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Bank opacity and risk-taking: Evidence from analysts' forecasts☆

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Abstract

We depart from existing literature by invoking analysts' forecasts to measure banking system opacity and then investigate the impact of such opacity on bank risk-taking, using a large panel of US bank holding companies, over the 1995–2013 period. We uncover three new results. Firstly, we find that opacity increases insolvency risks among banks. Secondly, we establish that the relationship between opacity and bank risk-taking is accentuated by the degree of banking market competition. Thirdly, we show that the bank business model moderates the risk-taking incentives of opaque banks, albeit only marginally. Overall, these findings suggest that the analysts' forecast measure of bank opacity is useful for understanding risk-taking by publicly-traded banks, with important implications for bank stability.

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1. Introduction

Banks are inherently opaque and, according to Blau et al. (2017), they are more opaque than other types of firms. Indeed, the age-old problem of bank opacity is well acknowledged in the theory, practice and regulation of banking. For example, bank regulators have called for more transparency and market discipline as part of the important policy initiatives towards Basel III (Basel Committee on Banking Supervision, 2013; Horváth and Vaško, 2016). Increased sophistication in bank business models has also heightened the problem of bank opacity (Morgan, 2002; Flannery et al., 2013), in the intermediation role that banks play as providers of liquidity (Diamond, 1984) and delegated monitors (Diamond and Dybvig, 1983). To the extent that opacity is associated with inefficient market discipline (Demsetz and Lehn, 1985; Cordella and Yeyati, 1998; Boot and Schmeits, 2000), its prevalence theoretically creates distorted risk-taking incentives. The existing evidence, whilst equivocally in support of the theoretical predictions, focuses on country-level transparency measures (Demirgüç-Kunt et al., 2008; Bushman and Williams, 2012; Horváth and Vaško, 2016) and accounting-based disclosure indicators (Nier, 2005; Nier and Baumann, 2006). The natural question, at this point, is whether more direct measures of opacity, particularly those used by practitioners, support the theoretical predictions.

In this paper, we examine empirically the effect of opacity on overall bank stability. We depart from the existing literature by using, as alternative measures of opacity, analysts' forecast errors and dispersions, which are highly informative measures that emphasise the precision of both private and public information. We further investigate the extent to which the interaction between opacity and bank stability is conditional on banking competition and bank business model. We also consider the implications of opacity for the competition-stability nexus and the relationship between bank business model and risk-taking in banking.

Our empirical results suggest that, firstly, a high degree of opacity impairs bank stability. This effect is present even after controlling for observable and unobservable bank characteristics, and the possible endogeneity problems that may plague this relationship. Secondly, the impact of opacity on banking stability is higher for bank-year periods of optimism than those of pessimism. Thirdly, opacity is more destabilising in the periods prior to and during the 2007-08 global financial crisis but not statistically robustly so post-crisis. Fourthly, the negative effect of opacity on bank stability is accentuated by a higher degree of banking competition. Equivalently, whilst a higher degree of banking competition is found to be associated with a less stable banking system, the effect is larger for highly opaque banks. Finally, we find that the effect of opacity on bank risk-taking is conditional on bank business models. Specifically, higher dependence on non-deposit (wholesale) funding increases the risk-taking behaviour of opaque banks, whilst diversification, in contrast, has a weak moderating effect. The finding suggests that banks with highly diversified business models have an incentive to maintain a high level of transparency and relatively high risk-aversion.

The paper makes three main new contributions to the literature. Firstly, and to the best of our knowledge, this paper is the first to relate opacity derived from analysts' earnings forecasts to bank stability. Analysts are regarded as informed intermediaries between organisations and investors (O'Brien and Bhushan, 1990; Chung and Jo, 1996), and their forecast properties have first-order causality on market liquidity (Roulstone, 2003). Hence, analysts' forecast activities provide a primary source of information to security investors. For instance, Roulstone (2003) finds that analysts' forecast dispersion reduces bid-ask spread, share depth and the adverse selection component of bid-ask spread. Another interesting feature of analysts' forecast activities as argued in Chung and Jo (1996) is that they have direct monitoring effects on organisations in the sense of Jensen and Meckling (1976). Also, using analysts' forecast inaccuracy allows us to disentangle the effects of optimism and pessimism on bank stability.

Secondly, our paper pulls together the literature on banking competition and opacity to explain the risk-taking behaviour of banks. Although these strands of the existing literature have long-standing strong theoretical interactions, our paper, to the best of our knowledge, is the first to study their joint effects on bank risk-taking using a direct measure of competition estimated at the bank level. By doing so, the paper helps to address some potential regulatory and supervisory concerns about whether, and to what extent, banking competition could be allowed to soften bank disclosure requirements. In other words, we shed light on whether there is an optimal level of competition at which opacity is less costly in banking. This question is crucial in the sense that both monitoring and bank failure can be extremely costly (Verrecchia, 1983; Bushman and Williams, 2012).

Thirdly, the paper sheds light on the complex interactions between bank business models and risk-taking. Evidence of significant interactions between opacity and diversification should have significant policy implications given that reliance on non-interest earnings income accounts for a sizeable proportion of US bank holding companies' total income, rising from about 32% in 1990 to 42% in 2004 (Stiroh, 2006), whilst opacity amongst US bank holding companies is significantly high (Flannery et al., 2013).

The rest of the paper is organised as follows. Section 2 presents a review of the relevant literature. Section 3 discusses the empirical estimation methods. Section 4 describes the data and variables used for the study. The empirical results are presented in Section 5, whilst Section 6 concludes.

2. Literature review and hypotheses development

Past studies have examined the interaction of country-level transparency measures, accounting disclosures, stock liquidity and risk-taking. Other strands of the literature examine competition and business model channels of bank risk-taking. In this section, we draw on these studies and existing theory to develop specific hypotheses. Specifically, we develop hypotheses relating to: (i) bank opacity and risk-taking; (ii) the moderating effect of competition on the nexus between bank opacity and risk-taking; and (iii) the moderating effect of bank business models on the relationship between bank opacity and risk-taking.

2.1. Bank opacity and risk-taking

Traditionally, bank assets are known to be relatively highly opaque (Morgan, 2002; Flannery et al., 2013), a situation which raises concerns about the effectiveness of market discipline and risk-taking. Theory predicts that opacity in banking impacts bank risk-taking incentives. This argument stems from the fact that, in equilibrium, more opaque banks face higher funding cost and higher risk-taking becomes their optimal choice.

It is argued that banks' funding cost is an increasing function of the extent of observability of their monitoring efforts or risk choices (Cordella and Yeyati, 1998; Boot and Schmeits, 2000; Nier, 2005). The required rates of return on deposits and investments in the banks are chosen to commensurate with the observed monitoring efforts. By providing more information to help the market observe monitoring efforts or risk choices, the banks are inherently electing to subject themselves to greater market discipline and commit to low risk-taking incentives. Consequently, a bank failing to provide information attracts the highest funding cost as its optimal strategy is assumed to be maximum risk-taking. Further, as transparency offers a yardstick to measure a bank's monitoring effort (Boot and Schmeits, 2000), opacity would create an incentive for the bank to commit to lower monitoring as monitoring efforts can be costly (Nier, 2005). Thus, theoretically, opacity increases bank risk-taking.

The existing evidence is equivocal on what really drives bank risk-taking behaviour. Demirgüç-Kunt et al. (2008) and Bushman and Williams (2012) find that country-level transparency measures improve bank soundness. Nier (2005) and Nier and Baumann (2006) find similar results using accounting-based disclosure indicators. Further, Vallascas and Keasey (2013) find that liquidity-based transparency measures reduce banks' default risk.

Clearly, the observed evidence is based mainly on measures of opacity derived from country-level and accounting disclosures on the one hand, and liquidity on the other. However, country-level disclosures fail to capture the heterogeneity in opacity across banks and over time, whilst accounting-based measures have little or no within-sample variation, implying that these disclosure indices capture the quantity rather than the quality of information disclosure at best (e.g., Vallascas and Keasey, 2013). Also, liquidity measures of opacity, to a large extent, capture uncertainty rather than the precision of information in the market. Based on the foregoing argument and the related evidence, we formulate our first hypothesis as:

Hypothesis 1: *Opacity increases risk-taking behaviour among banks.*

2.2. Bank opacity and risk-taking: the moderating effect of competition

It is argued that the extent to which opacity drives banks to take high levels of risk is conditional on banking market competition or their charter value (Cordella and Yeyati, 1998). Intuitively, the expected loss to a bank arising from risk-taking is larger if the bank has a higher charter value. The higher expected loss should reduce the risk-taking incentives of opaque banks. This argument is consistent with the strand of literature which suggests that intense banking competition decreases market power and profit margins and consequently increases risk-taking incentives (Marcus, 1984; Keeley, 1990; Boot and Thakor, 1993; Hellmann et al., 2000; Allen and Gale, 2004; Beck et al., 2013). This competition-fragility hypothesis can reinforce the opacity-driven risk-taking behaviour.

Another strand of the literature argues, at the same time, that banks in more competitive markets are less inclined to disclose information due to higher proprietary costs (Verrecchia, 1983, 1990; Clinch and Verrecchia, 1997) and have lower borrower-specific information (Marquez, 2002; Hauswald and Marquez, 2006). For instance, evidence from non-financial firms suggests that analysts' forecasts have less dispersion and are more accurate when market power is high (Gaspar and Massa, 2006; Datta et al., 2011; Haw et al., 2015). This competition-opacity hypothesis suggests a need for greater market discipline, suggesting further that a more intense banking competition leads to a higher marginal effect of opacity.

Based on the foregoing discussion of the relevant theoretical and empirical literature, we formulate the bank competition-opacity-fragility hypothesis:

Hypothesis 2: *The marginal effect of opacity on bank risk-taking increases with banking competition*

However, recent developments suggest, contrary to the above, that banking market competition reduces the effect of opacity on bank risk-taking. It is argued that lower competition can lead to more risk-taking as banks charge higher interest rates (Boyd and De Nicolo, 2005), which result in poor loan portfolios. Also, higher risk-taking incentives can result from the exploitation of the "too-big-to-fail" status banks acquire under less competitive environments (Kane, 2010; Acharya et al., 2013). Further, the entry deterrence argument (Darrough and Stoughton, 1990; Wagenhofer, 1990) suggests that competition would lead incumbent banks to disclose more information; the disclosure of bad news should deter potential entrants, whilst positive information should enhance market expectations. Some empirical evidence for non-financial firms is provided by Botosan and Stanford (2005) and Ali et al. (2014).

Moreover, by improving the quality of corporate governance (Shleifer and Vishny, 1997), discouraging discretionary earnings management (Leuz et al., 2003), and enabling peer benchmarking and improving the information environment (Holmstrom, 1982), competition should reduce the risk-taking incentives. Effectively, competition should moderate the risk-taking incentives of opaque banks.

Based on the foregoing arguments, we formulate our alternate hypothesis (that is, our competition-transparency-fragility hypothesis) as follows:

Hypothesis 3: *The marginal effect of opacity on bank risk-taking decreases with banking competition*

With such a mixed, yet rich, theoretical underpinning, the dependence of the effectiveness of market discipline on heterogeneity in bank competition deserves some empirical attention; the empirical literature largely ignores this interaction role of competition in the opacity–risk-taking relationship.[1]

2.3. Bank opacity and risk-taking: the moderating effect of bank business model

Bank business models have experienced significant levels of sophistication and have also assumed a trend towards increased revenue diversification, with implications for opacity and its relationship with risk-taking. Highly diversified banks may

[1] Nier and Baumann (2006) provide indirect support for this hypothesis by showing that transparency is associated with higher bank capital and that the effect is higher for banks in countries with a higher indicator of entry restriction. However, this proxy fails to capture competition at the bank level. Further, their focus is on bank capital, not on overall bank risk-taking or solvency.

be more opaque than their less diversified counterparts because earnings generated from different sources are less predictable than earnings generated from a largely single source. However, if segment earnings forecasts are imperfectly correlated, then opacity may be expected (Thomas, 2002). Also, revenue diversification could impact the opacity-risk-taking relationship via its direct effect on bank risk-taking or stability. For instance, several recent studies find that revenue diversification is associated with higher risk (e.g., DeYoung et al., 2004; Stiroh, 2004a,b, 2006). If opacity increases with diversification, or risk-taking increases with diversification, the marginal effect of opacity on bank risk-taking should be accentuated for highly diversified banks. However, the marginal effect of opacity on bank risk-taking should be limited for diversified banks if diversification reduces opacity, or if diversification decreases risk-taking.

On bank deposit structure, banks that rely on non-deposit funding are subject to close monitoring (Calomiris, 1999), suggesting that these banks face higher market discipline. For instance, King (2008) suggests that relatively riskier banks pay relatively higher rates on their inter-bank borrowings. Unsurprisingly, Dinger and Von Hagen (2009) find that banks with significant interbank borrowings take less risk. This argument suggests, therefore, that the marginal effect of opacity can be expected to be lower for banks that focus on non-deposit funding.

The above argument, however, does not consider the alternate arguments suggesting that non-deposit funding may not be an effective monitoring device due to its extremely short maturity (Rochet and Tirole, 1996). Further, non-deposit funding could be relatively less stable (Song and Thakor, 2007) and more likely to lead to inefficient liquidation in a costless, noisy information environment (e.g., Huang and Ratnovski, 2011). This argument suggests a possible higher marginal effect of opacity for banks that depend more on non-deposit funding. Hence, the interaction effect of opacity and deposit funding on bank risk-taking remains an empirical question.

Based on the forgoing argument, we formulate our fourth hypothesis as follows:

Hypothesis 4: *Bank business model moderates the marginal effect of opacity on bank risk-taking*

3. Empirical methodology

Our discussion in the preceding section conditions bank risk-taking on bank-specific opacity, competition and bank business model. Taking guidance from this and controlling for other variables as in Beck et al. (2013), we model bank risk-taking as a function of bank-level opacity (derived from analysts' forecast error and dispersion), competition and bank business model. We, therefore, formulate our econometric model as follows:

$$ln(Risk_{it}) = \alpha + \beta_1 Opacity_{it} + \beta_2 Competition_{it} + \sum_{k=1}^{2} \gamma_k Business_{k,it} + \sum_{m=1}^{4} \varphi_m Controls_{m,it} + E_{it} \quad (1)$$

where *Risk*, *Opacity*, *Competition*, *Business* and *Controls* are respective proxies for bank risk, opacity, competition, business model and control variables, all of which are as defined in Section 4; β, γ, φ and θ are parameters; k denote the number of business model variables, ranging from 1 to 2; m is the number of control variables, ranging from 1 to 4; and E is the error term, which is assumed to be mean zero and unit variance.

In order to account for the non-linearity in the effects on bank risk-taking of opacity, competition and business model, we reformulate Eq. (1) as follows:

$$ln(Risk_{it}) = \alpha + \beta_1 Opacity_{it} + \beta_2 Competition_{it} + \sum_{k=1}^{2} \gamma_k Business_{k,it} + \left(\theta Competition_{it} + \sum_{k=1}^{2} \eta_k Business_{k,it} \right) \times Opacity_{it} + \sum_{m=1}^{4} \varphi_m Controls_{m,it} + E_{it} \quad (2)$$

We then derive the marginal effects of opacity and competition by differentiating Eq. (2) with respect to *Opacity* and *Competition*, respectively, as follows:

$$\frac{\partial (ln(Risk_{it}))}{\partial (Opacity_{it})} = \beta_1 + \theta Competition_{i,t} + \sum_{k=1}^{2} \eta_k Business_{k,it} \quad (3)$$

and

$$\frac{\partial (ln(Risk_{it}))}{\partial (Competition_{i,t})} = \beta_2 + \theta Opacity_{i,t} \quad (4)$$

Likewise, the marginal effect of business model is derived by differentiating Eq. (2)

with respect to business model as follows:

$$\frac{\partial\,(ln(Risk_{it}))}{\partial\,(Business_{k,it})} = \gamma_k + \eta_k Opacity_{it}, \quad k = 1, 2. \tag{5}$$

4. Measurement and data

4.1. Measuring bank risk-taking

In this paper, we use mainly Z-score as our inverse measure of risk-taking. Z-score is a popular measure of bank soundness or solvency in the banking literature (e.g., Lepetit and Strobel, 2013; Chu, 2015; Köhler, 2015; Mergaerts and Vennet, 2016; Mollah et al., 2017). It measures the number of standard deviations by which profit has to fall for a bank to go bankrupt. Hence, it can be interpreted as a measure of distance to default (Mollah et al., 2017). For any given bank, the Z-score increases with the levels of profitability and capitalisation, but decreases with the volatility of profits. Following Lepetit and Strobel (2013) and Köhler (2015), we compute bank-specific and time-varying Z-score as follows:

$$Z{-}score_{it} = \frac{ROA_{it} + CAR_{it}}{\sigma_p(ROA)} \tag{6}$$

where ROA_{it} is the return on assets of bank i at time t, proxied by the ratio of net income to total assets; CAR_{it} is the ratio of total equity to total assets of bank i at time t; and $\sigma_p(ROA)$ is the standard deviation of return on assets of bank i over the sample period. We use other measures of risk or stability in our empirical analysis for robustness checks. First, we follow Köhler (2015) and decompose our $Z{-}score$ into risk-adjusted profits and risk-adjusted capital, respectively, as follows:

$$ZROA_{it} = \frac{ROA_{it}}{\sigma_p(ROA)} \tag{7}$$

$$ZCAR_{it} = \frac{CAR_{it}}{\sigma_p(ROA)} \tag{8}$$

Next, we use the market model to derive systematic and idiosyncratic risks for each bank in each period. Specifically, for each bank we estimate the following model:

$$r_{it} = \alpha + \beta rm_{it} + \varepsilon_{it} \tag{9}$$

where r_{it} is the daily return on the stock of bank i and rm_{it} is the CRSP value-weighted daily return. Consistent with previous literature (e.g., Pathan, 2009), for each bank i at time t we proxy systematic risk ($SYSR_{it}$) with β, idiosyncratic risk ($IDIOR_{it}$) with the annual standard deviation of E_{it} and, finally, total risk (TR_{it}) with the annual standard deviation of daily stock returns.

4.2. Measuring opacity

We describe in this section how we construct our measures of opacity. Previous literature (e.g., Flannery et al., 2004; Anolli et al., 2014) has used analysts' forecast errors and forecast dispersions as a measure of opacity to address different questions. Accordingly, we use these proxies as our measures of opacity in this study. We take care to ensure that we keep only the most recent earnings forecast for each analyst who provides more than one forecast. Also, to ensure that actual and forecast earnings per share are based on the same number of shares outstanding, we follow the approach in Robinson and Glushkov (2006) and adjust earnings forecast using the CRSP cumulative adjustment factor.

Specifically, we measure analysts' forecast error as the absolute value of the difference between mean analysts' forecasts and actual earnings per share scaled by the share price at the end of the period. Specifically, we compute analysts' forecast errors as below:

$$Forecast\ error_{it} = \frac{\underline{FEPS_{it} - AEPS_{it}}}{Price_{it}} \tag{10}$$

where $FEPS_{it}$ is the average of all earnings forecasts for bank i in fiscal year t; $AEPS_{it}$ is the actual earnings per share for bank i in fiscal year t; and $Price_{it}$ is the share price of bank i at the end of fiscal year t.

Next, we measure dispersion of analysts' earnings forecasts as the standard deviation of analysts' forecasts for the fiscal year scaled by the share price at the end of the year.

4.3. Measuring competition

Several measures of competition have been employed in the banking literature. These include the Lerner index, Panzar-Ross H-statistics, Boone indicator and structural measures, such as the Herfindahl-Hirschman Index (HHI). However, the Lerner index is the only measure of competition that varies at the bank level; the remaining measures are best suited for measuring cross-country differences in competition. Hence, we use the Lerner index as our measure of competition in this paper.

The Lerner index captures the extent to which banks are able to exercise market power by charging a higher price above marginal cost. Hence, higher values ofthe index are consistent with lower competition, and vice versa. It can be computed as follows:

$$Lerner_{it} = \frac{P_{it} - MC_{it}}{P_{it}}. \tag{11}$$

where P_{it} refers to price of total assets of bank i at time t, proxied by the ratio of total revenue to total assets; and MC_{it} refers to the marginal cost of bank i at time t.

Since marginal cost is not directly observable, we follow previous literature (Andrievskaya and Semenova, 2016; Ariss, 2010; Beck et al., 2013; Fernández et al., 2013) and derive it from a translog cost function (TCF) as in Eq. (12).

$$\begin{aligned} lnC_{it} &= \alpha + \beta_1 lnQ_{it} + \beta_2 lnQ_{it}^2 + \sum_{k=1}^{3} \delta_k lnW_{k,it} + \sum_{k=1}^{3}\sum_{s=1}^{3} \varphi_{k,s} lnW_{k,it} lnW_{s,it} \\ &+ \sum_{k=1}^{3} \gamma_k lnQ_{it} lnW_{k,it} + \lambda_t + \varepsilon_{it} \end{aligned} \tag{12}$$

where C_{it} refers to the total cost of bank i at time t; lnQ_{it} refers to output, proxied by total assets, of bank i at time t; and $lnW_{k,it}$ is input prices of labour (k = 1), capital (k = 2) and funding (k = 3) for bank i at time t. We apply symmetry and homogeneity of degree one in input prices by scaling the total cost (C) and the price of inputs by the input price of funds. The marginal costs are obtained from Eq. (12) as follows:

$$MC_{it} = \frac{C_{it}}{Q_{it}} \left(\beta_1 + 2\beta_2 lnQ_{it} + \sum_{k=1}^{3} \gamma_k lnW_{k,it} \right). \tag{13}$$

4.4. Measuring business model

We describe in this section how we construct our measures of bank business model. We follow Köhler (2015) and Mergaerts and Vennet (2016) and proxy bank business model with funding structure and income diversification. Funding structure ($Non\text{-}deposit_{it}$) is the ratio of non-deposit funding to total funding. Income structure ($Non\text{-}interest_{it}$) is the ratio of non-interest income to total income.

4.5. Control variables

The econometric models which we specify later in this paper control for other bank-specific variables, including credit risk, size and growth (e.g., Beck et al., 2013; Fosu, 2014; Mergaerts and Vennet, 2016), constructed for each bank i at time t. Credit risk ($Provisions_{it}$) is the ratio of loan loss provisions to total loans. Bank size ($Size_{it}$) is the natural logarithm of each bank's total assets. Finally, asset growth ($Growth_{it}$) is the annual growth rate of assets. The control variables are further defined in Table 1.

4.6. Data

Consolidated balance sheet and income statement data are obtained from the FRY-9C quarterly reports filed with the Federal Reserve Bank of Chicago. Market data for bank holding companies is obtained from the Center for Research in Security Prices (CRSP) database. These sets of data are then linked using the CRSP-FRB link table from the Federal Reserve Bank of New York.[2] We further link the resulting data to analysts' forecast and actual earnings per share data obtained from the detailed history file of the Institutional Brokers' Estimate System (I/B/E/S). We then retain the fourth quarter data for bank holding companies for which we could obtain matches across the aforementioned databases.

By following the approach described above, we are able to obtain an initial sample size of 744 bank holding companies. We apply the following exclusion criteria. First, we exclude bank-year observations with negative values of interest and non-interest income and stock price, as they can introduce noise and lead to spurious associations. Finally, we require each bank holding company to have at least three consecutive years of observation to permit robust estimation. The final sample that meets these criteria consists of 402 bank holding companies over the period 1995–2013.

A detailed list of variables used in the study is provided in Table 1.

[Table 1 about here.]

4.7. Summary statistics and correlation matrix

We present the descriptive statistics of the variables for our empirical analysis in Table 2. The mean value of the inverse measure of risk-taking is 33.69, suggesting that profit will have to fall about 33 times before the average bank defaults. This variable exhibits a high level of variability represented by a standard deviation of 52.86, which is about one and a half times the mean Z-score. This variable rises from a minimum of 0.011 to a maximum of 1402.92, suggesting a high degree of heterogeneity across banks. The average value of risk-adjusted profit is 3.37, whilst that for risk-adjusted capital is 30.32, suggesting that the stability of US bank holding companies largely stems from capitalisation. Both of these variables exhibit a significant amount of variability as well. Referring to the market measures of risk, the mean values of total risk, idiosyncratic risk and systematic risk are respectively 8.2%, 7% and 0.74. These variables exhibit moderate levels of variability.

[2] Available at http://www.newyorkfed.org/research/banking_research/datasets.html, accessed on 31 March 2016.

[Table 2 about here.]

The mean value of our two measures of opacity, analysts' forecast error and the dispersion of analysts' forecasts, are, respectively, 1.25 and 0.93; these variables have standard deviations of 2.296 and 1.415, respectively, implying a high degree of variability. The maximum values of these variables are, respectively, 9.44 and 5.62, whilst the minimum values are close to zero, suggesting a fair degree of heterogeneity.

Our inverse measure of competition has a mean value of 0.27 and a standard deviation of 0.08. The means of the proportions of non-deposit funding and non-interest income are, respectively, 0.183 and 0.802. These suggest that non-deposit funding represents about 18.3% of total funding, whilst non-interest income represents 80.2% of total income of the average US bank holding company.

Further, the mean value of provision for loan losses is about 0.6% of total loans outstanding. Total loans account for about 65% of the average bank holding company's assets, which records an annual growth rate of about 10%. Equity capital stands at 9.2% of total assets, on average. These variables, including bank size and market-to-book ratio, exhibit moderate levels of heterogeneity.

Table 3 displays the correlation between the estimation variables. As expected, Z-score is highly correlated with all of its components and negatively correlated with the market measures of risk. Also, the analysts' forecast error and dispersions are negatively correlated with the Z-score, risk-adjusted profit and risk-adjusted capital, but positively correlated with total risk, systematic risk and idiosyncratic risk. This correlation suggests a positive (but not necessarily causal) relationship between opacity and bank risk-taking. Table 3 further suggests a negative correlation between market power and risk-taking. Moreover, the correlation between non-deposit funding and non-interest income on the one hand, and risk-taking on the other hand is negative.

[Table 3 about here.]

Overall, the univariate descriptive statistics and pair-wise correlations suggest that our data and sample periods appear not to be plagued by any serious data issues, such as large outliers and limited variations.

We further probe the relationship between opacity and risk-taking by plotting detrended opacity (based on analysts' forecasting error and dispersion) against detrended risk-taking (based on the Z-score). The scatter plots and the lines of best fit in Figures 1 and 2 suggest a negative relation between bank opacity and risk-taking.

[Figure 1 about here.]

[Figure 2 about here.]

5. Estimation and testing results

In this section, we present the main empirical results for Eqs. (1)–(2). We use a panel data approach with bank and year fixed effect in all estimations. We follow this up with a series of robustness checks, including the marginal effect analysis derived from Eqs. (3)–(5).

5.1. Information, competition, business model and risk-taking

Table 4 presents the empirical results for Eq. (1) testing the effects of opacity and competition on bank risk-taking. Analysts' forecast error is used as the measure of opacity in Models 1–4, whilst forecast dispersion is used in Models 6–8.

[Table 4 about here.]

We start our analysis with Models 1 and 5, where bank risk-taking is explained by opacity only. In both models, the coefficient on opacity is negative and statistically significant at the 1% level, which provides support for Hypothesis 1 that bank opacity increases risk-taking. We extend these models by including traditional determinants of bank risk-taking, namely loan loss provisions, bank size, loans and asset growth, as in Models 2 and 6. We further control for competition in Models 3 and 7 and then the shares of deposit funding to total funding and non-interest income to total income in Models 4 and 8. For each model variant, the coefficient on opacity remains negative and statistically significant at the 1% level. The results suggest that a one unit increase in opacity increases bank risk-taking by at least 1.2%. To put this into perspective, the results in the fully specified models (Models 4 and 8) suggest that a one standard deviation increase in opacity is associated with a 1.8–2.8% increase in bank risk-taking. This finding is generally consistent with the evidence obtained by Vallascas and Keasey (2013) on European banks: that bank default risk increases with information asymmetry.

The coefficient on the Lerner index is negative in Models 3–4 and 7–8 in Table 4, suggesting that banking competition increases bank risk-taking. Based on the results in Models 4 and 8, a one standard deviation increase in competition (or decrease in Lerner index) is associated with a 5.4–5.8% increase in risk-taking. This effect is statistically significant at the 1% level. This finding is consistent with the evidence in Beck et al. (2013) for a large cross-country study and Turk-Ariss (2009) for a large sample of developing countries.

Turning our attention to bank business model and the other control variables, we find that dependence on a large share of non-deposit funding makes banks more risky, suggesting that the stabilising role of deposit funding outweighs any benefits derived from the monitoring role of non-deposit funding. Also, diversification into non-interest income-generating activities leads to higher risk-taking. This finding is largely consistent with DeYoung and Roland (2001) and Stiroh (2004a,b, 2006).

Bank provisioning for loan losses is positively associated with increased risk-taking. This effect is statistically significant at the 1% level across all models and is consistent with the view that banks that face higher credit risk are less stable. We also find, consistent with Beck et al. (2013), that bank size is negatively associated with bank risk-taking, but this effect is statistically insignificant. Further, consistent with Köhler (2015), banks with a larger share of loans in their asset composition have lower risk-taking, suggesting that a focus on the traditional intermediation role of banks leads to more stability in banking. However, the statistical significance of this effect drops entirely once we control for competition, as well as funding structure and income structure (Models 3–4 and 7–8). Finally, consistent with Beck et al. (2013), the results suggest that increased expansion in assets is associated with increased risk-taking.

5.1.1. Addressing potential endogeneity

In this section, we address any concerns about potential simultaneity between opacity, competition and bank risk-taking. For instance, whilst opacity between investors and banks can lead to increased risk-taking incentives, the reverse can also be true: the earnings of banks with higher risk-taking incentives could be difficult to predict. Likewise, banks with higher risk-taking incentives could become less competitive. To mitigate these concerns, we adopt the two-stage least squares (2SLS) estimation approach to re-estimate Eq. (1). We follow the analysts' forecast literature (e.g., Huyghebaert and Xu, 2016) and use analysts' forecast horizon and earnings surprise, as well as one period lagged value of opacity, as instruments for our opacity measures.[3] Whilst the existing literature provides compelling evidence that these factors affect our measures of opacity, we believe that the factors should not have any direct effect on bank risk-taking. Following Beck et al. (2013), we employ as our instruments for competition cost-income ratio and lagged values of competition.

We report the results of the 2SLS estimation in Table 5. First, the Hansen J-statistic p-values suggest that the instruments are valid. Also, a comparison of the Kleibergen-Paap rk Wald F statistic to the Stock-Yogo critical values rules out weak instrument problems. In Models 1 and 5 of Table 5, we exclude competition,

[3] Forecast horizon is the number of calendar days between forecast announcement date and the date of fiscal year-end for each bank in each year, whilst earnings surprise is the annual change in earnings of each bank in each year scaled by the share price at the end of the fiscal year.

funding structure and income structure variables from the estimation. We introduce competition in Models 2 and 6, and again in Models 3 and 7 together with the funding structure and income structure variable, but treat it as exogenous. The fully specified models in which both opacity and competition are treated as endogenous are presented in Models 4 and 8.

The coefficient estimates in Table 5 are similar to those in Table 4. Particularly, the coefficient on opacity retains its negative sign and statistical significance at the 1% level, suggesting that opacity leads to increased risk-taking in banking, which corroborates Hypothesis 1. In fact, based on the results in Models 4 and 8, a one standard deviation increase in our measures of opacity is predicted to lead to a 4.8–5.8% increase in risk-taking. Also, the coefficient on the Lerner index remains positive and statistically significant at the 1% level. This supports our earlier finding that competition leads to higher risk-taking in banking. It is worth noting that the coefficients on opacity and Lerner index are stable across models with and without controlling for funding structure and income structure variables.

Thus, the findings in this section suggest that our earlier findings are unlikely to be driven by simultaneity between opacity and bank risk-taking.

[Table 5 about here.]

5.1.2. Using alternative measures of risk

The results obtained thus far are based on accounting measure of overall bank risk-taking or soundness. In this section, we assess the sensitivity of our results to alternative measures of risk. We decompose the Z-score into risk-adjusted profit and risk-adjusted capital and use them, together with the market measures of risk outlined in Section 4.1, as the dependent variables in Eq. (1). The results are presented in Table 6. The results based on risk-adjusted profit are presented in Models 1 and 6. The coefficient on opacity remains negative and statistically significant at the 1% level. The results thus support the positive relationship between opacity and bank risk-taking, which is in line with Hypothesis 1. Likewise, the relationship between competition and bank risk-taking remains negative and statistically significant at the 1% level. We present the results based on risk-adjusted capital in Models 2 and 7. Again, the results confirm the positive relationship between opacity and bank risk-taking on the one hand, and the positive relationship between competition and bank risk-taking on the other hand.

[Table 6 about here.]

The results in Models 3–5 and 8–10 are based on the market measures of risk.[4] In Models 3 and 8, we employ total risk as the dependent variable and confirm the positive relationship between opacity and bank risk-taking. The estimated coefficient is statistically significant at the 1% level. Also, the positive effect of competition on risk-taking is confirmed. Again, we find similar results in Models 4 and 9, where idiosyncratic risk is used as the dependent variable. However, we find only weak support for the relationship between opacity and risk-taking when we employ systematic risk in Models 5 and 10 as the relationship is only significant when we employ the dispersion of analysts' forecasts as the measure of opacity. Further, although consistently signed, the relationship between competition and systematic risk is not statistically significant.

On the effects of bank business model, we find that non-deposit funding reduces risk-adjusted profit (Models 1 and 6), whilst non-interest income generation reduces risk-adjusted capital (Models 2 and 7). Contrary to our expectation, we find a statistically significant negative relationship between non-deposit funding and idiosyncratic risk (Models 4 and 8).

5.1.3. Pessimism, optimism and crisis

The efficiency of analysts' forecasts may have a part to play in the way in which bank risk-taking incentives respond to opacity. Analysts have a tendency to be systematically optimistic or pessimistic. As the former case could be incentive-driven (Easterwood and Nutt, 1999), the forecast may be less informative and lead to a greater need for market discipline. In the latter case, the caution with which analysts generate forecasts may moderate the need for market discipline. Hence, we expect bank risk-taking to be more sensitive to opacity for bank-year periods with optimism than those with pessimism. We explore this conjecture by running separate regressions for periods of analyst optimism and pessimism.

For each bank-year period, we define optimism (pessimism) as when the mean analysts' forecast is greater (less) than the actual earnings per share. We present the results in Models 1–2 and 6–7 of Table 7. In Models 1 and 6, the coefficient on the measures of opacity remains negative and statistically significant at the 1% level. The point estimates suggest that a one standard deviation increase in opacity is associated with a 2.3–3.7% increase in risk-taking under periods of optimism. We do not find a similar relationship between opacity and risk-taking under pessimism in Models 3 and 7.

[4] Consistent with Pathan (2009), we include the ratio of equity to total assets and market-to-book ratio as additional control variables in these models.

[Table 7 about here.]

Motivated by the belief that industry-wide distress may accentuate the effect of opacity (Flannery et al., 2013), we test the robustness of our results to time periods with differing levels of distress. Particularly, we run separate regressions for the periods prior to, during and after the 2007-08 financial crisis. Specifically, we split the sample period into Pre-crisis (1995–2006), Acute crisis (2007–2008) and Post-crisis (2009-2013). The estimation results for each of these sub-periods are presented in Models 3–5 and 8–10 of Table 7. The coefficient on opacity derived from analysts' forecast error is negative and statistically significant at the 1% level in the pre-crisis, acute crisis and post-crisis periods. Likewise, the coefficient on opacity derived from analysts' forecast dispersion is negative but statistically insignificant for the post-crisis period. This suggests that lessons from the crisis may have encouraged strong monitoring of banks' behaviour (Fosu et al., 2016). Also, the effect of opacity is largest during the acute crisis period. Thus, the findings suggest that opacity drives risk-taking in banking, especially during the crisis period, although the finding for the post-crisis period needs to be treated with a fair amount of caution. Overall, the findings confirm the positive association between opacity and bank risk-taking, again corroborating Hypothesis 1, and are largely consistent with Vallascas and Keasey (2013).

Again, the coefficient on the Lerner index is positive and statistically significant at the 1% level across all models in Table 7. Competition increases bank risk-taking in periods of optimism and pessimism, as well as in the periods prior to, during and after the 2007-08 financial crisis. On the effect of bank business model, the coefficient on share of non-deposit funding is negative and statistically significant for all periods but the acute crisis and post-crisis periods. The findings suggest that the monitoring role of non-deposit funding counterbalances the stability derived from deposit funding during crisis and post-crisis periods. Further, diversifying into non-interest income generation is associated with higher bank risk-taking during periods of optimism and pre-crisis. This observation may be partly because of a greater need for market discipline when optimism is higher and prior to crisis.

5.2. Information, competition, business model and risk-taking – interactions and extensions

As mooted in Section 1, the relationship between opacity and bank risk-taking is likely to be non-linear. The same is true for the effects of competition and business model on risk-taking. In Table 8, we present the results of Eq. (2), which captures this non-linearity. We perform a battery of checks to ensure the robustness of our results. In Models 1 and 7, we exclude the control variables in order to check the extent of influence exerted on the relationships of interest by the control variables. We subsequently include the bank-specific control variables (in Models 2 and 8), as well as the business model variables (in Models 3 and 9) and their interactions with opacity (in Models 4–6 and 10–12).

The coefficient on the opacity proxies remains negative and significant at the 1% level, whilst the coefficient on the interaction term between opacity and competition is positive and also statistically significant at the 1% level. The findings suggest that, whilst opacity leads to an increased risk-taking in banking on average, the effect is moderated for banks with high market power. Equivalently, competition accentuates banks' opacity-driven risk-taking incentives, which is in line with Hypothesis 2. This finding is, however, inconsistent with our competition-transparency-stability hypothesis, Hypothesis 3.

[Table 8 about here.]

In fact, the moderating role of competition in the relationship between opacity and risk-taking is also economically significant. To make this clearer, in Table 9 we present the marginal effects derived from applying Eq. (4) to Models 6 and 12 of Table 8.[5] In Panel 1 of Table 9, the marginal effect on risk-taking of opacity derived from analysts' forecast error is −0.012 at the 25th percentile of the Lerner index. This effect reduces by 67% to −0.004 at the 75th percentile of the Lerner index. In economic terms, this represents a 1.8 percentage point reduction in banks' opacity-induced risk-taking.[6] The marginal effect of opacity derived from analysts' forecasts dispersion confirms this finding. The marginal effect is −0.014 at the 25th percentile of the Lerner index but −0.003 at the 75th percentile, yielding a striking difference of about 79%. In economic terms, this represents about a 1.5 percentage point reduction per one standard deviation in the effect of opacity on bank risk-taking.

On the moderating role of business model in the opacity and risk-taking relationship, we find only a weak accentuating role of non-deposit funding share. As shown in Table 8, we first enter the interaction terms between the opacity and each of the business model variables one at a time (Models 4–5 and 9–10). Each of these terms enters the model with a negative but statistically insignificant coefficient. However,

[5] The marginal effects analysis based on the remaining models of Table 8 yields similar results to those presented in here. We do not present them here for brevity and because Models 6 and 12 represent the fully specified model.

[6] We estimate economic effect as a product of the derived marginal effect and a one standard deviation change in opacity (the variable of interest).

when we include all the interaction terms simultaneously (Models 6 and 12), the interaction between opacity derived from the dispersion of analysts' forecasts (Model 12) and the share of non-deposit funding turns out to be statistically significant (at the 10% level). Probing the joint significance of opacity and the share of non-deposit funding, the results in Panel 2 of Table 9 show that the adverse effect of opacity is only marginally accentuated by increased share of non-deposit funding. These findings provide a weak level of support for Hypothesis 4.

Findings corollary to the aforementioned are that the risk-taking effects of competition and non-deposit funding increase with the level of opacity. As shown across all models in Table 8, the coefficient on the Lerner index remains positive and statistically significant at the 1% level, as does the coefficient on its interaction with opacity. Further, the analysis presented in Panel 3 of Table 9 shows that the marginal effect of market power increases from 0.475 at the 25th to 0.544 at the 75th percentile of opacity derived from analysts' forecast error. For example, this implies that wholesale banks, which are opaque, have higher incentives for risk-taking and a greater need for higher market discipline. A similar finding is obtained for the marginal effect of market power with respect to opacity derived from the dispersion of analysts' forecasts, as shown in Panel 4 of Table 9: the marginal effect ranges between 0.535 and 0.618 at the 25th and the 75th percentiles of opacity, respectively. In economic terms,these differences represent a significant 0.57–0.69 percentage point increase per one standard deviation in the effect of market power (competition) on risk-taking. Finally, the analysis in Panels 3 and 4 of Table 9 shows that opacity makes non-deposit funding more detrimental to banking stability; however, this evidence is not as economically significant and statistically robust.

[Table 9 about here.]

5.3. Robustness tests

We perform additional robustness tests to check the sensitivity of our results to alternative calculations of Z-score and opacity. First, we re-estimate our baseline and fully interacted models using Z-score where the standard deviation of returns is computed over a five-year rolling window as in Beck et al. (2013). We present the results in Table A1 in the appendix. Next, although we have used the most recent analyst forecast in our measures of opacity to conform to the extant literature (e.g., Hong and Kubik, 2003; Anolli et al., 2014), we also acknowledge that later forecast errors can be closer to actual earnings announcement and result in smaller forecast errors (O'Brien, 1988); hence, we re-estimate our models again using an alternative calculation of opacity where the first forecast for each period by each analyst is employed. The results are presented in Table A2 in the appendix.

Overall, these sets of results provide support for our main findings about the impact of opacity on bank risk-taking.

6. Conclusion

Bank regulators place considerable emphasis on transparency with the expectation that it can help to instil discipline in the market, as reflected in the ongoing architecture of Basel III. To this end, recent empirical attention has been drawn to investigating the effects of opacity on risk-taking in banking. However, the existing literature has mainly focused on accounting measures of disclosure and liquidity. In addition, the literature has not paid due attention to potential banking market interactions, such as the role played by competition and bank business model. Consequently, we seek to contribute to the existing literature by employing opacity derived from analysts' earnings forecasts. Our baseline conclusion is that opacity is associated with increased risk-taking for US bank holding companies. This finding is robust to different proxies for opacity and risk-taking. While the finding seems to be mainly optimism-driven, it persists in the periods prior to, during and, to some degree, after the 2007–08 global financial crisis. Further, we find that the effect of opacity on bank risk-taking increases (decreases) with banking competition (market power) and, to some extent, the share of non-deposit funding in total funding. We do not find evidence in support of a greater need for market discipline in respect of opaque diversified banks.

Our findings have some important policy implications. First, an increased disclosure requirement is essential to attaining stability in competitive banking markets. This is particularly true with the adoption of universal banking and the removal of inter-state banking restrictions. Second, our findings may have some implications for the ongoing debate relating to Basel III with regard to bank funding structure and the role of market discipline.

Whilst our findings are significant and robust, the limitations of our study need to be explicitly acknowledged. First, and similar to all archival studies of this nature, our proxies may or may not capture actual opacity, competition, risk-taking and business models in practice. Second, differences in regulations and monitoring regimes across states may have implications for opacity, competition and risk-taking. However, and due to lack of data currently, they have not been taken into account in our models. Future research may improve our findings by accounting for differences in the strength of state governance, regulatory and monitoring power in bank opacity, competition and risk-taking. Finally, our study focuses on the US; more insights can be gained by extending our analysis to a larger set of banks across different countries and over time, especially countries with different governance, regulatory, monitoring and deposit insurance regimes.

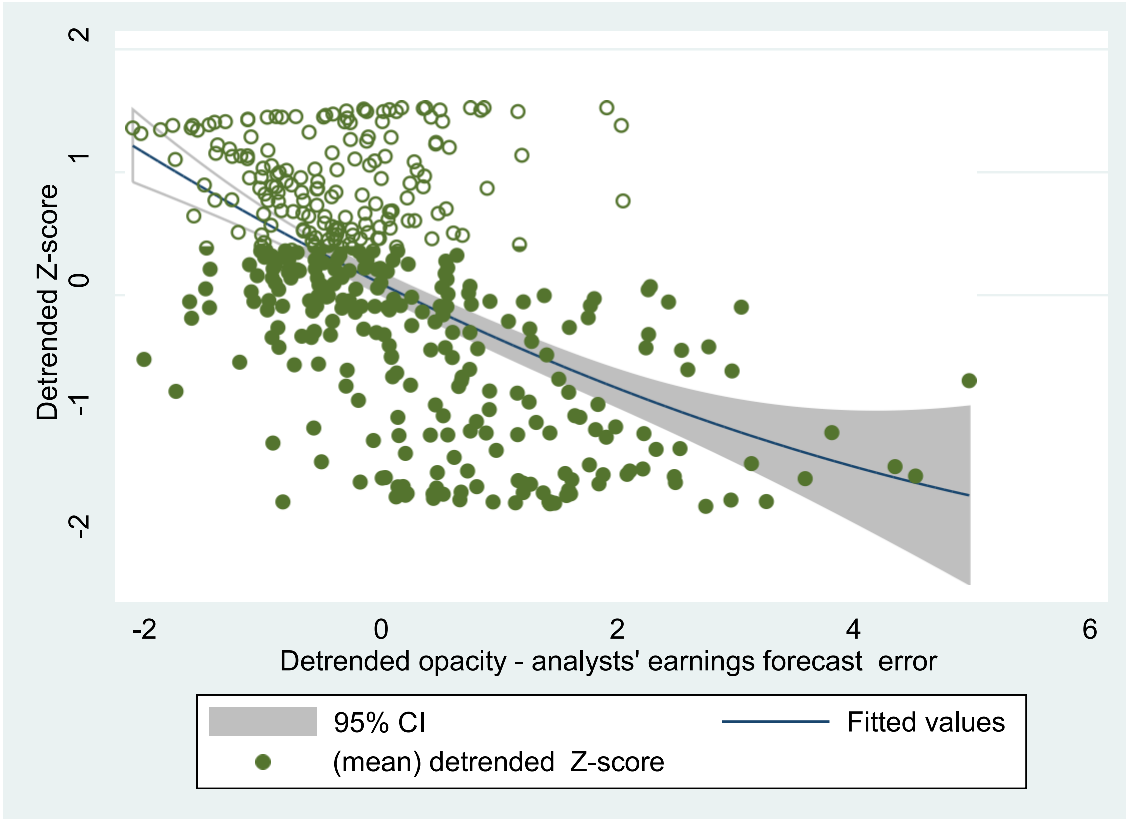

Figure 1
A scatter plot of detrended opacity and risk-taking.
This figure presents a scatter plot of detrended opacity, based on analysts' earnings forecast error, and risk-taking.

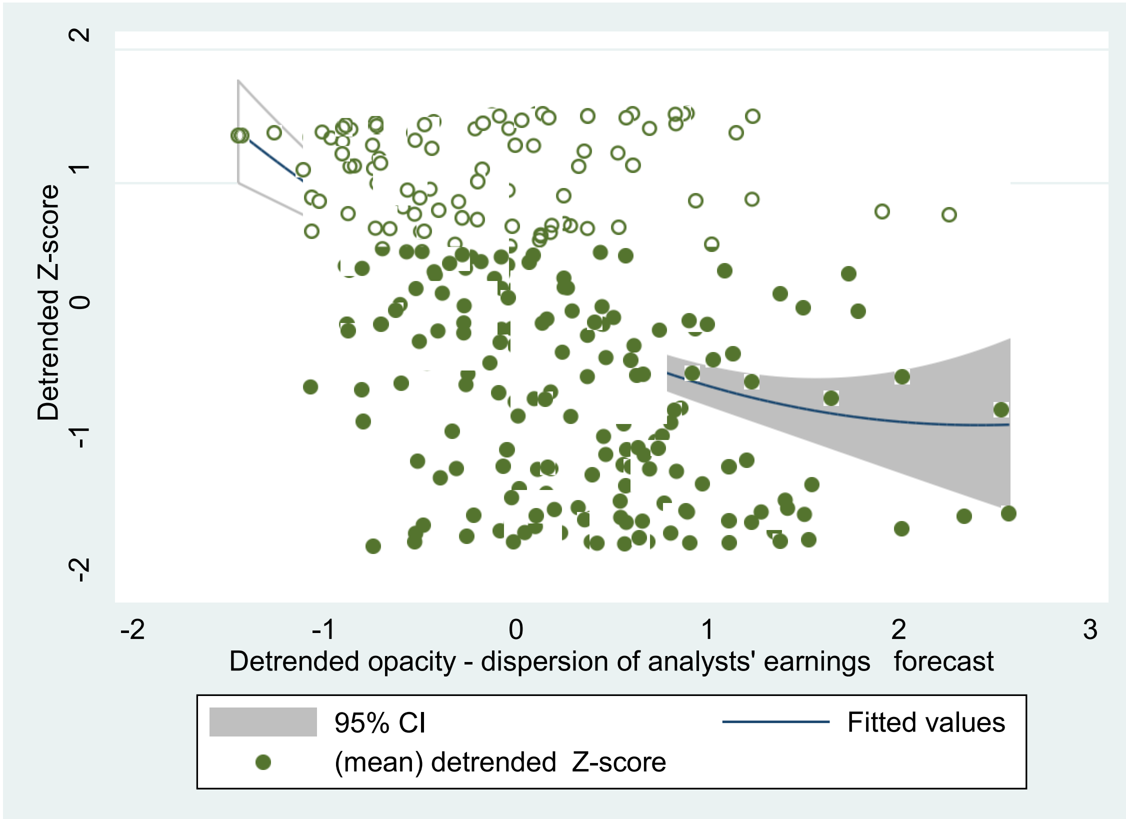

Figure 2
A scatter plot of detrended opacity and risk-taking.
This figure presents a scatter plot of detrended opacity, based on dispersion of analysts' earnings forecast, and risk-taking.

Table 1
Description of variables.

Variable	Description
Z-score	Inverse measure of bank risk-taking, measured as the sum of bank return on asset and equity-to-asset ratio divided by the standard deviation of return on assets over the sample period.
Z-ROA	Risk-adjusted profit, measured as bank return on asset divided by the standard deviation of return on assets over the sample period.
Z-CAR	Risk-adjusted capital, measured as bank equity-to-asset ratio divided by the standard deviation of return on assets over the sample period.
TR	Total risk, measured as the annual standard deviation of daily stock returns.
IDIOR	Idiosyncratic risk, measured as the standard deviation of the error term from the market model, Eq. (9).
SYSR	Systematic risk, measured as the beta (coefficient) from the market model, Eq. (9).
Forecast error	Measure of opacity, measured as the absolute value of the difference between mean analysts' forecasts and actual earnings per share scaled by the share price at the end of the period.
Forecast dispersion	Alternative measure of opacity, measured as the standard deviation of analysts' forecasts for the fiscal year scaled by the share price at the end of the year.
Lerner	Lerner index, as a measure of competition at the bank level.
Non-deposit	Proxy for bank business model in terms of funding structure, measured as the ratio of non-deposit funding to total funding.
Non-interest	Alternative proxy for bank business model in terms of income diversification, measured as the ratio of non-interest income to total income.
Provision	Credit risk measure, as the ratio of loan loss provisions to total loans.
Size	Bank size, the natural logarithm of each bank's total assets.
Loans	The ratio of bank loans to total assets.
Asset growth	The annual growth rate of assets.
Equity	Bank capital, measured as the ratio of equity to total assets.
Market-to-book	The sum of market value of equity and book value of liabilities divided by the book value of total assets.

This table presents the mnemonics of each variable and its respective description.

Table 2
Summary statistics of all variables.

Variable	Mean	Std. Dev.	Min.	Max.	N
Z-score	33.689	52.857	0.011	1402.915	3525
Z-ROA	3.374	5.361	−3.619	117.227	3525
Z-CAR	30.315	47.809	1.385	1285.688	3525
TR	0.082	0.049	0.012	0.629	3513
IDIOR	0.07	0.043	0	0.448	3513
SYSR	0.743	0.766	−4.188	6.745	3513
Forecast error	1.252	2.296	0.017	9.44	3525
Forecast dispersion	0.932	1.415	0.046	5.619	3525
Lerner	0.27	0.083	0.095	0.418	3525
Non-deposit	0.183	0.104	0.041	0.416	3525
Non-interest	0.802	0.106	0.542	0.942	3525
Provision	0.006	0.006	0	0.024	3525
Size	15.434	1.487	13.454	18.797	3525
Loans	0.659	0.113	0.387	0.830	3525
Asset growth	0.101	0.111	−0.057	0.377	3283
Equity	0.092	0.021	0.06	0.136	3525
Market-to-book	1.068	0.069	0.956	1.216	3525

This table presents the descriptive statistics for all variables used in this study. The sample comprises 402 US bank holding companies over the period 1995-2013. All variables are as described in Table 1.

Table 3
Correlation matrix.

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. ln(Z-score)	1.000																
2. ln(ZROA)	0.862 (0.000)	1.000															
3. ln(ZCAR)	0.998 (0.000)	0.835 (0.000)	1.000														
4. ln(TR)	−0.086 (0.000)	−0.206 (0.000)	−0.075 (0.000)	1.000													
5. ln(IDIOR)	−0.115 (0.000)	−0.214 (0.000)	−0.106 (0.000)	0.897 (0.000)	1.000												
6. ln(SYSR)	−0.061 (0.002)	−0.118 (0.000)	−0.055 (0.005)	0.279 (0.000)	−0.007 (0.712)	1.000											
7. Forecast error	−0.175 (0.000)	−0.310 (0.000)	−0.160 (0.000)	0.327 (0.000)	0.309 (0.000)	0.089 (0.000)	1.000										
8. Forecast dispersion	−0.121 (0.000)	−0.266 (0.000)	−0.108 (0.000)	0.356 (0.000)	0.288 (0.000)	0.149 (0.000)	0.735 (0.000)	1.000									
9. Lerner	0.119 (0.000)	0.299 (0.000)	0.097 (0.000)	−0.148 (0.000)	−0.169 (0.000)	0.009 (0.632)	−0.100 (0.000)	−0.082 (0.000)	1.000								
10. Non-deposit	−0.079 (0.000)	−0.002 (0.903)	−0.090 (0.000)	0.035 (0.074)	−0.001 (0.969)	0.027 (0.162)	0.037 (0.055)	0.023 (0.244)	−0.085 (0.000)	1.000							
11. Non-interest	−0.047 (0.015)	−0.092 (0.000)	−0.037 (0.055)	0.040 (0.038)	0.135 (0.000)	−0.145 (0.000)	0.024 (0.215)	−0.024 (0.221)	−0.059 (0.002)	−0.273 (0.000)	1.000						
12. Provisions	−0.064 (0.001)	−0.242 (0.000)	−0.049 (0.012)	0.398 (0.000)	0.311 (0.000)	0.142 (0.000)	0.384 (0.000)	0.377 (0.000)	0.090 (0.000)	0.069 (0.000)	−0.168 (0.000)	1.000					
13. Size	0.046 (0.018)	0.088 (0.000)	0.037 (0.057)	−0.044 (0.022)	−0.156 (0.000)	0.123 (0.000)	0.013 (0.513)	0.042 (0.031)	0.291 (0.000)	0.479 (0.000)	−0.560 (0.000)	0.182 (0.000)	1.000				
14. Loans	−0.199 (0.000)	−0.194 (0.000)	−0.194 (0.000)	−0.013 (0.498)	0.075 (0.000)	−0.113 (0.000)	0.041 (0.035)	−0.017 (0.389)	0.043 (0.028)	−0.288 (0.000)	0.360 (0.000)	−0.027 (0.159)	−0.297 (0.000)	1.000			
15. Asset growth	−0.056 (0.004)	−0.015 (0.431)	−0.058 (0.003)	0.056 (0.004)	0.075 (0.000)	−0.024 (0.223)	−0.032 (0.100)	−0.062 (0.001)	−0.027 (0.166)	0.005 (0.787)	0.111 (0.000)	−0.127 (0.000)	−0.056 (0.004)	−0.005 (0.794)	1.000		
16. Equity	0.158 (0.000)	−0.057 (0.003)	0.178 (0.000)	−0.029 (0.130)	−0.072 (0.000)	0.091 (0.000)	0.029 (0.134)	0.059 (0.002)	0.171 (0.000)	−0.264 (0.000)	−0.071 (0.000)	0.101 (0.000)	0.015 (0.425)	0.052 (0.007)	−0.132 (0.000)	1.000	
17. Market-to-book	0.044 (0.024)	0.358 (0.000)	0.007 (0.708)	−0.199 (0.000)	−0.188 (0.000)	−0.044 (0.024)	−0.331 (0.000)	−0.326 (0.000)	0.295 (0.000)	0.062 (0.001)	−0.142 (0.000)	−0.281 (0.000)	0.099 (0.000)	−0.067 (0.001)	0.167 (0.000)	−0.180 (0.000)	1.000

This table presents the unconditional correlation coefficient between any pair of variables. All variables are as described in Table 1.

Table 4
Opacity and bank risk-taking - fixed effect estimation.

Dependent variable: ln(Z-score)								
	Forecast Error				*Forecast Dispersion*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Opacity	−0.022*** (0.002)	−0.018*** (0.002)	−0.012*** (0.002)	−0.012*** (0.002)	−0.029*** (0.003)	−0.020*** (0.004)	−0.012*** (0.003)	−0.012*** (0.003)
Lerner			0.695*** (0.088)	0.653*** (0.093)			0.742*** (0.088)	0.701*** (0.093)
Non-deposit				−0.432*** (0.104)				−0.420*** (0.104)
Non-interest				−0.268*** (0.094)				−0.273*** (0.094)
Provisions		−4.449*** (1.023)	−4.632*** (0.978)	−4.751*** (0.961)		−6.131*** (0.982)	−5.845*** (0.946)	−6.006*** (0.927)
Size		0.038 (0.024)	0.018 (0.024)	0.042 (0.025)		0.037 (0.024)	0.016 (0.024)	0.039 (0.026)
Loans		0.193** (0.095)	0.119 (0.099)	0.069 (0.100)		0.179* (0.094)	0.105 (0.098)	0.057 (0.100)
Asset growth		−0.146*** (0.035)	−0.157*** (0.035)	−0.167*** (0.035)		−0.153*** (0.035)	−0.162*** (0.035)	−0.172*** (0.034)
Constant	3.037*** (0.016)	2.484*** (0.379)	2.654*** (0.390)	2.574*** (0.402)	3.038*** (0.016)	2.515*** (0.380)	2.684*** (0.393)	2.613*** (0.405)
Observations	3525	3283	3283	3283	3525	3283	3283	3283
Adjusted R^2	0.195	0.230	0.280	0.302	0.171	0.213	0.272	0.293
Number of banks	402	402	402	402	402	402	402	402

This table shows the fixed-effect estimation results for the effect of opacity derived from analysts' forecasts on banking risk-taking. Time fixed effects are included in all estimations. Robust standard errors clustered at the bank level are in parentheses. *** ** and * indicate significance at 1%, 5% and 10%, respectively.

Table 5
Opacity and bank risk-taking – two-stage least squares estimation.

Dependent variable: ln(Z-score)	*Forecast Error*				*Forecast Dispersion*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Opacity	−0.034***	−0.022***	−0.021***	−0.020***	−0.070***	−0.045***	−0.043***	−0.041***
	(0.004)	(0.005)	(0.005)	(0.004)	(0.010)	(0.010)	(0.010)	(0.010)
Lerner		0.606***	0.578***	0.682***		0.594***	0.569***	0.671***
		(0.094)	(0.101)	(0.093)		(0.101)	(0.106)	(0.097)
Non-deposit			−0.438***	−0.434***			−0.439***	−0.435***
			(0.107)	(0.108)			(0.105)	(0.106)
Non-interest			−0.247**	−0.233**			−0.235**	−0.221**
			(0.100)	(0.100)			(0.098)	(0.097)
Provisions	−0.737	−2.440*	−2.840**	−2.937**	−0.139	−2.116	−2.573*	−2.643**
	(1.389)	(1.362)	(1.319)	(1.280)	(1.426)	(1.401)	(1.365)	(1.327)
Size	0.033	0.016	0.040	0.036	0.026	0.012	0.036	0.033
	(0.024)	(0.025)	(0.027)	(0.027)	(0.025)	(0.025)	(0.027)	(0.028)
Loans	0.215**	0.147	0.092	0.081	0.207**	0.143	0.087	0.077
	(0.098)	(0.100)	(0.102)	(0.103)	(0.100)	(0.101)	(0.102)	(0.103)
Assets growth	−0.155***	−0.159***	−0.170***	−0.171***	−0.194***	−0.184***	−0.194***	−0.193***
	(0.037)	(0.036)	(0.036)	(0.036)	(0.039)	(0.038)	(0.037)	(0.038)
Observations	3092	3092	3092	3092	3092	3092	3092	3092
Adjusted R^2	0.081	0.161	0.187	0.188	−0.036	0.107	0.138	0.142
Number of banks	402	402	402	402	402	402	402	402
Hansen J-statistic p-vale	0.337	0.293	0.380	0.476	0.104	0.088	0.152	0.256
Kleibergen-Paap rk Wald F stat.	67.712	55.300	56.233	39.533	36.797	27.900	28.013	20.178

This table shows the two-stage least squares estimation results for the effect of opacity derived from analysts' forecasts on banking risk-taking. Asy is treated as endogenous in all Models. Lerner is treated as exogenous in Models 2, 3, 6 and 7 but as endogenous in Models 4 and 8. Time fixed effects are included in all estimations. Robust standard errors are in parentheses.
*** ** and * indicate significance at 1%, 5% and 10%, respectively.

Table 6
Information asymmetry and bank risk-taking – alternative measures of risk.

Dependent variable:	*Forecast Error*					*Forecast Dispersion*				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	ZROA	ZCAR	TR	IDIOR	SYSR	ZROA	ZCAR	TR	IdDIOR	SYSR
Opacity	−0.019**	−0.007***	0.014***	0.017***	0.011	−0.019**	−0.008**	0.033***	0.037***	0.030**
	(0.008)	(0.002)	(0.003)	(0.004)	(0.008)	(0.010)	(0.003)	(0.006)	(0.006)	(0.013)
Lerner	4.536***	0.240***	−0.718***	−0.765***	−0.353	4.551***	0.265***	−0.704***	−0.761***	−0.328
	(0.271)	(0.091)	(0.113)	(0.125)	(0.275)	(0.269)	(0.090)	(0.112)	(0.122)	(0.271)
Non-deposit	0.147	−0.521***	−0.207	−0.373**	0.117	0.150	−0.515***	−0.197	−0.367**	0.134
	(0.133)	(0.106)	(0.141)	(0.145)	(0.360)	(0.134)	(0.105)	(0.139)	(0.144)	(0.359)
Non-interest	−0.737***	−0.146	−0.024	−0.112	0.182	−0.729***	−0.148	−0.038	−0.125	0.169
	(0.200)	(0.100)	(0.125)	(0.140)	(0.263)	(0.196)	(0.099)	(0.124)	(0.139)	(0.263)
Provisions	−43.800***	−1.350	12.391***	12.489***	12.800***	−44.676***	−1.991**	11.836***	12.212***	11.994***
	(3.196)	(0.917)	(1.635)	(1.734)	(3.647)	(3.035)	(0.876)	(1.581)	(1.693)	(3.704)
Size	−0.130***	0.057**	−0.002	0.013	−0.053	−0.132***	0.055**	0.000	0.016	−0.052
	(0.033)	(0.027)	(0.027)	(0.027)	(0.064)	(0.033)	(0.027)	(0.027)	(0.027)	(0.065)
Loans	−0.199	0.097	0.014	−0.075	0.038	−0.199	0.090	0.020	−0.065	0.037
	(0.138)	(0.107)	(0.133)	(0.134)	(0.311)	(0.139)	(0.106)	(0.131)	(0.132)	(0.311)
Asset growth	−0.445***	−0.137***	−0.032	−0.012	−0.020	−0.456***	−0.140***	−0.014	0.007	−0.003
	(0.056)	(0.037)	(0.055)	(0.060)	(0.145)	(0.056)	(0.036)	(0.056)	(0.061)	(0.145)
Equity			0.256	0.509	−1.939			0.278	0.515	−1.900
			(0.511)	(0.505)	(1.322)			(0.503)	(0.497)	(1.306)
Market-to-book			0.422**	0.373*	0.211			0.472**	0.426**	0.262
			(0.191)	(0.201)	(0.436)			(0.190)	(0.200)	(0.437)
Constant	2.281***	2.260***	−3.077***	−3.342***	0.837	2.308***	2.281***	−3.176***	−3.455***	0.755
	(0.517)	(0.425)	(0.503)	(0.520)	(1.213)	(0.520)	(0.426)	(0.499)	(0.515)	(1.220)
Observations	3047	3283	3272	3272	2881	3047	3283	3272	3272	2881
Adjusted R^2	0.652	0.287	0.610	0.557	0.245	0.650	0.284	0.613	0.560	0.246
Number of banks	401	402	402	402	401	401	402	402	402	401

This table shows the fixed effect estimation results for the effect of opacity on banking risk-taking. Time fixed effects are included in all estimations. Robust standard errors clustered at the bank level are in parentheses. *** ** and * indicate significance at 1%, 5% and 10%, respectively.

Table 7
Opacity and bank risk-taking – sub-sample analysis.

Dependent variable: ln(Z-score)

	Forecast Error					*Forecast Dispersion*				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Optimism	Pessimism	Pre-crisis	Acute crisis	Post-crisis	Optimism	Pessimism	Pre-crisis	Acute crisis	Post-crisis
Opacity	−0.016***	0.000	−0.010***	−0.016***	−0.012***	−0.016***	0.001	−0.009**	−0.022**	−0.003
	(0.003)	(0.004)	(0.004)	(0.006)	(0.003)	(0.004)	(0.005)	(0.005)	(0.010)	(0.004)
Lerner	0.635***	0.574***	0.872***	0.738***	0.554***	0.725***	0.577***	0.895***	0.785***	0.675***
	(0.111)	(0.135)	(0.130)	(0.238)	(0.120)	(0.109)	(0.136)	(0.130)	(0.231)	(0.129)
Non-deposit	−0.398***	−0.417***	−0.535***	−0.235	−0.113	−0.365***	−0.416***	−0.533***	−0.219	−0.060
	(0.114)	(0.145)	(0.134)	(0.302)	(0.188)	(0.115)	(0.145)	(0.134)	(0.300)	(0.193)
Non-interest	−0.271**	−0.152	−0.490***	0.509	−0.107	−0.318**	−0.152	−0.498***	0.473	−0.014
	(0.133)	(0.121)	(0.173)	(0.577)	(0.148)	(0.134)	(0.119)	(0.173)	(0.578)	(0.155)
Provisions	−3.533***	−6.517***	−7.943***	0.834	−5.488***	−5.624***	−6.601***	−8.547***	−0.797	−7.141***
	(1.153)	(1.457)	(1.651)	(3.047)	(1.416)	(1.114)	(1.516)	(1.583)	(2.689)	(1.424)
Size	0.024	0.053*	0.077**	−0.166	−0.282***	0.021	0.053*	0.077**	−0.234	−0.304***
	(0.030)	(0.029)	(0.032)	(0.261)	(0.080)	(0.031)	(0.029)	(0.032)	(0.252)	(0.082)
Loans	0.131	−0.005	0.008	−0.587*	0.195	0.126	−0.005	−0.000	−0.636*	0.132
	(0.118)	(0.124)	(0.128)	(0.341)	(0.157)	(0.119)	(0.124)	(0.128)	(0.351)	(0.162)
Asset growth	−0.110**	−0.278***	−0.115***	−0.150	−0.058	−0.110**	−0.278***	−0.115***	−0.146	−0.069
	(0.048)	(0.047)	(0.041)	(0.113)	(0.060)	(0.047)	(0.046)	(0.041)	(0.119)	(0.063)
Constant	2.704***	2.514***	2.219***	5.265	7.436***	2.762***	2.513***	2.225***	6.370	7.711***
	(0.488)	(0.442)	(0.485)	(4.197)	(1.261)	(0.498)	(0.442)	(0.485)	(4.050)	(1.291)
Observations	1657	1626	2057	416	810	1657	1626	2057	416	810
Adjusted R^2	0.301	0.344	0.260	0.260	0.422	0.285	0.344	0.257	0.255	0.398
χ^2		35.84			30.34		15.19			9.27
$Prob > \chi^2$		0.000			0.000		0.001			0.026
Number of banks	375	374	355	230	213	375	374	355	230	213

This table shows the fixed effect estimation results for the effect of opacity derived from analysts' forecasts on banking risk-taking. Time fixed effects are included in all estimations. Robust standard errors clustered at the bank level are in parentheses. χ^2 indicates the Wald chi-square test statistics for the test of equality of the coefficients on opacity in periods of optimism and pessimism as well as in pre-crisis, acute crisis and post-crisis. *** ** and * indicate significance at 1%, 5% and 10%, respectively.

Table 8
Opacity and bank risk-taking – interactions with market power and business model.

Dependent variable: ln(Z-score)												
	Forecast Error						*Forecast Dispersion*					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Opacity	−0.032***	−0.030***	−0.028***	−0.009**	0.004	−0.020	−0.044***	−0.039***	−0.036***	−0.006	0.007	−0.015
	(0.004)	(0.004)	(0.004)	(0.004)	(0.013)	(0.018)	(0.007)	(0.007)	(0.007)	(0.006)	(0.020)	(0.026)
Lerner	0.510***	0.478***	0.467***	0.656***	0.640***	0.466***	0.569***	0.531***	0.520***	0.705***	0.692***	0.521***
	(0.098)	(0.098)	(0.102)	(0.093)	(0.094)	(0.103)	(0.105)	(0.104)	(0.108)	(0.093)	(0.094)	(0.109)
Opacity×Lerner	0.076***	0.083***	0.073***			0.074***	0.106***	0.115***	0.101***			
	0.100*** (0.029)	(0.017)	(0.018)			(0.018)	(0.019)	(0.026)	(0.027)			(0.028)
Non-deposit			−0.416***	−0.411***	−0.432***	−0.388***			−0.412***	−0.388***	−0.421***	−0.372***
			(0.102)	(0.105)	(0.103)	(0.105)			(0.103)	(0.105)	(0.103)	(0.105)
Non-interest			−0.226**	−0.263***	−0.224**	−0.210**			−0.237**	−0.267***	−0.236**	−0.206**
			(0.098)	(0.095)	(0.098)	(0.101)			(0.098)	(0.095)	(0.100)	(0.104)
Opacity×Non-deposit				−0.019		−0.025				−0.035		−0.045*
				(0.017)		(0.018)				(0.026)		(0.026)
Opacity×Non-interest					−0.020	−0.004					−0.025	−0.016
					(0.017)	(0.018)					(0.026)	(0.027)
Provisions		−4.343***	−4.496***	−4.816***	−4.722***	−4.575***		−5.550***	−5.747***	−6.117***	−5.963***	−5.864***
		(0.937)	(0.928)	(0.952)	(0.955)	(0.914)		(0.926)	(0.912)	(0.926)	(0.925)	(0.908)
Size		0.021	0.043*	0.041	0.042*	0.041*		0.018	0.040	0.038	0.040	0.039
		(0.024)	(0.025)	(0.025)	(0.025)	(0.025)		(0.024)	(0.025)	(0.026)	(0.025)	(0.025)
Loans		0.148	0.094	0.066	0.068	0.090		0.128	0.075	0.055	0.055	0.072
		(0.098)	(0.100)	(0.100)	(0.100)	(0.099)		(0.098)	(0.100)	(0.100)	(0.100)	(0.100)
Asset growth		−0.171***	−0.177***	−0.167***	−0.171***	−0.178***		−0.176***	−0.183***	−0.172***	−0.175***	−0.185***
		(0.035)	(0.034)	(0.035)	(0.035)	(0.035)		(0.034)	(0.034)	(0.035)	(0.035)	(0.034)
Constant	2.919***	2.652***	2.562***	2.588***	2.535***	2.573***	2.907***	2.695***	2.612***	2.627***	2.582***	2.609***
	(0.026)	(0.381)	(0.394)	(0.402)	(0.397)	(0.391)	(0.027)	(0.387)	(0.400)	(0.406)	(0.398)	(0.394)
Observations	3525	3283	3283	3283	3283	3283	3525	3283	3283	3283	3283	3283
Adjusted R^2	0.259	0.293	0.312	0.303	0.303	0.313	0.242	0.282	0.301	0.294	0.294	0.302
Number of banks	402	402 0	402	402	402	402	402	402	402	402	402	402

This table shows the fixed effect estimation results for the effect of opacity derived from analyst forecast on banking risk-taking. Time fixed effects are included in all estimations. Robust standard errors clustered at the bank level are in parentheses. *** ** and * indicate significance at 1%, 5% and 10%, respectively.

Table 9
Marginal effects of opacity, competition and business model.

	25th%	50th%	75th%	Change(25th–75%)	Based on
Panel 1					
Lerner index at:	**0.219**	**0.271**	**0.325**		
Forecast error	−0.012*** (0.002)	−0.008*** (0.003)	−0.004 (0.003)	−0.008*** (0.002)	Table 8, column 6
Forecast dispersion	−0.014*** (0.004)	−0.008** (0.004)	−0.003 (0.003)	−0.011*** (0.004)	Table 8, column 12
Panel 2					
Non-deposit funding at:	**0.219**	**0.271**	**0.325**		
Forecast error	−0.006** (0.003)	−0.008*** (0.003)	−0.010*** (0.003)	0.004 (0.005)	Table 8, column 6
Forecast dispersion	−0.005 (0.004)	−0.008** (0.004)	−0.0012*** (0.004)	0.005 (0.005)	Table 8, column 12
Panel 3					
Forecast error at:	**0.121**	**0.322**	**1.052**		
Lerner index	0.475*** (0.102)	0.490*** (0.100)	0.544*** (0.095)	0.069*** (0.018)	Table 8, column 6
Non-deposit	−0.390*** (0.104)	−0.396*** (0.103)	−0.414*** (0.103)	0.024 (0.017)	Table 8, column 6
Panel 4					
Forecast dispersion at:	**0.138**	**0.335**	**0.965**		
Lerner index	0.535*** (0.107)	0.554*** (0.104)	0.618*** (0.097)	0.083*** (0.024)	Table 8, column 12
Non-deposit	−0.378*** (0.105)	−0.387*** (0.104)	−0.415*** (0.103)	0.037* (0.022)	Table 8, column 12

This table shows the marginal effect analysis of the results presented in Table 8. Marginal effects are evaluated at the 25th, 50th and 75th percentiles of the interacted variable of interest (at the indicated values of Lerner index, non-deposit funding, forecast error and forecast dispersion in panels 1, 2, 3 and 4, respectively) holding other interacted variables at their median values. Standard errors are in parentheses. *** ** and * indicate significance at 1%, 5% and 10%, respectively.

Appendix

Table A1
Information asymmetry and bank risk taking – alternative calculation of Z-score.

Dependent variable: ln(Z-score)	*Forecast Error*		*Forecast Dispersion*	
	(1)	(2)	(3)	(4)
Opacity	−0.017**	−0.250***	−0.051***	−0.319***
	(0.008)	(0.054)	(0.016)	(0.094)
Lerner	1.434***	1.153**	1.307***	0.972**
	(0.426)	(0.475)	(0.424)	(0.469)
Opacity × Lerner		0.158**		0.227*
		(0.071)		(0.122)
Non-deposit	0.104	0.110	0.071	0.107
	(0.564)	(0.560)	(0.550)	(0.553)
Non-interest	−0.605	−1.101*	−0.592	−0.979
	(0.582)	(0.599)	(0.569)	(0.613)
Opacity × Non-deposit		−0.007		−0.003
		(0.068)		(0.118)
Opacity × Non-interest		0.248***		0.275***
		(0.058)		(0.099)
Constant	1.464	1.953	1.594	2.025
	(1.765)	(1.747)	(1.719)	(1.731)
Control variables	Yes	Yes	Yes	Yes
Observations	1868	1868	1868	1868
Adjusted R^2	0.416	0.424	0.422	0.427
Number of banks	232.000	232.000	232.000	232.000

This table shows the fixed effect estimation results for the effect of opacity on banking risk-taking using alternative calculation of Z-score, where the standard deviation of returns is calculated over a five-year rolling window. Time fixed effects are included in all estimations. Robust standard errors clustered at the bank level are in parentheses. *** ** and * indicate significance at 1%, 5% and 10%, respectively

Table A2
Information asymmetry and bank risk taking – using first analyst forecasts.

Dependent variable: ln(Z-score)	*Forecast Error*		*Forecast Dispersion*	
Dependent variable:	(1)	(2)	(3)	(4)
Opacity	−0.012***	−0.021	−0.012***	−0.016
	(0.002)	(0.017)		
Lerner	0.643***	0.457***	0.689***	0.505***
	(0.094)	(0.103)	(0.092)	(0.109)
Opacity × Lerner		0.074***		0.103***
		(0.019)		(0.029)
Non-deposit funding	−0.428***	−0.388***	−0.416***	−0.368***
	(0.103)	(0.104)	(0.103)	(0.104)
Non-interest income	−0.276***	−0.214**	−0.279***	−0.215**
	(0.095)	(0.102)	(0.095)	(0.104)
Opacity × Non-deposit		−0.023		−0.045*
		(0.018)		(0.027)
Opacity × Non-interest		−0.004		−0.014
		(0.018)		(0.027)
Constant	2.593***	2.588***	2.650***	2.646***
	(0.403)	(0.393)	(0.406)	(0.395)
Control variables	Yes	Yes	Yes	Yes
Observations	3277	3277	3277	3277
Adjusted R^2	0.301	0.312	0.293	0.301
Number of banks	401.000	401.000	401.000	401.000

This table shows the fixed effect estimation results for the effect of opacity on banking risk-taking using an alternative calculation of opacity where the first forecast for each period by each analyst is used. The standard control variables, including forecast horizon, are included in these regressions. Time fixed effects are included in all estimations. Robust standard errors clustered at the bank level are in parentheses. ***, ** and * indicate significance at 1%, 5% and 10%, respectively

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