after the institution mergers relative to the control banks. We compute counterfactual ownership linkages in terms of the number of commonly held banks (*COBank1*) and the structural profit weights on commonly held banks (*COWeight1*).

In the first step, we verify the validity of our DiD approach by showing that the mergers have led to more portfolio diversification for the involved institutional shareholders and more common ownership linkages across banks. Appendix B lists the institution mergers used in the DiD analysis and reports the number of firms and industries held in investment portfolios by the acquirer institutions in the quarter before the announcement and after the completion date of the mergers. In the post-merger period, the acquirers obtained more diversified portfolios by taking over the target portfolios. In doing so, some of banks face more common ownership. Column (1) of Table 4 shows that the treatment banks have significantly a greater degree of common ownership in the post-merger period.

Next, we analyze the treatment effect on bank risk-taking. In Columns (2) to (9) of Table 4, we report the results from the DiD regression model in equation 2. We define the treatment banks based on the number of commonly held banks in Panel A and the structural profit weights on commonly held banks in Panel B. The coefficients of the interaction term $Treat * Post$ are significantly negative in Columns (2) to (7), in each of which we employ a different type of bank risk measures and fixed effects. The results suggest that the treatment banks which are expected to have more common ownership linkages undertake less risk than the control banks in the post-merger period. The default probability and the (negative) Z-score of the treatment banks decrease by about four percent and eighteen percent, respectively, during the two years after the mergers compared to the two years before the mergers. Their stock return volatility also gets lower while the risk-weighted asset ratio does not show a significant change. We find similar results when we use alternative time windows around the merger dates (i.e., one year and three years). The coefficient estimates in the DiD analysis are slightly larger than those in the panel regressions, indicating the possibility of endogeneity problem that makes common ownership coefficients downward.[10] Yet, our main findings are not affected by the endogeneity concern.

In line with the panel regression results, the DiD analysis provides further evidence of the common ownership hypothesis. The diversification hypothesis argues that diversified shareholders are less sensitive to firm-specific risk and incentivize corporate risk-taking to maximize their portfolio payoff. However, our DiD results imply the opposite in that these diversified shareholders disincentivize bank risk-taking. As predicted by the common ownership hypothesis, the common shareholders seem to care more about the negative impact of risk-taking externalities on the profits of their commonly held banks. This is the case even when the common shareholders have diversified portfolios. Our findings, therefore, suggest that the common ownership hypothesis is dominant and common ownership improves financial stability in the U.S. banking industry. In other industries in the absence of between-firm risk-taking externalities, the effect of common

[10] He and Huang (2017) also note this endogeneity issue as inherent in the empirical models with common ownership as the key explanatory variable.

ownership could be different from our findings in this paper, and diversified common owners may have more incentives to undertake riskier investments as predicted by the diversification hypothesis.

5 Conclusion

We examine two conflicting theoretical arguments to identify the empirical relation between common ownership and financial stability. Using quarterly data from the U.S. banking industry from 1991 to 2016, we find that banks undertake lower risk when they share more common owners with other banks, in line with the common ownership hypothesis which argues that joint financial interests promote the internalization of risk-taking externalities. The result is robust to alternative measurement and data construction as well as model specifications that account for potential endogeneity. Specifically, we construct seven alternative proxies of common ownership and four different measures of bank risk. In addition to panel regressions, we conduct the DiD analysis based on the quasi-natural experiment of mergers between institutional shareholders that generate more diversified portfolios for the acquirer institutions and exogenous variations in ownership structure of banks.

Our work contributes to the literature by providing empirical evidence on the relation between common ownership and financial stability for the first time. Despite the policymaker's need for research on common ownership from a financial stability perspective, the extent of common ownership beyond market competition has not been well explored. Our findings suggest that common ownership improves bank stability. Accordingly, the recent discussions on antitrust regulations to restrict common ownership need to consider stability in the banking industry. Potential regulatory actions towards common ownership would depend on policymaker's focus on financial stability objectives versus competition objectives. If policymakers have stronger financial stability objectives, they would take cautious steps in regulating cross-shareholdings in the banking industry.

There are several possible channels in which common ownership affects financial stability. Shareholders can make management more aligned with their interests, for

example, by selling off stocks, voting against management, or changing managerial incentives. Commonly held banks can have better understanding of their externalities by forming collaborative activities or hiring common audits. We leave the identification of channels that connect common ownership to bank risk-taking behavior for the future research.

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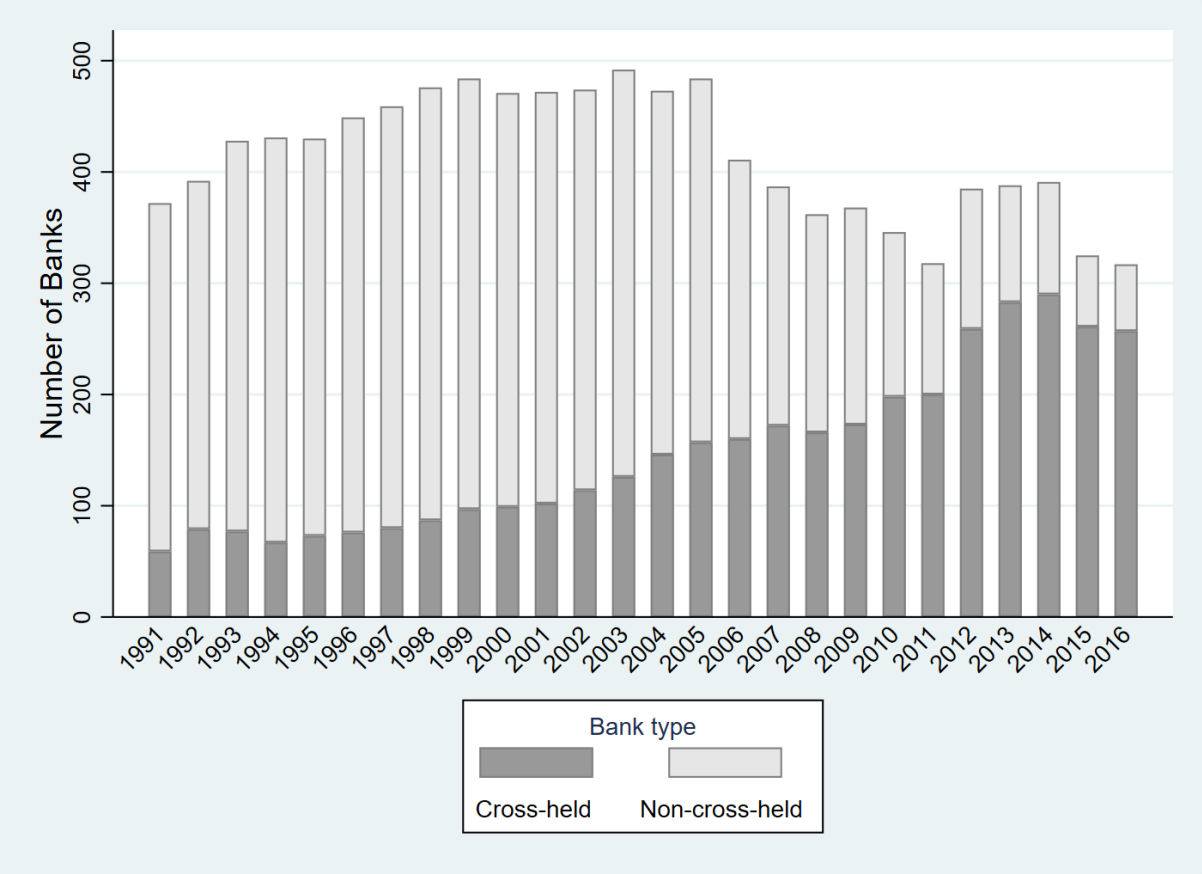
Figures and Tables

Figure 1: Common ownership in the U.S. banking industry



Notes: This figure plots the number of banks that are commonly held by institutional blockholders among the listed U.S. banks from 1991 to 2016, where blockholders are defined as shareholders with more than 5% of issued shares. Data on institutional shareholdings come from 13F filings.

Table 1: Summary statistics

Variable	Mean	P25	Median	P75	SD	N
Bank Risk						
P(Default)	0.188	0.078	0.157	0.267	0.140	42,680
Z-score	3.420	3.137	3.380	3.708	0.622	42,005
σ(Stock)	0.025	0.014	0.020	0.028	0.020	42,680
RWA	0.716	0.645	0.721	0.795	0.118	31,546
Common Ownership						
CODummy	0.352	0.000	0.000	1.000	0.477	42,680
COBank1	23.078	0.000	0.000	10.000	53.179	42,680
COBank2	13.775	0.000	0.000	7.000	32.021	42,680
COInvestor	0.631	0.000	0.000	1.000	1.050	42,680
COShare	0.047	0.000	0.000	0.069	0.082	42,680
COWeight1	0.014	0.000	0.000	0.006	0.035	42,680
COWeight2	0.024	0.000	0.000	0.001	0.081	42,680
Bank Characteristics						
Lerner	0.237	0.143	0.232	0.328	0.175	42,680
Asset	14.307	13.243	14.040	15.231	1.488	42,680
Loan	0.650	0.588	0.667	0.735	0.131	42,680
LLP	0.065	0.016	0.033	0.066	0.116	42,680
Deposit	0.037	0.000	0.000	0.000	0.172	42,680
NIAct	0.167	0.090	0.139	0.210	0.122	42,680
ROA	0.005	0.003	0.005	0.008	0.007	42,680
Equity	0.094	0.076	0.089	0.105	0.034	42,680

Notes: This table provides descriptive statistics based on the sample of the U.S. listed commercial banks and bank holding companies from 1991Q1 to 2016Q4. *P(Default)* is the default probability estimated from the distance to default model of Merton (1974) as in Bharath and Shumway (2008). *Z-score* is the natural logarithm of the sum of equity over assets and return on assets divided by the standard deviation of return on assets. *σ(Stock)* is the standard deviation of daily stock returns. *RWA* is the ratio of risk weighted assets to total assets. *CODummy* is an indicator variable that equals one if the bank has overlapping institutional blockholders with other banks. *COBank1* is the number of peer banks commonly held by the blockholders. *COBank2* is the average number of peer banks that each of the blockholders hold. *COInvestor* is the number of the overlapping blockholders. *COShare* is the sum of percentage shareholdings of the overlapping blockholders. *COWeight1* is the average of the model-implied weights that the bank internalizes its price effect on the peer profits due to the overlapping blockholders. *COWeight2* is the market share weighted average of the structural profit weights used in *COWeight1*. Other variables include the Lerner index (*Lerner*), the natural logarithm of total assets (*Asset*), the ratio of total loans to total assets (*Loan*), loan loss provisions to interest income (*LLP*), the ratio of total deposits to total assets (*Deposit*), non-interest income to total operating income (*NIAct*), return on assets (*ROA*), and the ratio of total equity to total assets (*Equity*). Continuous variables are winsorized at 1% and 99%.

Table 2: Correlation coefficients

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	P(Default)	1.00																		
2	Z-score	-0.01	1.00																	
3	σ(Stock)	0.77	-0.12	1.00																
4	RWA	-0.02	-0.09	0.04	1.00															
5	CODummy	-0.07	0.03	-0.10	-0.04	1.00														
6	COBank1	-0.06	0.03	-0.09	-0.07	0.74	1.00													
7	COBank2	-0.06	0.03	-0.08	-0.06	0.74	0.89	1.00												
8	COInvestor	-0.06	0.04	-0.09	-0.06	0.84	0.80	0.59	1.00											
9	COShare	-0.06	0.03	-0.08	-0.05	0.79	0.72	0.52	0.94	1.00										
10	COWeight1	-0.06	0.02	-0.08	-0.04	0.67	0.82	0.91	0.55	0.46	1.00									
11	COWeight2	-0.12	-0.03	-0.08	0.01	0.44	0.51	0.57	0.35	0.29	0.63	1.00								
12	Lerner	-0.45	-0.14	-0.30	0.12	0.11	0.11	0.12	0.09	0.08	0.11	0.24	1.00							
13	Asset	-0.30	-0.16	-0.24	0.05	0.15	0.17	0.16	0.15	0.13	0.15	0.29	0.76	1.00						
14	Loan	0.07	0.00	0.06	0.68	-0.06	-0.06	-0.06	-0.06	-0.05	-0.04	-0.08	-0.12	-0.21	1.00					
15	LLP	0.20	-0.17	0.18	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.12	0.17	1.00				
16	Deposit	0.09	0.01	0.10	0.06	-0.01	-0.01	-0.01	-0.02	-0.02	-0.01	-0.01	-0.13	-0.16	0.06	0.03	1.00			
17	NIAct	-0.18	-0.15	-0.09	0.00	0.06	0.05	0.06	0.04	0.03	0.05	0.15	0.39	0.47	-0.31	0.07	-0.09	1.00		
18	ROA	-0.45	-0.04	-0.26	0.07	0.02	0.01	0.02	0.00	0.00	0.02	0.09	0.60	0.20	-0.05	-0.33	-0.05	0.25	1.00	
19	Equity	-0.34	0.24	-0.10	0.01	0.06	0.04	0.03	0.06	0.05	0.02	0.04	0.09	-0.08	-0.05	-0.10	0.04	0.05	0.30	1.00

Notes: This table reports the pairwise correlation coefficients of variables used in this study. We employ four different bank risk measures (*P(Default), Z-score, σ(Stock), RWA*) and seven alternative common ownership proxies (*CODummy, COBank1, COBank2, COInvestor, COShare, COWeight1, COWeight2*). Variable definitions are provided in Appendix A.

Table 3: Effect of common ownership on bank risk: panel regressions

Panel A: Default probability							
	Dependent Variable: P(Default)$_{t+1}$						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CODummy	-0.011***						
	(0.002)						
ln(COBank1)		-0.004***					
		(0.001)					
ln(COBank2)			-0.004***				
			(0.001)				
ln(COInvestor)				-0.013***			
				(0.003)			
COShare					-0.061***		
					(0.018)		
COWeight1						-0.123***	
						(0.044)	
COWeight2							-0.040**
							(0.018)
Lerner	-0.100***	-0.097***	-0.097***	-0.099***	-0.101***	-0.098***	-0.098***
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
Asset	0.001	0.001	0.001	0.001	0.001	0.002	0.002
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Loan	-0.004	-0.003	-0.003	-0.003	-0.003	-0.002	-0.002
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
LLP	0.157***	0.156***	0.156***	0.157***	0.157***	0.155***	0.155***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Deposit	0.225*	0.232**	0.231**	0.228*	0.230**	0.233**	0.232*
	(0.116)	(0.116)	(0.116)	(0.117)	(0.117)	(0.118)	(0.118)
NIAct	0.022	0.023	0.023	0.023	0.023	0.023	0.024
	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)
ROA	-1.184***	-1.215***	-1.215***	-1.188***	-1.173***	-1.231***	-1.227***
	(0.216)	(0.216)	(0.216)	(0.215)	(0.216)	(0.215)	(0.214)
Equity	-0.959***	-0.945***	-0.949***	-0.950***	-0.958***	-0.963***	-0.969***
	(0.063)	(0.063)	(0.063)	(0.063)	(0.063)	(0.063)	(0.063)
Constant	0.279***	0.270***	0.271***	0.274***	0.277***	0.263***	0.266***
	(0.063)	(0.063)	(0.063)	(0.063)	(0.063)	(0.063)	(0.063)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	42,680	42,680	42,680	42,680	42,680	42,680	42,680
R-squared	0.776	0.776	0.776	0.776	0.776	0.775	0.775

(Continued)

Table 3: Continued

Panel B: Z-score							
	Dependent Variable: -(Z-score)$_{t+1}$						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CODummy	-0.050***						
	(0.017)						
ln(COBank1)		-0.027***					
		(0.006)					
ln(COBank2)			-0.026***				
			(0.006)				
ln(COInvestor)				-0.086***			
				(0.020)			
COShare					-0.435***		
					(0.128)		
COWeight1						-0.936***	
						(0.261)	
COWeight2							-0.223**
							(0.105)
Lerner	-1.212***	-1.191***	-1.195***	-1.202***	-1.214***	-1.202***	-1.210***
	(0.100)	(0.100)	(0.100)	(0.100)	(0.101)	(0.099)	(0.099)
Asset	0.135***	0.140***	0.139***	0.138***	0.136***	0.145***	0.140***
	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)
Loan	0.146	0.146	0.146	0.148	0.150	0.153	0.153
	(0.115)	(0.114)	(0.114)	(0.114)	(0.115)	(0.115)	(0.115)
LLP	1.508***	1.506***	1.507***	1.507***	1.507***	1.505***	1.505***
	(0.100)	(0.100)	(0.100)	(0.100)	(0.100)	(0.101)	(0.101)
Deposit	-0.023	-0.008	-0.008	-0.031	-0.007	0.023	0.023
	(0.529)	(0.535)	(0.533)	(0.531)	(0.531)	(0.532)	(0.530)
NIAct	0.289**	0.296**	0.294**	0.294**	0.295**	0.293**	0.295**
	(0.138)	(0.137)	(0.137)	(0.138)	(0.138)	(0.137)	(0.137)
Constant	-5.285***	-5.338***	-5.332***	-5.310***	-5.299***	-5.433***	-5.378***
	(0.404)	(0.408)	(0.407)	(0.407)	(0.407)	(0.409)	(0.410)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	42,005	42,005	42,005	42,005	42,005	42,005	42,005
R-squared	0.431	0.433	0.432	0.432	0.432	0.432	0.431

(Continued)

Table 3: Continued

Panel C: Stock return volatility							
	Dependent Variable: $\sigma(\text{Stock})_{t+1}$						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CODummy	-0.141***						
	(0.033)						
ln(COBank1)		-0.043***					
		(0.011)					
ln(COBank2)			-0.043***				
			(0.012)				
ln(COInvestor)				-0.161***			
				(0.038)			
COShare					-0.675**		
					(0.279)		
COWeight1						-0.325	
						(0.411)	
COWeight2							0.183
							(0.156)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	42,680	42,680	42,680	42,680	42,680	42,680	42,680
R-squared	0.591	0.591	0.591	0.591	0.591	0.590	0.590
Panel D: Risk-weighted asset ratio							
	Dependent Variable: RWA_{t+1}						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CODummy	-0.004**						
	(0.002)						
ln(COBank1)		-0.001*					
		(0.001)					
ln(COBank2)			-0.001*				
			(0.001)				
ln(COInvestor)				-0.005**			
				(0.002)			
COShare					-0.026*		
					(0.014)		
COWeight1						-0.056	
						(0.039)	
COWeight2							-0.024
							(0.016)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	31,546	31,546	31,546	31,546	31,546	31,546	31,546
R-squared	0.870	0.870	0.870	0.870	0.870	0.870	0.870

Notes: This table reports regression results on the effect of bank risk on common ownership. As dependent variables, we use the default probability in Panel A, the Z-score in Panel B, the stock return volatility in Panel C, and the risk-weighted asset ratio in Panel D. We adopt alternative proxies of common ownership (CODummy, COBank1, COBank2, COInvestor, COShare, COWeight1, COWeight2) in each column. Variable definitions are provided in Appendix A. Continuous variables are winsorized at 1% and 99%. The sample is based on the quarterly data of the U.S. listed commercial banks and bank holding companies over the period of 1991Q1–2016Q4. Heteroskedasticity-robust standard errors clustered for banks are presented in parentheses. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 4: Effect of institution mergers on bank risk and common ownership: DiD regressions

Panel A: Sorted by COBank1

Variable	(1) COBank1	(2) P(Default)	(3) P(Default)	(4) -(Z-score)	(5) -(Z-score)	(6) σ(Stock)	(7) σ(Stock)	(8) RWA	(9) RWA
Treat * Post	0.537***	-0.043***	-0.037***	-0.232***	-0.178***	-0.529***	-0.360***	-0.009	-0.007
	(0.122)	(0.007)	(0.006)	(0.077)	(0.069)	(0.096)	(0.094)	(0.008)	(0.006)
Post	-0.037***	0.000	-0.000	0.017***	0.016***	0.003	0.002	0.001	0.001
	(0.011)	(0.001)	(0.001)	(0.006)	(0.006)	(0.016)	(0.018)	(0.001)	(0.001)
Treat	0.780***	0.025***		0.092*		0.558***		-0.002	
	(0.149)	(0.010)		(0.048)		(0.132)		(0.007)	
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	No	Yes	No	Yes	No	Yes	No
Merger FE	Yes	Yes	No	Yes	No	Yes	No	Yes	No
Bank-Merger FE	No	No	Yes	No	Yes	No	Yes	No	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	28,675	28,675	28,675	28,286	28,286	28,675	28,675	14,726	14,726
R-squared	0.672	0.837	0.862	0.465	0.501	0.620	0.636	0.873	0.896

(Continued)

Table 4: Continued

Panel B: Sorted by COWeight1

Variable	(1) COWeight1	(2) P(Default)	(3) P(Default)	(4) -(Z-score)	(5) -(Z-score)	(6) σ(Stock)	(7) σ(Stock)	(8) RWA	(9) RWA
Treat * Post	0.013***	-0.043***	-0.037***	-0.246***	-0.186***	-0.533***	-0.358***	-0.011	-0.008
	(0.002)	(0.006)	(0.006)	(0.075)	(0.066)	(0.099)	(0.095)	(0.008)	(0.006)
Post	-0.001***	0.000	-0.000	0.018***	0.017***	-0.002	-0.003	0.001	0.001
	(0.000)	(0.001)	(0.001)	(0.006)	(0.006)	(0.017)	(0.018)	(0.001)	(0.001)
Treat	0.006***	0.025***		0.093**		0.538***		0.001	
	(0.001)	(0.009)		(0.047)		(0.127)		(0.006)	
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	No	Yes	No	Yes	No	Yes	No
Merger FE	Yes	Yes	No	Yes	No	Yes	No	Yes	No
Bank-Merger FE	No	No	Yes	No	Yes	No	Yes	No	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	28,600	28,600	28,600	28,214	28,214	28,600	28,600	14,651	14,651
R-squared	0.532	0.837	0.862	0.466	0.502	0.619	0.635	0.872	0.895

Notes: This table reports the DiD regression results on the effect of institution mergers on bank risk and common ownership. *Treat* equals one if a banks is a treatment and zero if it is a control. *Post* indicates the post-merger period. We calculate the post-merger implied common ownership by treating shareholdings of merging institutions in the quarter of the announcement date as if they are held by a single entity. Among banks held by one of the merging institutions, we define the treatment group as those that have increased implied common ownership and the control groups as those that do not. As the proxy of common ownership, we use the number of commonly held banks (COBank1) in Panel A, and the structural profit weights on commonly held banks (COWeight1) in Panel B. We use two-year window around the merger dates, and control for bank-specific characteristics as in the panel regressions of Table 3. Variable definitions are provided in Appendix A. Continuous variables are winsorized at 1% and 99%. The sample is based on the quarterly data of the U.S. listed commercial banks and bank holding companies over the period of 1991Q1–2016Q4. Heteroskedasticity-robust standard errors clustered for banks are presented in parentheses. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

Appendix A. Variable Definitions

Variable	Definition	Data Source
P(Default)	Default probability from the distance to default model of Merton (1974) calculated following Bharath and Shumway (2008)	CRSP, FRB
Z-score	The natural logarithm of the sum of equity over total assets and return on assets divided by the one-year rolling standard deviation of return on assets	FRB
σ(Stock)	Standard deviation of daily stock return in the quarter	CRSP
RWA	Risk-weighted assets relative to total assets	FRB
CODummy	An indicator variable that equals one if the bank has at least one overlapping institutional blockholder with other banks, where a blockholder is defined as shareholders that hold more than 5% of issued shares.	SDC
COBank1	The number of peer banks commonly held by the institutional blockholders	SDC
COBank2	The average number of peer banks held by each of the institutional blockholders	SDC
COInvestor	The number of common institutional blockholders that hold the bank and other banks simultaneously.	SDC
COShare	The sum of percentage ownership shareholdings held by the common institutional blockholders	SDC
COWeight1	The average structural weights that the bank places on the profits of other commonly held banks relative to its own profit	SDC
COWeight2	The firm-level common ownership measure used in Azar et al. (2018) instead of the market-level common ownership measure, MHHI delta. This is the market share weighted average version of COWeight1.	SDC
Lerner	Markup over price, where price is proxied by the ratio of total operating income to total assets and marginal costs are estimated using a translog cost function	FRB
Asset	The natural logarithm of total assets, bank size	FRB
Loan	The ratio of total loans to total assets, asset composition	FRB
LLP	The ratio of loan loss provisions to interest income, credit risk (credit quality, monitoring cost)	FRB
Deposit	The ratio of total deposits to total assets, liquidity risk/funding structure	FRB
NIAct	The ratio of non-interest income to total operating income	FRB
ROA	Net income relative to total assets, profitability	FRB
Equity	Total equity relative to total assets, capital buffer/leverage	FRB

Appendix B. Institution Mergers

Acquirer Name	Target Name	Announce	Effective	Pre-merger		Post-merger	
				#Firm	#Ind.	#Firm	#Ind.
First Union (60)	Lieber & Co. (62)	19931018	19940701	791	48	1206	48
First Union (60)	Evergreen Invest. (62)	19940306	19940630	792	48	1185	48
TCW Group (62)	Continental Asset. (67)	19950616	19950616	830	45	864	45
Barclays (60)	Lehman Brothers (62)	20080916	20080922	4714	48	4871	48
BlackRock (62)	BGI (62)	20090611	20091201	1246	46	4273	48

Notes: This table presents the list of institution mergers used in the DiD analysis. For each merger, we provide the names of the acquirer and target institutions, and the announcement and effective dates. The last six columns report the number of firms and (Fama-French 48) industries held by the acquirers in the quarter before the announcement dates and after the effective dates, respectively. Two-digit SIC codes of the merging institutions are in parentheses (60: depository institutions, 62: security & commodity brokers, 67: holding & other investment offices).

Appendix C. Profit Weights

To compute the proxy of common ownership, *COWeight*, we derive the structural profit weights from the following profit maximization. Bank j chooses its risk level to maximize its shareholder's profits. As in Azar et al. (2016), there are two types of shareholders: (1) non-bank institutional investor i, and (2) asset manager of bank k. Non-bank institutional investor i has a portfolio that invests in multiple banks, and the portfolio returns the sum of bank operating profits weighted by its ownership shares, $\pi^i = \sum_j \beta_{ij}\pi_j$. Overall, bank j maximizes the total profits of non-bank institutional investor i and bank k relative to their control power:

$$
\begin{aligned}
\max_{\sigma_j} \; & \sum_i \gamma_{ij}\pi^i + \sum_{k\neq j} \gamma_{kj}\pi_k \\
&= \sum_i \gamma_{ij} \sum_j \beta_{ij}\pi_j + \sum_{k\neq j} \gamma_{kj}\pi_k \\
&= \sum_i \gamma_{ij}(\cdots + \beta_{ij}\pi_j + \beta_{ik}\pi_k + \cdots) + \sum_{k\neq j} \gamma_{kj}\pi_k \\
&\propto \pi_j + \sum_{k\neq j} \frac{\sum_i \gamma_{ij}\beta_{ik} + \gamma_{kj}}{\sum_i \gamma_{ij}\beta_{ij}}\pi_k,
\end{aligned}
$$

where γ_{ij} and γ_{kj} are the control power of non-bank institutional investor i and bank k within bank j, respectively, and β_{ij} and β_{ik} are the number of ownership shares of bank j and k that non-bank institutional investor i has, respectively. We define $\frac{\sum_i \gamma_{ij}\beta_{ik}+\gamma_{kj}}{\sum_i \gamma_{ij}\beta_{ij}}$ as the model-implied weight that bank j places upon bank k relative to its own profit, which reflects the extent to which bank j internalizes its risk-taking effect on the profit of bank k in consideration of overlapping shareholders with bank k. We assume that the number of ownership shares has the equal amount of control power similar to Gramlich and Grundl (2017).

Appendix D. Marginal Cost Estimation

To derive quarterly marginal cost for banks, we estimate the following translog cost function:

$$lnC_{it} = \alpha_0 + \alpha_1 \ln Q_{it} + \alpha_2 (\ln Q_{it})^2 + \sum_{j=1}^{3} \beta_j \ln w_{it}^j + \sum_{j=1}^{3} \sum_{k=1}^{3} \beta_{jk} \ln w_{it}^j \ln w_{it}^k + \sum_{j=1}^{3} \gamma_j \ln w_{it}^j \ln Q_{it} + \nu_t + \varepsilon_{it},$$

where C_{it} is total operating costs (interest, personnel, and other operating and administrative expenses), Q_{it} is total output (total assets) for bank i at time t, and ν_t is a time dummy. Following the previous banking literature Berger et al. (e.g., 2009); Beck et al. (e.g., 2013), we employ three inputs—physical capital, labor, and borrowed funds—, of which prices are captured by w_{it}^j with $j \in \{1, 2, 3\}$. The three input prices are proxied by the ratio of interest expenses to the sum of total deposits and other borrowed money market funds, the ratio of personnel expenses to total assets, and the ratio of other operating and administrative expenses to total assets, respectively. For homogeneity of degree one in input prices, we impose the restrictions, i.e., $\sum_{j=1}^{3} \beta_j = 1, \sum_{j=1}^{3} \gamma_j = 0, \sum_{j=1}^{3} \sum_{k=j}^{3} \beta_{jk} = 0$. Thereby, marginal cost is obtained as:

$$MC_{it} = \frac{\partial C_{it}}{\partial Q_{it}} = \frac{C_{it}}{Q_{it}} (\hat{\alpha}_1 + 2\hat{\alpha}_2 lnQ_{it} + \sum_{j=1}^{2} \hat{\gamma}_j ln \frac{w_{i,t}^j}{w_{i,t}^3}).$$

The regression result using the translog cost function is reported in the following table.

Variable	Estimate	S.E.
$\ln Q$	1.962***	0.008
$\ln Q^2$	-0.033***	0.000
$\ln w_1$	0.844***	0.019
$\ln w_2$	0.593***	0.008
$\ln w_3$	-0.437***	0.020
$\ln w_1$ * $\ln w_1$	-0.010***	0.002
$\ln w_1$ * $\ln w_2$	-0.057***	0.002
$\ln w_1$ * $\ln w_3$	0.068***	0.001
$\ln w_2$ * $\ln w_2$	0.086***	0.001
$\ln w_2$ * $\ln w_3$	-0.029***	0.002
$\ln w_3$ * $\ln w_3$	-0.038***	0.002
$\ln w_1$ * $\ln Q$	-0.028***	0.001
$\ln w_2$ * $\ln Q$	0.007***	0.000
$\ln w_3$ * $\ln Q$	0.021***	0.001