Banking liberalization and diversification benefits

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Abstract

This paper investigates whether U.S. banks that face higher undiversifiable risk diversify more if they have the opportunity to do so. Using data on disaster damages over the period 1969 to 2012, we show that catastrophic risk as a measure for undiversifiable risk in banks' home markets matters significantly for the banks' reactions to the liberalization of geographic banking restrictions through the Riegle-Neal Act of 1994: banks facing high catastrophic risks diversify more actively into other states. We find that this diversification effect is driven by larger banks organized in already more diversified bank holding structures and banks that did not have enough diversification possibilities in their home states before the liberalization.

Keywords: banking liberalization, banking market structure, catastrophic risk, diversification benefits

JEL Classification: G21, G28

1 Introduction

This paper analyzes whether higher undiversifiable risk causes banks to diversify more when diversification is possible. To identify a causal link between risk and diversification of banks we use two sources: damages from natural disasters that allow for separating banks according to the undiversifiable risk that arises due to these damages and deregulation of U.S. banking markets in the 1990s that allowed banks to regionally diversify their business by banking and branching into other states. Our results show robustly that banks that face higher undiversifiable risk from natural disaster diversify significantly more after the liberalization wave of the 1990s compared to banks facing low undiversifiable risk.

The theoretical literature strongly emphasises the role of (geographic) diversification for bank risk (Winton, 1997; Acharya et al., 2006), for banks' lending decisions (Winton, 2000; Loutskina and Strahan, 2011), and for the ability to obtain funding, especially in crisis periods (Ivashina and Scharfstein, 2010). The literature on the effects of diversification on banking system outcomes is faced with the problem that the degree to which banks are diversified is endogenous. This problem has largely been addressed by using the removal of interstate banking restrictions in the U.S. banking system during the 1980s and 1990s as an instrument (Brook et al., 1998; Rice and Strahan, 2010; Goetz et al., 2013). However, even in a liberalised environment not all banks diversify or diversify equally strongly. Hence, the instrument may not satisfy the exclusion restriction of being uncorrelated with bank outcomes. For example, banks that diversify in response to deregulation may be more efficiently run, less risk averse or otherwise different from banks that do not. This paper addresses this issue at least partially by using an exogenous non-diversifiable source of risk for the bank (the local damages due to natural disasters) as an instrument for diversification, in addition to deregulation.

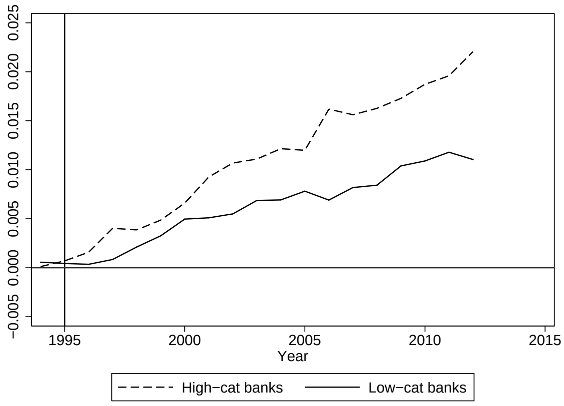
Following Brook et al. (1998), Rice and Strahan (2010) or Goetz et al. (2013) we use the Riegle-Neal Interstate Banking and Branching Efficiency Act of 1994 for identification. This act allowed unrestricted interstate banking and interstate branching in the U.S. from 1994. Moreover, the different states were allowed to liberalize at different points in time and different intensities (Rice and Strahan, 2010). In order to differentiate between banks that face high or low undiversifiable risks, we allocate each bank a measure of catastrophic risk in its banking region, based on reported damages from hurricanes, earthquakes and other natural disasters during the period 1969 to 2012. This

Spatial Hazard Events and Losses Database for the United States comes from the Hazards & Vulnerability Research Institute that collects county-specific damages from natural disasters such as thunderstorms, hurricanes, floods, wildfires, and tornados. Hence, using a difference-in-difference estimation technique, our identification strategy allows us to explore whether the liberalization of banking regulation through the Riegle-Neal Act of 1994 had different consequences for banks facing high (catastrophic) undiversifiable risk (high-cat banks) and banks facing low (catastrophic) undiversifiable risk (low-cat banks).

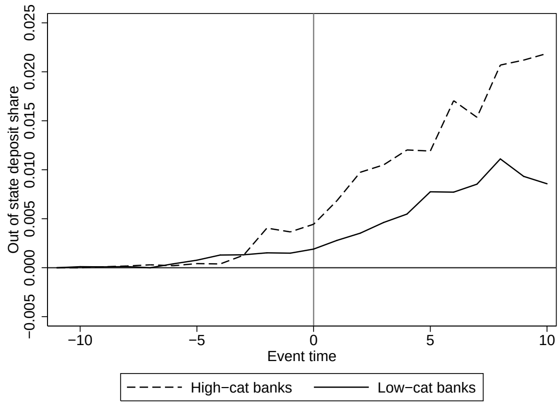
Figure 1 illustrates our baseline result of banks' geographic diversification after banking liberalization through the Riegle-Neal Act of 1994 for the groups of low-cat banks and high-cat banks. The diversification measure (out-of-state share of deposits) is similar between low-cat banks and high-cat banks in 1994, but diverges rapidly subsequently. The right panel shows the same development in event time. The lower part of Figure 1 shows mean values and confidence bandwidths for the group of low-cat banks and high-cat banks before and after the event, respectively. The graphs present results from difference-in-difference regressions from OLS and OLS with year dummies and bank fixed effects. The graphs in the lower panel thereby previews our main results by showing that catastrophic risk in a bank's home market matters significantly for a bank's reaction to the relaxation of geographical restrictions on bank expansion. Banks facing relatively high (catastrophic) undiversifiable risks in their home market expand more rapidly into other states – have higher out-of-state deposit shares – following the Riegle-Neal Act of 1994, and thereby take advantage of the opportunity to diversify geographically, compared to banks facing relatively low (catastrophic) undiversifiable risks. Our results thereby are directly related to Goetz et al. (2014) who show that geographic expansion lowers risk by reducing exposure to idiosyncratic local risks.

In other regression we further show that the diversification effect is not present when we consider within-state diversification opportunities or events in which the banking market were not fully liberalized. Considering different types of banks and organizational forms we find that commercial banks and banks organized in a multi banking holding structure benefited significantly more from the liberalization events in terms of out-of-state diversification. Also, larger banks and banks that did not have many diversification possibilities in their home market before liberalization increase their share of out-of-state deposits significantly more. In terms of the relation between the timing of liberalization

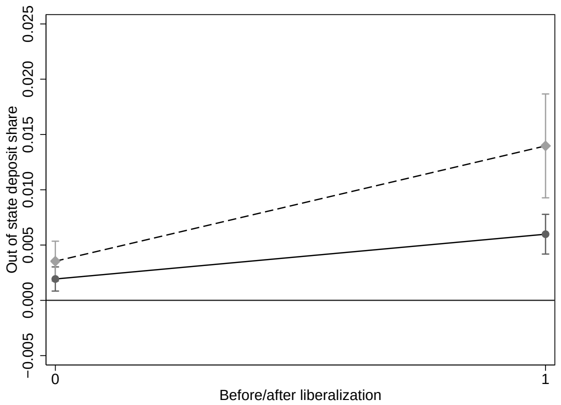
Figure 1: Geographic diversification of banks



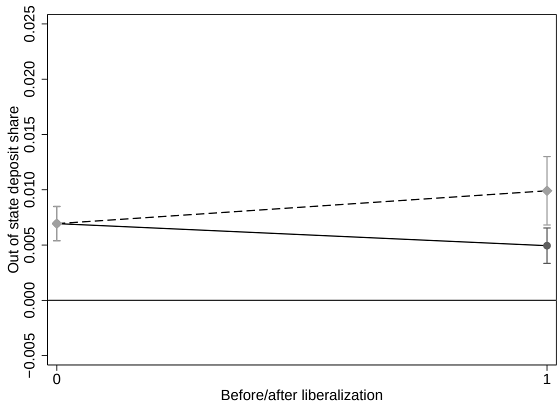
(a) Real time



(b) Event time



(c) DiD (OLS)



(d) DiD (fixed effects)

Notes: The first two graphs of this figure shows the average share of a bank's deposits outside its home state for the groups of banks facing high catastrophic risks (high-cat banks, dashed line) and banks facing low catastrophic risks (low-cat banks, solid line). The solid vertical line in the left graph indicated the year 1995 when the liberalization became effective in the different states of the U.S. The solid line in the right graph indicates the event time at which states liberalized their banking markets in a significant way. Note that the data on banks' deposits by state is not available before 1994. The lower graphs show the difference-in-difference effect for the average share of a bank's deposits outside its home state for the groups of banks facing high catastrophic risks (high-cat banks, dashed line) and banks facing low catastrophic risks (low-cat banks, solid line). The vertical lines indicate the 95% confidence interval.

and our measure of undiversifiable risks, we find that differences between banks in different states regards damages from natural disaster did not significantly affect when the liberalization took place.

The paper contributes to a large literature on bank risk-taking and deregulation in the U.S. and other countries. For example, Keeley (1990) and related also Gan (2004) show that liberalization of banking regulation during the 1970s and 1980s led to higher competition, lower charter values and subsequently higher risk-taking of banks while Brook et al. (1998) show allowing beneficial consolidation following the act. In contrast, Goetz et al. (2013) show that valuations of bank holding companies were negatively affected by the deregulation phase during he 1990s. Rice and Strahan (2010) show that relaxation of geographical restrictions on bank expansion in the 1990s led to lower loan rates for SMEs. In this literature, liberalization of banking regulation, such as relaxation of geographical restrictions on bank expansion, is primarily viewed as a cause for higher competition among banks in their home markets. We are interested in a complementary aspect of such liberalization, namely, that banks can expand into new markets and thereby purse new investment opportunities and diversify.

We further contribute to a growing body of literature that analyzes consequences of catastrophic risk. For example Strobl (2011) investigates the effect of damages from hurricanes in the U.S. Gulf Coast region on local economic growth rates, and finds a considerable decrease of growth rates by on average 0.45 percentage points in affected regions. Related, Cavallo et al. (2013) find that only extremely large disasters adversely affect output on the country level. Garmaise and Moskowitz (2009) use the 1994 Northridge earthquake in California to show that earthquake risk impacts credit markets through a more than 20 percent decreased provision of commercial real estate loans. Very recently, Cortes and Strahan (2014) show that banks operating in many regions reallocate capital after natural disasters in the case, as a consequence, credit demand increases. Additionally, Chavaz (2014) finds that lenders that had very concentrated portfolios in markets affected by the 2005 hurricane season increased lending through loan sales. Klomp (2014) shows that natural disasters decrease the stability of banking sectors by increasing the likelihood of failure of the banks therein.

Our paper proceeds as follows: Section 2 provides some background in U.S. banking market structure. Section 3 describes the data used in this study. Section 4 presents our empirical model and our estimation results. Section 5 concludes.

2 Background on U.S. banking liberalization through the Riegle-Neal Act

The Riegle-Neal Interstate Banking and Branching Efficiency Act of 1994 (Riegle-Neal Act) followed intra-state banking deregulations in the 1980s (Keeley, 1990) and removed many of the restrictions on opening bank branches across state lines. These restrictions were largely the 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. In addition, the Riegle-Neal Act allowed banking organizations to acquire banks in any other state under a uniform, nationwide standard (Johnson and Rice, 2008; Rice and Strahan, 2010).[1]

3 Data

Liberalization of banking and branching restrictions. For each state in the U.S. we consider the particular year when geographic restrictions on banking were significantly removed or relaxed, following the Riegle-Neal Act of 1994. The degree of liberalization differed between states. Following Johnson and Rice (2008) and Rice and Strahan (2010), we consider five categories of liberalization restrictiveness based on the minimum age of institutions for acquisitions, *de novo* interstate branching, acquisitions of single branches, and statewide deposit caps on branch acquisitions. The corresponding "branching restrictiveness index" takes values between 0 and 4 (Rice and Strahan, 2010), where 0 is the least restrictive liberalization. In this study, we consider significant liberalization events that correspond to a value of 0 or 1 ($Event = 1$). This happened in 7 states during the year 1995, in 2 states during 1996, in 4 states during 1997, in 1 state during 1998, in 2 states during 2000, in 3 states during 2001, in 1 state 2002, in 2 states during 2003, in 1 state during 2004, and in 1 state 2005. State legislation that is relatively restrictive (index of 2 to 4) is considered as no significant liberalization ($Event = 0$). We further consider all years before a first liberalization step of a state as $Event = 0$.

[1]Source: www.federalreservehistory.org

Catastrophic risk and definition of "high-cat banks" and "low-cat banks". In order to differentiate between banks that face high or low (catastrophic) undiversifiable risks in their business regions, we need to calculate a catastrophic risk measure for each bank. Ideally, such a measure is forward looking and reflects expectations of each bank about the frequency and impact of catastrophic events. Unfortunately, such a measure is not directly observable. The proxy we use for a bank's catastrophic risk is the actual disaster damage in the bank's business region over the period 1969 to 2012, denoted as $\overline{DIS}_i$.

We calculate $\overline{DIS}_i$ in four steps: First, we determine the yearly damage by county in US$, using over 20.000 individual records on property damages from the *Spatial Hazard Events and Losses Database for the United States* (SHELDUS) for the period 1969 to 2012.[2] The database is provided by the Hazards and Vulnerability Research Institute at the University of South Carolina.[3] Second, we scale these numbers by a county's yearly total personal income, which is available from the *Bureau of Economic Analysis*.[4] 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. The value we obtain for Los Angeles County in 1994 when the Northridge earthquake occurred is 0.0964.

Third, we need to identify how much individual banks operating in one or several counties may be affected by disaster damage. If a bank operates only in one county, our damage measure of bank i at year t, $DIS_{i,t}$, equals the calculated property losses over total personal income of the respective county. For example, Santa Monica Bank (now part of U.S. Bank) had only branches in Los Angeles County in 1994, the year of the Northridge earthquake, and we assign a value $DIS_{i,t}$ equal to the value of Los Angeles County in that year, i.e., 0.0964. If a bank has branches in more than one county, which is the case for the large majority of banks, we calculate $DIS_{i,t}$ as the weighted county damage, using the bank's shares of deposits per county before the liberalization as of 1994 as weights. The deposit data come from the *Summary of Deposits* statistic, which shows

[2]Note that the SHELDUS database is even more extensive. We restrict our analysis to the reported property damages of at least US$ 10 million (inflation-adjusted for 2011).

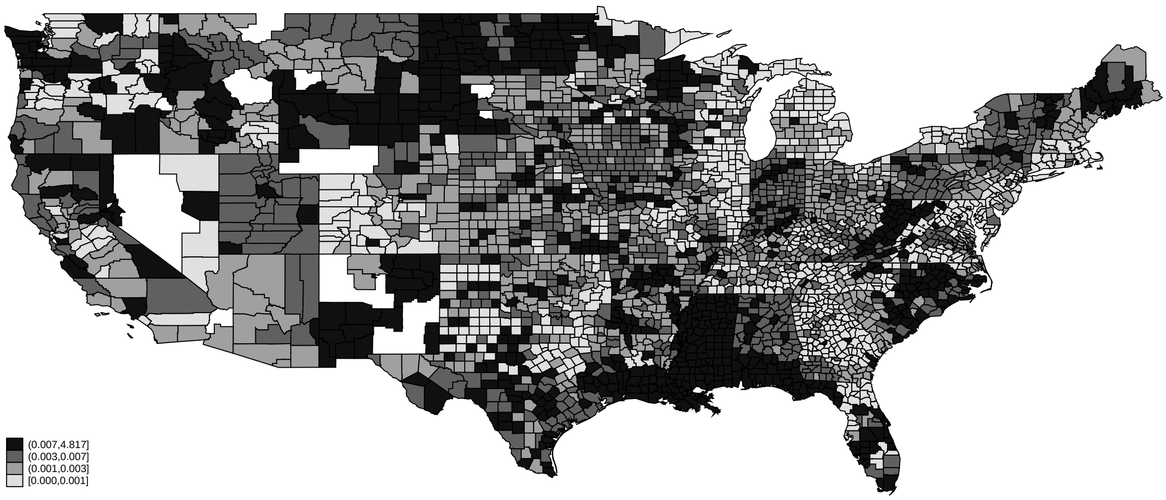
[3]Internet source: webra.cas.sc.edu/hvri.

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

the amount of deposits by branch and county for all U.S. banks since 1994.[5] 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. Because there were no reported disaster damages in Orange county in 1994, Capital Bank gets a value for $DIS_{i,t}$ equal to two-thirds of the disaster damages in Los Angeles County, i.e., 0.0662. Finally, we calculate for each bank the damage $\overline{DIS}_i$ as the average over all $DIS_{i,t}$ from 1969 to 2012.

Average measures of $\overline{DIS}_i$ for all banks with their headquarter in a certain county are illustrated in Figure 2. As the figure shows, banks in some counties are facing on average only small disaster damages (colored in white), while banks in other counties are facing high disaster damages (colored in darker colors). Banks with headquarters in the U.S. Gulf Coast region near New Orleans (2005 Hurricane Katrina), in south Florida (frequent hurricanes) and in Los Angeles county (1994 Northridge earthquake) are among the banks with very high disaster damages $\overline{DIS}_i$ over our sample period.

Figure 2: Losses from natural disasters by county



Notes: The figure shows average measures of $\overline{DIS}_i$ (between 1969 and 2012) for all banks with their headquarter in a certain county.

We assign banks to the group of banks facing relatively high catastrophic risk ("high-cat banks") if their catastrophic risk measure $\overline{DIS}_i$, as described in the previous paragraph, is in the top quartile of the sample. Correspondingly, we assign banks to the group

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

of banks facing relatively low catastrophic risk ("low-cat banks") if their catastrophic risk measure is in the bottom quartile of the sample.

Sample construction, variables and descriptive statistics. We focus our study on banks in the 48 continental states of the United States (excluding Alaska, Hawaii and all off-shore U.S. territories) that experienced significant liberalization in their home state during the sample period 1993 to 2012. We require that a bank existed at least one year before and one year after the respective significant liberalization year in the bank's home state. Further, we exclude banks without consecutive annual data during the sample period. We do not perform any further data cleaning. This leads to a dataset covering 1,655 banks, yielding about 24,564 bank-year observations for our main regressions. From the 1,655 banks we consider 526 banks as high-cat banks. The remaining 1129 banks are the control group of low-cat banks. We give an overview over all variables and descriptions in Table 1.

[Table 1 around here]

Our main dependent variable is DIV, a measure of geographic diversification as a bank's share of deposits outside the bank's home state, based on the *Summary of Deposits* statistics from the FDIC. The data is available on a yearly basis since 1994. The descriptive statistics in Table 2 shows that the mean bank in our sample has about 0.68% of their deposits outside their home state. However, the spread is quite a bit and we find also banks with a share of roughly 23%. Further, Figure 1 also indicates that the share increased for all banks since 1994. The counterpart of the this share is the banks' diversification within the home state ($DIV(WS)$). We find that banks on average have 14% of their deposits outside their home county but within home-state borders.

We use a set of variables for controlling for regional dynamics and to differentiate between different groups of banks. Therefore, we use year-end financial information on U.S. banks for the period 1993 to 2012, as provided by the Federal Deposit Insurance Corporation (FDIC).[6] The database contains data from banks' "call reports" for all banks that are regulated by the FDIC. The data thereby provide the information that the sample includes thrifts and savings banks by around 23% (by a dummy variable BM), 38% are independent (IP), 17% belong to a multi-bank holding company ($MBHC$) and 2% are

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

part of a multi-state – active in more than one state – bank holding company. The information about these groups are taken in the years before the first liberalization wave. In the same vein we calculate per bank a measure $Size$ that is the natural logarithm of total assets and HHI as the average deposit market concentration a bank faced. Last, we compute $SD(DIS)$ which is the per state volatility (standard deviation) of damages from natural disasters over personal income between 1969 and 2012. We also employ county-specific unemployment rates[7] (UR) and the Case-Shiller house price index[8] (CS) on the state level.

[Table 2 around here]

4 Empirical model and results

4.1 The effect of catastrophic risk on banks' geographic diversification

Our main analysis tests whether banks responded differently to the liberalization of the Riegle-Neal Act of 1994 depending on whether they faced high or low (catastrophic) undiversifiable risks in their home markets. We estimate the following difference-in-difference model:

$$DIV_{it} = \nu_i + \beta_1 \text{Event}_{jt} + \beta_2(\text{Event}_{jt} \times \text{Risk}_i) + \gamma_1 UR_{rt} + \gamma_2 CS_{st} + \tau_t + e_{it} \qquad (1)$$

DIV_{it} represents our measure of diversification, defined as a bank's share of deposits outside the bank's home market, i.e., the home state, for bank i at year t. The variable $Risk$ shows whether a bank faces high catastrophic risks in its home market ($Risk = 1$, high-cat risk banks) or not ($Risk = 0$, low-cat risk banks). The variable $Event_{jt}$ is 0 before a significant liberalization in state j at year t, and 1 afterwards. We are most interested in the differential effect β_2, which tells us whether banks facing high catastrophic risk diversify relatively more or less after the regulatory change in comparison to the banks facing low catastrophic risk.

We control for bank fixed effects ν_i and year fixed effects τ_t. We further introduce two regional control variables that vary over time. UR_{rt} indicates the year-end unemployment

[7]See www.bls.gov

[8]See www.bea.gov.

rate for county r in year t and control for business cycle effects in our regression. Moreover, CS_{st} is the Case-Shiller house price index for state s and year t that cover different developments in real estate markets between states.

Results for regressions of Equation (1) are shown in Column (1) of Table 3. The coefficient of the interaction term β_2 of 0.005 shows that banks acting in regions with high catastrophic risk significantly increase geographic diversification relative to the group of low catastrophic risk banks by 50 basis points. Given a mean value for DIV about 0.68%, this effect is economically important. The following Columns (2) to (4) corroborate this result for specifications without bank and/or year fixed effects. The variable *Event* in Column (2) and (3) thereby indicates that during the sample period, the control group of banks facing rather low damages from natural disasters increase its out-of-state deposit share also by 41 and 22 basis points, respectively. The second column further indicates – by the coefficient of *Risk* – that the difference in diversification between high-cat and low-cat banks was already around 16 basis points before the significant liberalization, given a setup without year and bank fixed effects. In summary, we find that catastrophic risk in a bank's home market matters significantly for a bank's geographic diversification following the Riegle-Neal Act of 1994.

[Table 3 around here]

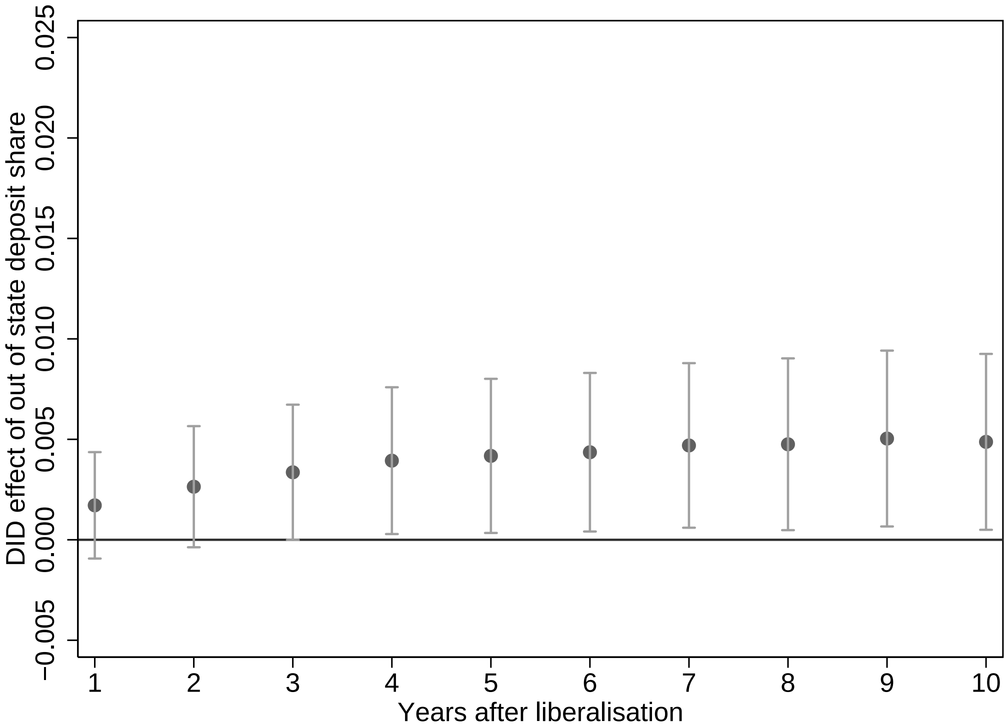
The time dimension of the difference-in-difference effect is illustrated in Figure 3.[9] Each point in the figure shows the coefficient and the 95% confidence interval of the interaction effect β_2 for a regression with a sample period considering 1, 2,. . . , 10 years after a significant liberalization event. Results show that the diversification effect becomes significant three years after the liberalization. The coefficient for a sample period up to 10 years after the liberalization event resembles the results shown in Column (1) of Table 3, which uses the full sample period.

4.2 Within state diversification and non-significant liberalization events

Table 4 resembles the regressions from Table 3 but uses the within-home state diversification ($DIV(WS)$) as dependent variable. We do this in order to check whether damages

[9]Regressions are unreported and available upon request.

Figure 3: Effect after the event



Notes: The figure shows the interaction effect β_2 and its 95% confidence interval from regression of Equation (1 with a sample period considering 1, 2,. . . , 10 years after a significant liberalization event.

from natural disasters are also driving high-cat banks to diversify within-state borders, too. The regression results show that within-state diversification is not significantly different for the high-cat banks after a significant liberalization with regard to the low-cat banks as reflected by the coefficient of the interaction term. Interestingly, the column (2) to (4) indicate that the low-cat banks (the control group) increase diversification also within-state borders. Although, this time the diversification activities of high-cat are not significantly larger. Both *Risk* coefficients in Column (2) and (3) indicate that high-cat banks already diversified more within states before the liberalization of the 1990s took place. Overall, the results of Table 4 in comparison to our baseline results show that the significant liberalization was important for high-cat banks since it allowed those banks to diversify across state borders and not only within their home states, where they potentially already absorbed all diversification possibilities.

[Table 4 around here]

To further explore how the intensity of liberalization affects our results Table 5 shows regression results for our baseline regression for liberalization waves that were less significant, i.e., indices higher than 1 according to the index of Rice and Strahan (2010). Column (1) thereby replaces the event variable by a dummy that is zero before the first liberalization wave and 1 afterwards. In Column (2) and (3) this event dummy changes to 1 if the liberalization intensity was at least 3 or 2 according to Rice and Strahan (2010). We further introduces a dummy variable $SigLIB$ indicating whether a state liberalized significantly (and index below 2) at the event that we consider. Thereby, Table 5 is organized in the sense that the upper part shows the interaction between $Risk$, $Event(4)$ to $Event(2)$, the number indicates the minimum level of liberalization that we consider for the event to shift to one, and $SigLIB$. The triple interaction thereby indicates whether the difference-in-difference effect is significantly different for banks in states that liberalized up to an index value of 4, 3 or 2 and the banks in states that liberalized below a value of 2. The lower part shows the difference-in-difference effect for both groups separately.

[Table 5 around here]

The results of Table 5 shows that liberalization events in which states lowers restrictions only to a level of 4, 3 or 2 do not trigger the high-cat banks to significantly diversify more after liberalization in comparison with the low-cat banks. But, if we focus again on the states that liberalized significantly, our main results show up in each of the specifications of Table 5. Thereby, Table 5 shows that not every liberalization wave produce enough opportunities for banks to diversify away from their home states.

4.3 Bank types and bank characteristics

This section explores whether certain bank types or bank characteristics drive our main results. Therefore, we consider in Table 6 differences between banks in the year before the significant liberalization took place in the form of business models (commercial vs savings banks or thrifts, BM), independence (independent banks vs banks belonging to a bank holding company, IP), multibank holding companies (MBHC) and banks that belong to a holding structure that spreads across at least one state border (MSBHC). Again, Table 6 is organizes as follows: the upper part shows the triple interaction between $Risk$, $Event$ and the dummy that separates the specific banking types. The lower part further shows the interaction affect between *Risk* and *Event* for the bank types, respectively. The results of Table 6 thereby show that commercial banks show a significant increase with respect to diversification – relative to the control group – after liberalization when they are considered as a high-cat bank. But, this effect is not significantly different from the high-cat savings banks and thrifts in our sample. The second column shows very similar results when we compare independent banks with banks belonging to a bank holding company. We find a weak significant interaction effect for the bank holding company banks but this effect is not statistically different from the effect of independent banks. This is different for the third column of Table 6 in which we consider differences between multi bank holding companies and all other banks in the sample. There we find that the interaction effect is only significant for banks belonging to a multi bank company and that this effect is also significantly different from the other banks in the sample. Last, Column (4) even shows that the diversification effect of high-cat banks is the strongest when we consider banks that did belong to a bank holding company that operated in multi states. In sum, the results of Table 6 might suggest that a sufficient factor for diversification for high-cat banks following the liberalization is, that they belong to a large enough network of banks. Our results thereby also suggest that diversification is harder to achieve for single or single bank holding company banks that were too local before liberalization. In other words, only those banks that had a crucial size and scope could afford to reap the fruits of the liberalization wave of the 1990s.

To further analyze which high-cat banks are more likely to diversify, Table 7 further explores other *pre liberalization* characteristics of banks. Again, the upper part of Table 7 shows the triple interaction between *Risk*, *Event* and the specific bank characteristic and the lower part explores the conditional marginal effects for the main parts of the distribution of the respective characteristic. Column (1) of Table 7 starts by exploring the effect of bank size on the differential effect β_2 of Equation (1). What we find is that high-cat banks that were larger at the time of the liberalization diversify significantly more than smaller banks. The lower part of the table shows that this effect comes into place for the top half of the size distribution. This result corroborates in a way the results of Table 6 in which we show that there might be a potential size of the network of the high-cat banks that allows for diversification after the liberalization.

Besides size, diversification possibilities within-states that were feasible for some high-cat banks before liberalization might also play an important role for the diversification decisions enabled by the significant liberalization wave. We therefore differentiate banks according to their state specific volatility of damages from natural disaster, i.e., $SD(DIS)$. A higher value of $SD(DIS)$ means that the standard deviation of natural disasters arising in counties in one state is higher and therefore, there should be more possibilities for the resident banks to diversify away from the risk of natural disasters already before liberalization took place. The regression results in Column (2) show exactly this. The triple interaction term is significant and negative indication that high-cat banks located in states with a higher $SD(DIS)$ diversify significantly less after liberalization than high cat banks in states with a lower volatility from damages due to natural disasters. As the lower part of Table 7 shows, this is effect becomes important for the top 50% of the distribution of $SD(DIS)$. This result highlights that banks that already had some diversification possibilities within-state borders before the liberalization wave during the 1990s have been in less need to diversify into other states.

The last column of Table 7 finally investigates the interaction effect regards the average concentration of deposits a banks faced in the markets it was active before the liberalization came into effect. The result of this column shows that the market concentration plays no role for the interaction effect of *Risk* and *Event*.

4.4 Does catastrophic risk drive state-level deregulation?

Next, we take up the question raised by Kroszner and Strahan (1999) and explore the role of catastrophic risk on bank deregulation following the Riegle-Neal Act of 1994. In more detail, Kroszner and Strahan (1999) use a set of state-specific bank characteristics like asset shares, capital ratios, yields and insurances to banking as well as political indicators like the party of the running government to explain why some state deregulated their banking markets earlier than other. Using a hazard model they find that a larger share of small banks and higher capital ratios of theses banks delayed deregulation. Also, they find that states ran by a Republican government deregulated earlier. Kroszner and Strahan (1999) summarize that private interests seems to have a larger impact on deregulation than public-interest grounds.

$$h[t, \boldsymbol{x}(t), \boldsymbol{b}] = h_0(t) \exp[\boldsymbol{x}(t)'\boldsymbol{b}] \tag{2}$$

We follow Kroszner and Strahan (1999) and estimate two versions of hazard models using the Weibull distribution that explain i) the time to the significant liberalization wave per state and ii) the time to the first liberalization wave per state. Our explanatory variables on the right-hand side that belongs to the vector $\boldsymbol{x}$ comprises damages from natural disasters (scaled by total personal income) between 1969 and 2012 ($\overline{\text{DIS}}$) and UR and CS as the average unemployment rates and the Case-Shiller house price index on the state level, respectively. We further include the state-specific share of savings banks and thrifts (BM), the share of independent banks (IP) and the share of banks that belonged to a multi bank holding companies ($MBHC$). We also estimate the effect of $Size$ and and EQ which are state-specific measures of average bank size (log of total assets) and the equity-asset ratio, respectively. All control variables – except $\overline{\text{DIS}}$ – are measured in the year before the first liberalization took place. Table 8 shows regression results for all hazard models and provide descriptive statistics for all independent variables in the lower panel.

[Table 8 around here]

Column (1) of Table 8 indicates that higher state-specific damages from natural disasters do not increase the likelihood of an earlier significant liberalization. This result holds when we include the other control variables in Column (2). Here, only the coefficients for the Case-Shiller Index, the share of savings banks and thrifts and the share of banks belonging to a multi bank holding company are significant. On an economic scale, a increase by the Case-Shiller Index of one standard deviation (35.6) decrease the time to a significant liberalization by 42% indicating that states with a better mortgage market are more likely to fully liberalize early. In contrast Column (2) shows that higher share of savings banks and thrifts as well as a higher share of banks in multi bank holding companies increase the time at which the states liberalized significantly. Column (3) and (4) of Table 8 draw a very similar picture of the effects for the time to the first liberalization wave. Again, scaled damages from natural disasters have no significant influence on the time when states liberalized in regressions with and without other control variables. Column (4) shows that a higher unemployment rate, a higher share of independent banks and a higher share of $MBHC$ banks delay the time when a state liberalizes its banking system according to multi state banking and branching restrictions for the first time.

Overall, the results from Table 8 indicate that the time of liberalization and the kind of liberalization seems to be unrelated to differences in severity with which banks in different states have to cope with damages from natural disaster. This is important because it further corroborates our assumption about the potential exogeneity of the natural disaster variable for the identification of Equation (1), our main regression.

5 Conclusion

In this study we use two sources to identify the effect of banking sector liberalization on diversification of banks. First, we use damages from natural disasters to separate between banks facing high and low undiversifiable risk and thereby should be more or less in need to increase diversification. Second, we observe the point in time at which deregulation on the state level, the Riegle-Neal Act of 1994, allowed banks to do banking and branching in other states than their home states. We use this liberalization to investigate whether the banks that face higher undiversifiable risk – the high-cat banks – diversify more after deregulation in comparison to the banks facing low undiversifiable risk that serve as the control group.

We find that liberalization of banking markets between U.S. states during the 1990s enabled banks that are confronted with higher risk from natural disasters to diversify more across state borders than the group of control banks. The effect is statistically significant, robust through many checks and also economically relevant. If we compare two banks that differ by one standard deviation in our risk variable, banks facing high catastrophic risk increased geographic diversification by 50 basis points. In terms of diversification, this would mean an increase of more than one standard deviation.

Our results further highlight that banks size and an advanced networks, like a multi bank holding structure, of the high-cat banks before liberalization make the diversification effect even more pronounced. We also show that not every liberalization wave allow for a significant diversification of the high-cat banks. Only a significant liberalization – an index value of less than 2 according to Rice and Strahan (2010) – provide enough possibilities for banks to diversify significantly across state borders. Additionally, banks that did not have enough diversification possibilities in their home states before the liberalization, diversify more actively after the lifting of entry barriers to other states.

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Appendix: Tables

Table 1: Variable description

Variable name	Description
$\overline{\text{DIS}}$	**Average disaster damages:** The average property disaster damages over total personal income by bank for the period 1969 to 2012, using banks' summary of deposits before a significant liberalization as weights. Source: SHELDUS database, Bureau of Economic Analysis, FDIC Summary of Deposits, and own calculations.
SD(DIS)	**Volatility of disaster damages:** The state specific standard deviation of property disaster damages over total personal income for all banks in a state for the period 1969 to 2012.
DIV	**Out-of-state diversification:** Measured as a bank's share of deposits that the bank has outside its home state (where its headquarter is located).
DIV	**Within state diversification:** Measured as a bank's share of deposits that the bank has outside its home county (where its headquarter is located) but within its home state.
Event	**Liberalization event:** State legislation with a "branching restrictiveness index" of zero or one according to Rice and Strahan (2010).
Risk	**Catastrophic risk:** This is a binary variable with a value of one if the bank is classified as high-cat bank, and zero if the bank is classified as low-cat bank. See Section 3 for details.
CS	**Case-Shiller index:** This index reflects regional estate prices. We use it on state level. Our source for this index is the Federal Reserve Bank of St. Louis.
UR	**Rate of unemployment per county:** This variable is the county-level information provided by the Bureau of Labor Economics related to the unemployment rate.
	Size: We calculate the z-score for each bank and quarter as the natural logarithm of the sum of a bank's return on assets and its core capital ratio, standardized by the 12-quarter rolling standard deviation of the bank's return on assets.
BM	**Banks' business models:** Indicates whether a bank is a thrift or a savings banks (1) or not (0) in the year before liberalization took place.
IP	**Banks' independence:** Indicates whether a bank belong to a bank holding company (1) or not (0) in the year before liberalization took place.
MBHC	**Multi bank holding company:** Indicates whether a bank belongs to a multi bank holding company (1) or not (0) in the year before liberalization took place.
MSBHC	**Multi state bank holding company:** Indicates whether a bank belongs to a multi state bank holding company (1) or not (0) in the year before liberalization took place.
Size	**Bank size:** Indicates the natural logarithm of a bank's total assets (FDIC code: asset) in the year before liberalization took place.
HHI	**Banking markets structure:** Indicates the average concentration in term of deposits a bank faced in all its markets in the year before liberalization took place.

The source for the variables below as well as their descriptions is the *Federal Deposit Insurance Corporation (FDIC)* website, if not stated otherwise.

Table 2: Descriptive statistics

	Mean	SD	Percentiles	
			$1st$	$99th$
DIS	0.0017	0.0064	0.0000	0.0245
DIV	0.0068	0.0413	0.0000	0.2267
DIV(WS)	0.1433	0.2188	0.0000	0.8756
CS	2.6184	0.8932	1.2226	5.5533
UR	0.0577	0.0241	0.0200	0.1310
BM	0.2251	0.4176	0.0000	1.0000
IP	0.3831	0.4861	0.0000	1.0000
MBCH	0.1713	0.3768	0.0000	1.0000
MSBHC	0.0208	0.1427	0.0000	1.0000
Size	11.4197	1.1299	8.9103	14.9036
SD(DIS)	0.0597	0.2467	0.0009	1.7280
HHI	0.1561	0.1080	0.0381	0.3137
Observations	24564			
Banks	1655			

This table shows descriptive statistics. See Table 1 for a detailed description of all variables.

Table 3: Out of state diversification

Dependent variable:	DIV			
	(1)	(2)	(3)	(4)
Event	-0.0020	0.0041***	0.0022**	0.0007
	(0.0013)	(0.0010)	(0.0010)	(0.0011)
Event × Risk	0.0050**	0.0064***	0.0056**	0.0067***
	(0.0023)	(0.0023)	(0.0023)	(0.0023)
Risk		0.0016**	0.0010	
		(0.0007)	(0.0008)	
CS	0.0016	0.0021**	0.0007	0.0055***
	(0.0018)	(0.0009)	(0.0012)	(0.0010)
UR	-0.1003**	0.0411	-0.0025	0.0515**
	(0.0475)	(0.0252)	(0.0386)	(0.0203)
Constant	0.0024	-0.0058**	-0.0011	-0.0128***
	(0.0048)	(0.0023)	(0.0034)	(0.0025)
Bank FE	Yes	No	No	Yes
Year FE	Yes	No	Yes	No
Observations	24564	24564	24564	24564
Banks	1655	1655	1655	1655
Adj. R2	0.0343	0.0151	0.0173	0.0270

This table shows results for Equation (1), using the share of deposits outside a bank's home state as dependent variable. The first column covers a sample period from 1994 to 2005, and the second column covers a sample period from 1994 to 2010. Event is a dummy that is 0 for the years prior to the liberalization in a specific state and 1 afterwards. Risk is dummy that is 0 for banks facing relatively low damages from natural disasters and 1 for banks facing relatively high damages from natural disasters. Event×Risk is the interaction between both dummies. Clustered standard errors (by bank) are in parentheses. All regressions include year fixed effects. ***, ** and * indicate significant coefficients at the 1%, 5%, and 10% levels, respectively. See Table 1 for a detailed description of all variables.

Table 4: Within-state diversification

Dependent variable:	DIV(WS)			
	(1)	(2)	(3)	(4)
Event	0.0040	0.0715***	0.0812***	0.0295***
	(0.0047)	(0.0074)	(0.0091)	(0.0043)
Event × Risk	-0.0044	0.0069	0.0076	0.0046
	(0.0069)	(0.0118)	(0.0123)	(0.0069)
Risk		0.0324***	0.0352***	
		(0.0107)	(0.0107)	
CS	-0.0085	0.0094**	0.0152**	0.0243***
	(0.0053)	(0.0047)	(0.0070)	(0.0035)
UR	-0.0117	0.1319	0.0705	0.4548***
	(0.1463)	(0.1556)	(0.2423)	(0.0711)
Constant	0.1034***	0.0494***	0.0550**	0.0322***
	(0.0137)	(0.0145)	(0.0221)	(0.0090)
Bank FE	Yes	No	No	Yes
Year FE	Yes	No	Yes	No
Observations	24564	24564	24564	24564
Banks	1655	1655	1655	1655
Adj. R2	0.1145	0.0371	0.0389	0.0881

This table shows results for Equation (1), using the share of deposits outside a bank's home county (but within its home state) as dependent variable. The first column covers a sample period from 1994 to 2005, and the second column covers a sample period from 1994 to 2010. Event is a dummy that is 0 for the years prior to the liberalization in a specific state and 1 afterwards. Risk is dummy that is 0 for banks facing relatively low damages from natural disasters and 1 for banks facing relatively high damages from natural disasters. Event×Risk is the interaction between both dummies. Clustered standard errors (by bank) are in parentheses. All regressions include year fixed effects. ***, ** and * indicate significant coefficients at the 1%, 5%, and 10% levels, respectively. See Table 1 for a detailed description of all variables.

Table 5: Out of state diversification: other events

Dependent variable:	DIV		
	(1)	(2)	(3)
Event(4)	0.0009		
	(0.0009)		
Event(4) × Risk	0.0003		
	(0.0010)		
Event(4) × SigLIB	0.0028*		
	(0.0016)		
Event(4) × Risk × SigLIB	0.0096**		
	(0.0049)		
Event(3)		-0.0009	
		(0.0011)	
Event(3) × Risk		-0.0007	
		(0.0011)	
Event(3) × SigLIB		0.0028	
		(0.0017)	
Event(3) × Risk × SigLIB		0.0105**	
		(0.0049)	
Event(2)			-0.0013
			(0.0014)
Event(2) × Risk			-0.0001
			(0.0018)
Event(2) × SigLIB			0.0025
			(0.0021)
Event(2) × Risk × SigLIB			0.0101**
			(0.0051)
CS	0.0043***	0.0046***	0.0067***
	(0.0012)	(0.0013)	(0.0019)
UR	-0.0150	-0.0261	-0.0777**
	(0.0195)	(0.0226)	(0.0326)
Constant	-0.0059**	-0.0059**	-0.0074*
	(0.0025)	(0.0028)	(0.0042)
Bank FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	76634	57283	33391
Banks	5415	4056	2261
Adj. R2	0.0291	0.0309	0.0413
Event × Risk for SigLIB=0	0.0003	-0.0007	-0.0001
	(0.0010)	(0.0011)	(0.0018)
Event × Risk for SigLIB=1	0.0098**	0.0098**	0.0100**
	(0.0047)	(0.0047)	(0.0047)

This table shows results for Equation (1), using the share of deposits outside a bank's home state as dependent variable. The first column covers a sample period from 1994 to 2005, and the second column covers a sample period from 1994 to 2010. Event is a dummy that is 0 for the years prior to the liberalization in a specific state and 1 afterwards. Risk is dummy that is 0 for banks facing relatively low damages from natural disasters and 1 for banks facing relatively high damages from natural disasters. Event×Risk is the interaction between both dummies. SigLIB indicates states with a significant liberalization for each liberalization wave. Clustered standard errors (by bank) are in parentheses. All regressions include year fixed effects. ***, ** and * indicate significant coefficients at the 1%, 5%, and 10% levels, respectively. See Table 1 for a detailed description of all variables.

Table 6: Out of state diversification: bank types

Dependent variable:	DIV			
	(1)	(2)	(3)	(4)
Event	-0.0021	-0.0014	-0.0025*	-0.0025*
	(0.0014)	(0.0016)	(0.0014)	(0.0013)
Event × Risk	0.0040*	0.0055*	0.0029	0.0046**
	(0.0024)	(0.0028)	(0.0023)	(0.0022)
Event × Risk × BM	0.0073			
	(0.0077)			
Event × Risk × IP		-0.0025		
		(0.0047)		
Event × Risk × MBHC			0.0127*	
			(0.0077)	
Event × Risk × MSBHC				0.0804*
				(0.0448)
Event × BM	0.0006			
	(0.0029)			
Event × IP		-0.0019		
		(0.0022)		
Event × MBHC			0.0021	
			(0.0024)	
Event × MSBHC				0.0206**
				(0.0101)
CS	0.0014	0.0018	0.0017	0.0016
	(0.0018)	(0.0018)	(0.0018)	(0.0018)
UR	-0.1043**	-0.0981**	-0.1010**	-0.1005**
	(0.0477)	(0.0476)	(0.0476)	(0.0475)
Constant	0.0031	0.0020	0.0025	0.0027
	(0.0048)	(0.0048)	(0.0048)	(0.0048)
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	24564	24564	24564	24564
Banks	1655	1655	1655	1655
Adj. R2	0.0348	0.0346	0.0367	0.0410
Dummy=0	0.0040*	0.0055*	0.0029	0.0046**
	(0.0024)	(0.0028)	(0.0023)	(0.0022)
Dummy=1	0.0113	0.0030	0.0156**	0.0850*
	(0.0072)	(0.0037)	(0.0073)	(0.0447)

This table shows results for Equation (1), using the share of deposits outside a bank's home state as dependent variable. The first column covers a sample period from 1994 to 2005, and the second column covers a sample period from 1994 to 2010. Event is a dummy that is 0 for the years prior to the liberalization in a specific state and 1 afterwards. Risk is dummy that is 0 for banks facing relatively low damages from natural disasters and 1 for banks facing relatively high damages from natural disasters. Event×Risk is the interaction between both dummies. Clustered standard errors (by bank) are in parentheses. All regressions include year fixed effects. ***, ** and * indicate significant coefficients at the 1%, 5%, and 10% levels, respectively. See Table 1 for a detailed description of all variables.

Table 7: Out of state diversification: size, volatility and concentration

Dependent variable:	DIV		
	(1)	(2)	(3)
Event	-0.0642***	-0.0028**	0.0033
	(0.0148)	(0.0013)	(0.0024)
Event × Risk	-0.0572**	0.0061***	0.0063
	(0.0285)	(0.0024)	(0.0042)
Event × Risk × Size	0.0055**		
	(0.0026)		
Event × Risk × SD(DIS)		-0.0214*	
		(0.0127)	
Event × Risk × HHI			-0.0212
			(0.0199)
Event × Size	0.0054***		
	(0.0013)		
Event × SD(DIS)		0.0182	
		(0.0120)	
Event × HHI			-0.0252**
			(0.0107)
CS	0.0003	0.0013	0.0023
	(0.0018)	(0.0019)	(0.0018)
UR	-0.1187**	-0.1026**	-0.0818*
	(0.0476)	(0.0474)	(0.0474)
Constant	0.0061	0.0031	0.0002
	(0.0048)	(0.0048)	(0.0048)
Bank FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	24564	24564	24564
Banks	1655	1655	1655
Adj. R2	0.0517	0.0363	0.0364
5^{th}	-0.0025	0.0061	0.0054
	(0.0031)	(0.0024)	(0.0035)
25^{th}	0.0024	0.0059	0.0047
	(0.0018)	(0.0023)	(0.0031)
50^{th}	0.0064***	0.0053**	0.0041
	(0.0024)	(0.0023)	(0.0027)
75^{th}	0.0106***	0.0047**	0.0006
	(0.0041)	(0.0023)	(0.0029)
95^{th}	0.0184**	0.0008	-0.0003
	(0.0076)	(0.0035)	(0.0035)

This table shows results for Equation (1), using the share of deposits outside a bank's home state as dependent variable. The first column covers a sample period from 1994 to 2005, and the second column covers a sample period from 1994 to 2010. Event is a dummy that is 0 for the years prior to the liberalization in a specific state and 1 afterwards. Risk is dummy that is 0 for banks facing relatively low damages from natural disasters and 1 for banks facing relatively high damages from natural disasters. Event×Risk is the interaction between both dummies. Clustered standard errors (by bank) are in parentheses. All regressions include year fixed effects. ***, ** and * indicate significant coefficients at the 1%, 5%, and 10% levels, respectively. See Table 1 for a detailed description of all variables.

Table 8: Hazard model of catastrophic risk affecting state branching deregulation

Dependent variable:	Time to liberalization			
	Significant liberalization		First Liberalization wave	
	(1)	(2)	(3)	(4)
$\overline{\text{DIS}}$	-5.5933	4.6848	2.6984	9.8339
	(7.7887)	(9.8375)	(5.1549)	(7.1439)
UR		1.9761		6.7325**
		(2.2027)		(2.9064)
CS		-0.0119**		0.0012
		(0.0053)		(0.0048)
Size		-0.4096		-0.7048
		(0.4909)		(0.5316)
EQ		23.4068		-7.1406
		(18.6037)		(19.5476)
BM		9.9263***		-2.4199
		(1.6726)		(1.5517)
IP		1.6742		9.9326***
		(2.9744)		(2.6558)
MBHC		5.6071*		7.1665**
		(2.9708)		(2.8607)
Constant	-2117.9689***	-3247.0057***	-19302.1015***	-23765.6306***
	(624.2777)	(663.9376)	(2908.7993)	(2981.3324)
Observations	48	48	48	48
Log likelihood	210.4174	228.9709	306.2266	315.8083
p-value of χ^2 regression	0.4727	0.0000	0.6006	0.0000
Descriptive statistics:	Mean	SD	Percentiles	
			$1st$	$99th$
$\overline{\text{DIS}}$	0.0122	0.0201	0.0006	0.1184
UR	0.0662	0.0514	0.0162	0.2817
CS	187.7994	35.5962	126.1600	295.1300
Size	11.6236	0.6138	10.5307	13.5674
EQ	0.1090	0.0136	0.0889	0.1675
BM	0.2063	0.1980	0.0169	0.8178
IP	0.3748	0.1829	0.0847	0.7581
MBCH	0.2335	0.1168	0.0225	0.4661

The upper part of this table shows hazard rate regression coefficients explaining the time to the year of the significant liberalization (first and second column) and the year of the first liberalization wave (third and fourth column) for each state. The descriptive statistics for all independent variables, measured in the year before the first liberalization wave took place, are presented in the lower part. ***, ** and * indicate significant coefficients at the 1%, 5%, and 10% levels, respectively. See Table 1 for a detailed description of all variables.