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Deposit Supply and Bank Transparency

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Abstract. Does a bank's dependence on different external funding sources shape its voluntary disclosure of information? We evaluate whether economic shocks that increase the supply of bank deposits alter the cost–benefit calculations of bank managers concerning voluntary information disclosure. We measure information disclosure using 10-K filings, 8-K filings, and earnings guidance. As for the funding shock, we use unanticipated technological innovations that triggered shale development and booms in bank deposits. Further analyses suggest that greater exposure to shale development reduced information disclosure by relaxing the incentives for managers to disclose information to attract funds from external capital markets.

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Keywords: bank transparency • information production • deposit supply

1. Introduction

Extensive research explores the connections between bank transparency and bank stability, lending, and liquidity creation (e.g., Beatty and Liao 2014, Bushman and Williams 2015, Acharya and Ryan 2016, and Leuz and Wysocki 2016). Given these connections between transparency and bank operations and research demonstrating the impact of bank operations on economic stability and growth (e.g., Ashcraft 2005, Levine 2005, and Schularick and Taylor 2012), it is surprising that relatively little research analyzes the determinants of bank's voluntary disclosure of information. In this paper, we examine one potential determinant—access to funding—by evaluating the impact of shocks to the supply of deposits on voluntary information disclosure. We focus on voluntary disclosure because banks are subject to extensive regulatory reporting requirements, and we seek to understand how access to finance, not adherence to regulatory mandates, shapes the disclosure decisions of bank executives.

Research suggests that bank managers weigh the expected benefits and costs to voluntarily disclosing information to the public. On benefits, one line of research holds that reductions in informational asymmetries between banks and capital markets can improve market discipline and thereby lower the costs to banks of raising external funds through securities issuances (e.g., Jensen and Meckling 1976, Myers and Majluf 1984, Leuz and Verrecchia 2000, and Balakrishnan and Ertan 2019). Research also notes the potential costs to managers from disclosure. Leuz et al. (2003) and Leuz and Wysocki (2016) stress that to the extent that disclosure improves market discipline, it also limits the ability of insiders to extract private rents. Furthermore, disclosure might release proprietary information that aids competitors (e.g., Verrecchia 1983, 2001) or elicits the unwanted attention of tax authorities (Ellul et al. 2016). As another cost of disclosure, Dang et al. (2017) and Chen et al. (2020) emphasize that transparency can make banks more vulnerable to depositor withdrawals, which boosts fragility. Thus, executives must weigh an assortment of factors in making disclosure decisions, and shocks to one of the expected benefits or costs of transparency will likely alter those decisions.

Based on this research, we evaluate differing views concerning the impact of shocks to banks' access to funding on voluntary information disclosure. As discussed in greater detail below, the "bank financing view" begins from the premise that depositors demand less information and exert less discipline over banks than capital markets. Depositors may demand less information than capital markets, because explicit and implicit deposit insurance and depositors' seniority over capital market investors in bank liquidations reduce the incentives of disparate depositors to coordinate and engage in the complex, time-consuming process of monitoring banks and disciplining bank executives (e.g., White 1981, Calomiris 1990, Demirgüç-Kunt and Detragiache 2002, Demirgüç-Kunt and Huizinga 2004, Nier and Baumann 2006, and Calomiris and Jaremski 2019).[1] Under the premise that depositors demand less information than capital market investors, the bank financing view, therefore, predicts that deposit windfalls will (a) lessen the need for recipient banks to issue securities in capital markets, (b) diminish one of the benefits of voluntary information disclosure—easing access to capital markets—and (c) induce banks to disclose less information to the public. There are, however, alternative views and potentially countervailing influences. For example, if a bank receiving a deposit windfall gains a competitive advantage over its rivals and becomes less concerned about releasing information to competitors, then the windfall could push the bank toward disclosing more information. From another perspective, if official regulatory mandates concerning information disclosure are sufficiently demanding, voluntary disclosures may be insensitive to deposit windfalls. Given these differing views, we evaluate the impact of deposit windfalls on disclosure.

To assess the impact of deposit supply shocks on transparency, we use three types of measures of voluntary information disclosure. First, we use data from the Management Discussion and Analysis (MD&A) section of banks' 10-K filings. Although the Securities and Exchange Commission (SEC) mandates that the MD&A discusses particular themes, managers have flexibility over the breadth and depth of information that they release to the public. Following Brown and Tucker (2011), we use textual analysis to construct measures of the length and information content of each bank's annual MD&A. Second, we use voluntary disclosures in 8-K filings. Although the SEC also mandates that 8-K filings provide information about particular corporate events, managers have latitude with respect to disclosing information about risk factors, litigation, new products, etc. within the "Regulation Fair Disclosure" and "Other Events" sections of 8-Ks. Following Boone and White (2015), we use these "voluntary disclosures" in 8-K filings to create three additional measures of the length, frequency, and market impact of each bank's voluntary information disclosures. Third, we use data on banks' earnings forecasts to gauge the forward-looking earnings guidance issued by bank managers. Specifically, we construct three additional measures of managerial information disclosure: the frequency of earnings forecasts, the precision of those forecasts, and the impact of the forecasts on market prices.

To identify an exogenous source of variation in bank deposits, we exploit the unanticipated large-scale extraction of shale gas and oil triggered by technological breakthroughs at the end of 2002—that is, "fracking." These unexpected innovations materially lowered the costs of extracting gas and oil from shale deposits. This technology shock led energy companies to sign mineral leases with landowners in promising areas and immediately drill wells to assess the viability of extracting resources from those lands. These leases provided landowners with large initial payments and a share of any profits after drilling and extraction. After receiving these payments, landowners deposited much of the cash windfalls into local bank branches, inducing an unexpected surge in deposits. We measure each bank holding company's (BHC's) exposure to deposit windfalls generated by shale-drilling activities by combining information on the geographic location of the BHC's branches and the number of wells drilled in each shale-boom county.

We take shale development as an exogenous economic shock that boosted bank deposits and reduced the incentives for banks to access capital markets for the following five reasons. First, as emphasized by Gilje et al. (2016), (a) technological advancements in fracking were unanticipated, so that neither financial markets nor energy experts had foreseen the breakthroughs that lowered the costs of extracting oil and gas from shale; and (b) energy companies moved quickly to purchase shale mineral leases in promising areas following the technological breakthroughs, so that banks did not alter their branch networks before these leases were signed and initial payments were distributed. Second, when comparing "treated" banks (banks with branches in counties exposed to shale discoveries) and "untreated" banks, we find no evidence of differential "pretrends" in changes in deposits. Third, we find that exposure to shale development materially boosts bank deposits. Indeed, the impact is large enough, such that exposed banks increase mortgage lending in nonboom counties as shown by Gilje et al. (2016). Fourth, a BHC's exposure to shale development is negatively associated with the price of deposits (i.e., interest payments on deposits). The finding that shale development boosts deposits and reduces the interest rate on those deposits is (a) consistent with a positive shock to the supply of deposits and (b) inconsistent with the increase in deposits being driven only by an increase in banks' demand for deposits, as a demand shock would tend to increase interest rates. Fifth, a BHC's exposure to shale development materially reduces its issuances of bonds and equities in capital markets. If the increase in deposits caused by a shale boom were merely used to satisfy an increase in the local demand for loans, we would not find a reduction in securities issuances or a reduction in reliance on external capital markets among exposed banks. Taken together, these findings suggest that shale development increases the supply of deposits and reduces the need for banks to raise funds in capital markets.

Using the measures of voluntary information disclosure and the shale shocks that boosted deposits, our empirical strategy proceeds as follows. We employ a difference-in-differences regression structure that includes BHC and year fixed effects, as well as an assortment of time-varying, BHC-specific characteristics. In our analyses, the core explanatory variable is the degree to which BHCs are exposed to shale discoveries in counties in which they have branches. We then conduct a sequence of analyses to (a) assess whether a BHC's exposure to shale developments that triggered deposit windfalls influenced voluntary information disclosure and (b) address concerns that channels beyond the impact of deposit windfalls account for the exposure–disclosure nexus that we discover.

Consistent with the bank financing view, we discover that positive shocks to a BHC's exposure to shale development reduced voluntary information disclosure by bank managers. In particular, exposure reduced (a) the MD&A disclosure indicators, (b) the 8-K filing measures, and (c) the earnings guidance indicators. The estimated coefficients suggest that shale-development shock exerts economically meaningful effects on disclosure. For example, our estimates suggest that in response to a one-standard-deviation increase in exposure, (a) the length of MD&A text-based disclosures would drop by about 3% of the sample mean, (b) the frequency of voluntary 8-K filings would drop by about 10% of the sample mean, and (c) the frequency of issuing managerial earnings guidance forecasts would decrease by 7% of the corresponding sample mean.

We extend the analyses and assess whether the impact of shale development on information disclosure varies across banks in a theoretically predictable manner. First, as noted by Verrecchia (1983), information disclosure provides valuable information to competitors. Thus, BHCs in more competitive environments might be more reluctant to release information to the public. This suggests that the negative impact of shale development on information disclosure might be more pronounced among BHCs facing stiffer competition. Consistent with this conjecture, we discover that the disclosure-reducing effects of shale development are greater among BHCs facing more intense competition. This finding is consistent with the view that (a) information disclosure provides valuable information to competitors; and (b) bank managers limit the release of such valuable information subject to other constraints, such as using information disclosure to maintain access to external funding sources. Second, to the extent that some BHC executives perceive comparatively high net costs to voluntarily disclosing information beyond regulatory mandates, they tend to have comparatively opaque banks prior to any shale shocks and change disclosure less in response to funding shocks. This suggests that the negative impact of shale development on information disclosure will be less pronounced among more opaque banks. This is what we find: The disclosure-reducing effects of shale shocks are muted among more opaque banks. Third, we also conduct a falsification test. If the deposit boom triggered by shale development reduces the need for banks to voluntarily disclose information to obtain capital market financing, then any given deposit windfall induced by shale discoveries should have little or no impact on the capital market financing and disclosure decisions of the largest BHCs. Consistent with this view, we find that bank exposure to shale development is not associated with a change in bank disclosure among the largest banks.

Our findings are robust to several additional considerations. First, the findings are robust to examining alternative measures of bank exposure to shale development, including measures of the cumulative number of wells drilled in a county. Second, the results hold when using different MD&A disclosure metrics, such as the number of exhibits and the degree to which the MD&A section of 10-K filings provides numbers. Third, we were concerned that other forms of information might substitute for voluntary disclosure or alter the quality of disclosure (e.g., Einhorn 2005, Hirst et al. 2007, and Einhorn and Ziv 2012). We, however, find that various factors, such as the overall quality of earnings disclosed by banks, analyst coverage, media analyses, or the degree to which a major auditing firm covers a bank, do not shape our findings. Finally, there might be concerns that deposit windfalls hurt bank performance and induce executives to hide this poor performance by limiting disclosure. However, we find no evidence that windfalls hurt bank performance. Rather, we find consistent evidence that positive shale shocks reduce the voluntary disclosure of information by bank managers in a manner that confirms the predictions from the bank financing view.

Our work contributes to research exploring the linkages between information disclosure and access to capital markets. In particular, a large body of work examines the connections between disclosure and access to funding among nonfinancial firms (e.g., Diamond and Verrecchia 1991, Frankel et al. 1995, Lang and Lundholm 2000, Healy and Palepu 2001, Leuz and Wysocki 2016, Chen and Vashishtha 2017, Goldstein and Yang 2017, and Breuer et al. 2018). We focus on the banking industry for two reasons. First, research suggests that the stability and functioning of the banking system influences firms, industries, and national living standards (e.g., Levine 1997). Thus, given the linkages between the functioning of banks and information disclosure, we examine whether access to funding influences banks' voluntary disclosure of information. Second, banks might be different from nonfinancial firms. Compared with nonfinancial firms, banks are subject to bank regulations and more stringent Securities and Exchange Commission disclosure requirements.[2] Furthermore, on bank–nonfinancial firm differences, the constellation of expected benefits and costs of voluntary information to executives discussed above (and developed in greater detail in Section 2) may differ materially for bank and nonfinancial firm executives. As a result, the net impact of funding shocks on information disclosure could differ for banks. Thus, we offer what we believe is the first assessment of the impact of shocks that increase the supply of deposits on banks' voluntary disclosure of information.

Our work relates to the findings in Chen et al. (2020), who show that when banks are more transparent, uninsured bank deposits are more sensitive to bank performance. Their findings are consistent with the view that bank transparency facilitates monitoring by uninsured depositors. Our study is distinct from Chen et al. (2020) in several respects. Rather than evaluating the impact of transparency on uninsured bank-deposit flows, we examine how shocks to a bank's funding sources influence its voluntary disclosure of information. We discover that shale shocks that trigger deposit windfalls (a) reduce deposit interest rates; (b) reduce issuances of bond and equity securities; and (c) reduce voluntary information disclosure, which is consistent with the view that banks weigh the benefits and costs of voluntary information disclosure and adjust their disclosure decisions when a funding shock alters these calculations. Note that our research and Chen et al. (2020) do not contradict each other. Our findings do not indicate that depositors exert no market discipline. Rather, our findings imply that due to explicit and implicit deposit insurance, as well as the legal ordering of creditors in bank liquidation, depositors demand less information and exert less discipline over banks than capital market participants.

In the remainder of the paper, Section 2 provides further details on the analytical framework and testable hypotheses, while Section 3 provides the institutional background of fracking and shale discoveries in the United States. Section 4 describes the data. Section 5 provides information on using shale development as an exogenous shock to the supply of bank deposits. Section 6 reports the results. Section 7 concludes.

2. Framework and Hypothesis Development

2.1. Benefits and Costs of Disclosure

Our framework for assessing how deposit supply shocks influence voluntary information disclosure begins by recognizing the various benefits and costs to banks executives from disclosing information to the public. Regarding potential benefits, the pioneering research by Jensen and Meckling (1976) and Myers and Majluf (1984) explains how reducing information asymmetries between a firm and capital markets can lower the costs to the firm of issuing securities in those public markets. Extensive research on nonfinancial firms confirms this view, showing that transparency lowers the costs of raising funds in capital markets (e.g., Francis et al. 2005, Bharath et al. 2008, and Graham et al. 2008). On banks, recent work by Balakrishnan and Ertan (2019) finds that greater disclosure eases capital market frictions and allows banks to raise funds at cheaper rates.[3]

Research also highlights the costs to bank executives of disclosure. First, extensive research explains that disclosure can release proprietary information that helps competitors. For example, Verrecchia (1983, 2001) explains that in more competitive product market environments, firms will be more reluctant to release information to competitors.[4] Second, greater transparency can restrict the ability of executives to extract private control benefits. From this perspective, disclosure might boost bank valuations, while hurting bank executives. For example, Leuz et al. (2003) show that corporate insiders use opacity to protect their private control benefits, and Leuz and Wysocki (2016) review the extensive literature on the impact of transparency on private rent extraction by insiders. Another line of research explains that disclosure can release information that triggers more intense monitoring by tax authorities. For example, Ellul et al. (2016) show that firms disclose less information when statutory corporate tax rates are higher. Third, banking research notes that transparency can impede liquidity creation by banks. In particular, banks create liquid liabilities that facilitate exchange without requiring depositors to obtain and analyze much information about banks (e.g., Gorton and Pennacchi 1990). Dang et al. (2017) argue that banks can supply these valuable liquid liabilities only if they are sufficiently opaque. They explain that in more transparent environments, new information can increase the volatility of the value of bank assets and liabilities. Chen et al. (2020) provide empirical support for this hypothesis, showing that greater transparency interferes with the ability of banks to provide stable, liquid deposits.

This simple perspective frames our analyses. Managers at each bank make disclosure decisions after weighing the various benefits and costs of disclosure. Consequently, shocks that alter the expected benefits or costs of disclosure will likely prompt executives to reevaluate their disclosure decisions. We consider the impact of a particular shock—a shock that increases the supply of deposits—and evaluate how this deposit windfall alters voluntary information disclosure.

2.2. Hypotheses Regarding Deposit Windfalls and Disclosure: Bank Financing View

Research offers differing views and predictions regarding how a positive shock to the supply of deposits, which account for about 75% of U.S. commercial bank liabilities (Hanson et al. 2015), will alter the expected benefits and costs of information disclosure and, hence, banks' information-disclosure decisions. In this subsection, we focus on the bank financing view, which holds that, ceteris paribus, deposit windfalls will reduce the incentives of bank executives to disclose information and lead to a reduction in voluntary information disclosure. In the next subsection, we discuss other, countervailing views and their hypotheses concerning the impact of deposit supply shocks on information disclosure.

A key premise of the bank financing view is that depositors demand less information and exert less discipline over banks than capital market participants. Research provides ample support for this premise. First, the Federal Deposit Insurance Corporation explicitly insures more than half of all U.S. deposits. This insurance reduces the incentives of insured depositors to monitor and discipline banks, as indicated by the findings in, for example, Demirgüç-Kunt and Detragiache (2002) and Demirgüç-Kunt and Huizinga (2004). Second, many uninsured depositors expect that the authorities would bail them out if their bank were to fail. That is, even though the U.S. government has not made an explicit commitment to guarantee those deposits, depositors believe that there is an "implicit" guarantee. Given these expectations, depositors with implicit insurance will also be reluctant to undertake the difficult task of scrutinizing their banks. The empirical findings in Buser et al. (1981) and Penati and Protopapadakis (1988) suggest that implicit insurance materially reduces the incentives of depositors to exert governance over banks. Furthermore, Barth et al. (2006, 2012) provide examples in which authorities bailout depositors even when no explicit law or regulations commit them to guarantee those deposits. Third, in the liquidation of a failed bank, depositors are paid first from the bank's assets, and only then do capital market investors holding subordinated debt, notes, bonds, and equity receive payments. Thus, beyond explicit and implicit deposit-insurance guarantees, the priority of payments in bankruptcy further suggests that capital markets participants have stronger incentives to scrutinize banks.

Much empirical evidence is consistent with the premise that capital markets demand more information from banks and scrutinize banks more effectively than depositors. For example, White (1981), Calomiris (1990), and Calomiris and Jaremski (2019) use U.S. data from the 19th and early 20th centuries and show that deposit insurance materially reduces market discipline by depositors, which, therefore, leaves the monitoring and governance of banks to bond and equity holders and regulators. Flannery (1998) provides a detailed review of the literature on the relative importance of capital markets in monitoring banks. Barth et al. (2006) and Nier and Baumann (2006) provide international evidence suggesting that capital market investors play a larger role in monitoring and disciplining banks than depositors. Furthermore, research indicates that capital markets rely on and respond to information disclosed by banks. In particular, although capital market investors can generate their own information about banks, research suggests that these analyses are not perfect substitutes for the information released by banks, due to the opaqueness of banks resulting from their underlying assets and capital structure (e.g., Morgan 2002). Studies by Berger and Davies (1998), DeYoung et al. (2001), and Badertscher et al. (2018) collectively show that stock and subordinated debt prices respond to the bank-specific information disclosure, indicating that capital markets use the information disclosed by banks in evaluating banks.

There are several features worth noting about how deposit supply shocks shape disclosure. First, the premise that capital market participants demand more information than depositors does not imply that depositors demand no information. Prior studies (e.g., Berger and Turk-Ariss 2015 and Chen et al. 2020) indicate that uninsured depositors monitor and exert governance over banks. The underlying economic mechanism simply assumes that capital market participants are more information-demanding than depositors, so that if a shock reduces the need for banks to access capital markets, there will be less pressure on banks to disclosure information.

Second, the view that shocks to the supply of deposits induce banks to reduce issuance of securities in capital markets requires that (1) banks view raising funds from depositors and capital markets as partial, but not necessarily perfect, substitutes; and (2) there are costs to depositors from switching banks. In terms of substitutability, research notes differences between deposits and capital market instruments. For example, demand deposits are highly liquid and have shorter durations than bonds and equities (e.g., Diamond and Rajan 2001). Nevertheless, these differences do not suggest that there is no substitutability between deposits and securities as sources of funding for bank activities. Time deposits, which account for a significant proportion of total deposits, have a much longer duration than demand deposits and can serve as a partial substitute for some capital market instruments. In

Table 2, we find that an increase in shale exposure induces a significant increase in the ratio of time deposits to bank assets. Also consistent with this view, we show below that a bank's reliance on deposits increases and its issuances of securities in capital markets decrease after it receives a positive deposit supply shock. In terms of the "stickiness" of deposits, research indicates that depositors often develop enduring relationships with their banks that facilitate access to mortgages, business loans, transaction services, and wealth-management services. Ivashina and Scharfstein (2010) show these bank–depositor relationships make deposits a relatively stable source of funding for banks. These bank–depositor relationships, together with the view that depositors are relatively insensitive to information disclosure, suggest that depositors will not readily change banks if disclosure falls following a deposit windfall. Below, we provide empirical evidence confirming this prediction.

In sum, the bank financing view builds on the premises that (a) there are benefits and costs to disclosure, (b) one of the benefits is that disclosure eases access to capital market financing, (c) depositors demand less information than capital markets, (d) there is some degree of substitutability between raising funds from depositors and capital markets, and (e) enduring bank–depositor relationships increase the costs to deposits of switching banks. Based on these premises, the bank financing view predicts that deposit windfalls will (1) increase the degree to which banks finance themselves with deposits, (2) decrease banks' issuances of securities in capital markets, and (3) induce banks to disclose less information to the public.

2.3. Hypotheses Regarding Deposit Windfalls and Disclosure: Alternative Views

There are, however, alternative views and potentially countervailing influences. First, one may argue that the extent to which capital markets demand more information and more effectively discipline bank insiders relative to depositors has diminished over time due to too-big-to-fail policies that have limited the role of capital markets. This view would suggest that deposit windfalls will not have much of an effect on the comparative benefits and costs of disclosing information and, therefore, will have little impact on disclosure. Second, a bank receiving a deposit windfall may become more dominant in the local market. This could lead the bank to become less concerned about releasing information to competitors. From this perspective, the positive deposit supply shock could induce the bank toward disclosing more information, not less, as predicted by the bank financing view. Third, if official regulatory mandates concerning information disclosure are sufficiently demanding, voluntary disclosures may be insensitive to deposit windfalls. According to this view, shocks that increase the supply of deposits will have little effect on a bank's voluntary disclosures. Thus, the overall impact of deposit windfalls on disclosure is an empirical question.

3. Background on Fracking and Shale Discoveries

Although high-volume hydraulic fracturing and horizontal drilling had been invented before the 1990s, it was not until the end of 2002 that Mitchell Energy discovered how to combine them to extract shale gas and oil at very low costs. This technological breakthrough, commonly known as "fracking," revolutionized the U.S. oil and gas industry. According to the U.S. Energy Information Administration, shale oil and gas accounted for less than 2% of U.S. oil and gas production in 2000 and accounted for more than half of all U.S. oil and gas production by 2016.

Following these unexpected technological innovations, energy companies purchased mineral leases from landlords in areas with promising shale deposits and quickly began drilling operations to extract resources. These leases typically involved both a large initial payment and a royalty percentage based on the amount of oil and gas extracted from the land, providing enormous, unexpected windfalls to landowners. For example, Scott (2008) reported that land with promising shale deposits could fetch between $10,000 and $30,000 an acre, so that a fortunate landowner who leased out only 100 acres of promising land could immediately receive the upfront bonus of $3 million, regardless of the well's ultimate productivity, plus a future monthly royalty payment of 20%–30% of the value of gas and oil extracted from the well. According to anecdotal evidence, some shale counties received leasing payments of $1 billion a year.

Landowners who received large upfront payments generally deposited a large share of these payments in their local bank branches, triggering a surge in deposits at these exposed banks. In our analyses, we find that BHCs with branches in shale counties experienced sharp increases in both non-interest-bearing deposits (such as some forms of demand deposits) and interest-bearing deposits (such as saving deposits, time deposits, and certificates of deposits), but they did not experience increases in brokered deposits.

Shale development provides a natural experiment for assessing how deposit windfalls affect information disclosure by bank managers. At least two factors suggest that the deposit windfalls resulting from shale development represent a deposit supply shock, plausibly exogenous to unobserved bank traits. First, as emphasized by Lake et al. (2013) and Gilje et al. (2016), neither financial markets nor energy industry experts anticipated the technological advancements in fracking that triggered the boom in shale development. Second, it was very difficult for banks to alter their branch networks to gain greater exposure to the shale shock because (a) as just noted, financial markets and industry experts did not predict the fracking boom; and (b) energy companies moved very quickly to purchase shale mineral leases from landlords in areas with prospective shale formations, making it unlikely that banks opened branches before these leases were signed and initial payments were distributed. Thus, we exploit a BHC's exposure to shale development through its branch network to assess how an unexpected deposit supply shock affects information disclosure by bank managers.

4. Data and Sample

4.1. BHC Sample

Our sample comprises publicly listed U.S. BHCs, some of which have branches in counties experiencing a boom from shale development. The sample begins in 2000, which is three years before technological innovations triggered an explosion of shale development using fracking techniques, and runs through 2007. After merging BHC financial accounts in the Y-9C provided by the Federal Reserve and disclosure data based on SEC EDGAR with information on shale development, our primary sample contains 3,611 BHC-year observations involving 566 BHCs.

4.2. BHC Exposure to Shale-Induced Deposit Shocks

To measure the extent to which each BHC is exposed to the shale-drilling boom, we first obtain information on the spud date, location, and well orientation of the wells drilled across the United States over the 2003–2007 period from IHS Markit Energy's North American well database. We focus on horizontal wells, because after 2002, almost all horizontal wells were drilled to extract shale. This yields a sample of 15,265 wells with detailed locational information over the 2003–2007 period. Our sample stops in 2007 to avoid the 2008 financial crisis period. Figure 1 shows the geographic dispersion of shale-drilling activities across U.S. counties from 2003 to 2007, represented by the total number of shale wells drilled in each county, with darker colors indicating more drilling. We combine this information with data from the Federal Deposit Insurance Corporation's (FDIC's) Summary of Deposits database on the location of each bank branch, deposits at each branch, and the branch's affiliated holding company.

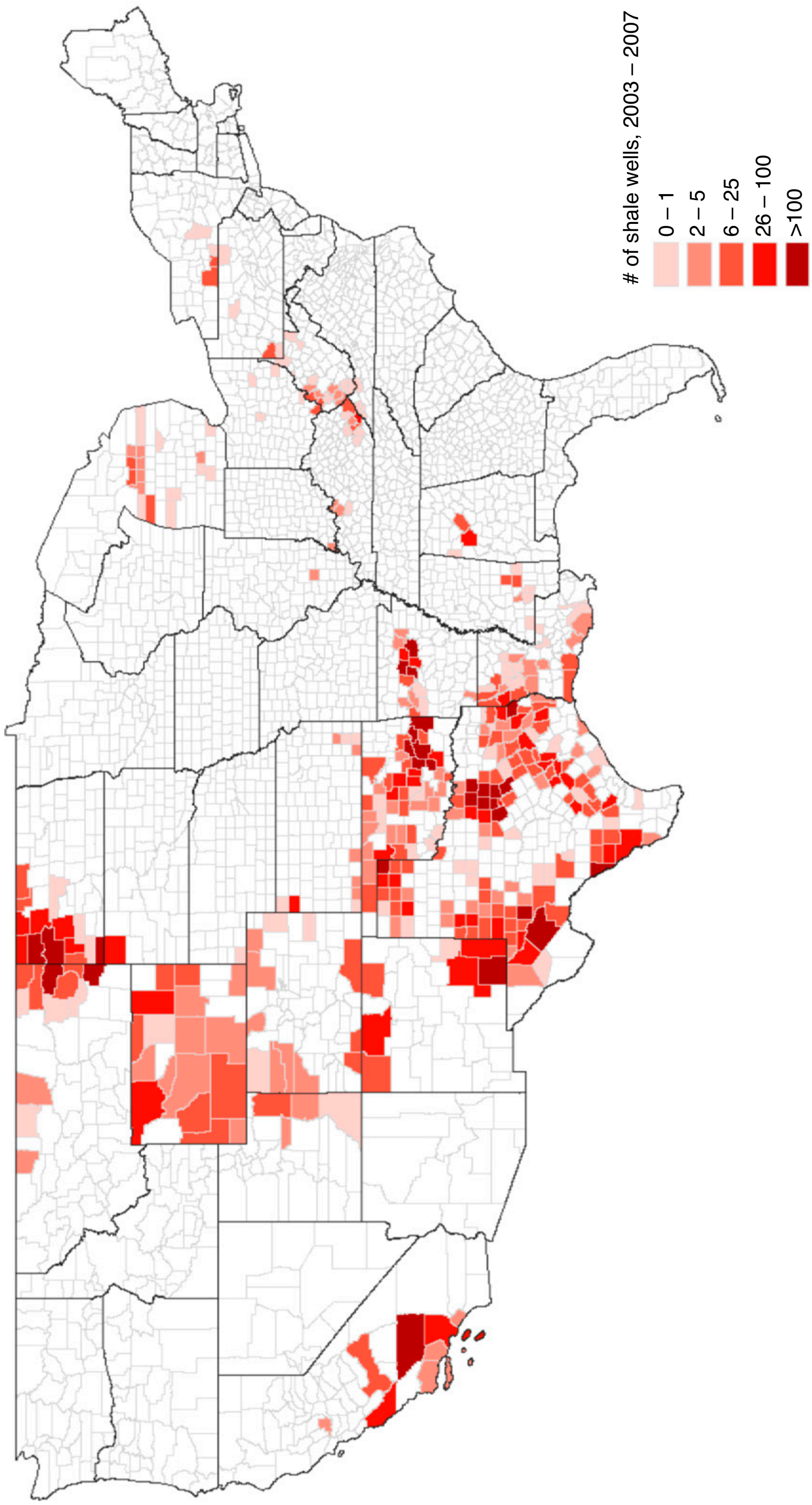
For each BHC in a year, we then measure its exposure to shale-drilling activities by combining information on the geographic location of bank branches across counties and information on the number of wells drilled in each shale-boom county. More specifically,

$$Bank\ Exposure_{b,t} = \ln[1 + \sum_{j}(Wells_{j,t} * Mktshr_{b,j,t} * 1(Boom_{j,t}))/Branches_{b,t}], \qquad (1)$$

where subscripts b, j, and t denote bank, county, and year, respectively. $Wells_{j,t}$ equals the total number of shale wells drilled in county j during year t, so that it measures the intensity of shale development in the county during year t. We use the number of wells drilled during year t, and not measures of land lease payments, to measure each bank's exposure to the shale boom due to data limitations on lease payments. $Mktshr_{b,j,t}$ equals the share of total deposits in county j in year t held by bank b—that is, the market share of bank b in county j in year t. Note that in counties where bank b has no branches, *Mktshr* equals zero. $1(Boom_{j,t})$ is an indicator variable that equals one if county j is categorized as a shale-boom county in year t, and zero otherwise. County j is treated as experiencing shale booms if the number of shale wells drilled in that county in year t is in the top quartile of the sample across all county-year observations. Note that our core results hold when eliminating $1(Boom_{j,t})$ from Equation (1) in computing the bank-exposure measure as shown below. $Branches_{b,t}$ equals the total number of branches owned by BHC b in year t across all counties in the United States. We multiply $Wells_{j,t}$ by $Mktshr_{b,j,t}$ to gauge the degree to which shale development in county j in year t influences BHC b. We further multiply by $1(Boom_{j,t})$ to account for shale development in shale-boom counties. We then scale the shale-development shock to BHC b across shale-boom counties ($\sum_j Wells_{j,t} * Mktshr_{b,j,t} * 1(Boom_{j,t})$) by the number of branches that BHC b has in the United States ($Branches_{b,t}$). Although mineral leases typically involved both a large initial payment and a royalty percentage based on the amount of oil and gas extracted from the land, we use the number of wells drilled during year t, and not the cumulative number of wells drilled since 2003, to measure each bank's exposure to the shale boom due to data limitations on individual wells' future productivity. In later analyses, we show that the results are robust to measuring bank-specific shale exposure using the *cumulative* number of shale wells in each county, rather than the number of new wells drilled in a year.

Bank Exposure equals zero for (a) all BHCs in the years before 2003, which is the year when large-scale shale development started; and (b) those BHCs that have no branches located in shale-boom counties. This measure increases for a BHC as more wells are drilled in the counties in which the BHC has branches. Out of

Figure 1. (Color online) The Number of Shale Wells Drilled from 2003 to 2007 by U.S. County



Notes. Based on IHS North America Performance Evaluator. This figure represents the number of shale wells drilled in each county over the period of 2003–2007, with darker shades indicating higher values.

the primary sample of 566 BHCs, more than 10% were exposed to shale development at some point during the 2003–2007 period. As we show below, the degree of BHC exposure to shale development is positively associated with increases in deposits.

Panel A of Table 1 provides summary statistics of the key variables used in the analyses. As shown, *Bank Exposure* has a mean of 0.01, with a standard deviation of 0.12. We also note that *Bank Exposure* ranges from 0 to 4.7 for the full sample of BHCs, and among banks exposed to shale development, *Bank Exposure* has a sample mean of 0.14, with a standard deviation of 0.53. Panel B of Table 1 compares BHCs with and without exposure to shale-development shocks. Consistent with the findings in Gilje et al. (2016), exposed BHCs are, on average, larger and have more branches than "nonexposed" BHCs. The two groups of banks, however, are more alike with respect to funding structure, as measured by the ratio of total deposits to total assets and the cost of deposits.

4.3. BHC Disclosure Measures

To measure the extent to which a BHC's management voluntarily discloses information to the public, we construct three categories of measures based on (1) the Management Discussion and Analysis section of annual reports (i.e., 10-K filings), (2) the voluntary items in 8-K filings, and (3) the forward-looking earnings guidance provided by BHC managers.

The first category of BHC disclosure measures is based on data from the MD&A section of 10-K filings. Since 1980, the Securities and Exchange Commission of the United States requires public firms to augment Generally Accepted Accounting Principles-mandated disclosure with unaudited, narrative disclosures in their annual reports. These MD&A sections disclose information to the public that augments the numerical data provided in financial and other accounting statements. The SEC stipulates that MD&A disclosure should discuss and analyze the firm's operational performance, financial condition, and project trends, to

Table 1. Summary Statistics: Key Variables

Panel A. Summary statistics for key variables

	(1)	(2)	(3)
Variable	*N*	Mean	Standard deviation
Bank Exposure	3,611	0.01	0.12
MD&A Length	3,611	7.84	3.19
MD&A Modification	2,988	2.02	0.38
Voluntary 8-K Frequency	3,611	1.24	0.89
Voluntary 8-K Length	3,611	6.00	3.41
Voluntary 8-K_CAR(-1,1)	3,611	0.05	0.10
Voluntary 8-K_CAR(-3,3)	3,611	0.07	0.14
Managerial Earnings Guidance Frequency	1,200	0.46	0.66
Managerial Earnings Guidance Precision	1,200	0.42	0.77
Managerial Earnings Guidance_CAR(-1,1)	1,200	0.03	0.06
Managerial Earnings Guidance_CAR(-3,3)	1,200	0.04	0.08
Size	3,611	7.32	1.55
LLP	3,611	0.42	0.45
Cap	3,611	8.90	2.34
ROA	3,611	0.97	0.57
Tier 1 Capital	3,611	12.02	3.32
Total Deposits/Total Assets	3,357	0.77	0.16
Time Deposits/Total Assets	3,357	0.63	0.14
Demand Deposits/Total Assets	3,357	0.11	0.06
Cost of Deposits	3,356	0.04	0.02
Bond & Equity Issuance Frequency	3,611	0.06	0.25
Bond & Equity Issuance Amount	3,611	0.04	0.25

Panel B. Summary statistics of bank characteristics for banks exposed to the shale boom vs. banks not exposed to the shale boom

	(1)	(2)	(3)	(4)	(5)	(6)
	Exposed banks			Nonexposed banks		
Variable name	*N*	Mean	Standard deviation	*N*	Mean	Standard deviation
# of Branches	444	354	902	3167	55	157
Size	444	8.87	2.16	3167	7.10	1.31
Total Deposits/Total Assets	393	0.72	0.23	2964	0.78	0.15
Cost of Deposits	393	0.04	0.03	2963	0.04	0.02

improve the ability of investors to make informed predictions about the firm's prospects, and provide incremental information to other public financial statements (SEC 1980). Although the SEC requires MD&A disclosure, each firm's management has considerable discretion about the format and content of the information actually disclosed.

Following prior research (e.g., Brown and Tucker 2011), we use textual analysis to construct two primary measures of information disclosure based on the MD&A section of 10-K filings. First, for each BHC in each year, we calculate *MD&A Length*, which equals the natural logarithm of one plus the number of words in the MD&A section of the BHC's 10-K filings. We interpret higher values of *MD&A Length* as conveying more information. Second, using the cosine similarity method, we compute a year-over-year modification index (*MD&A Modification*) that is defined as the natural logarithm of one plus MD&A modification score, where MD&A modification score equals one minus the similarity score from comparing MD&A section for year t with year $t-1$. The similarity score is calculated based on the Vector Space Model (VSM), an algorithm commonly used by Internet search engines to measure the similarity between documents.[5] A higher value of *MD&A Modification* indicates a higher degree of modification in a BHC's MD&A section this year compared with that of last year, suggesting that the BHC's report in year t contains more new information.

The second category of disclosure measures is based on 8-K filings (or "current reports"). In particular, the SEC mandates that publicly listed companies disclose material corporate events in 8-K filings in a timely manner, so that investors obtain a continuous stream of relevant information on corporate performance (Carter and Soo 1999, Leuz and Wysocki 2016). For example, the SEC requires that 8-K filings include information on acquisitions or dispositions of assets, entry into bankruptcy or receivership, changes in control of the registrant, changes in registrant's directors and officers, etc. Other types of disclosures—voluntary disclosures—are left to the discretion of management. Following Boone and White (2015) and others, we define "voluntary disclosures" as those 8-K filings under items "Regulation Fair Disclosure (Reg FD)" and "Other Events (Other)," which managers choose to disclose to investors. These voluntary disclosures include, for example, updated risk factors associated with a company's business or capital structure, exposure to actual or threatened litigation, the launch of new products or entry into new markets, and other agreements or appointments. We obtain the 8-K filings from the SEC's EDGAR database.

From the 8-K filings, we construct three measures of BHC disclosure. Specifically, for each BHC in each year, (a) *Voluntary 8-K Frequency* equals the logarithm of one plus the total number of 8-K filings reported under items Reg FD and Others (which are regarded as voluntary disclosures through 8-K filings); (b) *Voluntary 8-K Length* equals the logarithm of one plus the average length (in characters) of these 8-K filings; and (c) *Voluntary 8-K_CAR(−n, +n)* measures the market reaction to the release of these 8-K filings and equals the absolute value of the cumulative abnormal returns (CARs) from n days before until n days after the announcement day. We report the results with $n = 1$ and $n = 3$—that is, with 1-day and 3-day announcement returns—though the results also hold for $n = 2$. We estimate daily abnormal stock returns using a standard market model with an estimation window of $[t-200, t-21]$, where t denotes the 8-K announcement date. Larger values of these three disclosure measures suggest greater voluntary information disclosure by BHC management. BHCs in our sample release an average of four voluntary 8-K filings per year, with the average number of characters in each report equal to 3,209.

Our third category of BHC disclosure measures uses data on corporate earnings guidance—that is, the official earnings forecast provided by bank managers. We obtain data on corporate earnings guidance from the Company Issued Guidance (CIG) database, which is contained in the First Call Historical Database. We start with all entries of management forecasts of earnings per share during the forecast period and exclude preannouncements of earnings. We further restrict our sample to banks that have issued earnings guidance at least once during the 2000–2007 sample period, based on the CIG database, to ensure that banks in our sample are covered by the CIG database. This ameliorates concerns that we may wrongly take uncovered firms as providing no forecasts.

We construct three widely used measures of managerial information disclosure based on earnings guidance (e.g., Healy and Palepu 2001). First, for each BHC in each year, we calculate *Managerial Earnings Guidance Frequency*, which equals the logarithm of one plus the number of management earnings forecasts issued by the BHC in a given year. This frequency measure gauges the intensity with which managers provide information to outside investors. Second, *Managerial Earnings Guidance Precision* gauges the precision of managerial earnings forecasts. Specifically, when the earnings forecast provides a precise point estimate, such as "next year's earnings per share is estimated to be $50," this is coded as one (the most precise). When the earnings forecast provides a range, such as "next year's earnings per share is estimated to be between $40 and $60," this is coded as 0.75. When the earnings forecast is more open-ended, such as "next year's earnings per share is estimated to exceed $40," this is coded as 0.5. Finally, when no earnings forecast is provided, this is coded as zero (the least precise). Third, we follow the literature (Carter and Soo 1999, Asquith et al. 2005) and measure the information content of management earnings forecasts by examining the instantaneous market reaction to those forecasts. *Managerial Earnings Guidance_CAR(−n, n)* equals the absolute value of CARs associated with managerial earnings forecasts *n*-day(s) around the announcement date, where $n = 1$ or 3. We estimate daily abnormal stock returns in the same manner as discussed above. Greater values of *Managerial Earnings Guidance_CAR(−n, n)* suggest that earnings guidance delivers more information to outside investors.

4.4. Other BHC Traits

In assessing the relationship between a BHC's exposure to shale development and information disclosure, we follow prior research (e.g., Ellul and Yerramilli 2013) and condition on an assortment of time-varying bank characteristics. Using the Federal Reserve's Y-9C reports, which provide consolidated balance sheets and income statements for BHCs, we condition on the following BHC traits. *Size* equals the natural logarithm of total BHC assets in millions of U.S. dollars. To capture the potential nonlinear relation between bank size and disclosure, we further include *BHC size dummies*, which represent a set of indicators of whether a bank's size falls within 0–25, 25–50, 50–75, or 75–100 percentile ranges respectively. *LLP* equals the loan-loss provisions divided by the one-year-lagged total BHC loans. *Cap* equals the ratio of the book value of equity to total assets. *ROA* equals net income divided by book value of total assets. *Tier 1 Capital* equals tier 1 capital divided by risk-weighted assets.

5. Shale Development as an Exogenous Shock to the Supply of Deposits: Validity Tests

In this section, we address a key assumption underlying our analyses: Shale development triggered an exogenous increase in the supply of deposits in local banks. As demonstrated by Gilje et al. (2016), (a) an unanticipated technological innovation at the end of 2002 made gas and oil extraction from shale economically profitable; (b) this "fracking" innovation triggered large financial windfalls to landlords in promising areas, as energy companies purchased mineral leases and began drilling; and (c) a proportion of these windfalls were deposited in local branches, so that exposed banks—banks with branches in areas where landlords leased mineral rights to shale developers—experienced a surge in deposits. Although these researchers find that BHC's exposed to shale development experienced deposit booms, we reassess this connection within the context of our research design.

5.1. Shale Shocks and Deposits

We evaluate the relationship between shale development and bank deposits using three measures of the degree to which a BHC relies on deposits. The first measure is simply the ratio of total deposits held at the BHC to the book value of the total assets of the BHC (*Total Deposits/Total Assets*), where *Total Deposits* equals the summation of (a) demand deposits and (b) time deposits plus certificates of deposits (CDs). The second measure, *Demand Deposits/Total Assets*, equals the annual average ratio of demand deposits to the book value of total BHC assets, and the third measure, *Time Deposits and CDs/Total Assets*, is the annual average ratio of interest-bearing deposits (time deposits, CDs, and other interest-bearing deposits) to the book value of total BHC assets. These measures provide information on BHC reliance on deposits, relative to other sources of financing.

We assess the impact of exposure to shale development on BHC reliance on deposits by regressing each of the deposit reliance measures for BHC *b*, which are measured over year $t + 1$, on the exposure of BHC *b* in year *t* to shale development (*Bank Exposure*). We condition on a vector of time-varying BHC traits, *Size*, *BHC Size dummies*, *LLP*, *ROA*, *Cap*, and *Tier 1 Capital*, and also control for BHC and year fixed effects to account for time-invariant BHC characteristics and year-specific influences on deposits.

As shown in Table 2, *Bank Exposure* enters positively and significantly in regressions where the dependent variable is *Total Deposits/Total Assets*, *Time Deposits and CDs/Total Assets*, or *Demand Deposits/Total Assets*. This finding indicates that BHCs with greater exposure to shale development experienced a surge in reliance on deposits, including both low-cost, noninterest-bearing deposits (such as demand deposits) and longer-term, interest-bearing deposits (such as savings deposits, time deposits, or CDs). This result holds for total deposits and separately for time deposits and demand deposits. To illustrate the economic magnitudes, consider (a) a BHC with no exposure to shale booms and a BHC with *Bank Exposure* that is one sample standard deviation greater than no exposure (i.e., *Bank Exposure* = 0.53); and (b) the coefficient estimates reported in column (1). Compared with the unexposed bank, the estimates suggest that the exposed BHC experiences a 2.53-percentage-point ($= 0.0478 \times 0.53$) surge in the deposit–asset ratio. This is equivalent to about 3.3% of the corresponding sample mean of the deposit–asset ratio.

5.2. Shale Shocks and Interest Rates on Deposits

To provide evidence on whether this increase in bank deposits from shale development represents a shock to the supply of deposits, and not a shift in demand, we examine prices. If the increase in bank deposits is

Table 2. Bank Exposure to the Shale Shock and Bank Funding Structure

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	*Total Deposits/ Total Assets*	*Time Deposits and CDs/Total Assets*	*Demand Deposits/ Total Assets*	*Cost of Deposits*	*Bond & Equity Issuance Frequency*	*Bond & Equity Issuance Amount*
Bank Exposure	0.0478***	0.0266***	0.0092*	−0.0044***	−0.0614***	−0.0604***
	(0.0080)	(0.0081)	(0.0048)	(0.0011)	(0.0121)	(0.0145)
Size	−0.1070***	−0.0138	−0.0238***	0.0148***	0.0303	0.0129
	(0.0111)	(0.0108)	(0.0050)	(0.0019)	(0.0224)	(0.0135)
LLP	−0.0050	0.0008	−0.0000	0.0004	−1.2759	−0.5447
	(0.0044)	(0.0039)	(0.0017)	(0.0011)	(0.9561)	(0.5311)
Cap	0.0009	−0.0018	0.0007	−0.0008***	−0.4239	−0.0539
	(0.0017)	(0.0017)	(0.0007)	(0.0002)	(0.2846)	(0.1580)
ROA	0.0027	−0.0081*	0.0003	−0.0018***	0.0029	0.0001
	(0.0052)	(0.0044)	(0.0022)	(0.0007)	(0.0065)	(0.0036)
Tier 1 Capital	−0.0010	−0.0002	−0.0012***	0.0003*	−0.0000	−0.0000
	(0.0011)	(0.0010)	(0.0005)	(0.0002)	(0.0017)	(0.0008)
BHC Size dummies	Yes	Yes	Yes	Yes	Yes	Yes
BHC fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
N	3,357	3,357	3,357	3,356	3,611	3,611
R^2	0.8758	0.8886	0.8860	0.8169	0.7839	0.9320

Notes. This table presents regression results of bank deposits (columns (1)–(3)), cost of deposits (column (4)), and issuances of securities through capital markets (columns (5) and (6)) on the bank's exposure to shale development (*Bank Exposure*). BHC controls include book value of total assets (*Size*), loan loss provisions (*LLP*), capital-asset ratio (*Cap*), return-on-assets (*ROA*), and tier 1 capital ratio (*Tier 1 Capital*). The appendix provides detailed variable definitions. Heteroskedasticity robust standard errors clustered at the BHC level are reported in parentheses.

*$p < 0.10$; ***$p < 0.01$.

driven by a positive supply-side shock, then the price of deposits should decline. We measure the price of deposits, *Cost of Deposits*, as the ratio of interest expenses on deposits over interest-bearing deposits. We use the same specification as in column (1) of Table 2, except that the dependent variable is now *Cost of Deposits*. As shown in column (4) of Table 2, BHCs with greater exposure to shale development reduce their interest payments on deposits relative to less exposed banks, suggesting that shale development triggers a positive shock to the supply of deposits that lowers the price of deposits. To illustrate the economic magnitudes, we again compare a BHC with no exposure to shale development and a BHC with exposure that is one sample standard deviation greater than zero (i.e., *Bank Exposure* = 0.53). The coefficient estimates in column (4) indicate that the cost of deposits would drop by about 5.8% (= 0.53 × 0.0044/0.04) of the sample mean of the *Cost of Deposits* for the exposed BHC relative to the unexposed BHC.

5.3. Shale Shocks, Deposit Windfalls, and Substituting Out of Capital Market

We next explore one mechanism through which positive deposit shocks can induce bank managers to disclose less information to the public: Deposit windfalls reduce banks' need to fund themselves by issuing securities in public capital markets. Specifically, in this subsection, we test whether shale-induced deposit shocks reduce banks' issuances of stocks and bonds in public markets. To test this hypothesis, we measure the extent to which each bank obtains capital market financing: (a) the number of bond and equity issuances (*Bond & Equity Issuance Frequency*), and (b) the dollar amount of bond and equity issuances (*Bond & Equity Issuance Amount*). Both are measured over a rolling five-year window. A higher value of *Bond & Equity Issuance Frequency/Amount* means greater dependence on capital market financing. To evaluate the effects of bank exposure to the shale shock on subsequent capital market financing, we employ a regression model similar to column (1) of Table 2, while replacing the dependent variable with one of the measures of capital market financing. If the shale-induced deposit shock relaxes banks' need to finance themselves through securities issuances in capital markets, then we expect the coefficient estimate on *Bank Exposure* to be negative.

Consistent with the view that shale-induced deposit windfalls reduce banks' issuances of securities in capital markets, Table 2, columns (5) and (6), show that bank exposure to shale development is negatively associated with BHCs' subsequent issuances of stocks and bonds in public markets. The key explanatory variable, *Bank Exposure*, enters negatively and significantly in both specifications, suggesting that the shale-induced deposit windfalls allow banks to substitute out of capital market financing. Overall, the results in Table 2 are consistent with the mechanism running from shale shocks, to boosts in banks; reliance on

Table 3. Shale Exposure and Pretrends in Bank Deposits

	(1)	(2)	(3)	(4)	(5)
Dependent variable	*Total Deposits/ Total Assets 2000-2002*	*Total Deposits/ Total Assets 2000-2001*	*Δ Total Deposits/ Total Assets 2000-2002*	*%Δ Total Deposits/ Total Assets 2000-2002*	*Total Deposits/ Total Assets 2002*
Bank Exposure, 2003-2007	−0.1061	−0.1217	−0.0109	−0.0261	−0.0877
	(0.0761)	(0.0825)	(0.0183)	(0.0266)	(0.0728)
BHC controls, pre 2003	Yes	Yes	Yes	Yes	Yes
N	479	442	417	417	479
R^2	0.4830	0.4784	0.0128	0.0121	0.4430

Notes. This table presents regression results of various deposit ratios during the preshale discovery period, 2000–2002, on bank exposure to shale development over the 2003–2007 period. The dependent variables are *Total Deposits/Total Assets*, averaged over the preshale discovery period from 2000–2002 (column (1)), averaged over 2000–2001 (column (2)), change from 2000 to 2002 (column (3)), percentage change from 2000 to 2002 (column (4)), and the value in year 2002 (column (5)). The key explanatory variable, *Bank Exposure, 2003-2007*, is the average bank-specific exposure to shale discoveries in the post-2002 period. BHC controls include *Size*, *BHC size dummies*, *LLP*, *Cap*, *ROA*, and *Tier 1 Capital*, averaged over the 2000–2002 period in column (1), over 2000–2001 in column (2), and in year 2002 in columns (3)–(5). The appendix provides detailed variable definitions. Heteroskedasticity robust standard errors clustered at the BHC level are reported in parentheses.

deposits, to a lessening of banks' issuance of securities in capital markets, to a reduction in the desirability of voluntarily disclosing information to facilitate access to capital market financing.

5.4. Pretrends

Next, we address the concern of whether shale was discovered in counties that, for other reasons, were experiencing banking-system changes, and it is these other factors that explain subsequent changes in information disclosure. To evaluate this concern, we test whether there were differential pretrends in bank deposits prior to shale developments, using the following regression specification:

$$Deposit_{b,pre} = \lambda_1 Bank\ Exposure_{b,2003-2007} + \lambda_2 X_b + e_b, \quad (2)$$

where the dependent variable, $Deposit_{b,pre}$, represents one of the five measures of bank b's reliance on total deposits over the preshale discovery period from 2000 to 2002. In particular, *Total Deposits/Total Assets 2000-2002(2001)* equals the average deposit-asset ratio over the preshale discovery period from 2000 to 2002 (2001); Δ *Total Deposits/Total Assets 2000-2002* equals the change of the deposit–asset ratio from 2000 to 2002; %Δ *Total Deposits/Total Assets 2000-2002* equals the growth rate of the deposit–asset ratio from 2000 to 2002; and *Total Deposits/Total Assets 2002* equals the deposit–asset ratio in 2002. The key explanatory variable, $Bank\ Exposure_{b,2003-2007}$, is the average exposure of BHC b to shale discoveries in the post-2002 period, and X_b includes the same vector of BHC-specific control variables used above (*Size*, *BHC size dummies*, *LLP*, *ROA*, *Cap*, and *Tier 1 Capital*), measured over the 2000–2002 period.

As shown in Table 3, we find no evidence of pretrends in bank deposits before shale discoveries. That is, a BHC's future exposure to shale discoveries is unrelated to either the level or changes in bank deposits before shale discovery. As shown: *Bank Exposure, 2003-2007* enters insignificantly when examining either the pre-2003 level of deposits, the growth rate of deposits, or the change of deposits in the period before the fracking boom. Taken together, these preliminary analyses are consistent with the view that shale development represents a plausibly exogenous boost to the supply of bank deposits.

6. Results: Bank Exposure and Information Disclosure

6.1. Baseline Results

In this subsection, we evaluate the impact of bank exposure to shale development on voluntary information disclosure. In particular, we estimate the following regression:

$$Disclosure_{b,t} = \beta \cdot Bank\ Exposure_{b,t} + \gamma' \cdot X_{b,t} + \theta_b + \theta_t + \varepsilon_{b,t}, \quad (3)$$

where $Disclosure_{\ b,t}$ denotes one of the measures on MD&A disclosure in 10-K filings (i.e., *MD&A Length*, or *MD&A Modification*) for BHC b in year t. The key explanatory variable, *Bank Exposure*, denotes the BHC's exposure to shale development. We include the same set of time-varying BHC traits ($X_{\ b,t}$), namely, *Size*, *BHC size dummies*, *LLP*, *ROA*, *Cap*, and *Tier 1 Capital*, as well as BHC (θ_b) and year (θ_t) fixed effects. Coefficient β captures the impact of unexpected shale development that boosts the supply of deposits on bank-disclosure decisions. We report heteroskedasticity-robust standard errors clustered at the BHC level.[6]

The regression results indicate that BHC exposure to shale development reduces information disclosure by managers. As shown in Table 4, *Bank Exposure*

Table 4. Bank Exposure and Disclosure via Management Discussion and Analysis

	(1)	(2)	(3)	(4)
Dependent variable	*MD&A Length*	*MD&A Modification*	*MD&A Length*	*MD&A Modification*
Bank Exposure	−0.2838*	−0.1431***	−0.4593***	−0.1359***
	(0.1612)	(0.0222)	(0.1477)	(0.0253)
BHC controls	No	No	Yes	Yes
BHC fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
N	3,611	2,955	3,611	2,955
R^2	0.6594	0.5182	0.6880	0.5258

Notes. This table presents regression results of banks' MD&A disclosure on bank exposure to shale development (*Bank Exposure*). BHC controls include *Size*, *BHC size dummies*, *LLP*, *Cap*, *ROA*, and *Tier 1 Capital*. The appendix provides detailed variable definitions. Heteroskedasticity robust standard errors clustered at the BHC level are reported in parentheses.

*$p < 0.10$; ***$p < 0.01$.

enters negatively and significantly in all regressions when the dependent variable is the length of MD&A disclosure in 10-K filings (*MD&A Length)* or the modification score of MD&A disclosure (*MD&A Modification*). Furthermore, the results hold when including or excluding the set of bank-specific time-varying traits. These results suggest that BHCs exposed to shale development through their branches in shale-boom counties—which tends to induce sharp increases in BHC deposits as shown above—reduce their information disclosures in the MD&A section. To the extent that deposit windfalls relax a bank's external funding constraints and, therefore, lower the benefits of using information disclosure to facilitate access to capital markets, these results indicate that bank managers tend to reduce the release of information following a surge in the supply of deposits.

The estimates indicate a large economic impact of bank exposure to shale development on voluntary disclosure. For example, the point estimate in column (3) of Table 4 suggests that a one-standard-deviation increase in bank exposure to the deposit supply shock reduces the length of a bank's MD&A section by about 3% (= (0.53 × 0.459)/7.84) of the sample mean of *MD&A Length*. When we consider the MD&A modification results reported in column (4), the estimated coefficients suggest that a one-standard-deviation increase of bank exposure to deposit shocks reduces the bank's MD&A modification score by about 3.6% of the sample mean value of *MD&A Modification*.

We conduct two additional robustness tests. First, we examine two alternative measures of information disclosure based on information in the MD&A section: (1) counts of exhibits in the MD&A sections (*MD&A Exhibits)*; and (2) counts of numbers in the MD&A disclosure (*MD&A Numbers*). As reported in Table A1 in the online appendix, we find that the exposure to shale development significantly reduces both of these alternative information-disclosure measures.

Second, we use two alternative measures of banks' exposure to shale development. First, the core measure of bank exposure requires that a bank's branch is in a shale-boom county before that counties' wells are included in the exposure measure, where a country is defined as a "shale-boom county" if the number of shale wells drilled in that county in year *t* is above the top quartile across all county-year observations. As a robustness check, we drop this requirement—that is, we eliminate *1(Boom)* from Equation (1), so that *Bank Exposure Alternative 1* for BHC *b* in year *t* equals $\ln\left[1+\sum_j (Wells_{j,t} * Mktshr_{b,j,t})/Branches_{b,t}\right]$, where all variables are defined the same as in Equation (1). The second alternative measure uses the lagged value of the bank's market share in a boom county when weighting its exposure to shale development. Specifically, *Bank Exposure Alternative2* for BHC *b* in year *t* equals $\ln\left[1+\sum_j (Wells_{j,t} * Mktshr_{b,j,t-1} * 1(Boom_{j,t}))/Branches_{b,t}\right]$, where $Mktshr_{b,j,t\text{-}1}$ equals the share of total deposits held by bank *b* in county *j* in year *t*-1. As reported in Table A2 in the online appendix, using these alternative measures of bank exposure to shale development, we continue to find that exposure is negatively associated with disclosure.

6.2. Heterogeneous Effects, Differentiating by Competition

We next examine whether the impact of exposure to shale development on information disclosure varies across BHCs in a predictable manner. Existing research explains that voluntary disclosure could provide valuable information to competitors and, therefore, induce firms in more competitive environments to reduce disclosure (Verrecchia 1983, Bamber and Cheon 1998, Verrecchia and Weber 2006). This leads to a testable prediction: The negative impact of a BHC's exposure to a shale-deposit boom on voluntary information disclosure should be more pronounced among BHCs facing more intense competition.

To test this prediction, we construct a bank-specific measure of competition. Following Li et al. (2013) and Bushman et al. (2016), we measure how managers perceive their banks' competitive environment using textual analysis of banks' 10-K filings. Compared with market-concentration measures, this text-based measure captures managers' perceptions of the competitive pressures from any sources, such as potential entrants or nonbank competitors. For each BHC, we count the number of occurrences of the following words in its 10-K filings: "competition," "competitor," "competitive," "compete," and "competing," and refer to this total as "competition words." We construct this competition index using each BHC's 10-K filing

Table 5. Bank Exposure and MD&A Disclosure, Differentiate by Market Competition

	(1)	(2)
Dependent variable	*MD&A Length*	*MD&A Modification*
Bank Exposure × Competition	−0.3152**	−0.1059***
	(0.1457)	(0.0404)
Bank Exposure	−0.0583	−0.0490
	(0.1322)	(0.0387)
Competition	−0.1550*	0.0038
	(0.0809)	(0.0176)
BHC controls	Yes	Yes
BHC fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
N	3,234	2,955
R^2	0.5520	0.5260

Notes. This table presents regression results of banks' MD&A disclosure on bank exposure to shale development (*Bank Exposure*) and its interaction with market competition. The dependent variables are *MD&A Length* (column (1)), and *MD&A Modification* (column (2)). *Competition* is a dummy variable that equals one if bank *i*'s competition is higher than the sample median level, and zero otherwise. To measure bank competition, we use the extent to which managers perceive their banks' competition environment using textual analysis of each bank's 10-K filings. BHC controls include *Size*, *BHC size dummies*, *LLP*, *Cap*, *ROA*, and *Tier 1 Capital*. The appendix provides detailed variable definitions. Heteroskedasticity robust standard errors clustered at the BHC level are reported in parentheses.

*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

in a year. Specifically, $Competition_{b,t}$ is a dummy variable that equals one if the number of competition-related words in the BHC *b*'s 10-K filing in a year is above that year's sample median value, and zero otherwise.

As shown in Table 5, the negative impact of shale exposure on MD&A disclosures is more pronounced among BHCs facing greater competition. In particular, we modify the regression model in Equation (3) by adding the interaction term between *Bank Exposure* and *Competition*. The interaction between *Bank Exposure* and *Competition* enters negatively and significantly in all specifications. The results hold when using either of the two MD&A disclosure measures. Table 5 results are consistent with the notion that greater competition induces managers to withhold information disclosure due to the potential proprietary costs associated with transparency, thereby aggravating the negative impact of deposit windfalls on information disclosure.

6.3. Heterogeneous Effects, Differentiating by Pre-existing Opacity

We also examine whether the impact of shale exposure on voluntary disclosure varies across BHCs with different levels of preshock opacity. We differentiate by preshock opacity for the following reason. In assessing the expected benefits and costs to voluntary information disclosure, some BHC executives perceive relatively high net costs, whereas others view disclosure more favorably. This will lead to cross-BHC heterogeneity in disclosure prior to the deposit windfalls triggered by shale discoveries. Thus, we use preshale opacity as a signal of the degree to which a BHC's executives are wary of disclosure. To the extent that a BHC already viewed the costs of disclosure as high relative to other banks, we expect that it will be comparatively unresponsive to deposit windfalls. In this regard, we expect the impact of shale discoveries that trigger booms in deposits on bank disclosure to be weaker among banks that were more opaque prior to the boom.

We measure the degree of opacity using *Preopaque*, which is a dummy variable that equals one if a bank's MD&A disclosure length is below the sample median over the preshale-discovery period, 2000–2002, and zero otherwise. We then evaluate the heterogeneous effects of shale exposure on disclosure across BHCs with different degrees of opacity by adding the interaction term between *Preopaque* and *Bank Exposure*.

The estimation results reported in Table 6 show that the disclosure-reducing effects of the shale exposure are weaker among BHCs that have a lower level of voluntary disclosure prior to the shock. As shown, the interaction term, *Bank Exposure × Pre-Opaque*, enters positively and significantly in all columns, whereas the linear term, *Bank Exposure*, enters negatively and significantly. These results suggest that although exposure to shale development on average reduces banks' voluntary information disclosure, the disclosure-reducing effects were less pronounced among banks that were more opaque prior to the shale development shock.

6.4. Voluntary Disclosure in 8-K Filings and Managerial Earnings Forecasts

In this subsection, we examine the other two categories of information-disclosure indicators. We first examine the three measures of information disclosure based on the items within 8-K filings over which managers have considerable discretion (i.e., 8-K filings under items *Reg FD* or *Other Events*): (i) the frequency of voluntary 8-K filings by each BHC during a year (*Voluntary 8-K Frequency*); (ii) the average length, in terms of the number of characters, of a BHC's voluntary 8-K filings (*Voluntary 8-K Length*); and (iii) the absolute value of the cumulative abnormal returns around the release of voluntary 8-K filings (*Voluntary 8K_CAR(−n,+n)*). The first two measures gauge the quantity of disclosure, while the third gauges the impact of information disclosed by managers. We estimate a model specification that is similar to Equation (3),

Table 6. Bank Exposure and MD&A Disclosure, Differentiate by Pre-opacity

	(1)	(2)
Dependent variable	*MD&A Length*	*MD&A Modification*
Bank Exposure × *Pre-Opaque*	0.9949**	0.0846**
	(0.4533)	(0.0345)
Bank Exposure	−0.6354***	−0.1508***
	(0.2250)	(0.0166)
BHC controls	Yes	Yes
BHC fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
N	3,611	2,955
R^2	0.6882	0.5259

Notes. This table presents regression results of banks MD&A disclosure on bank exposure to shale development (*Bank Exposure*) and its interaction with bank opaqueness before the windfall. The dependent variables are *MD&A Length* (column (1)) and *MD&A Modification* (column (2)). *Preopaque* is a dummy variable that equals one if banks' MD&A disclosure length is below sample median over the period 2000–2002, and zero otherwise. BHC controls include *Size*, *BHC size dummies*, *LLP*, *Cap*, *ROA*, and *Tier 1 Capital*. The appendix provides detailed variable definitions. Heteroskedasticity robust standard errors clustered at the BHC level are reported in parentheses.

$^{**}p < 0.05$; $^{***}p < 0.01$.

where the dependent variable now becomes one of the 8-K related measures, and report the results in Table 7.

As shown in Table 7, columns (1) and (2), greater exposure to shale development reduces the *quantity* of information that banks voluntarily disclose via 8-K filings. As shown in columns (1) and (2), *Bank Exposure* enters negatively and significantly in both columns, suggesting that both the frequency and length of voluntary 8-K filings drop among BHCs receiving positive deposit gains from shale development. The impact is economically meaningful. The estimates from columns (1) and (2) indicate that a BHC that receives an exposure shock equal to one-standard-deviation value would reduce *Voluntary 8-K Frequency* and *Voluntary 8-K Length* by 10% and 12.6%, respectively, of their corresponding sample mean values.

Table 7, columns (3) and (4) show that these results also hold when examining *Voluntary 8K_CAR(−n,+n)*, which measures the impact of information disclosed in 8-K filings on market valuations. As shown, greater exposure to shale developments that boosted the supply of deposits reduces the impact of information that bank managers voluntarily disclose on stock returns. We examine the CARs of BHCS within $\pm n$ days (where $n = 1$ or 3) around the announcement of an 8-K filing. As shown in columns (3) and (4), *Bank Exposure* enters negatively and statistically significantly across all specifications. The results are consistent with the view that voluntary 8-K filings become less informative for BHCs exposed more heavily to shale-development shocks. To interpret the economic sizes of the estimated coefficient, consider column (4), where we examine *Voluntary 8K_CAR(−3,3)*. The estimates indicate that *Voluntary 8K_CAR(−3,3)* drops by 1.6% points when a BHC receives a one-standard-deviation increase in exposure, which is 23% of the sample mean of *Voluntary 8K_CAR(−3,3)*.

We next examine the impact of exposure to shale development on information disclosure using measures based on forward-looking earning guidance. As noted in the data section, we use three measures based on earnings guidance: *Managerial Earnings Guidance Frequency* measures how often managers provide information to outsider investors about earning projections; *Managerial Earnings Guidance Precision* measures the precision of managerial earning projections; and *Managerial Earnings Guidance_CAR(−n, n)* measures the impact of earnings-guidance forecasts on the markets. We then use the same regression specification as in Equation (3), except that we use *Managerial Earnings Guidance Frequency*, *Managerial Earnings Guidance Precision*, and

Table 7. Bank Exposure and Voluntary 8-K Filings

	(1)	(2)	(3)	(4)
	Voluntary 8K Frequency	*Voluntary 8K Length*	*Voluntary 8K _CAR(−1,1)*	*Voluntary 8K _CAR(−3,3)*
Bank Exposure	−0.2406**	−1.4240**	−0.0205***	−0.0299***
	(0.1151)	(0.6130)	(0.0038)	(0.0050)
BHC controls	Yes	Yes	Yes	Yes
BHC fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
N	3,611	3,611	3,611	3,611
R^2	0.6772	0.4852	0.5740	0.6013

Notes. This table presents regression results of voluntary 8-K filings on a bank's exposure to shale development (*Bank Exposure*). The dependent variables are *Voluntary 8K Frequency* (column (1)), *Voluntary 8K Length* (column (2)), *Voluntary 8K_CAR(−1,1)* (column (3)), and *Voluntary 8K_CAR(−3,3)* (column (4)). BHC controls include *Size*, *BHC size dummies*, *LLP*, *Cap*, *ROA*, and *Tier 1 Capital*. The appendix provides detailed variable definitions. Heteroskedasticity robust standard errors clustered at the BHC level are reported in parentheses.

$^{**}p < 0.05$; $^{***}p < 0.01$.

Table 8. Bank Exposure and Managerial Earnings Guidance

	(1)	(2)	(3)	(4)
	Managerial Earnings Guidance			
	Frequency	*Precision*	*CAR(−1,1)*	*CAR(−3,3)*
Bank Exposure	−0.0631***	−0.1333***	−0.0202***	−0.0200***
	(0.0220)	(0.0239)	(0.0019)	(0.0024)
BHC controls	Yes	Yes	Yes	Yes
BHC fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
N	1,200	1,200	1,200	1,200
R^2	0.5287	0.3828	0.4868	0.4741

Notes. This table presents regression results of bank managerial earnings guidance on bank exposure to shale development (*Bank Exposure*). The dependent variables are *Managerial Earnings Guidance Frequency* (column (1)), *Managerial Earnings Guidance Precision* (column (2)), *Managerial Earnings Guidance_CAR(-1,1)* (column (3)), and *Managerial Earnings Guidance_CAR(-3,3)* (column (4)) associated with managerial earnings guidance. BHC controls include *Size*, *BHC size dummies*, *LLP*, *Cap*, *ROA*, and *Tier 1 Capital*. The appendix provides detailed variable definitions. Heteroskedasticity robust standard errors clustered at the BHC level are reported in parentheses.

***$p < 0.01$.

Managerial Earnings Guidance_CAR(−n, n) as the dependent variables. These measures improve our analyses by considering additional disclosure measures, including those that address issues of quality (e.g., Hirst et al. 2007 and Einhorn and Ziv 2012).

Consistent with our previous finding, we find that greater exposure to shale development, and the resultant increase the supply of deposits, reduced (a) the frequency of managerial earnings forecasts, (b) the precision of earnings forecasts, and (c) the impact of earnings forecasts on abnormal stock returns. As shown in Table 8, *Bank Exposure* enters negatively and significantly in all specifications. The results hold for each of the measures. The evidence is consistent with the view that unanticipated shale discoveries boosted the supply of bank deposits, increased the degree to which banks rely on deposits for funding, and, therefore, reduced the extent to which banks needed to access capital market funding, and reduced information disclosure by bank managers.

6.5. Extensions

We conduct several additional tests to sharpen the interpretation of the findings. First, we examine an alternative measure of bank exposure to shale development. In an effort to capture deposit windfalls, we use the number of new wells drilled in a county in a year in our core analyses above. This approach is consistent with the fact that shale leases typically involve large initial payments. Because successful wells also typically pay a royalty percentage to landowners, we now examine a measure based on the cumulative number of wells drilled in a country since 2003, although we do not have information on the oil production of individual wells. Specifically, we construct and examine *Bank Exposure (Cumulative Wells)*, which equals $\ln[1 + \sum_j (Wells_{j,2003\ to\ t} * Mktshr_{b,j,t} * 1(Boom_{j,t}))/Branches_{b,t}]$, where $Wells_{j,2003\ to\ t}$ denotes the cumulative number of shale wells drilled in county j since 2003 till t. Other variables are the same as in Equation (1). As shown in Table 9, all of the results hold when using this alternative measure.

Second, we conduct a falsification test. Our interpretation of the results is that shale development in some counties induces an increase in the supply of deposits that is large enough to influence the degree to which banks need to access capital market financing, such that they reduce voluntary information disclosure. If our interpretation is correct, then deposit windfalls induced by shale discoveries will have little or no impact on the capital market financing and disclosure decisions of the largest BHCs. To conduct this test, we re-estimated Equation (3) using a sample of large BHCs. We define large banks as the group of the largest BHCs that are not subsidiaries of other banks during our sample period, that exist as independent legal entities throughout the 2000–2007 period, and that together account for around 90% of total assets over the 2000–2007 period. As shown in Table 10, the results are insignificant among large banks.

Third, there might be concerns that deposit inflows triggered by shale developments bring excess cash flows that enable managers to pursue agendas that they expect will be privately beneficial, but that may harm their banks, inducing managers to reduce voluntary disclosure to hide that bad performance. This agency effect could contribute to the negative association between shale exposure and information disclosure. To test this, we evaluate whether exposure to shale development changes the behaviors of bank insiders in ways that are likely to be privately beneficial, but value-destroying. In particular, we use measures of (a) *Insider Loans*, (b) *Insider Trading*, (c) *Charge-offs*, and (d) the overall performance of a BHC (*Loss*). *Insider Loans* equals the log of the value of credit extended to all executive officers, directors, principal shareholders (and their related interests in a BHC's subsidiaries) as a proportion of total loans. *Insider Trading* equals the log of the frequency of stock transactions conducted by corporate insiders in a year. Insider trading data come from the Thomson Reuters Insider Filings database, where corporate insiders are defined as entities that have "access to non-public, material, insider information," which includes officers, directors, and beneficial owners that hold more than 10% of a firm's equity securities. *Charge-Offs* equals the log of the amount of charge-offs on

Table 9. Alternative Bank Exposure and Disclosure

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	*MD&A Length*	*MD&A Modification*	*Voluntary 8K Frequency*	*Voluntary 8K Length*	*Managerial Earnings Guidance Frequency*	*Managerial Earnings Guidance Precision*
Bank Exposure (Cumulative Wells)	−0.5213**	−0.1096***	−0.2204**	−1.2188**	−0.0617***	−0.1218***
	(0.2185)	(0.0277)	(0.1016)	(0.4962)	(0.0226)	(0.0220)
BHC controls	Yes	Yes	Yes	Yes	Yes	Yes
BHC fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
N	3,611	2,955	3,611	3,611	1,200	1,200
R^2	0.6882	0.5257	0.6773	0.4852	0.5288	0.3829

Notes. This table presents regression results of banks' MD&A disclosure (columns (1) and (2)), voluntary 8-K filings (columns (3) and (4)), and bank managerial earnings guidance (columns (5) and (6)) on banks' cumulative exposure to shale development. *Bank Exposure (Cumulative Wells)* is defined similarly to *Bank Exposure*, except for using the cumulative number of shale wells drilled in county *j* since 2003 till *t*. BHC controls include *Size*, *BHC size dummies*, *LLP*, *Cap*, *ROA*, and *Tier 1 Capital*. The appendix provides detailed variable definitions. Heteroskedasticity robust standard errors clustered at the BHC level are reported in parentheses.

$^{**}p < 0.05$; $^{***}p < 0.01$.

allowance for loan and lease losses as a proportion of total loans. *Loss* is a dummy variable that equals one if net income is negative, and zero otherwise. As shown in Table A3 in the online appendix, we do not find a significant increase in insider activities or decrease in bank performance after a BHC receives a shale shock.

Fourth, we were also concerned that other forms of information might substitute for voluntary disclosure, such as analyst coverage, media analyses, or the degree to which the big-4 auditing firms cover a bank. We engage in two types of analyses to address this concern. First, as shown in Table A4 in the online appendix, our main findings are robust to further controlling for *Analyst Coverage* and *Big 4 Auditors*. *Analyst Coverage* equals the log of the number of analysts following a BHC. *Big 4 Auditors* is an indicator that equals one if the BHC hires one of the big-4 auditing companies, and zero otherwise. Data on analysts and auditors are retrieved from the Institutional Brokers' Estimate System and Audit Analytics, respectively. In the second type of analysis to address the concern that alternative information sources substitute for voluntary disclosure, we redo the analyses while replacing the dependent variable that measures voluntary disclosure with *Analyst Coverage*, *Media Coverage*, *Earnings News*, or a measure of abnormal accruals of loan loss provisions (*Discretionary LLP*) used in Jiang et al. (2016). Both *Media Coverage* and *Earnings News* are constructed by using data from RavenPack News Analytics. For any news story that mentions a firm, RavenPack assigns a relevance score between 0 and 100, in which higher values indicate that the news item is more directly relevant to and focused on the firm. For example, a score of 0 means the firm is passively mentioned, whereas a score of 100 means the firm is the key feature of the news item. *Media Coverage* equals the log of the number of news items with a relevance score of 100, excluding corporate press releases scaled by total assets. *Earnings News* equals the log of the number of news items related to earnings, revenues,

Table 10. Bank Exposure and Disclosure, Large BHCs

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	*MD&A length*	*MD&A modification*	*Voluntary 8K frequency*	*Voluntary 8K length*	*Frequency*	*Precision*
Bank Exposure	−2.3513	−1.4469	−2.9524	5.3202	−3.4368	−1.7280
	(2.4440)	(0.9531)	(2.7723)	(8.4967)	(2.1043)	(2.8381)
BHC controls	Yes	Yes	Yes	Yes	Yes	Yes
BHC fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
N	521	497	521	521	379	379
R^2	0.7395	0.5488	0.6937	0.4595	0.5301	0.3219

Notes. This table presents regression results of large banks MD&A disclosure (columns (1) and (2)), voluntary 8-K filings (columns (3) and (4)), and bank managerial earnings guidance (columns (5) and (6)) on bank exposure to shale development. The sample consists of large U.S. public BHCs that account for around 90% of total assets over the 2000–2007 period. The key explanatory variable, *Bank Exposure*, is the BHC-specific measure of the extent to which a BHC is exposed to shale-drilling activities. BHC controls include *Size*, *BHC size dummies*, *LLP*, *Cap*, *ROA*, and *Tier 1 Capital*. Heteroskedasticity robust standard errors clustered at the BHC level are reported in parentheses.

and dividends as a proportion of the total number of news items about the firm. As loan-loss provisions are a major mechanism through which banks manage earnings and regulatory capital, *Discretionary LLP* measures the overall quality of bank disclosure and is calculated as the log of the absolute value of residuals predicted from Equation (1) in Jiang et al. (2016). As shown in Table A5 in the online appendix, we do not find a significant impact of the shale shock on these other forms of information disclosure. Taken together, these analyses reduce the concern that other sources of information about BHCs are substituting for voluntary information disclosure.

7. Conclusions

In this study, we evaluate the impact of an economic shock—a shock that triggered a surge in bank reliance on deposits and a corresponding reduction in banks' dependence on external capital markets—on banks' voluntary disclosure of information. In particular, we exploit the unanticipated technological innovations at the close of 2002 that made fracking economically profitable. This shock triggered a boom in shale development, a surge in bank deposits in affected counties, and a reduction in the extent to which banks in those counties issue stocks and bonds in public markets. We examine whether this relaxation of external funding constraints altered the cost–benefit calculations of bank managers with respect to voluntary information disclosure in theoretically consistent ways. That is, exploiting bank-specific exposure to the shale-development booms, we assess the impact of the fracking-induced funding shocks on voluntary information disclosure.

We discover the following. First, banks with greater exposure to shale development (a) increased their reliance on deposits and (b) decreased the interest rate on deposits. These findings suggest that the increase in bank deposits from the shale boom represents a shock to the supply of deposits, and not a shift in demand. Second, banks with greater exposure to shale booms reduced their issuance of securities in capital markets. These findings are consistent with the view that deposit windfalls relax a bank's external funding constraints and, therefore, lower the benefits to bank managers of voluntarily releasing information to facilitate the issuances of securities in capital markets. Third, greater exposure to shale development is associated with reductions in the voluntary disclosure of information. Fourth, consistent with the view that bank managers weigh specific benefits and costs of voluntarily releasing information to the public, we find that greater exposure to shale booms reduces voluntary information disclosure more (a) among banks in more competitive environments and (b) among banks with a greater ex ante level of opacity. Thus, our findings indicate that economic shocks that lead to a deposit boom and reduce banks' usage of external capital markets tend to reduce voluntary information disclosure.

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Appendix. Variable Definition

Variable name	Definition and source
Bank Exposure	For each bank b in year t, we compute: $\ln[1+\sum_j (Wells_{j,t} * Mktshr_{b,j,t} * 1(Boom_{j,t}))/Branches_{b,t}]$, where b, j, and t denote bank, county, and year, respectively. $Wells_{j,t}$ equals the number of shale wells drilled in county j in year t. $Mktshr_{b,j,t}$ equals the share of total deposits in county j in year t held by bank b, i.e., the market share of bank b in county j in year t. $Branches_{b,t}$ equals the total number of branches owned by BHC b in year t across the United States. Source: IHS Markit Energy, FDIC's Summary of Deposits.
Bank Exposure (Cumulative Wells)	For each bank b in year t, we compute: $\ln[1+\sum_j (Wells_{j,2003\ to\ t} * Mktshr_{b,j,t} * 1(Boom_{j,t}))/Branches_{b,t}]$, where b, j, and t denote bank, county, and year, respectively. $Wells_{j,2003\ to\ t}$ equals the cumulative number of shale wells drilled in county j over the period from 2003 through year t. Other variables are the same as before. Source: IHS Markit Energy, FDIC's Summary of Deposits.

Appendix. (Continued)

Variable name	Definition and source
MD&A Length	The length of the Management's Discussion and Analysis sections in 10-K filings, which equals Ln(1+ # of words in the MD&A section of 10-K filings in year *t*). Source: SEC EDGAR
MD&A Modification	The modification aspect of MD&A disclosure, which equals Ln(1+ MD&A modification score). MD&A modification score equals one minus the similarity score from comparing MD&A section for year t with year $t-1$, multiplied by 100. The similarity score is calculated using the Vector Space Model with term frequency weighting after common words are removed. Common words are identified as words used in at least 95% of the sample documents. *MD&A Modification* measures the degree to which MD&A disclosure changed from year $t-1$ to year t. Source: SEC EDGAR
Voluntary 8K Frequency	The logarithm of one plus the total number of 8-K filings reported under items Reg FD and Others. Source: SEC EDGAR
Voluntary 8K Length	The logarithm of one plus the average length (in characters) of the 8-K filings reported under items Reg FD and Others. Source: SEC EDGAR
Voluntary 8K_CAR(−n, n)	Measures the market reaction to the release of voluntary 8-K filings, and equals the $\pm n$ day absolute value of the cumulative abnormal return around the announcement day, where $n = 1$ or 3. We estimate daily abnormal stock returns using a standard market model with an estimation window of $[t-200, t-21]$, where t denotes the 8-K announcement date. Source: SEC EDGAR, CRSP
Managerial Earnings Guidance Frequency	Ln(1+ # of management earnings forecasts issued during a given year). Source: Company Issued Guidance from the First Call Historical Database
Managerial Earnings Guidance Precision	The average precision score of management earnings forecasts issued by a bank in a year. The precision score equals 1 for a point estimate (the most precise), 0.75 for a range estimate, 0.5 for an open-ended estimate, 0.25 for a qualitative estimate, and 0 for no forecast (the least precise). Source: Company-Issued Guidance from the First Call Historical Database
Managerial Earnings Guidance_CAR(−n, n)	The $\pm n$ day absolute cumulative abnormal return around the announcement of a corporate earnings guidance disclosure, where $n = 1$ or 3. We estimate daily stock abnormal returns using a standard market model with an estimation window of $[t-200, t-21]$, where t denotes the date of issuing guidance. Source: Company Issued Guidance from the First Call Historical Database, CRSP
Size	The natural logarithm of total assets in million \$. Source: FRY-9C
LLP	Loan loss provision scaled by beginning-of-period total loans (in percentage). Source: FRY-9C
Cap	Book value of equity over total assets (in percentage). Source: FRY-9C
ROA	Net income scaled by total assets (in percentage). Source: FRY-9C
Tier 1 Capital	Tier 1 (core) capital scaled by risk-weighted assets (in percentage). Source: FRY-9C
BHC size dummies	Four bank-size indicators with each indicator representing bank size falls within 0–25 percentile, 25–50 percentile, 50–75 percentile, and 75–100 percentile in the sample. Source: FRY-9C
Time Deposits and CDs/Total Assets	The annual average ratio of interest-bearing deposits to the book value of total assets, where interest-bearing deposits include time deposits, CDs, and other interest-bearing deposits. Source: FRY-9C
Demand Deposits/Total Assets	The annual average ratio of demand deposits to the book value of total assets. Source: FRY-9C
Total Deposits/Total Assets	The sum of *Time Deposits and CDs/Total Assets* and *Demand Deposits/Total Assets*. Source: FRY-9C
Cost of Deposits	Interest expense over a year divided by the annual average of total interest-bearing deposits. Source: FRY-9C

Appendix. (Continued)

Variable name	Definition and source
Bond & Equity Issuance Frequency	The log of one plus the total number of bond & equity issuance averaged over $t+1$ to $t+5$, where t denotes the year of the shock. Source: Global New Issues Databases in SDC Platinum
Bond & Equity Issuance Amount	The logarithm of one plus the dollar amount (in millions) of bond and equity issuance average over $t+1$ to $t+5$, where t denotes the year of the shock. Source: Global New Issues Databases in SDC Platinum

Endnotes

[1] See https://www.fdic.gov/consumers/banking/facts/priority.html.

[2] It is worth noting that, although banks are subject to separate disclosure requirements, these disclosure requirements were not changed during our sample period. In particular, the SEC issued *Industry Guide 3*, "Statistical Disclosure by Bank Holding Companies," in 1976 and revised it substantially in 1986. It was not changed, however, until the fall of 2020, as reported in Reuters (https://tax.thomsonreuters.com/news/sec-overhauls-bank-disclosure-requirements/). Thus, while these bank SEC disclosure requirement could shape the differential disclosure decisions of banks relative to nonbanks, the fact that these requirements did not change during the estimation period, plus the inclusion of year fixed effects in our analyses, suggests that changes in SEC disclosure requirements facing banks do not account for our findings.

[3] By reducing adverse selection and moral hazard problems, information disclosure can have positive repercussions on bank operations (e.g., Ertan et al. 2017 and Balakrishnan and Ertan 2018).

[4] The overall impact of competition on transparency is unsettled. When the costs of entering a market fall, existing firms might use disclosure to discourage firms from entering the market (e.g., Darrough and Stoughton 1990). In banking, Jiang et al. (2016) find that an intensification of competition induced banks to become more transparent, and Burks et al. (2018) find that greater competition spurred banks to increase press releases with negative news to dissuade potential entrants.

[5] The VSM model uses an n-dimensional vector to represent a document. It measures the similarity of any two documents by the angle between the two vectors representing the two documents. Specifically, consider a sample with n unique words, the VSM approach represents two documents using an n-dimension vector—v_1 for document 1 and v_2 for document 2, where $v_1 = (\tau_1, \tau_2, \ldots \tau_{n-1}, \tau_n)$, $v_2 = (\rho_1, \rho_2, \ldots \rho_{n-1}, \rho_n)$, and τ_i and ρ_i are counts of each word $i \in (1, n)$. The similarity score is defined as follows: Similarity score $= \cos(\theta) = \frac{v_1}{\| v_1 \|} \cdot \frac{v_2}{\| v_2 \|}$, where θ denotes the angle between v_1 and v_2, and $\|v_1\|$ and $\|v_2\|$ represent the vector length of v_1 and v_2.

[6] These results are robust to double clustering at the BHC and year levels.

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