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What Drives Banks' Geographic Expansion? The Role of Locally Non-Diversifiable Risk

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What drives banks' geographic expansion? The role of locally non-diversifiable risk*

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Abstract

We show that banks that are facing relatively high locally non-diversifiable risks in their home region expand more across states than banks that do not face such risks following branching deregulation in the 1990s and 2000s. These banks with high locally non-diversifiable risks also benefit relatively more from deregulation in terms of higher bank stability. Further, these banks expand more into counties where risks are relatively high and positively correlated with risks in their home region, suggesting that they do not only diversify but also build on their expertise in local risks when they expand into new regions.

Keywords: banking, geographic expansion, deregulation, locally non-diversifiable risk, catastrophic risk
JEL Classification: G21, G28

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1 Introduction

We explore why some banks expand geographically while others do not and which regions banks select for their expansion. While it is sometimes assumed in related studies that local risks are a determinant of banks' geographic expansion, it has not been, to our knowledge, directly tested before. A large amount of literature examines whether banks' geographic expansion increases or reduces bank risk (e.g., Chong, 1991; Demsetz and Strahan, 1997; Goetz, Laeven, and Levine, 2016). One major challenge that this literature faces is that both risk-taking and whether or not a bank responds to deregulation by geographic expansion are endogenous to the bank and may be driven by some common unobserved factors. Empirically, only some banks choose to open operations in other regions, and this choice may be interrelated in a myriad of ways with the choice of the bank regarding how much risk to take. In this paper, we take advantage of an exogenous source of locally non-diversifiable risk to the bank: local natural disasters. We combine this exogenous source of risk with the staggered process of branching deregulation in the United States during the 1990s and 2000s in order to cleanly identify an important motivation behind banks' geographic expansion activities.

Our key findings are as follows: banks facing a high level of locally non-diversifiable risk in their home market expand significantly more into other states than banks that face a low level of such risk. Accordingly, these banks with high locally non-diversifiable risks become relatively more geographically diversified when entry barriers into others states were lowered following the Interstate Banking and Branching Efficiency Act of 1994 (IBBEA or Riegle-Neal Act). They also increase their stability compared with banks that have low locally non-diversifiable risks, as reflected in relative increases in bank z-scores following deregulation. Further, our evidence shows that banks with high locally non-diversifiable risks favor counties where locally non-diversifiable risks are positively correlated with the risks in their home market (controlling for distances between counties).

This suggests that these banks do not only diversify, but they also rely on their expertise in local risks when they expand into other regions. Our study thus provides new evidence that the effect of branching deregulation in the United States in the 1990s and 2000s depended on banks' exposures to locally non-diversifiable risk in their business regions.

Our identification strategy relies on several data sources. Data from the FDIC's Summary of Deposits database allows us to identify the regional spread of banks' branching networks and to calculate banks' out-of-state geographic expansion by year. Based on this bank branching data and data on disaster damages from the Spatial Hazard Events and Losses Database for the United States (SHELDUS), we calculate for each bank its exposure to natural disasters in its business region, which is our proxy for locally non-diversifiable risk to the bank. Further, we use yearly data by state on the staggered deregulation process following the Riegle-Neal Act of 1994, which created new opportunities for banks' geographic expansions (Johnson and Rice, 2008; Rice and Strahan, 2010). We use bank financial data from the FDIC and regional economic data from the Bureau of Economic Analysis to control for further bank and regional characteristics in our regressions. We also control for the distance between the county where a bank has its headquarters and out-of-state counties where the bank may open new branches. Finally, unobserved bank characteristics and regional economic developments are captured by fixed effects. The empirical approach allows us to control for confounding factors and to identify the banks' decisions regarding whether to expand out-of-state using two exogenous variables: local disaster risk and the relaxation of bank branching restrictions following the Riegle-Neal Act of 1994.

Our paper is related to different strands of literature. The theoretical and empirical literature on bank risk-taking strongly emphasizes the role of (geographic) diversification for banks' lending decisions and bank risk (Winton, 1997; Demsetz and Strahan, 1997; Acharya, Hasan, and Saunders, 2006; Winton, 2000; Deng and Elyasiani, 2008; Loutskina and Strahan, 2011). For example, Loutskina and Strahan (2011) show that if banks diversify geographically, their screening efforts and profits are lower, which makes them more vulnerable during the financial crisis of 2008-09. Goetz, Laeven, and Levine (2016) analyze whether the geographic expansion of U.S. bank holding companies' affects their risk. By modeling the entry decisions of bank holding companies into other metropolitan areas using banking market deregulation as an instrument, they find that geographical expansion reduces the risk of multi-bank holding companies, although it does not enhance loan quality. Other related papers on banks' geographic expansion include Chong (1991); Berger and DeYoung (2001); Akhigbe and Whyte (2003); Emmons, Gilbert, and Yeager (2004); Carlson and Mitchener (2009); Meslier et al. (2016). While these papers provide evidence on the effects of geographic expansion on bank risk, our paper explores the role of risk as a determinant of geographic expansion.

More generally, our paper contributes to the literature on the effects of banking deregulation in the United States. For the intrastate branching deregulation in California in the 1920s, Carlson and Mitchener (2009) show that the state-wide branching efforts of banks increase the stability of unit banks and make them more resilient during the Great Depression. In contrast to these positive effects from within-state branching deregulation, Keeley (1990), Jayaratne and Strahan (1998) and Gan (2004) show that the liberalization of banking regulation during the 1970s and 1980s led to higher competition, lower charter values and subsequently higher risk-taking and profits on behalf of banks. In a recent study, Goetz (2018) challenges this result by showing that bank stability increases as a consequence of higher market contestability triggered by the deregulation efforts from the 1980s and 1990s. Moreover, Brook, Hendershott, and Lee (1998) provide evidence for beneficial consolidation in the banking industry following the deregulation act of 1994. Further, Goetz, Laeven, and Levine (2013) show that valuations of bank holding companies were negatively affected by the deregulation phase during the 1990s. Black and Strahan (2002) find that the deregulation of geographical restrictions on bank expansion in the 1990s and 2000s led to a higher rate of business incorporations, while Rice and

Strahan (2010) show that it also led to lower loan rates for small- and medium-sized enterprises. In this literature, the liberalization of banking regulation is primarily viewed as a cause for higher competition among banks in their home markets. Further, the literature shows that a more integrated banking system in the United States, which resulted from banks' out-of-state expansion following interstate deregulations, reduced economic volatility within states and economic divergence between states (Morgan, Rime, and Strahan, 2004). Hence, banking deregulation may have important economic effects. We are interested in a complementary aspect of such deregulation, namely, why some banks expand geographically in response to deregulation and others do not, which helps us to better understand the relation between banks' geographic expansion and risk.

This paper also contributes to a growing body of literature that analyzes consequences of catastrophic risks on banking. Garmaise and Moskowitz (2009) use the 1994 Northridge earthquake in California to show that earthquake risk impacts credit markets through a more than 20 % decreased provision of commercial real estate loans. Cortes and Strahan (2017) show that banks operating in many regions reallocate capital when local credit demand increases after natural disasters. Chavaz (2016) finds that lenders that had very concentrated portfolios in markets affected by the 2005 hurricane season increased lending through loan sales. Koetter, Noth, and Rehbein (2019) investigate the 2013 Elbe flood in Germany and find that banks with relationships to flooded firms significantly increase lending and have a higher profitability and lower risk. Noth and Schüwer (2018) show that weather-related natural disasters weaken the stability of U.S. banks. Schüwer, Lambert, and Noth (2019) find that banks that were exposed to Hurricane Katrina in 2005 react to the shock by increasing their risk-based capital ratios. Our paper adds to this literature by showing a further strategy of banks regarding how to react to catastrophic risk: geographic expansion.

2 Background information on interstate bank branching (de-)regulation

Banking in the United States was geographically restricted for a long time during the twentieth century. This was a result of the McFadden Act of 1927 and other laws that attempted to address long-standing concerns about the concentration of financial activity and worries that large banking organizations operating in multiple states could not be adequately supervised. Following a long period of high stability in the banking industry, many of these restrictions were abolished during the 1970s, 1980s and 1990s.

Our study focusses on the removal of many of the restrictions on opening bank branches across state lines through the Interstate Banking and Branching Efficiency Act of 1994 (IBBEA or Riegle-Neal Act). The key event of IBBEA was the permission of interstate branching, which was largely restricted prior to the act, and complemented previous legislation during the 1970s and 1980s that deregulated interstate banking and intrastate branching.

Following the passage of IBBEA in 1994, each state had to deregulate its banking market in some form, but there was much leeway regarding how and when to do this. In particular, states were allowed to curb deregulation by restricting entry based on four measures: they could prohibit *de novo* interstate branching, they could prohibit acquisitions of single branches, they could require a minimum age of institutions for acquisitions of up to five years, and they could require a statewide deposit cap on branch acquisitions of up to 30%. States were also allowed to opt-out of interstate branching altogether, but this was only used by Texas and Montana in 1995, before they decided to op-in in 1999 and 2001, respectively. Hence, the timing and intensity by which each state opened its banking market differed widely between states (Johnson and Rice, 2008; Rice and Strahan, 2010; Goetz, 2018).

Some states applied reciprocity conditions, which allowed branching by an out-of-state bank only when the laws of the other state permitted the same level of interstate branching. For example, the 1999 Texas interstate branching laws allowed de novo interstate branching and acquisitions of single branches only with reciprocity. Oklahoma did the same in 2000, also with reciprocity. New Mexico, however, did not allow de novo interstate branching or single acquisitions by out-of-state banks. Hence, banks from Oklahoma have had the opportunity to branch into Texas since 2000, but banks from New Mexico did not.

An important element of the 1994 Riegle-Neal Act is Section 109, which requires that a bank complies with minimum statewide loan-to-deposit ratios in each state where it establishes or acquires a branch outside its home state. The idea of this regulation is that banks are prohibited from using out-of-state branches primarily for the purpose of deposit production. Based on this regulation, banks that establish or acquire out-of-state branches must also expand their out-of-state loans.

Our identification strategy uses the information if a state allowed de novo branching or acquisition of single branches (with or without reciprocity). Table 1 documents these rules for each state between 1994 and 2007. Finally, although it is beyond the scope of our study, it is woth mentioning that the Dodd-Frank Act of 2010 (Section 613) removed all restrictions on branching into any other state.

[Table 1 around here]

3 Identification Strategy and Data

3.1 Identification strategy

We explore why some banks expand geographically while others do not. In particular, we are interested in the role of bank risk as a determinant for banks' decisions to expand into new regions when deregulation of interstate branching created new expansion opportunities. A major challenge for our empirical analysis is to identify a causal relation between bank risk and whether or not a bank expands geographically. Both bank risk and geographic expansion are endogenous to a bank's strategy and may be driven by some common unobserved factors.

Our identification strategy is based on an exogenous source of *locally non-diversifiable risk to the bank*: local natural disasters. We combine this exogenous source of risk with the staggered process of bank branching deregulation in the United States during the 1990s and 2000s in order to cleanly identify the motivation behind banks' geographic expansion activities.

Our measure of locally non-diversifiable risk uses data on property damages in each county across the United States since 1969. For each bank, we calculate the average long-term disaster damage in its business region. We find a large variation across the United States regarding how U.S. counties and banks are affected by disaster risk. The distribution of long-term disaster damage by county (see Section 3.3 for more details), is illustrated in Figure 1. As the figure shows, some counties face only minor disaster damages on average (light colors), while other counties face a relatively high amount of disaster damages (dark colors). In particular, counties in the U.S. Gulf Coast region (e.g., the 2005 Hurricanes Katrina, Rita and Wilma) and in some regions of California (e.g., the 1994 Northridge earthquake) face relatively high disaster risk. Importantly for our study, natural disasters are not restricted to a few regions, but occur across the United States. For example, counties in New Mexico experienced the 2000 Cerro Grande Fire, a disastrous forest fire with damages amounting to more than US$ 1 billion, and counties in North Dakota were affected by the 1997 Red River flood, which caused damages amounting to more than US$ 2 billion. Our general conclusion from Figure 1 is that there is considerable variation in disaster damages across the United States.

[Figure 1 around here]

Our measure for bank branching deregulation, which we refer to as *expansion opportunities*, uses information about the first time a state allowed banks from other states to enter via de novo branches or acquisitions of single branches. Prior to this deregulation, geographic expansion into other states was not impossible. For example, banks may have been able to expand across states through a multi-state bank holding company. Nevertheless, geographic expansion before deregulation was significantly more costly and complex. Hence, the permission to open de novo branches or to acquire single branches significantly lowered entry barriers into other states (Johnson and Rice, 2008; Rice and Strahan, 2010). Figure 2 illustrates which states passed more open or more restrictive laws in white and gray colors, respectively.

[Figure 2 around here]

We identify whether banks' geographic expansion following new expansion opportunities depends on banks' exposures to locally non-diversifiable risk in their business region. Figure 3 illustrates our identification strategy.

[Figure 3 around here]

We use two different measures for geographic expansion: the share of out-of-state branches, $\text{EXP}^B_{i,s,t}$, and the share of out-of-state deposits, $\text{EXP}^D_{i,s,t}$. Each measure represents the geographic expansion of bank i, which resides in home state j, into neighboring state s in year t. We then estimate the following model:

$$EXP_{i,s,t} = \alpha_i + \nu_{j,t} + \tau_{s,t} + \beta_1 OPP_{j,s,t} + \beta_2 \text{LND-RISK}_{i,t} + \beta_3 \left(OPP_{j,s,t} \times \text{LND-RISK}_{i,t}\right) + \gamma_1 Distance_{h,s} + \gamma_2 Size_{i,t-1} + \gamma_3 Equity_{i,t-1} + \epsilon_{i,s,t}, \quad (1)$$

where $\text{EXP}_{i,s,t}$ stands for either $\text{EXP}^B_{i,s,t}$ or $\text{EXP}^D_{i,s,t}$. Bank fixed effects, α_i, control for differences in banks' business models and all other time-invariant factors that may affect a bank. Further, we take into account developments in each home state and potential host state by including *home-state*×*year* fixed effects, $\nu_{j,t}$, and *host-state*×*year* fixed effects, $\tau_{s,t}$, in the regression model. These fixed effects take into consideration that the timing of branching deregulation across states was not random, but affected by the interests of different groups such as large banks (pro deregulation) and small banks (against deregulation), as shown by Kroszner and Strahan (1999).

The variable $\text{OPP}_{j,s,t}$ represents expansion opportunities following the deregulation of branching restrictions, where the variable takes a value of 1 if entry via de novo branches or acquisitions of single branches is allowed for banks in state j towards state s following the staggered deregulation at state level in year t, and 0 otherwise. It is determined by policymakers in the banks' neighboring states, and not by policymakers in the banks' home states (apart from effects of reciprocity provisions), which mitigates concerns that banks could affect changes in OPP.

The variable $\text{LND-RISK}_{i,t}$ is our proxy for a bank's locally non-diversifiable risk and represents the bank's disaster risk perceived in year t (long term average disaster damages until year t). The variable $\text{Distance}_{h,s}$ reflects the average distance between a bank's home county h and counties in host state s, which typically plays an important role in a bank's decision regarding whether to expand into state s (e.g., Deng and Elyasiani, 2008; Goetz, Laeven, and Levine, 2016). The lagged variables $\text{Size}_{i,t-1}$ and $\text{Equity}_{i,t-1}$ control for time-variant bank characteristics, namely, banks' logs of total assets and total equity ratios. Standard errors are clustered at the bank-host state level.[1]

We are most interested in the differential effect β_3, i.e. the coefficient of the interaction term OPP×LND-RISK, which tells us whether banks' geographic expansion following new expansion opportunities through the interstate branching deregulation in the 1990s and 2000s depends on banks' exposures to locally non-diversifiable risks in their business

[1]We also check several alternative ways to cluster the standard errors, as discussed in the robustness section.

region. Hence, the interpretation of our regression results always focuses on the differences between the effects of expansion opportunities on actual bank expansion for banks with high locally non-diversifiable risks and banks with low locally non-diversifiable risks.

Furthermore, it is important to note that home-state×year and host-state×year fixed effects capture the effects of deregulation on our dependent variables in the home state and host state. The variation in OPP that remains for the coefficient of the single term OPP comes from the reciprocity provisions in the respective state laws. For example, Arizona allowed acquisitions of single branches in 2001 with reciprocity, which created new expansion opportunities for banks from Utah (where this was already allowed in 1995), but not for banks from New Mexico (where interstate branching restrictions were not deregulated until the 2010 Dodd-Frank Act).

We illustrate the identification strategy in Figure 4, which shows four stylized states (A to D) and banks' headquarters (rectangles) and their branches (circles) therein. Each state comprises regions with high locally non-diversifiable risk (gray-shaded areas) and regions with low locally non-diversifiable risk (white areas). We differentiate between high LND-risk banks (black-filled rectangles) and low LND-risk banks (white-filled rectangles). In our stylized example, State A does not allow for out-of-state branching regulation, while State B allows out-of-state branching with neighboring State D, which has also allowed branching by banks from other states. In terms of Figure 4, our fixed effects regression from Equation (1) estimates whether the high-risk bank from State B is more likely than the low-risk bank (also from State B) to expand in State D as a consequence of the liberalization efforts between State B and D.

[Figure 4 around here]

3.2 Sample description

The sample covers banks with a headquarters in 49 states of the United States (excluding Hawaii) and the District of Columbia during the period 1994 to 2007.[2] We focus on banks with assets in 1994 of at least US$ 250 million,[3] because our data show that small banks are generally not willing or capable of expanding across state borders (see the evidence presented in Figure 5). Further, we exclude banks if the location of their headquarters changes from one state to another during the sample period. We drop observations if the information on variables we employ in our analysis is missing. We use bank-level data and not consolidated bank holding company data because the regulatory change that we use for identification, i.e. the deregulation of geographic branching restrictions through the Riegle-Neal Act of 1994, primarily affected the bank level and not the bank holding company level.[4] This leads to a sample that contains 1,385 banks.

The sample structure and the number of observations depend on the regional scope of the analysis. First, when we explore banks' out-of-state expansions into neighboring states, we use a sample on the bank-state-year level that includes 50,283 observations. Second, when we explore the role of county-specific risks for banks' out-of-state expansions, we use a sample on the bank-county-year level that includes 1,969,759 observations. An overview of all variables used in this paper is provided in Table 2. Summary statistics are shown in Table 3.

[Table 2 and Table 3 around here]

[2]The beginning of the sample period is 1994 because this is the first year when data on bank branching is available from the FDIC's Summary of Deposits. The end of our sample is 2007 because this represents a sufficiently long period the deregulation became effective, and we want to exclude the turmoil from the financial crisis.

[3]The US$ 250 limit mirrors the threshold used by the FDIC (2012) in the late 1980s to define community banks.

[4]We also analyze the role of bank holding companies in Section 4.4.

3.3 Variables

Geographic expansion. We use alternative measures for bank geographic expansion as dependent variables in order to explore banks' expansion strategies following the Riegle-Neal Act of 1994. Our first variable for the geographic expansion of banks is EXP^B, which measures a bank's share of branches outside that bank's home state. The calculation of this measure is based on annual data since 1994 from the Summary of Deposits of the FDIC:[5]

$$EXP^B_{i,s,t} = \frac{\text{number of out-of-state branches of bank i in state s in year t}}{\text{number of total branches of bank i in year t}}.$$

Next, we consider that different branches may be more or less important within the branching network of a bank. The following measure uses the amount of deposits per branch as a proxy for its relative importance:

$$EXP^D_{i,s,t} = \frac{\text{amount of out-of-state deposits of bank i in state s in year t}}{\text{amount of total deposits of bank i in year t}}.$$

As a first indication of a bank's geographic expansion following deregulation in 1994, consider Figure 5. The graphs on the left show the developments for the sample of medium and large banks (assets in 1994 of at least US$250 million), which is used in the regression analysis. The upper left graph illustrates the number of banks with or without out-of-state branches. First, we can observe that the overall number of banks decreases over this period of time, which reflects the merger and acquisition wave in the banking industry during the 1990s and 2000s. Second, we observe that the number of banks that expand out-of-state increases over the sample period, especially until around 2000 when most of the state-level branching deregulation had taken place. The middle left graph shows the development of the average share of banks' out-of-state branches relative to their total

[5] Internet source: www2.fdic.gov/sod/.

branches (EXP^B) for the same sample. Furthermore, the graph separates between banks that are facing relatively high locally non-diversifiable risks, denoted as high LND-risk banks (above the median of LND-RISK, which is explained in detail below) and banks that are facing relatively low locally non-diversifiable risks, denoted as low LND-risk banks (below the median of LND-RISK). The bottom left graph is similar, but shows the development of the average share of banks' out-of-state deposits relative to their total deposits (EXP^D) on the y-axis. Overall, the graphs show a significant increase in geographic expansion (out-of state branching and deposits) following interstate branching deregulation in 1994, and also give a preliminary indication that banks facing relatively high locally non-diversifiable risks expand more actively out-of-state than banks facing relatively low locally non-diversifiable risks.

The graphs on the right in Figure 5 show the developments for the sample of small banks (assets in 1994 below US$250 million). As we can see, geographic expansion in terms of the number of banks with out-of-state branches, the share of out-of-state branches or the share of out-of-state deposits is relatively small. This suggests that small banks were generally not willing or capable of expanding across state borders following deregulation in 1994. Hence, a first noteworthy finding of our analysis is that small banks generally did not take advantage of the opportunities to diversify presented to them by the deregulation of the 1990s and 2000s.

[Figure 5 around here]

Expansion opportunities. We construct a variable OPP for each bank to approximate the extent of opportunities that a bank with its headquarters in state j has to expand into neighbor state s in year t, following the passage of the Interstate Banking and Branching Efficiency Act of 1994. Note that OPP may be different for banks from different home states j that consider expanding into state s in year t because of the respective reciprocity conditions. The variable is defined as follows:

$$OPP_{j,s,t} = \begin{cases} 1 & \text{, if entry is allowed via de novo branches} \\ & \text{ or acquisitions of single branches} \\ \\ 0 & \text{, otherwise} \end{cases}$$

Figure 6 illustrates the average value of OPP between 1994 and 2007. The value is close to zero in 1994, when only Alaska allowed out-of-state banks to enter via acquisition of single branches; it then rises to around 0.45 in 1997, when all states had passed some form of legislation according to the act; and it further rises to about 0.55 up until 2007. The changes between 1997 and 2007 are due to revised legislation at the state level. For example, Illinois passed rather restrictive legislation in 1997, which prohibited de novo branching and acquisitions of single branches, and introduced more liberal legislation in 2004.

[Figure 6 around here]

Banks' locally non-diversifiable risks. Our proxy for banks' locally non-diversifiable risks (LND-RISK) is based on a measure of long-term disaster damages at the county level, and information about the banks' activities in each county. The idea is that borrower property (loan collateral) is destroyed by natural disasters, which negatively affects banks' non-performing assets and, hence, bank performance and bank stability (see Noth and Schüwer, 2018). Bank managers are generally aware of the disaster risk in their business region, and they may update their perception of this risk each year.[6] Specifically, we calculate LND-RISK$_{i,t}$ as the average long-term disaster damage in all counties c of bank i's business region until year t (LND-CountyRISK$_{c,t}$), using the bank's activities in each

[6]The proxy for banks' locally non-diversifiable risks (LND-RISK) uses average disaster risks over more than 25 years (1969 to year t, which is from 1994 to 2007), such that each new year implies only minor changes in LND-RISK, unless new disaster damages are huge. In robustness regressions, we calculate LND-RISK based on average disaster damages from 1969 to 1994 (without updating), and show that our results are stable when variations of LND-RISK over time are excluded.

county c in the year of the Riegle-Neal-Act (1994) as weights:

$$\text{LND-RISK}_{i,t} = \sum_{c=1}^{C} \text{LND-CountyRISK}_{c,t} \times \frac{\text{Local bank activities}_{i,c,1994}}{\text{Total bank activities}_{i,c,1994}}.$$

In order to calculate $\text{LND-CountyRISK}_{c,t}$, we use more than 20,000 individual records on property damages (measured in US$) from the Spatial Hazard Events and Losses Database for the United States (SHELDUS) for the period 1969 to 2007. The database was developed by the Hazards and Vulnerability Research Institute at the University of South Carolina and is now provided by the Center for Emergency Management and Homeland Security at Arizona State University.[7] First, we scale these numbers according to a county's yearly total personal income (also measured in US$), which is available from the Bureau of Economic Analysis.[8] For example, the standardized disaster damage we obtain for Orleans County in 2005, when Hurricane Katrina hit the region, is 0.95. Thus, according to our measure, total property losses nearly equaled the total personal income of the population of Orleans County in 2005. Second, we calculate the average long-term disaster exposure of each county from the first available year in the database (1969) to year t as follows:

$$\text{LND-CountyRISK}_{c,t} = \frac{1}{(t-1968)} \sum_{t=1969}^{t} \frac{\text{county c disaster damages in US\$ in year t}}{\text{county c total personal income in US\$ in year t}}$$

We also need a proxy for the regional distribution of banking activities, as reflected in the ratio $\frac{\text{Local bank activities}_{i,c,1994}}{\text{Total bank activities}_{i,c,1994}}$. This allows us to identify how much individual banks operating in one or several counties are exposed to disaster damages. Ideally, we could measure local bank activities across counties based on the bank's loan book and other exposures on the asset side, such as credit lines or bonds, because the most direct effect of natural disasters is on the asset collateral and, hence, asset quality. Unfortunately,

[7]Internet source: https://cemhs.asu.edu/sheldus/.

[8]Internet source: www.bea.gov.

information about the geographic spread of bank loans and other assets is limited. For our baseline set of analysis, we calculate $\textit{Local bank activities}_{i,c,1994}$ based on 1994 data from the FDIC's Summary of Deposits statistics, which shows for all U.S. banks whether a bank has a branch in a certain county, as well as the amount of deposits that each branch has. Further, we use the total deposits of bank i as a proxy for $\textit{Total bank activities}_{i,c,1994}$, and then calculate the ratio of $\textit{Local bank activities}_{i,c,1994}$ and $\textit{Total bank activities}_{i,c,1994}$. For example, Capital Bank had branches in Los Angeles County and Orange County in 1994, with a share of deposits of about two-thirds and one-third, respectively. Capital Bank gets a value for $\text{LND-RISK}_{i,t}$ equal to two-thirds of the average disaster damages in Los Angeles County and one-third of the average disaster damages in Orange County between 1969 and year t.

Finally, we are also interested in the correlation between a bank's disaster risk and the disaster risk in a host county where the bank may open a branch. In particular, we calculate the Pearson correlation coefficient for $\text{LND-RISK}_{i,t}$ and $\text{LND-CountyRISK}_{c,t}$ for all observations between 1969 and year t:

$$CORR_{i,c,t} = \frac{\text{cov}(\text{LND-RISK}_{i,t}, \text{LND-CountyRISK}_{c,t})}{\text{std}(\text{LND-RISK}_{i,t}) \times \text{std}(\text{LND-CountyRISK}_{c,t})}.$$

Geographic diversification. In line with the literature, we define geographic diversification as one minus the Herfindahl–Hirschman Index for market concentration (e.g., Goetz, Laeven, and Levine, 2013; Chavaz, 2017):

$$DIV_{i,t} = 1 - \sum_{c} \left[\frac{\text{deposits of bank } i \text{ in county } c \text{ at time } t}{\text{total deposits of bank } i \text{ at time } t} \right]^2,$$

Hence, a higher value of DIV indicates a higher level of geographic diversification. The data for the calculation of this measure comes from the Summary of Deposits statistics of the FDIC.

Bank-level variables. We further use year-end financial information of banks for the period 1994 to 2007, as provided by the Federal Deposit Insurance Corporation (FDIC).[9] The database contains data from banks' Call Reports for all banks that are regulated by the FDIC. Based on this data, we calculate the bank z-score as a measure of bank stability. It is defined as the natural logarithm of the sum of a bank's return on assets and its core capital over assets, standardized by the standard deviation of the bank's return over assets. A higher z-score indicates a greater distance to default, and hence, higher bank stability. Furthermore, we use the non-performing assets ratio (NPA) as a measure of the overall quality of the bank's loan book. We use lagged values from the log of banks' total assets (Size) and of banks' total equity ratio (Equity) as control variables in all regressions. We also use information regarding whether a bank belongs to a multi-state bank holding company (MSBHC) that has subsidiaries in at least two states in 1994 based on the FDIC's Summary of Deposits statistics.

Geographic characteristics. The variable $\text{Distance}_{i,s}$ measures the average distance between bank i's home county and all counties of state s. The variable $\text{Distance}^{c}_{i,c}$ measures the distance between bank i's home county, where its headquarters is located, and county c.

4 Analysis

4.1 Do banks facing locally non-diversifiable risk expand more?

The analysis in this section explores whether and how banks' geographic expansion following deregulation depends on banks' exposure to locally non-diversifiable risk in their business regions, based on the identification strategy discussed in Section 3.1.

In a first step, we focus on the effect of new expansion opportunities (OPP) resulting

[9] Internet source: www.fdic.gov/bank/statistical

from deregulation on banks' geographic expansion. We therefore estimate a parsimonious version of Equation (1) with bank and year fixed effects, but without locally non-diversifiable risk (LND-RISK) and without home state×year and host state×year fixed effects. Regression results are shown in the first two columns of Table 4. The first column uses EXP^B, the share of out-of-state branches of bank i in state s in year t, as dependent variable. The second column uses EXP^D, the corresponding share of out-of-state deposits in neighboring states, as dependent variable. The positive and significant coefficients of OPP in columns (1) and (2) corroborate the common result in the literature that liberalization of inter-state branching restrictions spur out-of-state expansion by banks (e.g., Jayaratne and Strahan, 1996; Johnson and Rice, 2008; Rice and Strahan, 2010).

Next, we estimate the full model as specified in Equation (1) of Section 3.1, including LND-RISK, the interaction OPP×LND-RISK, as well as home state×year and host state×year fixed effects. The results in columns (3) an (4) show that the coefficient of interest, β_3, comes out positive and significant at the 5% level for both the regression with EXP^B and the regression with EXP^D as dependent variables (0.3861 and 0.2751, respectively). This shows that the share of out-of-state branches and the share of out-of-state deposits increase more for high LND-risk banks compared to low LND-risk banks when new opportunities for branching became effective after deregulation. For the economic interpretation, we calculate the differential effect of OPP for banks with high LND-risk (0.56) and low LND-risk (0.01). Both values correspond to the average values of LND-RISK for the most and least affected percentiles, respectively. Based on these values, the differential effect, which is presented in the middle of the table, is 0.2121 for the share of out-of-state branches (i.e. $0.3861 \times 0.56 - 0.3861 \times 0.01$) and 0.1511 for the share of out-of-state deposits (i.e. $0.2751 \times 0.56 - 0.2751 \times 0.01$). This explains about 29% of the mean share of out-of-state branches (0.7417) and about 35% of the mean share of out-of-state deposits (0.4289) in a neighboring state following deregulation, and is thus economically highly significant.

The effect of the single term OPP, which is largely captured by the *home state×year* and *host state×year* fixed effects in the regressions, is insignificant. The effect of the single term LND-RISK is significantly negative, which suggests that banks expand relatively less in years when major disaster damages occur in their business region, so that LND-RISK increases (note that bank fixed effects capture bank specific levels of LND-RISK).

The bank-level control variables come out as expected in all four regressions in Table 4. The negative coefficient of Distance shows that banks expand more actively into states if the distance from the location of their headquarters to the neighboring state is not too great. Moreover, the positive coefficient of the lagged value of bank size shows that banks that have grown in size in the previous period are more active in out-of-state expansion. Further, the positive coefficient of the lagged value of banks' equity ratios suggests that banks have relatively higher equity ratios the year before they expand out-of-state.[10]

[Table 4 around here]

Overall, our regression results provide new evidence that local market risks are an important determinant of banks' geographic expansions. While this is assumed to be the case in some related studies, to our knowledge, it has not been tested directly before, using an identification based on an exogenous source of local market risks.

4.2 Banks' stability and loan quality

The previous finding on banks' geographic expansion suggests that the development of banks' stability and loan quality following the branching deregulation in the 1990s and 2000s may also depend on banks' locally non-diversifiable risks. In this section, we explore the development of banks' Z-scores as a measure of bank stability,[11] and the development

[10] In unreported regressions, we find that results are unchanged when we run the regressions without the bank-level control variables.

[11] The Z-score is defined as the natural logarithm of the sum of a bank's return on assets and its equity-to-asset ratios, standardized by the standard deviation of the bank's return on assets. A lower Z-score indicates a lower distance to default, and hence, lower bank stability. See, e.g., Laeven and Levine (2009).

of banks' non-performing assets ratios as a measure of loan quality. We also explore the development of banks' geographic diversification, which is analyzed in several studies in connection with bank stability and loan quality (e.g., Loutskina and Strahan, 2011; Goetz, Laeven, and Levine, 2016). Geographic diversification, denoted as DIV, is related to but distinct from geographic expansion into other states, EXP. As defined in Section 3.3, DIV measures one minus the market concentration across counties for each bank and year.

First, as shown in Table 5, we compare the median values of several variables for the samples of low LND-risk banks and high LND-risk banks (bottom and top percentiles of the distribution of LND-risk, respectively) at the first year of our sample period, i.e. 1994. We find that banks' median Z-scores are slightly lower for high LND-risk banks than for low LND-risk banks (3.913 vs. 3.926), but this difference is not statistically different. When we consider the components of banks' Z-scores, i.e. equity ratio, return over assets (RoA) and standard deviation of return over assets (SD(RoA)), we find that they are also relatively similar. However, the median RoA is significantly lower by 4 basis points for high LND-risk banks (1.108 vs. 1.151). Further, the median non-performing assets ratio is relatively similar for both groups of banks and not statistically different (0.769 vs. 0.759). Hence, the comparison so far indicates that both groups of banks are similar in terms of stability at the beginning of our sample period; however, by definition, the high LND-risk banks face higher risks of regional shocks over the long-term.[12] Finally, high LND-risk banks show significantly higher values of geographic diversification (0.451 vs. 0.146), which suggests that these banks used the possibilities of intrastate branching (which was already permitted in contrast to interstate branching) relatively more actively and distributed their branches less concentrated across counties within their home states before out-of-state branching became possible in the 1990s and 2000s.

At the end of our sample period, i.e. 2007, the Z-score of high-risk banks is relatively

[12] The possibility to compare bank stability measures for several years before 1994 is restricted by the lack of data availability.

higher than in 1994 (3.913 in 1994 and 4.631 in 2007), but again not statistically different from the Z-score of low LND-risk banks. The equity ratio of high LND-risk banks is also relatively higher than in 1994 (8.278 in 1994 and 10.433 in 2007), but increased less than the equity ratio of low LND-risk banks (8.367 in 1994 and 11.515 in 2007). The RoA also increased for high LND-risk banks (1.108 in 1994 and 1.149 in 2007), in particular relative to the RoA of low LND-risk banks that show a lower RoA in 2007 compared with 1994 (1.151 in 1994 and 0.741 in 2007). The difference between the median RoA of high LND-risk vs. low LND-risk banks is now significantly positive in 2007, while it is significantly negative in 1994. The SD(RoA) has decreased for both high LND-risk and low LND-risk banks, and is not statistically different between both groups. Further, high LND-risk banks show a higher non-performing asset ratio in 2007 compared with 1994 (0.769 in 1994 and 1.045 in 2007), while low LND-risk banks show a lower non-performing asset ratio in 2007 compared with 1994 (0.759 in 1994 and 0.421 in 2007). Finally, as expected, the geographic diversification of high LND-risk banks is significantly higher in 2007 compared with 1994 (0.200 in 1994 and 0.650 in 2007), while the geographic diversification of low LND-risk banks increased only slightly (0.146 in 1994 and 0.200 in 2007).

[Table 5 around here]

Next, by using the Z-score, non-performing assets ratio (NPA) and geographic diversification (DIV) as dependent variables in the previous model (see Equation (1) of Section 3.1), we test whether the effect of new expansion opportunities, OPP, on these variables depends on banks' locally non-diversifiable risks, LND-RISK.[13] Regression results in Column (1) of Table 6 consider the bank Z-score as dependent variable in the regression. The significant positive coefficient of the interaction term OPP×LND-RISK (0.0499) shows

[13]Note that we run this regression for the bank-host state-year sample as before, while the dependent variables are calculated at the bank-year level. Technically, this is taken into consideration by using clustered standard errors at the home state level in the regression.

that bank stability increases significantly for banks with high locally non-diversifiable risk compared with banks with low locally non-diversifiable risk following deregulation. Similar to before, we do not observe the total effect, which is partly captured by the fixed effects in the regression model. The significantly negative coefficient of LND-RISK shows that the Z-score decreases when the bank's business region is hit by a natural disaster that causes an increase in LND-RISK, which is the case if the damages in the bank's business region are above the long-term average. Overall, this result contributes to the more general discussion of whether deregulation increases or decreases bank stability (e.g., Goetz, Laeven, and Levine, 2016; Goetz, 2018) by showing the differential effect of deregulation for banks with more or less exposures to locally non-diversifiable risks.

Furthermore, related studies examine the relation between banks' geographic expansion and banks' loan quality. Goetz, Laeven, and Levine (2016) find no evidence that geographic expansion following interstate bank deregulation over the period from 1978 to 1994 affects the loan quality of banks. Results by Loutskina and Strahan (2011) show that geographic expansion following interstate branching deregulation over the period from 1992 to 2007 leads to a decline in banks' mortgage loan quality. While we do not test this relation directly, we contribute to this literature by showing the differential effect of interstate branching deregulation for banks with high or low locally non-diversifiable risks. Specifically, we use the non-performing assets ratio as dependent variable in the regression model. As shown in Column (2) of Table 6, we do not observe a significant coefficient of the interaction term OPP×LND-RISK. Hence, we find no evidence that deregulation has a differential effect on the loan quality of banks with high or low locally non-diversifiable risk, which are more or less active in geographic expansion, respectively.

Finally, in Column (3), we test whether geographic diversification is more pronounced for banks with high locally non-diversifiable risks compared to banks with low locally non-diversifiable risks following deregulation. Regression results show a significant positive effect of the interaction term (0.0074) at the 5 percent level, in line with the expectation that more geographic expansion of banks with high locally non-diversifiable risks is associated with more geographic diversification.

[Table 6 around here]

4.3 Where do banks expand to?

Based on the previous results, the question arises whether and how banks take into account the risks of the target regions into which they expand. Our setting allows for such a test. In particular, we explore whether risks in potential host markets have explanatory power – in addition to banks' own disaster risks – for the out-of-state expansion activities of banks following deregulation in 1994. We are interested in the following related questions:

1. Do banks with high locally non-diversifiable risks expand into counties with high or low locally non-diversifiable risks?
2. Do banks with high locally non-diversifiable risks expand into counties with positively correlated or uncorrelated risks?

In order to answer these questions, we extend the sample from the *bank-host state-year* to the *bank-host county-year* level, and we now control for the distance between a bank's home county and a potential host county, instead of the distance between a bank's home county and a neighboring state. Most importantly, we introduce new variables into the model that capture locally non-diversifiable risks for each potential host county (LND-CountyRISK) and its relation to the bank's risk (CORR). The new variable LND-CountyRISK$_{c,t}$ reflects the locally non-diversifiable risk of county c measured in year t, as discussed in Section 3.3. The variable CORR$_{i,c,t}$ captures the correlation over time between LND-RISK of bank i and LND-CountyRISK of county c from 1969 to year t, as discussed in Section 3.3. Both new variables are interacted with all other variables of interest. The resulting extended model is specified as follows:

$$
\begin{aligned}
EXP^{c}_{i,c,t} = \alpha_i + \nu_{j,t} + \tau_{s,t} + \upsilon_c + \beta_1 OPP_{j,s,t} + \beta_2 \text{LND-RISK}_{i,t} + \beta_3 \left(OPP_{j,s,t} \times \text{LND-RISK}_{i,t}\right) \\
+ \delta_1 \text{LND-CountyRISK}_{c,t} + \delta_2 \left(\text{LND-RISK}_{i,t} \times \text{LND-CountyRISK}_{c,t}\right) \\
+ \delta_3 \left(OPP_{j,s,t} \times \text{LND-CountyRISK}_{c,t}\right) \qquad (2) \\
+ \delta_4 \left(OPP_{j,s,t} \times \text{LND-RISK}_{i,t} \times \text{LND-CountyRISK}_{c,t}\right) \\
+ \eta_1 CORR_{i,c,t} + \delta_2 \left(\text{LND-RISK}_{i,t} \times CORR_{i,c,t}\right) \\
+ \eta_3 \left(OPP_{j,s,t} \times CORR_{i,c,t}\right) \\
+ \eta_4 \left(OPP_{j,s,t} \times \text{LND-RISK}_{i,t} \times CORR_{i,c,t}\right) \\
+ \eta_5 \left(OPP_{j,s,t} \times \text{LND-RISK}_{i,t} \times \text{LND-CountyRISK}_{c,t} \times CORR_{i,c,t}\right) \\
+ \gamma_1 Distance^{c}_{h,c} + \gamma_2 Size_{i,t-1} + \gamma_3 Equity_{i,t-1} + \epsilon_{i,c,t}.
\end{aligned}
$$

The dependent variable $\text{EXP}^{c}_{i,c,t}$ stands for two alternative measures of banks' geographic expansion at hte bank-host county-year level: the share of out-of-state branches of bank i in county c in year t, $\text{EXP}^{cB}_{i,c,t}$, and the corresponding share of out-of-state deposits, $\text{EXP}^{cD}_{i,c,t}$. Similar to before, the variables α_i, $\nu_{j,t}$ and $\tau_{s,t}$ are bank fixed effects, home state-year fixed effects and host state-year fixed effects, respectively. Further, υ_c represents host county fixed effects (home county fixed effects are subsumed by bank fixed effects). The variable $\text{LND-RISK}_{i,t}$ represents bank i's long-term locally non-diversifiable risk in year t, and $\text{OPP}_{j,s,t}$ represents the expansion opportunities of banks in home state j towards host state s in year t. The variables $\text{LND-CountyRISK}_{c,t}$ and $\text{CORR}_{i,c,t}$ represent local non-diversifiable risk for each county and its relation to a bank's risk, as described above. $\text{Distance}^{c}_{h,c}$ represents the distance between the bank's home county h and the host county c. The lagged variables $\text{Size}_{i,t-1}$ and $\text{Equity}_{i,t-1}$ are included as control variables that capture time-variant bank characteristics. Standard errors are clustered at the bank-host county level.

We are most interested in the marginal effects of OPP for the expansion of banks with high locally non-diversifiable risks into counties with low/high LND-CountyRISK and uncorrelated/high CORR. Given the many interaction terms in the regression model, there is no single coefficient that is useful to interpret. Instead, we need to interpret marginal effects for specific values of LND-RISK, LND-CountyRISK and CORR. We also test whether coefficients are significantly different. Hence, we calculate the marginal and differential effects for expansion of high LND-RISK banks into potential host counties with the following characteristics:[14]

LND-CountyRISK	**CORR** **0**	**0.15**	**0.74**	**DIFF**
0.02	(1) low/uncorrelated	(2) low/mean	(3) low/high	(3)-(1)
0.11	(4) mean/uncorrelated	(5) mean/mean	(6) mean/high	(6)-(4)
0.31	(7) high/uncorrelated	(8) high/mean	(9) high/high	(9)-(7)
DIFF	(7)-(1)	(8)-(2)	(9)-(3)	(9)-(1)

Naturally, geographic expansion into a county with the characteristics depicted in the upper left gray field (1) would offer the most opportunities for diversification and reduction of risks. Contrary, geographic expansion into a county with the characteristics depicted in the lower right gray field (9) would offer the least opportunities. Note, however, that expansion into the latter would still result in risk diversification as long as CORR<1. It would also result in a reduction of a bank's average locally non-diversifiable risk as long as LND-CountyRISK < LND-RISK.

We show the corresponding marginal and differential effects for the specifications with

[14] The value that we use for LND-RISK represents banks with locally non-diversifiable risk in the top percentile (LND-RISK of 0.53). Further, low, mean or high values of LND-CountyRISK correspond to the average value of the bottom quartile, the average value of the full sample, and the average value of the top quartile (LND-CountyRISK of 0.02, 0.11 and 0.31, respectively). Finally, uncorrelated, mean or high values of CORR correspond to zero, the average value of the full sample, and the average value of the top quartile (CORR of 0, 0.15 and 0.74, respectively).

$\text{EXP}^{cB}_{i,c,t}$ and with $\text{EXP}^{cD}_{i,c,t}$ as dependent variable in Table 7, and we report the full set of coefficients in the Online Appendix (Table OA1). We find the largest marginal effect of OPP on geographic expansion of high LND-RISK banks for potential host counties where locally non-diversifiable risks are relatively high and strongly correlated with the banks' risks (lower right gray field). In particular, for the regression using $\text{EXP}^{cB}_{i,c,t}$ as dependent variable, the marginal effect is 0.0222 for expansion into a conty with LND-CountyRISK of 0.31 and CORR of 0.74 (both values correspond to the average of the top 25th percentile). The marginal effect is 0.0021 for expansion into a county with LND-CountyRISK of 0.02 and CORR of 0 (upper left gray field). Hence, the differential effect of expanding into a more risky county relative to a less risky county is 0.0201. Results are qualitatively the same when $\text{EXP}^{cD}_{i,c,t}$ is used as dependent variable.

Overall, we find no evidence that banks with high locally non-diversifiable risks predominantly expand into counties where locally non-diversifiable risks are low or uncorrelated with their own risks. Hence, the motive to reduce and diversify risks may not be the only or the main driver of geographic expansion of these banks. The marginal effects even indicate that these banks rather expand into regions where locally non-diversifiable risks are relatively high and positively correlated with their own risks. This suggests that banks build on their expertise in local risks when they expand into new regions.

[Table 7 with marginal effects around here]

[Table OA1 with full regression results is provided in the Online Appendix]

4.4 Extensions and Robustness

This section provides extensions and robustness tests for our main results.

Out-of-state branching probabilities. As a first robustness for our results that banks with high locally non-diversifiable risks expand relatively more (Section 4.1 and Table (4)), we use a dummy variable instead of the share of out-of-state branches (EXP^{B}) or the share of out-of-state deposits (EXP^D) as dependent variable in the regression model of Equation (1). The dummy variable has a value of one if bank i has established a branch in its neighbor state s in year t, and zero otherwise. This allows us to estimate the probability of out-of-state branching, $\Pr(\text{EXP}^B > 0)$, using a linear probability model with the same specification and fixed effects as in Section 4.1.

The results in Table OA2 (see the Online Appendix) show that the evidence from this regression is in line with our previous results. In particular, new expansion opportunities (OPP) make it significantly more likely that a bank expands out-of-state (Column (1)). Further, results in Column (2) show that the effect of OPP is significantly stronger for banks with high locally non-diversifiable risks in their business region compared with banks with low locally non-diversifiable risks.

[Table OA2 is provided in the Online Appendix]

The role of multi-state bank holding companies. One question that arises is how banks that are part of a multi-state bank holding company (MSBHC) affect our results. On the one hand, these banks may react less to local risk in their business region because they are part of a holding company that is already geographically diversified. Thus, they may rely on internal transfers within the bank holding company to deal with shocks from natural disasters. On the other hand, these banks may take advantage of interstate branching deregulation to consolidate their branching network under one bank.

In order to examine the role of MSBHCs, we expand our baseline Equation (1) with the interaction terms OPP×MSBHC, LND-RISK×MSBHC and OPP×LND-RISK×MSBHC, where MSBHC is a dummy variable that takes a value of one if bank i is part of a MSBHC in 1994 (the year when IBBEA was enacted), and zero otherwise.[15]

Regression results in Table OA3 show that our results are driven by banks that are

[15]Note that the single term MSBHC is captured by bank fixed effects, and thus not included in the regressions.

not part of a MSBHC. In particular, we find insignificant coefficients for the interaction terms with MSBHC, and regression results for the group of non-MSBHC banks are very similar to the previous results.

[Table OA3 is provided in the Online Appendix]

Effects on banks' lending practices. We also measure the geographic expansion of banks using mortgage data from the *Home Mortgage Disclosure Act* (HMDA) database.[16] The advantage of this data versus the deposit data is that it is related to the banks' loan origination, and hence measures an element of its asset side. The disadvantage for our analysis is that it is only indirectly related to bank branching, because a branch is not a precondition for granting a mortgage loan. For each bank i, we calculate the share of out-of-state mortgage loans in neighbor state s in year t as follows:

$$\text{EXP}^{M}_{i,s,t} = \frac{\text{amount of out-of-state mortgage loans of bank i in state s in year t}}{\text{amount of total mortgage loans of bank i in year t}}.$$

Further, the data allows us to differentiate between a bank's mortgage lending in counties where the bank has or has not established a branch. Following Cortes and Strahan (2017), we consider the former as a bank's core market, and the latter as a bank's non-core market. Intuitively, a bank has better customer relationships and better information about loans in its core market compared with its non-core market. We define a bank's share of out-of-state lending in its core market as follows:

$$\text{EXP}^{MC}_{i,s,t} = \frac{\text{amount of out-of-state mortgage loans of bank i in its core market in state s in year t}}{\text{amount of total mortgage loans of bank i in year t}},$$

where a bank's core market includes all counties where the bank has established a branch at the end of the sample period or at any time during the sample period. Hence, the effect of OPP and LND-RISK on $\text{EXP}^{MC}_{i,s,t}$ shows if mortgage lending in this fixed (time

[16]Internet source: https://www.ffiec.gov/hmda/.

invariant) set of counties increases, and not if more counties are classified as core market over time. Finally, the measure EXP^{MN} reflects a bank's s total share of out-of-state mortgages in its non-core markets.

Column (1) of Table OA4 shows that the differential effect of OPP between high and low LND-risk banks is insignificant, which suggests that banks exposed to high locally non-diversifiable risk do not use expansion opportunities to hand out more new mortgage loans out-of-state, compared with banks with low locally non-diversifiable risks. However, the results in Column (2) indicate that they significantly increase new mortgage lending in out-of-state regions where they have established a branch as well. When we turn to banks' non-core markets in Column (3) we find a negative differential effect that is not significant. Taken together, the three differential effects add up correctly (0.0522=0.1686-0.1164) and indicate that high LND-risk banks change their out-of-state mortgage business – which they were already allowed to undertake prior to deregulation – from non-core to core markets following the deregulation of interstate branching.

We regard this as a plausible result since branches allow for more and better information gathering and processing, which enables banks to provide better loans in their core markets and also to shield those markets better against competitors by means of, for example, locked-in customers (Hauswald and Marquez, 2006; Agarwal and Hauswald, 2010).

[Table OA4 is provided in the Online Appendix]

Locally non-diversifiable risk based on data until 1994. Our proxy for banks' locally non-diversifiable risks ($\text{LND-RISK}_{i,t}$) is generally calculated as average long-term disaster damages in bank i's business region over the period from 1969 to year t. The idea is that bank managers are generally aware of the disaster risk in their business region, and they may update their perception of this risk each year. As a robustness test, we calculate LND-RISK_i^{94} for each bank over the period from 1969 to 1994, which is the first year of our sample period. This makes LND-RISK$_i^{94}$ time-invariant and ensures that the development of disaster damages over the sample period does not affect our results. As shown in Table OA5 in the Online Appendix, results remain qualitatively unchanged.

[Table OA5 is provided in the Online Appendix]

Clustering. We check several alternative ways to cluster the standard errors for our baseline results in Table 4. We find that the standard errors do not change significantly, or they even become smaller if we cluster at the bank, home state, host state, or year level instead. We provide the results in Table OA6.

[Table OA6 is provided in the Online Appendix]

Baseline for bank-host county-year sample. We test the robustness of our baseline results for the bank-county-year sample, too. As shown in Table OA7, we again find a significant positive effect for the interaction term OPP×LND-RISK, which confirms the baseline results in Table 4 also at this more granular level.

[Table OA7 is provided in the Online Appendix]

Distance. A potential concern about regression results in Table 7 is that the correlation between the non-diversifiable bank risk and county risk, CORR, may be correlated with the distance between a bank and a potential host county. The variable Distance is already included in all previous regressions. For further robustness, we extend the regressions in Table 7 by the interaction term OPP×Distance. Regression results in Table OA8 show that results remain intact.

[Table OA8 is provided in the Online Appendix]

5 Conclusion

This paper introduces a measure of locally non-diversifiable risk in order to disentangle two interrelated bank decisions: how much risk to take and whether or not to expand geographically. We use local damages from natural disasters as our measure of exogenous locally non-diversifiable risk. We combine the degree to which banks are exposed to non-diversifiable risk with branching deregulation in the United States during the 1990s and 2000s, and we estimate whether and where banks expand to.

We find robust evidence that banks that face a higher level of non-diversifiable risk in their business region are significantly more active in geographic expansion following deregulation than banks that face a low level of such risk, and hence become more geographically diversified. However, when looking to expand, banks with high locally non-diversifiable risk favor counties where locally non-diversifiable risk is positively correlated with the risk in their home market (controlling for distances between counties). This suggests that these banks tend to rely on their expertise in managing disaster risk when they expand into other regions and are not exclusively looking to diversify. Nevertheless, they still reduce their bank risk and increase their stability relative to banks with low levels of such risk, as measured by bank z-scores.

The paper provides new evidence on the effect of branching deregulation in the United States in the 1990s and 2000s. It shows that deregulation affected banks significantly differently, depending on the prevailing risk in their home market.

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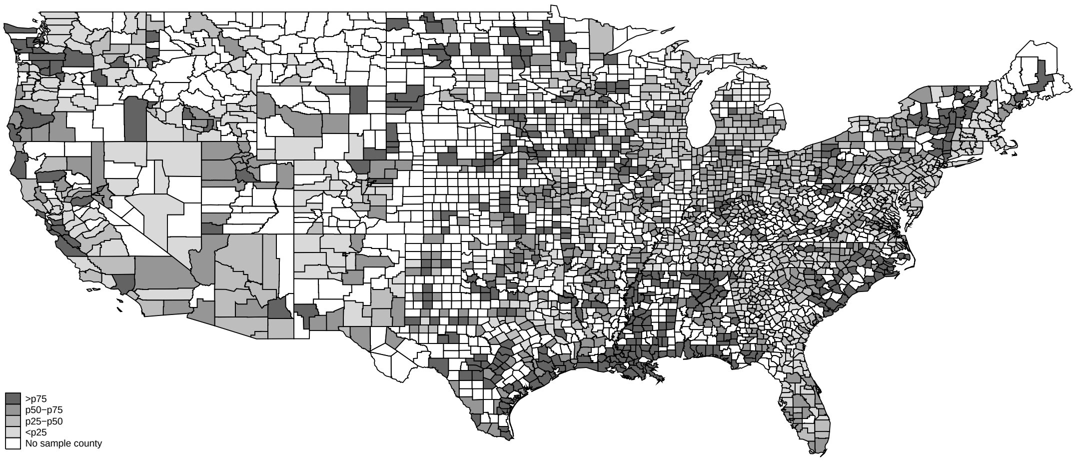
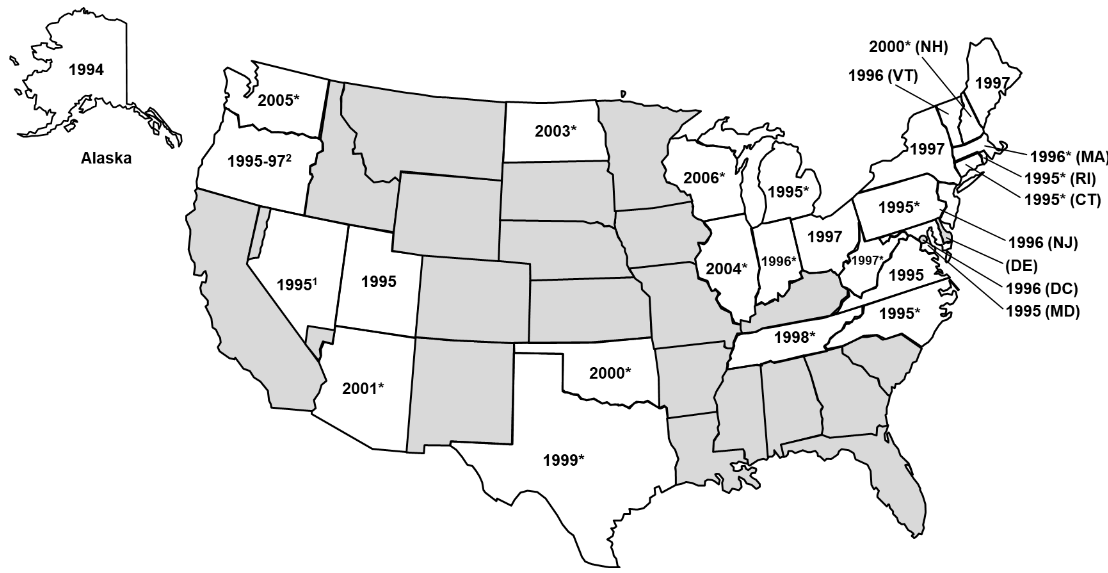
Figures

Figure 1: Average long-term disaster damages at the county level (LND-CountyRISK)



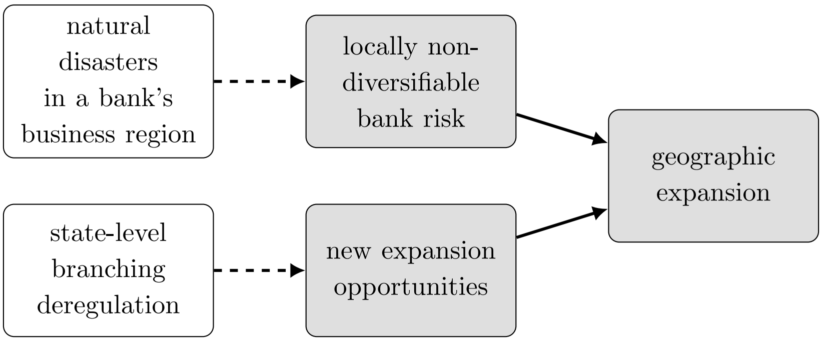
This figure shows the average disaster damage for the period 1969 to 2007 for all counties that are included in our sample, i.e. that are part of a metropolitan or micropolitan statistical area (MSA or μSA). Note that counties in Alaska are also in the sample, but not represented on this map. The map illustrates four quartiles of LND-CountyRISK, where darker colors represent higher average disaster damages.

Figure 2: Interstate branching deregulation between 1994 and 2007



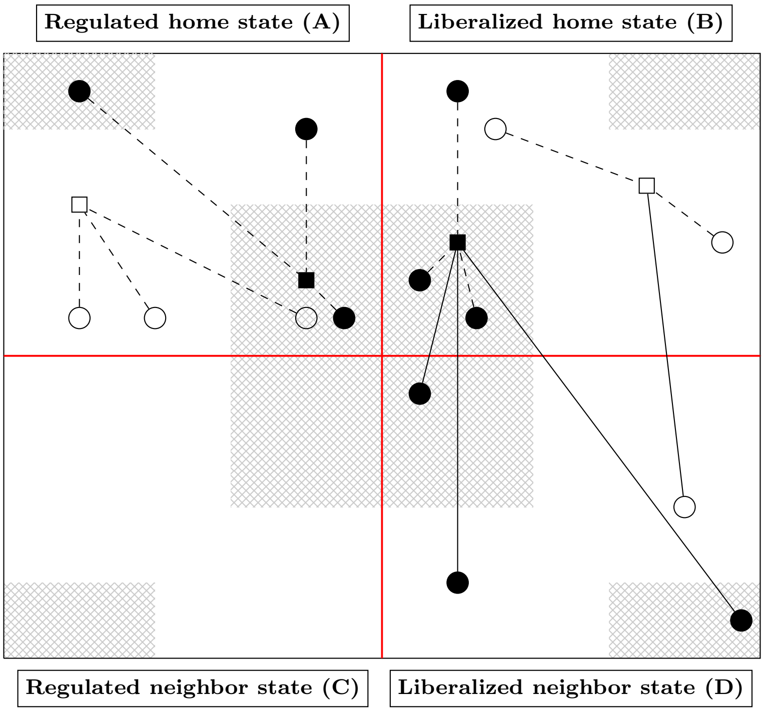
This figure shows the development of interstate branching deregulation between 1994 and 2007. States with interstate branching laws that are more open to out-of-state entry or more restrictive are shown in white and gray colors, respectively. We consider a law as more open if it allows branching by de novo branches or by acquisition of single branches. For the more open states, the year when the law became effective is provided. An asterix (*) indicates that reciprocity is required. The superscript 1 indicates that Nevada permitted interstate branching only into counties with a population less than 100,000, i.e. in all counties excl. Clark County (Las Vegas) and Washoe County (Reno). The superscript 2 indicates that Oregon permitted interstate branching by acquisition of single branches in 1995, but prohibited it in 1997. The source for this overview is Johnson and Rice (2008) for all changes between 1994 and 2005, and the 2005 Wisconsin Act 217 for the interstate branching deregulation in Wisconsin (effective 2006).

Figure 3: Summary of the identification strategy



This figure illustrates our identification strategy to establish a causal link between a bank's locally non-diversifiable risk, expansion opportunities and geographic expansion.

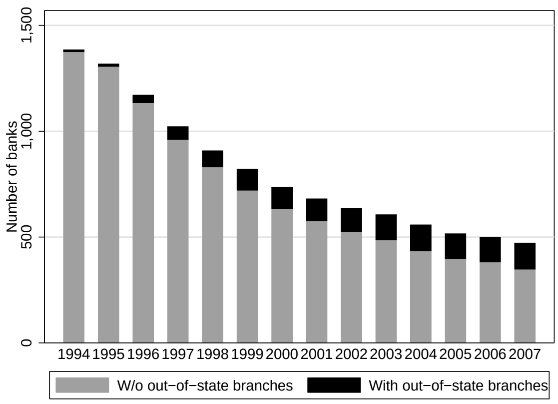
Figure 4: Stylized identification strategy – State (B) liberalizes branching restriction



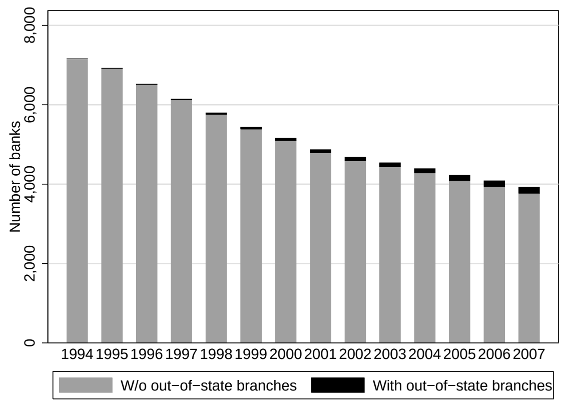
This figure shows four states (A to D) and it illustrates the stylized difference between State (A) and State (B), where State A does not liberalize its branching regulation, while State B does. Both states share borders (red lines) with neighboring states (C and D), of which State C has not liberalized its branching regulation while State D has liberalized and thereby allows branching by banks from other states. The figure shows banks (rectangles) and their connections (dashed lines) to their branches (circles) in States A and B. The gray shaded areas in each state indicate regions with high locally non-diversifiable risk and the white areas indicate regions with low locally non-diversifiable risk. A bank is exposed to high locally non-diversifiable risk (black-filled rectangle) if the majority of its branches are in regions with high locally non-diversifiable risk. A bank is exposed to low locally non-diversifiable risk (white-filled rectangle) if the majority of its branches are in regions with low locally non-diversifiable risk. The solid lines indicate banks' expansion efforts into State D after the deregulation of State B.

Figure 5: Banks' geographic expansion via interstate branching

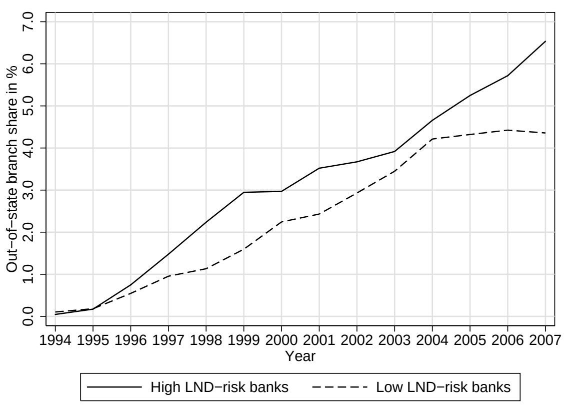
Medium and large banks | **Small banks**



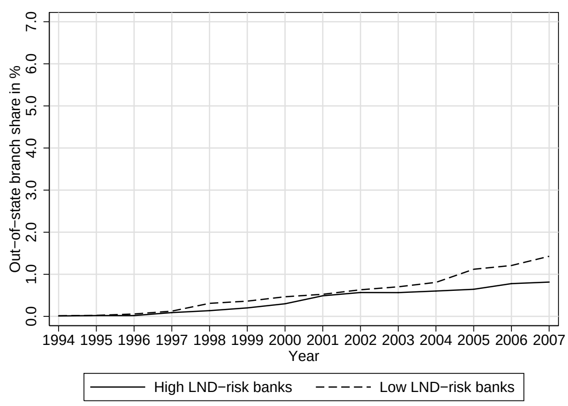
(a) Distribution of banks with or without out-of-state branches



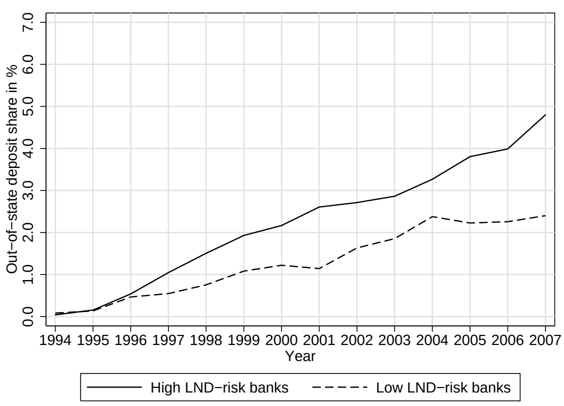
(b) Distribution of banks with or without out-of-state branches



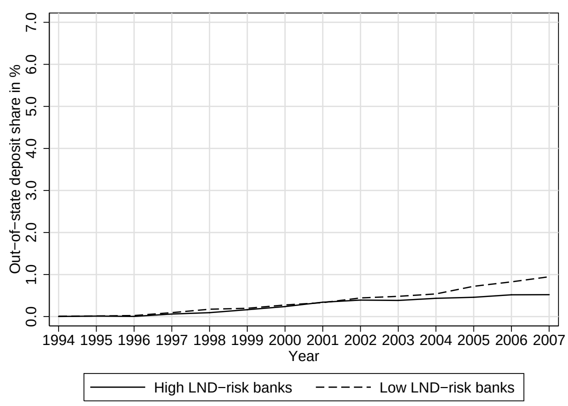
(c) Share of out-of-state branches (EXP^B)



(d) Share of out-of-state branches (EXP^B)



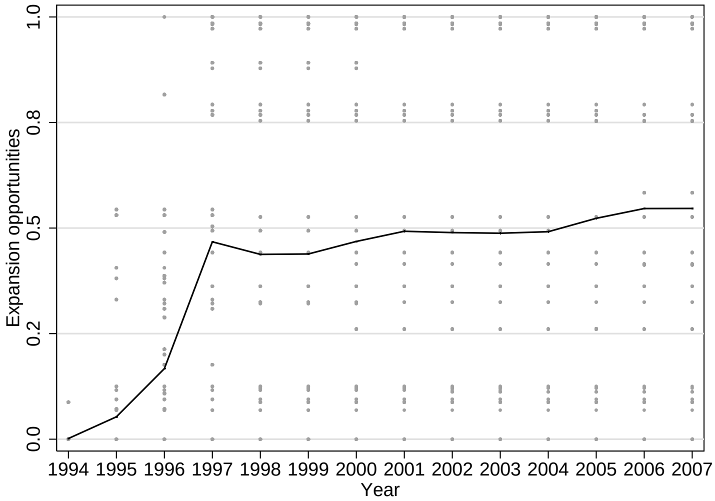
(e) Share of out-of-state deposits (EXP^D)



(f) Share of out-of-state deposits (EXP^D)

This figure shows the geographic expansion of median and large banks (graphs on the left) and small banks (graphs on the right). The samples include banks with assets in 1994 of at least US$250 million, or less, respectively. The two graphs at the top show the development of the number of banks with or without out-of-state branches. The two graphs in the middle show the development of the average shares of banks' out-of-state branches (summarized for the banks' neighboring states) for banks with relatively high or relatively low locally non-diversifiable risks (LND-RISK above or below the median, respectively) between 1994 and 2007. The graphs at the bottom show the corresponding averages for banks' shares of out-of-state deposits.

Figure 6: Opportunity for out-of-state branching (OPP)



This figure shows the development of banks' expansion opportunities (OPP) in banks' neighboring states. The solid line indicates the yearly averages and the dots show the variation across banks. 1994 is the year when IBBEA was enacted and led to a deregulation of branching restrictions that differed widely in its timing and intensity across states.

Tables

Table 1: Interstate branching laws between 1994 and 2007

State		effective date	allows de novo branching	allows acquisition of single branches
AK	Alaska	1/1/1994	no	yes
AL	Alabama	5/31/1997	no	no
AR	Arkansas	6/1/1997	no	no
AZ	Arizona	8/31/2001	no	reciprocity
AZ	Arizona	9/1/1996	no	no
CA	California	9/28/1995	no	no
CO	Colorado	6/1/1997	no	no
CT	Connecticut	6/27/1995	reciprocity	reciprocity
DC	District of Columbia	6/13/1996	yes	yes
DE	Delaware	9/29/1995	no	no
FL	Florida	6/1/1997	no	no
GA	Georgia	5/10/2002	no	no
GA	Georgia	6/1/1997	no	no
IA	Iowa	4/4/1996	no	no
ID	Idaho	9/29/1995	no	no
IL	Illinois	8/20/2004	reciprocity	reciprocity
IL	Illinois	6/1/1997	no	no
IN	Indiana	7/1/1998	reciprocity	reciprocity
IN	Indiana	6/1/1997	reciprocity	reciprocity
KS	Kansas	9/29/1995	no	no
KY	Kentucky	3/22/2004	no	no
KY	Kentucky	3/17/2000	no	no
KY	Kentucky	6/1/1997	no	no
LA	Louisiana	6/1/1997	no	no
MA	Massachusetts	8/2/1996	reciprocity	reciprocity
MD	Maryland	9/29/1995	yes	yes
ME	Maine	1/1/1997	reciprocity	reciprocity
MI	Michigan	11/29/1995	reciprocity	reciprocity
MN	Minnesota	6/1/1997	no	no
MO	Missouri	9/29/1995	no	no
MS	Mississippi	6/1/1997	no	no
MT	Montana	3/13/2001	no	no
MT	Montana	9/29/1995	na	na
NC	North Carolina	7/1/1995	reciprocity	reciprocity
ND	North Dakota	8/1/2003	reciprocity	reciprocity
ND	North Dakota	5/31/1997	no	no

This table continues on the next page.

Table 1: Interstate branching laws between 1994 and 2007 (cont.)

State		effective date	allows de novo branching	allows acquisition of single branches
NE	Nebraska	5/31/1997	no	no
NH	New Hampshire	1/1/2002	reciprocity	reciprocity
NH	New Hampshire	8/1/2000	reciprocity	reciprocity
NH	New Hampshire	6/1/1997	no	no
NJ	New Jersey	4/17/1996	no	yes
NM	New Mexico	6/1/1996	no	no
NV	Nevada	9/29/1995	lim	lim
NY	New York	6/1/1997	no	yes
OH	Ohio	5/21/1997	yes	yes
OK	Oklahoma	5/17/2000	reciprocity	reciprocity
OK	Oklahoma	5/31/1997	no	no
OR	Oregon	7/1/1997	no	no
OR	Oregon	2/28/1995	no	yes
PA	Pennsylvania	7/6/1995	reciprocity	reciprocity
RI	Rhode Island	6/20/1995	reciprocity	reciprocity
SC	South Carolina	7/1/1996	no	no
SD	South Dakota	3/9/1996	no	no
TN	Tennessee	3/17/2003	reciprocity	reciprocity
TN	Tennessee	7/1/2001	reciprocity	reciprocity
TN	Tennessee	5/1/1998	no	reciprocity
TN	Tennessee	6/1/1997	no	no
TX	Texas	9/1/1999	reciprocity	reciprocity
TX	Texas	8/28/1995	na	na
UT	Utah	4/30/2001	reciprocity	yes
UT	Utah	6/1/1995	no	yes
VA	Virginia	9/29/1995	reciprocity	yes
VT	Vermont	1/1/2001	reciprocity	yes
VT	Vermont	5/30/1996	no	yes
WA	Washington	5/9/2005	reciprocity	reciprocity
WA	Washington	6/6/1996	no	no
WI	Wisconsin	3/27/2006	reciprocity	reciprocity
WI	Wisconsin	5/1/1996	no	no
WV	West Virginia	5/31/1997	reciprocity	reciprocity
WY	Wyoming	5/31/1997	no	no

The source for this overview is Johnson and Rice (2008) for all changes between 1994 and 2005, and the 2005 Wisconsin Act 217 for the interstate branching deregulation in Wisconsin that became effective in 2006. Texas and Montana initially elected to opt out of the interstate branching rules in 1995, but later opted back in (1999 and 2001, respectively).

Table 2: Variable description

Variable name	Description
Panel A: Variables at the bank-year level	
DIV	**Geographic diversification:** One minus the Herfindahl–Hirschman Index for market concentration, based on banks' deposits across counties. A higher value indicates a higher level of geographic diversification. Source: FDIC Summary of Deposits.
Equity	**Equity ratio (in percent):** The ratio of a bank's equity to total assets. The term L.Equity represents the one year lag of this variable. Source FDIC (eqv*100).
LND-RISK	**Locally non-diversifiable risk by bank:** The average long-term property disaster damages over total personal income in a bank's business region by bank for the period 1969 to year t. The banks' regional distribution of deposits as of 1994 is used as weights. Source: Own calculations based on SHELDUS, Bureau of Economic Analysis and FDIC Summary of Deposits.
MSBHC	**Multi-state bank holding company:** A dummy variable with a value of 1 if the bank is part of a bank holding company with banks in more than one state, and zero otherwise. Source: FDIC.
NPA	**Non-performing assets ratio (in percent):** The ratio of a bank's loans past due 30-90+ days but still accruing interest and nonaccrual loans to total assets. Source: FDIC $((p3asset+p9asset+naasset)/asset*100)$.
RoA	**Return over assets (in percent):** The ratio of returns to total assets. Source: FDIC $(roa * 100)$.
SD(RoA)	**Return volatility:** The return volatility is calculated as the rolling 8-quarter standard deviation of RoA for each bank and year.
Size	**Bank size:** The natural logarithm of a bank's total assets. The term L.Size represents the one year lag of this variable. Source: FDIC (asset).
Z-score	**Z-score:** The natural logarithm of the sum of a bank's equity ratio and its return on assets, standardized by the standard deviation of return on assets using a rolling 8-quarter window. Source: Own calculations based on FDIC data.
Panel B: Variables at the bank-host state-year level	
Distance	**Distance:** The average distance between a bank's home county, where its headquarters is located, and all counties in a specific neighboring state.
EXP^B	**Share of out-of-state branches:** The ratio of the number of a bank's branches in a neighboring state and the bank's total number of branches. Source: FDIC Summary of Deposits.
EXP^D	**Share of out-of-state deposits:** The ratio of the volume of a bank's deposits in a neighboring state and the bank's total volume of deposits. Source: FDIC Summary of Deposits.
OPP	**Expansion opportunities:** We consider that a bank in home state j has expansion opportunities into host state s (OPP=1) if state s allows banks from state j either de novo branching or acquisitions of single branches, or both. Source: Johnson and Rice (2008) and the 2005 Wisconsin Act 217.
Panel C: Variables at the bank-host county-year level	
CORR	**Correlation between bank and county disaster risk:** Correlation over time between LND-RISK and LND-CountyRISK for bank i and county c from 1969 to year t. Source: own calculations.
Distance^c	**Distance at bank-host county level:** The distance between a bank's home county, where its headquarters is located, and a county in a neighboring state.
EXP^{cB}	**Share of out-of-state branches:** The ratio of the number of a bank's branches in a county of a neighboring state and the bank's total number of branches. Source: FDIC Summary of Deposits.
EXP^{cD}	**Share of out-of-state deposits:** The ratio of the volume of a bank's deposits in a county of a neighboring state and the bank's total volume of deposits. Source: FDIC Summary of Deposits.
LND-CountyRISK	**Locally non-diversifiable risk:** The average long-term property disaster damages over total personal income by county for the period 1969 to year t. Source: Own calculations based on SHELDUS, Bureau of Economic Analysis and FDIC Summary of Deposits.

Table 3: Descriptive statistics

	Obs.	Mean	SD	Percentile 1st	Percentile 99th
Panel A: Variables on the bank-year level					
DIV	11,330	0.38	0.31	0.00	0.94
Equity (in percent)	11,330	9.69	4.82	5.35	29.10
LND-RISK	11,330	0.11	0.35	0.00	0.97
MSBHC	11,330	0.32	0.46	0.00	1.00
NPA (in percent)	11,330	0.93	4.64	0.00	4.75
RoA (in percent)	11,330	1.18	1.23	-0.79	4.33
SD(RoA)	11,330	0.26	1.00	0.02	2.10
Size	11,330	13.92	1.30	12.33	18.00
Z-score	11,330	4.38	0.94	1.81	6.30
Panel B: Variables on the bank-host state-year level					
Distance	50,283	270.72	142.42	62.00	609.00
EXP^{B}	50,283	0.74	4.51	0.00	26.03
EXP^{D}	50,283	0.43	3.02	0.00	15.14
EXP^{MT}	50,283	1.38	4.48	0.00	22.56
EXP^{MC}	50,283	0.47	2.77	0.00	14.32
EXP^{MN}	50,283	0.91	3.16	0.00	14.51
OPP	50,283	0.33	0.47	0.00	1.00
Panel C: Variables on bank-host county-year level					
CORR	1,969,759	0.15	0.47	-0.72	0.97
$Distance^{c}$	1,969,759	278.09	99.11	89.00	523.00
EXP^{cB}	1,969,759	0.02	0.51	0.00	0.00
EXP^{cD}	1,969,759	0.01	0.32	0.00	0.00
LND-CountyRISK	1,969,759	0.11	0.64	0.00	0.93

This table shows descriptive statistics for 1,385 banks from 49 home states and the District of Columbia (563 home counties) and 49 host states and the District of Columbia (1,798 host counties). Descriptive statistics for out-of-state expansion variables (EXP) are calculated for all years when branching into the respective state is permitted (OPP = 1).

Table 4: Do banks facing locally non-diversifiable risk expand more?

	bank-host state-year sample			
Dependent variable:	EXP^B (1)	EXP^D (2)	EXP^B (3)	EXP^D (4)
OPP	0.2897***	0.1107*	0.0289	-0.1879
	(0.1024)	(0.0662)	(0.3344)	(0.2195)
LND-RISK			-0.5532**	-0.5914**
			(0.2561)	(0.2864)
OPP×LND-RISK			0.3861**	0.2751**
			(0.1697)	(0.1162)
Distance	-0.0017***	-0.0009**	-0.0021**	-0.0009
	(0.0005)	(0.0004)	(0.0009)	(0.0007)
L.Size	0.8411***	0.7250***	0.8497***	0.7264***
	(0.1246)	(0.1132)	(0.1231)	(0.1081)
L.Equity	0.0287***	0.0230***	0.0321***	0.0259***
	(0.0078)	(0.0056)	(0.0078)	(0.0057)
Differential effect of OPP for LND-RISK=0.56 and LND-RISK=0.01:				
			0.2121**	0.1511**
Mean values of the dependent variables for OPP=1:				
	0.7417	0.4289	0.7417	0.4289
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	subsumed	subsumed
Home state-year FE	No	No	Yes	Yes
Host state-year FE	No	No	Yes	Yes
Observations	50,283	50,283	50,283	50,283
Banks	1,385	1,385	1,385	1,385
Adjusted R2	0.1427	0.1578	0.1730	0.1912

This table shows regression results for the model of Equation (1) with a sample at the bank-host state-year level. The first panel presents the regression estimates; the second panel shows the differential effect of OPP between high-risk and low-risk banks; and the third panel presents the mean values of the dependent variables which are calculated for all years when branching into the respective state is permitted (OPP = 1). Standard errors are clustered at the bank-host state level. ***, ** and * indicate significant coefficients at the 1%, 5%, and 10% levels, respectively. See Table 2 for a detailed explanation of every variable, and Table 3 for more summary statistics.

Table 5: Comparison of low LND-risk banks and high LND-risk banks

	1994 (first sample year)				2007 (last sample year)			
	low LND-risk	high LND-risk	Diff.	p-value	low LND-risk	high LND-risk	Diff.	p-value
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Z-score	3.926	3.913	-0.013	0.614	4.490	4.631	0.141	0.756
Equity	8.367	8.278	-0.089	0.999	11.515	10.433	-1.082	0.710
RoA	1.151	1.108	-0.043	0.058	0.741	1.149	0.408	0.002
SD(RoA)	0.205	0.198	-0.007	0.986	0.137	0.119	-0.018	0.328
NPA	0.759	0.769	-0.010	0.197	0.421	1.045	0.624	0.000
DIV	0.146	0.451	0.305	0.000	0.200	0.650	0.450	0.000

This table shows the median values of several variables at the first and last years of our sample period (1994 to 2007) for the samples of low LND-risk banks and high LND-risk banks. Low LND-risk banks include all banks in the bottom percentile of the distribution of LND-RISK. High LND-risk banks include all banks in the top percentile of the distribution of LND-RISK. P-values of the Wilcoxon rank test are shown in columns (4) and (8), and used to calculate whether the medians of low LND-risk banks and high LND-risk banks are significantly different. See Table 2 for a detailed explanation of every variable, and Table 3 for more summary statistics.

Table 6: Banks' stability and loan quality

	bank-host state-year sample		
Dependent variable:	Z-score (1)	NPA (2)	DIV (3)
OPP	-0.0039	-0.0014	-0.0006
	(0.0230)	(0.2579)	(0.0044)
LND-RISK	-0.0905**	0.0708***	0.0049
	(0.0456)	(0.0179)	(0.0045)
OPP × LND-RISK	0.0499***	0.0175	0.0074**
	(0.0174)	(0.0248)	(0.0035)
Differential effect of OPP for LND-RISK=0.56 and LND-RISK=0.01:			
	0.0274***	0.0096	0.0041**
Mean values of the dependent variables for OPP=1:			
	4.4972	0.8434	0.4021
Bank FE	Yes	Yes	Yes
Year FE	subsumed	subsumed	subsumed
Home state-year FE	Yes	Yes	Yes
Host state-year FE	Yes	Yes	Yes
Controls for Dist., L.Size, L.Equity	Yes	Yes	Yes
Observations	50,283	50,283	50,283
Banks	1,385	1,385	1,385
Cluster	6128	6128	6128
Adjusted R2	0.4937	0.5254	0.9277

This table shows regression results for the model of Equation (1) with a sample at the bank-host state-year level. The first panel presents the regression estimates; the second panel shows the differential effect of OPP between high-risk and low-risk banks; and the third panel presents the mean values of the dependent variables which are calculated for all years when branching into the respective state is permitted (OPP = 1). Standard errors are clustered at the bank-host state level. ***, ** and * indicate significant coefficients at the 1%, 5%, and 10% levels, respectively. See Table 2 for a detailed explanation of every variable, and Table 3 for more summary statistics.

Table 7: Where do banks expand to?
– marginal and differential effects –
(see the Online Appendix Table OA1 for full results)

	bank-host county-year sample	
Dependent variable:	EXP^{cB} (1)	EXP^{cD} (2)

Marginal effect of OPP for high-risk banks (LND-RISK=0.53):

LND-CountyRISK	**CORR 0**	**0.15**	**0.74**	**DIFF**	**CORR 0**	**0.15**	**0.74**	**DIFF**
0.02	0.0021	0.0037	0.0100	0.0079	-0.0006	0.0002	0.0033	0.0040
0.11	0.0011	0.0037	0.0138*	0.0127***	-0.0007	0.0006	0.0057	0.0063*
0.31	-0.0013	0.0035	0.0222*	0.0235**	-0.0008	0.0015	0.0108*	0.0116*
DIFF	-0.0035	-0.0003	0.0122	0.0201*	-0.0002	0.0013	0.0075	0.0114*

Differential effect of OPP for LND-RISK=0.53 and LND-RISK=0.01:

	(1)	(2)
Average host county with LND-County-RISK=0.11 and CORR=0.15:	0.0057***	0.0049***

Mean values of the dependent variables for OPP=1:

	(1)	(2)
	0.0214	0.0123
Bank FE	Yes	Yes
Year FE	subsumed	subsumed
Home state-year FE	Yes	Yes
Host state-year FE	Yes	Yes
Controls for Distance[c], L.Size, L.Equity	Yes	Yes
Home county FE	subsumed	subsumed
Host county FE	Yes	Yes
Observations	1,969,759	1,969,759
Banks	1,385	1,385
Adjusted R2	0.0160	0.0195

This table shows regression results for the model of Equation (2). The sample is at the bank-host county-year level. The first panel presents the marginal and differential effect of OPP for high-risk banks; the second panel presents the differential effect of OPP between high LND-risk and low LND-risk banks; and the third panel presents the mean values of the dependent variables which are calculated for all years when branching into the respective state is permitted (OPP = 1). We provide full regression estimates in Table OA1 in the Online Appendix. Standard errors are clustered at the bank-host county level. ***, ** and * indicate significant coefficients at the 1%, 5%, and 10% levels, respectively. See Table 2 for a detailed explanation of every variable, and Table 3 for more summary statistics.

Online Appendix

This additional material is for online publication only.

Table OA1: Where do banks expand to?
– full regression results –

	bank-host county-year sample	
Dependent variable:	EXP^{cB} (1)	EXP^{cD} (2)
OPP=1	-0.0004	-0.0032
	(0.0053)	(0.0025)
LND-RISK	-0.0139***	-0.0136***
	(0.0047)	(0.0052)
OPP=1 × LND-RISK	0.0053	0.0050*
	(0.0044)	(0.0028)
LND-CountyRisk	0.0008	0.0011
	(0.0020)	(0.0014)
LND-RISK × LND-CountyRisk	-0.0016	-0.0048
	(0.0097)	(0.0097)
OPP=1 × LND-CountyRisk	-0.0236**	-0.0118**
	(0.0094)	(0.0047)
OPP=1 × LND-RISK × LND-CountyRisk	0.0220	0.0209
	(0.0256)	(0.0173)
CORR	0.0004	0.0013
	(0.0017)	(0.0014)
LND-RISK × CORR	-0.0017	-0.0019
	(0.0041)	(0.0027)
OPP=1 × CORR	0.0007	-0.0013
	(0.0053)	(0.0035)
OPP=1 × LND-RISK × CORR	0.0160	0.0112
	(0.0107)	(0.0072)
LND-CountyRisk × CORR	0.0003	0.0004
	(0.0008)	(0.0007)
LND-RISK × LND-CountyRisk × CORR	0.0188	0.0121
	(0.0150)	(0.0116)
OPP=1 × LND-CountyRisk × CORR	0.0472*	0.0198
	(0.0263)	(0.0137)
OPP=1 × LND-RISK × LND-CountyRisk × CORR	0.0486	0.0303
	(0.1037)	(0.0590)
Differential effect of OPP for LND-RISK=0.53 and LND-RISK=0.01:		
	0.0057***	0.0049***
Mean values of the dependent variables for OPP=1:		
	0.0214	0.0123
Bank FE	Yes	Yes
Year FE	subsumed	subsumed
Home state-year FE	Yes	Yes
Host state-year FE	Yes	Yes
Controls for Distance^c, L.Size, L.Equity	Yes	Yes
Home county FE	subsumed	subsumed
Host county FE	Yes	Yes
Observations	1969759	1969759
Banks		
Cluster	247214	247214
Adjusted R2	0.0238	0.0272

This table shows regression estimates for the model of Equation (2). Standard errors are clustered at the bank-host county level. ***, ** and * indicate significant coefficients at the 1%, 5%, and 10% levels, respectively. See Table 2 for a detailed explanation of every variable, and Table 3 for more summary statistics.

Table OA2: Do banks facing disaster risk expand more?
– probabilities for out-of-state branching –

	bank-host state-year sample	
Dependent variable:	$Pr(EXP^{B}>0)$ (1)	$Pr(EXP^{B}>0)$ (2)
OPP	0.0138**	-0.0201
	(0.0055)	(0.0169)
LND-RISK		-0.0287**
		(0.0134)
OPP×LND-RISK		0.0243***
		(0.0092)
Distance	-0.0001***	-0.0001*
	(0.0000)	(0.0000)
L.Size	0.0674***	0.0672***
	(0.0069)	(0.0066)
L.Equity	0.0020***	0.0023***
	(0.0004)	(0.0004)
Difference in the effect of OPP between LND-RISK=0.56 and LND-RISK=0.01:		
		0.0134***
Mean values of the dependent variables for OPP=1:		
	0.0534	0.0534
Bank FE	Yes	Yes
Year FE	Yes	subsumed
Year-Home state FE	No	Yes
Year-Host state FE	No	Yes
Observations	50,283	50,283
Banks	1,385	1,385
Adjusted R2	0.2574	0.2817

This table shows regression results for the model of Equation (1) with a sample at the bank-host state-year level. The first panel presents the regression estimates; the second panel presents the differential effect of OPP between high-risk and low-risk banks; and the third panel presents the mean values of the dependent variables which are calculated for all years when branching into the respective state is permitted (OPP = 1). Standard errors are clustered at the bank-host state level. ***, ** and * indicate significant coefficients at the 1%, 5%, and 10% levels, respectively. See Table 2 for a detailed explanation of every variable, and Table 3 for more summary statistics.

Table OA3: Do banks facing locally non-diversifiable risk expand more?
– the role of multi-state bank holding companies (MSBHC) -

	bank-host state-year sample	
Dependent variable:	EXP^{B}	EXP^{D}
	(1)	(2)
OPP	0.0481	-0.2120
	(0.3608)	(0.2370)
LND-RISK	-0.4603*	-0.5000*
	(0.2657)	(0.2711)
OPP×LND-RISK	0.3789**	0.2724**
	(0.1676)	(0.1139)
MSBHC×LND-RISK	-0.4526	-0.4484
	(0.3289)	(0.3557)
OPP×MSBHC	-0.0237	0.0454
	(0.3412)	(0.2496)
OPP×MSBHC×LND-RISK	-0.6494	0.5894
	(3.9753)	(3.0279)
Difference in the effect of OPP between LND-RISK=0.56 and LND-RISK=0.01:		
For MSBHC=0	0.2077**	0.1487**
For MSBHC=1	-0.1486	0.4735
Mean values of the dependent variables for OPP=1:	0.7417	0.4289
Bank FE	Yes	Yes
Year FE	subsumed	subsumed
Home state-year FE	Yes	Yes
Host state-year FE	Yes	Yes
Controls for Distance, L.Size and L.Equity	Yes	Yes
Observations	50,283	50,283
Banks	1,385	1,385
Adjusted R2	0.1730	0.1912

This table shows regression results for an extended model of Equation (1) with a sample at the bank-host state-year level, where interactions with a dummy for banks that are part of a multi-state bank holding company are added ($OPP \times MSBHC$, $DIS \times MSBHC$ and $OPP \times DIS \times MSBHC$). The first panel presents the regression estimates; the second panel presents the differential effect of OPP between high-risk and low-risk banks for banks that are part of a multi-state bank holding company or not, respectively; and the third panel presents the mean values of the dependent variables which are calculated for all years when branching into the respective state is permitted (OPP = 1). Standard errors are clustered at the bank-host state level. ***, ** and * indicate significant coefficients at the 1%, 5%, and 10% levels, respectively. See Table 2 for a detailed explanation of every variable, and Table 3 for more summary statistics.

Table OA4: Do banks facing locally non-diversifiable risk expand more?
– mortgage lending –

	bank-host state-year sample		
Dependent variable:	EXP^{MT}	EXP^{MC}	EXP^{MN}
	(1)	(2)	(3)
OPP	-0.1865	-0.0825	-0.1040
	(0.2912)	(0.2067)	(0.1871)
LND-RISK	-0.8349**	-0.3145	-0.5204**
	(0.3945)	(0.1942)	(0.2630)
OPP×LND-RISK	0.0951	0.3069**	-0.2118
	(0.2355)	(0.1498)	(0.2193)
Difference in the effect of OPP between LND-RISK=0.56 and LND-RISK=0.01:			
	0.0522	0.1686**	-0.1164
Mean values of the dependent variables for OPP=1:			
	1.3818	0.4712	0.9107
Bank FE	Yes	Yes	Yes
Year FE	subsumed	subsumed	subsumed
Home state-year FE	Yes	Yes	Yes
Host state-year FE	Yes	Yes	Yes
Controls for Distance, L.Size and L.Equity	Yes	Yes	Yes
Observations	50,283	50,283	50,283
Banks	1,385	1,385	1,385
Adjusted R2	0.2285	0.2182	0.2089

This table shows regression results for the model of Equation (1) with a sample at the bank-host state-year level. Instead of out-of-state branches and deposits, the dependent variables here are new mortgages that a bank generate out-of-state (Column (1)). In Column (2) we consider only mortgages in core markets and check mortgages for non-core markets in Column (3). The first panel presents the regression estimates; the second panel presents the differential effect of OPP between high-risk and low-risk banks; and the third panel presents the mean values of the dependent variables which are calculated for all years when branching into the respective state is permitted (OPP = 1). Standard errors are clustered at the bank-host state level. ***, ** and * indicate significant coefficients at the 1%, 5%, and 10% levels, respectively. See Table 2 for a detailed explanation of every variable, and Table 3 for more summary statistics.

Table OA5: Do banks facing disaster risk expand more?
– alternative calculation of LND-risk based on data until the year 1994 –

	bank-host state-year sample			
Dependent variable:	EXP^B (1)	EXP^D (2)	EXP^B (3)	EXP^D (4)
OPP	0.2897***	0.1107*	0.0390	-0.1817
	(0.1024)	(0.0662)	(0.3351)	(0.2194)
OPP×LND-RISK^{94}			0.3326*	0.2537**
			(0.1965)	(0.1237)
Distance	-0.0017***	-0.0009**	-0.0021**	-0.0008
	(0.0005)	(0.0004)	(0.0009)	(0.0007)
Size	0.8411***	0.7250***	0.8493***	0.7259***
	(0.1246)	(0.1132)	(0.1231)	(0.1081)
Equity	0.0287***	0.0230***	0.0319***	0.0256***
	(0.0078)	(0.0056)	(0.0078)	(0.0057)
Difference in the effect of OPP between LND-RISK^{94}=0.50 and LND-RISK^{94}=0.01:				
			0.1602*	0.1222**
Mean values of the dependent variables for OPP=1:				
	0.7417	0.4289	0.7417	0.4289
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	subsumed	subsumed
Year-Home state FE	No	No	Yes	Yes
Year-Host state FE	No	No	Yes	Yes
Observations	50,283	50,283	50,283	50,283
Banks	1,385	1,385	1,385	1,385
Adjusted R2	0.1427	0.1578	0.1727	0.1908

This table shows regression results for the model of Equation (1) with a sample at the bank-host state-year level. The first panel presents the regression estimates; the second panel presents the average marginal effects of OPP; the third panel presents the differential effect of OPP between high-risk and low-risk banks; and the fourth panel presents the mean values of the dependent variables which are calculated for all years when branching into the respective state is permitted (OPP = 1). Standard errors are clustered at the bank-host state level. ***, ** and * indicate significant coefficients at the 1%, 5%, and 10% levels, respectively. See Table 2 for a detailed explanation of every variable, and Table 3 for more summary statistics.

Table OA6: Do banks facing locally non-diversifiable risk expand more?
– different clustering level –

	bank-host state-year sample				
Dependent variable:	EXP^{D}				
	(1)	(2)	(3)	(4)	(5)
OPP	-0.1879	-0.1879	-0.1879	-0.1879	-0.1879*
	(0.2195)	(0.2409)	(0.2093)	(0.1583)	(0.0990)
LND-RISK	-0.5914**	-0.5914*	-0.5914	-0.5914	-0.5914***
	(0.2864)	(0.3282)	(0.3595)	(0.3539)	(0.1835)
	(0.2195)	(0.2409)	(0.2093)	(0.1583)	(0.0990)
OPP×LND-RISK	0.2751**	0.2751**	0.2751**	0.2751**	0.2751***
	(0.1162)	(0.1368)	(0.1082)	(0.1111)	(0.0472)
Cluster	Bank-host state	Bank	Home state	Host state	Year
Bank FE	Yes	Yes	Yes	Yes	Yes
Year FE	subsumed	subsumed	subsumed	subsumed	subsumed
Home state-year FE	Yes	Yes	Yes	Yes	Yes
Host state-year FE	Yes	Yes	Yes	Yes	Yes
Controls for Distance, L.Size and L.Equity	Yes	Yes	Yes	Yes	Yes
Observations	50,283	50,283	50,283	50,283	50,283
Banks	1,385	1,385	1,385	1,385	1,385
Adjusted R2	0.1912	0.1907	0.1903	0.1912	0.1903

This table shows regression results for the model of Equation (1) with a sample at the bank-host state-year level. In each column, we provide our baseline results with alternative levels of clustering for the standard errors. ***, ** and * indicate significant coefficients at the 1%, 5%, and 10% levels, respectively. See Table 2 for a detailed explanation of every variable, and Table 3 for more summary statistics.

Table OA7: Do banks facing locally non-diversifiable risk expand more?
– robustness at the bank-host county-year sample –

	bank-host county-year sample	
Dependent variable:	EXP^{cB} (1)	EXP^{cD} (2)
OPP	-0.0019	-0.0045*
	(0.0051)	(0.0025)
LND-RISK	-0.0127**	-0.0138**
	(0.0050)	(0.0060)
OPP×LND-RISK	0.0077**	0.0071***
	(0.0035)	(0.0021)
Difference in the effect of OPP between LND-RISK=0.53 and LND-RISK=0.01:	0.0040**	0.0037***
Mean value of the dependent variable for OPP=1:	0.0214	0.0123
Bank FE	Yes	Yes
Year FE	subsumed	subsumed
Home state-year FE	Yes	Yes
Host state-year FE	Yes	Yes
Controls for $Distance^c$, L.Size and L.Equity	Yes	Yes
Observations	1,969,759	1,969,759
Banks	1,385	1,385
Adjusted R2	0.0160	0.0195

This table shows regression results for the model of Equation (1) with a sample at the bank-host county-year level. The first panel presents the regression estimates; the second panel presents the differential effect of OPP between high-risk and low-risk banks; and the third panel presents the mean values of the dependent variables which are calculated for all years when branching into the respective state is permitted (OPP = 1). Standard errors are clustered at the bank-host county level. ***, ** and * indicate significant coefficients at the 1%, 5%, and 10% levels, respectively. See Table 2 for a detailed explanation of every variable, and Table 3 for more summary statistics.

Table OA8: Where do banks expand to? (extended regression model)
– marginal and differential effects –
(see the Online Appendix Table OA9 for full results)

	bank-host county-year sample							
Dependent variable:	EXP^{cB} (1)				EXP^{cD} (2)			
Marginal effect of OPP for high-risk banks (LND-RISK=0.53):								
	CORR				**CORR**			
LND-CountyRISK	**0**	**0.15**	**0.74**	**DIFF**	**0**	**0.15**	**0.74**	**DIFF**
0.02	0.0013	0.0030	0.0097	0.0084*	-0.0014	-0.0005	0.0031	0.0045
0.11	0.0004	0.0030	0.0133*	0.0129***	-0.0013	0.0000	0.0052	0.0065
0.31	-0.0016	0.0031	0.0213*	0.0229**	-0.0011	0.0011	0.0100	0.0111*
DIFF	-0.0029	0.0000	0.0116	0.0200*	0.0003	0.0016	0.0069	0.0114*
Differential effect of OPP for LND-RISK=0.53 and LND-RISK=0.01:								
Average host county with LND-County-RISK=0.11 and CORR=0.15:								
	0.0055***				0.0047***			
Mean values of the dependent variables for OPP=1:								
	0.0214				0.0123			
Bank FE	Yes				Yes			
Year FE	subsumed				subsumed			
Home state-year FE	Yes				Yes			
Host state-year FE	Yes				Yes			
Controls for $Distance^c$, Size, Equity	Yes				Yes			
Controls for OPP×$Distance^c$	Yes				Yes			
Home county FE	subsumed				subsumed			
Host county FE	Yes				Yes			
Observations	1,969,759				1,969,759			
Banks	1,385				1,385			
Adjusted R2	0.0160				0.0195			

This table shows regression results for the model of Equation (2) with the additional interaction term OPP×$Distance^c$. The sample is at the bank-host county-year level. The first panel presents the marginal and differential effect of OPP for high-risk banks; the second panel presents the differential effect of OPP between high LND-risk and low LND-risk banks; and the third panel presents the mean values of the dependent variables which are calculated for all years when branching into the respective state is permitted (OPP = 1). We provide full regression estimates in Table OA9 in the Online Appendix. Standard errors are clustered at the bank-host county level. ***, ** and * indicate significant coefficients at the 1%, 5%, and 10% levels, respectively. See Table 2 for a detailed explanation of every variable, and Table 3 for more summary statistics.

Table OA9: Where do banks expand to? (extended regression model)
– full regression results –

	bank-host county-year sample	
Dependent variable:	EXP^{cB} (1)	EXP^{cD} (2)
OPP=1	-0.0165	-0.0182**
	(0.0132)	(0.0077)
LND-Risk	-0.0138***	-0.0135***
	(0.0047)	(0.0052)
OPP=1 × LND-Risk	0.0051	0.0048*
	(0.0044)	(0.0028)
LND-CountyRisk	0.0009	0.0012
	(0.0020)	(0.0014)
LND-Risk × LND-CountyRisk	-0.0023	-0.0054
	(0.0097)	(0.0098)
OPP=1 × LND-CountyRisk	-0.0225**	-0.0108**
	(0.0096)	(0.0047)
OPP=1 × LND-Risk × LND-CountyRisk	0.0235	0.0224
	(0.0256)	(0.0175)
CORR	0.0004	0.0013
	(0.0017)	(0.0014)
LND-Risk × CORR	-0.0016	-0.0017
	(0.0041)	(0.0027)
OPP=1 × CORR	0.0024	0.0003
	(0.0060)	(0.0038)
OPP=1 × LND-Risk × CORR	0.0144	0.0097
	(0.0109)	(0.0071)
LND-CountyRisk × CORR	0.0003	0.0004
	(0.0008)	(0.0007)
LND-Risk × LND-CountyRisk × CORR	0.0194	0.0126
	(0.0150)	(0.0117)
OPP=1 × LND-CountyRisk × CORR	0.0451*	0.0177
	(0.0267)	(0.0134)
OPP=1 × LND-Risk × LND-CountyRisk × CORR	0.0427	0.0248
	(0.1039)	(0.0602)
Differential effect of OPP for LND-RISK=0.53 and LND-RISK=0.01:		
	0.0055***	0.0047***
Mean values of the dependent variables for OPP=1:		
	0.0214	0.0123
Bank FE	Yes	Yes
Year FE	subsumed	subsumed
Home state-year FE	Yes	Yes
Host state-year FE	Yes	Yes
Controls for $Distance^c$, L.Size, L.Equity	Yes	Yes
Controls for OPP×$Distance^c$	Yes	Yes
Home county FE	subsumed	subsumed
Host county FE	Yes	Yes
Observations	1,969,759	1,969,759
Banks	1,385	1,385
Cluster	247214	247214
Adjusted R2	0.0238	0.0272

This table shows regression estimates for the model of Equation (2) with the additional interaction term OPP×$Distance^c$. Standard errors are clustered at the bank-host county level. ***, ** and * indicate significant coefficients at the 1%, 5%, and 10% levels, respectively. See Table 2 for a detailed explanation of every variable, and Table 3 for more summary statistics.

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