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Do financial crises cleanse the banking industry? Evidence from US commercial bank exits☆

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ABSTRACT

We examine the cleansing effect of financial crises via their contribution to the exit of inefficient US commercial banks from 1984 to 2013. We find a larger increase in the exit likelihood of less efficient banks as compared to more efficient banks in the years of the Savings and Loans Crisis but not during the Global Financial Crisis. We highlight how the magnitude of the shock of the Global Financial Crisis and the subsequent, broad government interventions might explain these different results. Furthermore, we highlight that both crisis periods have a disproportionate effect on young banks regardless of their efficiency levels and that they do not generate any positive spillover effects on surviving banks in the three years post-crises in spite of some reallocation benefits in favor of new entry banks. Our findings highlight that forms of prudential regulation designed to strengthen bank resilience in good times might contribute to mitigating the effects of crisis on the longer-term productivity of the banking industry.

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1. Introduction

Numerous studies highlight the large costs of financial crises in terms of financial instability and the decline of economic growth (Boyson et al., 2014; Brunnermeier, 2009; Dell' Ariccia et al., 2008; Flannery et al., 2013; Reinhart and Rogoff, 2014). While these costs are indisputable, more controversial is the possibility that some benefits might arise from these crises in terms of the exit of less productive firms (Hallward-Driemeier and Rijkers, 2013; Knott and Posen, 2005). The proponents of these benefits see crises as a selection process that accelerates the removal of the least productive firms with an overall positive effect at the industry level (Bresnahan and Raff, 1991; Hallward-Driemeier and Rijkers, 2013; Petrosky-Nadeau, 2013). This argument is formalized in the cleansing view of real and financial shocks, dating back to Schumpeter (1939) and his concept of creative destruction.

In this paper we evaluate whether the cleansing view applies to the exit of US commercial banks during the major episodes of financial crisis that occurred between 1984 and 2013. Understanding whether or not there is a cleansing effect in the banking industry during financial crises has important implications for regulators and policy makers. For instance, in the absence of a cleansing effect, government policies intended to reduce the short-term impact of crises are not in conflict with the longer-term objective of maximizing the productivity of the banking industry (Hallward-Driemeier and Rijkers, 2013).

The literature does not investigate the cleansing effect of financial crises in the banking industry but focuses on non-financial firms with conflicting findings. A first group of studies, looking at economic recessions (Bresnahan and Raff, 1991; Caballero and Hammour, 1994), offers support to the cleansing view and concludes that firms that do not keep up with innovations eventually fail. A second group of studies (Hallward-Driemeier and Rijkers, 2013; Nishimura et al., 2005), by examining financial shocks, shows that financial crises destroy firms, regardless of their degree of productivity, and lead to a scarring effect (see Barlevy, 2002, 2003; Blalock et al., 2008; Ouyang, 2009, for a related argument). An exception to this conclusion is contained in Berton et al. (2018), who study firms in an Italian region during the period 2008–2012.

Our analysis departs in two key respects from the existing studies on non-financial firms. First, we examine and compare the exit of commercial banks during two major crises – the Savings and Loans (S&L) crisis of the mid-eighties and the Global Financial Crisis (GFC) of 2007–2010. These crises show key differences in terms of exit. While the number of commercial banks that failed during

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the S&L crisis was greater than during the GFC, the latter crisis involved a much larger proportion of failed bank deposits. This is in line with the widely accepted view that the GFC is the most severe systemic shock that has hit the banking industry since the Great Depression (Altunbas et al., 2017; Brunnermeier, 2009; Laeven and Valencia, 2010). Therefore, analyzing the two crises with different features allows us to understand whether it is possible to reach general guidelines on crisis management in banking.

Second, we account for two bank exit mechanisms: failure and acquisition. The consideration of acquisitions is critical in any study of bank exit, as weak banks are more likely to be acquisition targets (Focarelli et al., 2002; Hannan and Pilloff, 2009; Wheelock and Wilson, 2000). Furthermore, regulators often favor the take-over of troubled institutions by healthier ones, especially during periods of distress, to contain the spread of panic (Berger et al., 1999). Hence, ignoring acquisition as an exit mechanism of unproductive banks might result in misleading conclusions in terms of bank exit via failure (DeYoung, 2003).

To identify the least productive banks, we follow a strand of the literature that examines the effects of bank productivity (measured in terms of efficiency) on bank exit without a specific focus on crisis periods (Cebenoyan et al., 1993; Focarelli et al., 2002; Hermalin and Wallace, 1994; Knott and Posen, 2005; Koetter and Poghosyan, 2010; Luo, 2003; Wheelock and Wilson, 2000). Accordingly, we measure bank productivity using cost efficiency, thus quantifying how effectively resources are used to produce bank outputs.

We test the interacting effect of crisis periods and bank efficiency on bank exit using a multinomial logistic regression as in DeYoung (2003). We find that the S&L crisis accelerates the removal of the least efficient institutions via both exit mechanisms, as suggested by the cleansing view. In contrast, the GFC increased the probability of failure of all banks, regardless of their levels of efficiency and favored the acquisition of banks with the highest degrees of efficiency. Our results are similar in settings that reduce endogeneity concerns. Furthermore, the cleansing effect that materializes during the S&L crisis disappears in the group of young banks; whereas the findings for the GFC remain consistent with a general scarring effect and independently of bank age. This indicates that crises might overly penalize young institutions that do not fully achieve their potential (Nishimura et al., 2005; Ouyang 2009).

We next examine two potential, but not mutually exclusive, explanations for the differences we observe across the two crises. First, it is likely that more widespread crises, such as the GFC, affect healthier and more productive institutions by generating panic amongst uninformed depositors (Chari and Jagannathan, 1988; Chen, 1999; Iyer and Puri, 2012; Saunders and Wilson, 1996) or by amplifying contagion risk via the interbank market (Dasgupta, 2004). In line with this interpretation, we document that when the magnitude of a systemic shock is larger, the average efficiency of exit banks is also higher. Second, the GFC was characterized by a widespread government intervention via the TARP and the Capital Purchase Program that might have contributed to sheltering some inefficient banks from exit (Bayazitova and Shivdasani, 2012). Along these lines, we document that supported banks were less efficient than other surviving banks pre-crisis.

Following our analysis of the explanations for the differences across the two crises, we examine broader effects of the two crisis periods. First, focusing on the crisis effects on the market share of survived banks, we find that only the S&L crisis negatively affected the market share of the least efficient institutions. Second, for acquiring institutions that might have benefitted from cheap deals during periods of systemic distress, we show a deterioration of acquiring bank efficiency levels post-acquisition.

In a final step, we examine whether there are post-crisis industry benefits to surviving and new entry firms due to the resources released from the failing institutions, as suggested by the cleansing view. We do not find any support for this conjecture and show instead that bank efficiency after the two crises remained significantly below the respective pre-crisis levels. Nevertheless, we do find some evidence that new entry banks during crisis periods benefit from efficiency gains post-crises.

Overall, our findings highlight the importance of regulatory requirements that strengthen banks in good times, in anticipation of future systemic distress. These rules play a role in safeguarding the long-term productivity of the banking industry.

Our study adds to the general literature on bank failures in crisis periods (Berger and Bouwman, 2013; Berger et al., 2012; Cole and White, 2012; DeYoung and Torna, 2013; Jin et al., 2011). In general, differently from our analysis, and with the exception of Berger and Bouwman (2013), these studies draw evidence only for periods of systemic distress and this does not allow for any differential effect as compared to normal times to be tested. Furthermore, we complement studies on the nexus between bank risk and efficiency, which conclude that inefficient banks are generally riskier (Berger and DeYoung, 1997; Fiordelisi et al., 2011) and are more likely to exit the market (Cebenoyan et al., 1993; Focarelli et al., 2002; Hermalin and Wallace, 1994; Knott and Posen, 2005; Koetter and Poghosyan, 2010; Luo, 2003; Wheelock and Wilson, 2000). However, these studies do not clarify if the exit of inefficient banks is more likely to happen in crisis times than in normal times.

The paper proceeds as follows. Section 2 describes the data and the methodology. Section 3 presents the results of the effect of bank efficiency on bank exit during crisis and normal times. Section 4 examines additional effects of the crises and Section 5 draws conclusions.

2. Sample, definition of financial crises and methodology

2.1. Sample

We obtain quarterly data for the population of US commercial banks for the period 1984:Q2–2013:Q4 from the Consolidated Reports of Condition and Income. More precisely, the data for the period before 1993:Q1 are from the Federal Reserve Bank of Chicago, while the data for the period after 1993:Q1 are from the Federal Deposit Insurance Corporation (FDIC).

The list provided by the FDIC (https://www.fdic.gov/bank/individual/failed/banklist.html) is then used to identify failed banks (Liu and Ngo, 2014). In this list, failed institutions are categorized into two broad groups: 1) banks whose charter is terminated; 2) banks whose charter survives.[1] Next, we use the data on structural changes provided by the FDIC (https://catalog.data.gov/dataset/fdic-institution-directory-id-insured-insitution-download-file) to identify banks that are acquired during the sample period. Specifically, acquired banks are those banks that are absorbed by another institution without government intervention.

To form our final data sample, we proceed as follows. First, we form a consistent time series on the basis of the data manual provided by Den Haan et al. (2002) and we remove observations where we identify a clear reporting error or with missing values.[2] Second, as explained in Section 3, we chose a two-quarter lag for the explanatory variables to reduce potential endogeneity

[1] The first group consists of banks that cease to exist and their assets are auctioned off. The second group includes banks that were re-privatised (a management takeover followed by a sale, not dependent on whether there was assistance for the takeover) or subject to an assisted transaction (either an open assistance transaction or the assistance was provided to an acquiring institution). For a full definition of failure and assistance transactions, visit http://www2.fdic.gov/hsob/help.asp#BF1TT.

[2] One of the issues related to using quarterly Call Report Data is the impact of the regulatory changes on the construction of aggregate entries in the Call Reports.

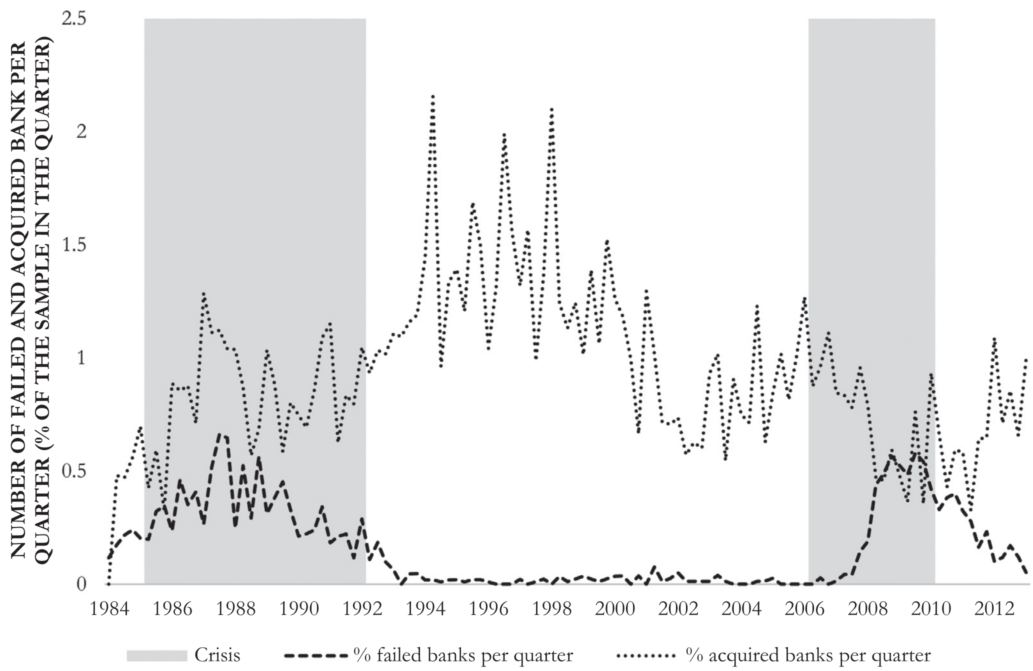

Fig. 1. Quarterly bank exits as a percentage of total banks in the quarter.
NOTES: This Figure shows the distribution of failed and acquired banks in the sample between 1984 and 2013. The definitions of failed and acquired banks have been obtained from the FDIC. Failed bank is defined as a bank that failed or received government assistance in a given quarter, and acquired bank is defined as a bank that was acquired without government assistance in a given quarter. The dashed and dotted lines show the number of failed and acquired banks in a quarter, respectively, as a percentage of total number of banks in that quarter. The shaded areas represent crisis periods and the unshaded areas represent normal times. The crisis periods include the S&L crisis in the period between 1986 and 1992 and the GFC that occurred in the period between 2007 and 2010.

problems in the econometric analysis. As a consequence, we lose the failures and the acquisitions that occur in the first two quarters of the sample period.

By applying the criteria described above, we obtain a final sample of 1,058,275 quarterly observations belonging to 18,120 unique commercial banks (of which 1,905 are failed banks, and 10,069 are acquired banks) between 1984:Q2 and 2013:Q4. To conduct our tests we construct a categorical variable (**Exit**) that is 0 for surviving banks over the sample period, 1 for banks that failed in a given quarter and 2 for acquired banks in a given quarter.

2.2. The identification of financial crises

Critical to our analysis is the identification of periods of financial crises affecting the US banking industry. While the literature offers several alternatives on how to identify crisis episodes (Berger and Bouwman, 2013; Boyson et al., 2014), we follow Liu and Ngo (2014) and focus on two major periods of financial crisis: the period between 1986 and 1992 characterized by the **S&L crisis** and the period 2007–2010 characterized by the **GFC** (Liu and Ngo. 2014). We identify each period with a dummy variable that we employ in our empirical tests.

Fig. 1 shows the evolution of the quarterly bank failure and acquisition rates - expressed as percentages of the total number of banks in a quarter - throughout the sample period. Two key findings emerge from this Figure. First, bank failures clearly cluster in the two crisis periods. Second, there is an upward trend in acquisition rates until the late 1990s, which is consistent with the consolidation wave that occurred in this period in the US (Berger et al., 1999). A downward trend in acquisition rates can, however, be seen in the second crisis period.

While Fig. 1 shows the total number of bank failures to be greater during the S&L crisis than during the GFC, a different picture emerges in Fig. 2. Here we compare the value of deposits that exit banks hold expressed as a percentage of the total value of deposits in the market in a given quarter. This Figure shows that the share of deposits that failed banks hold during the GFC was larger than during the S&L crisis. This is consistent with the widely accepted view that the GFC was the most harmful period of systemic distress since the Great Depression (see, for instance, Altunbas et al., 2017; Brunnermeier, 2009; Laeven and Valencia, 2010). The value of the deposits of acquisitions, however, more closely resembles the pattern of acquisition rates in Fig. 1. Specifically, value of the deposits of acquisitions is lower during the GFC as compared to the S&L crisis (with the exception of 2010) and is more pronounced during normal times.

In general, our definition of financial crises reflects periods of high bank exit especially via failure. Furthermore, while the number of failures appears higher during the S&L crisis than during the GFC, we offer evidence confirming that this latter crisis had a much more pronounced impact on US commercial banks. In fact, the two crises occur in periods with significant differences in the structure of the US banking industry, with a much larger number of banks operating during the S&L crisis and with a significantly larger average bank size in the latest part of our sample period.[3]

Some of the definitions of the components of the consolidated entries are not consistent throughout our sample period and some entries are newly introduced after the beginning of the same period. The data manual by Den Haan, et al. (2002) offers solutions on how to overcome these issues and construct consistent data series and provides guidance on how to deal with negative entries in the Call Report. Specifically, if there are negative entries in the Call Report, and these entries do not belong to the several exceptions that are allowed to be negative, it is a clear reporting error (Den Haan, et al., 2002).

[3] Specifically, on average, 12,246 banks with average total assets equal to US$ 168 m (in real terms) operated in a quarter during the S&L crisis. In contrast, during the GFC the average number of banks operating in a quarter dropped to 6,794 with nearly a tenfold increase in the average total assets to approximately US$ 1.5bn.

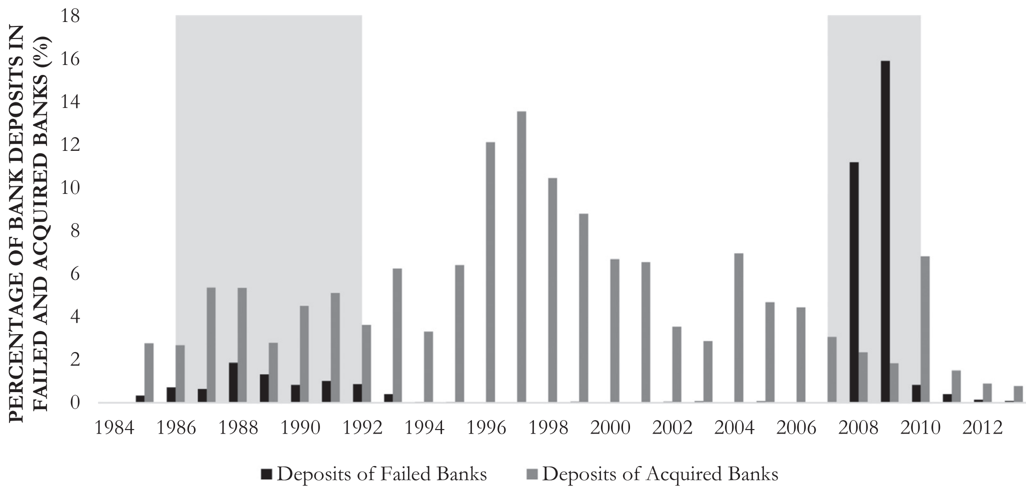

Fig. 2. Yearly bank deposits in exit banks as a percentage of total bank deposits in the sample.
Notes. This Figure shows the distribution of failed and acquired bank deposits as a percentage of total bank deposits in the sample by year in the period between 1984 and 2013. The definitions of failed and acquired banks have been obtained from the FDIC. Failed bank is defined as a bank that failed or received government assistance in a given quarter, and acquired bank is defined as a bank that was acquired without government assistance in a given quarter. The black and grey columns show the amount of deposits in failed and acquired banks in a year, respectively, as a percentage of total deposits of banks in that year. The shaded areas represent crisis periods and the unshaded areas represent normal times. The crisis periods include the S&L crisis in the period between 1986 and 1992 and the GFC that occurred in the period between 2007 and 2010.

2.3. The estimation of bank efficiency

As in Alam (2001), Curi et al. (2015), González (2009) and Wheelock and Wilson (1999) we employ Data Envelopment Analysis (DEA) to estimate the efficiency of banks.[4] DEA is part of the non-parametric approaches that the literature proposes to estimate firm efficiency. Such approaches do not use a specific function to define a constant relationship between the inputs and outputs used by banks to estimate efficiency. This is particularly important, as it is widely believed that banks do not operate using a specific "well defined production function" (Holod and Lewis, 2011).

The major concern about non-parametric techniques is that they do not take into account the existence of a random error (Berger and Humphrey, 1997). However, the study of Ruggiero (2007) suggests that the distributional assumption for the random error in parametric techniques undermines the potential advantages of these techniques over DEA.

We use an input-oriented Variable Return to Scale (VRS) DEA model to measure the cost efficiency of banks. Our measure of efficiency, therefore, reflects a bank's ability to effectively utilize resources for a given level of outputs. In general terms, DEA models assign efficiency scores for the entities (i.e. banks), formally known as Decision Making Units (DMUs), starting from the maximization of the ratio between outputs and inputs by varying the weights of the inputs and outputs used within each set of DMUs. We identify the sets of DMUs by size groups of banks and separately for each quarter.[5] The estimation by size allows us to control for differences in bank technology depending on bank production scale (Wheelock and Wilson, 2012), while the estimation by quarter removes concerns over a potential forward-looking bias in the estimation process. Essentially, the aim is to avoid measuring bank efficiency in a given quarter by using accounting information that is available only in future quarters. An efficient frontier in a set of banks is then formed from the most efficient banks, and the VRS approach allows us to include in the efficient frontier banks with different returns to scale. Finally, other banks are compared to those that form the efficient frontier and relative efficiency scores are assigned - where the distance from the efficient frontier reflects the resources a bank has wasted.

Critical to the estimation process of bank cost efficiency is the choice of bank inputs and outputs. As in the majority of the studies documented in Berger and Humphrey (1997) and later analyses (see Vander Vennet, 2002), we use the intermediation approach to describe the bank production process. Therefore, we employ total deposits, premises and fixed assets, and the number of employees as inputs. The related input prices are the interest paid on deposits scaled by total deposits, expenses of premises and fixed assets divided by total premises and fixed assets, and salaries and employee benefits, scaled by the number of employees, respectively. Bank outputs include total securities and total gross loans and leases. The Online Appendix provides summary statistics for inputs, input prices and outputs by size group.

Panel A of Table 1 provides descriptive statistics for bank efficiencies (and the crisis dummies). The average cost efficiency is 45.58%, which is lower than reported in other US based studies (see, for instance, Aly et al., 1990; Berger and Humphrey, 1997). Our estimates, however, focus on the cross-sectional dimension of bank efficiency to remove forward looking bias and on a significantly larger number of banks with relatively fewer banks forming an efficient frontier.

2.4. Multinomial logistic regression for bank exits

As in DeYoung (2003) we employ a multinomial logistic regression model for estimating the probabilities of a bank exiting the market via the different exit mechanisms of failure or acquisition.[6]

[4] DEA is also frequently used in non-banking studies. For instance, Demerjian et al. (2012) employ DEA to quantify non-financial firm efficiency and then extract an indicator of managerial ability, while Leverty and Grace (2012) focus on the property-liability insurance industry.

[5] We use the following five categories of bank size: very small (less than $50 million in assets), small (between $50 and $100 million in assets), medium (between $100 and $500 million in assets), large (between $500 million and $1 billion in assets) and very large (over $1 billion in assets).

[6] Our choice of using a multinomial logistic regression, as opposed to a competing risk survival model, is based on two main reasons. First, we cannot safely assume that failures and acquisitions are always competing events. In particular, although a failure event precludes the occurrence of the other, we do not know which banks would have failed if not acquired (distress acquisitions). Therefore, the joint determination of the two events does not appear appropriate in our setting. Second,

Table 1
Summary statistics.

(1) Symbol	(2) Description	(3) N	(4) Mean	(5) Median	(6) St. dev.	(7) p1	(8) p99
Panel A. Crisis dummies and cost efficiency							
S&L crisis	A dummy equal to 1 for the period 1986–1992.	1,058,275	0.314	0.000	0.464	0.000	1.000
GFC	A dummy equal to 1 for the period 2007–2010.	1,058,275	0.101	0.000	0.302	0.000	1.000
CE	Cost efficiency measured by using DEA (%).	1,058,275	45.581	46.200	19.260	6.100	92.500
Panel B. Main control variables							
ROA	Net income divided by bank total assets (%).	1,058,275	0.215	0.261	0.305	−1.398	0.824
Size	Log of total assets ($US000s) adjusted using an implicit price deflator provided by the Federal Reserve Bank of St. Louis.	1,058,275	11.504	11.367	1.252	9.199	15.555
Capital	Total book equity divided by total assets (%).	1,058,275	9.751	9.030	3.282	3.977	22.731
NPL	Non-performing loans over total loans (%).	1,058,275	0.978	0.454	1.411	0.000	7.929
M_Share	A bank's assets over total banking assets in the State where the bank is chartered (%).	1,058,275	0.414	0.113	1.216	0.006	9.767
Loans	Total loans and leases divided by total assets (%)	1,058,275	58.108	59.627	15.295	17.951	88.535
Young	A dummy variable that equals 1 if a bank has been operating for less than six years.	1,058,275	0.073	0.000	0.259	0.000	1.000
Adolescent	A dummy variable that equals 1 if a bank has been operating for six to twenty years.	1,058,275	0.152	0.000	0.359	0.000	1.000
Unemployment	Seasonally adjusted unemployment rate by state and quarter (%), provided by the Federal Reserve Bank of St. Louis.	1,058,275	5.840	5.500	1.860	2.600	11.300
ΔCoincident Index	An aggregate state economic activity measure that matches the trend for gross state product, provided by the Federal Reserve Bank of Philadelphia and expressed as a quarterly change (%).	1,058,275	0.641	0.739	0.785	−2.166	2.170

Notes. This Table presents descriptions and summary statistics of the key variables used in this study. Panel A presents the time dummy variables used in the empirical analyses and the measure of cost efficiency (**CE**). The year dummies include **S&L crisis** and **GFC**. The S&L crisis period represents the savings and loans crisis between 1986 and 1992 and the GFC represents the recent global financial crisis that occurred in the period between 2007 and 2010. Efficiency values are reported as percentages, and can have values between 0 and 100. Panel B presents definitions and summary statistics of the control variables employed in the econometric models: **ROA, Size, Capital, NPL, M_Share, Loans, Young, Adolescent, Unemployment, and ΔCoincident Index**. Variables ROA, Capital, NPL, M_Share, Loans, Unemployment and ΔCoincident Index are reported as percentages, Size is reported as the natural log in $US000s, and Young and Adolescent are dummy variables.

Our dependent variable is **Exit,** as defined in Section 2.1, while our key explanatory variables are bank efficiency (**CE**), **S&L crisis, GFC** and their interactions (see Berger and Bouwman, 2013, for a similar setting). The multinomial logit model, therefore, assumes the following form:

$$\begin{aligned}&\mathrm{Prob}(\mathrm{Exit}=\mathrm{i\ for\ i}=0,1,2)=\mathrm{F}(\mathrm{a_1CE_t}-2+\mathrm{a_2S\&L\ crisis}\\&+\mathrm{a_3GFC}+\mathrm{a_4CE_t}-2{*}\mathrm{S\&L\ crisis}+\mathrm{a_5CE_t}-2{*}\mathrm{GFC}+\\&\mathbf{bX}+\mathrm{Year\ Dummies}+\mathrm{Quarter\ of\ Year\ Dummies}\end{aligned} \quad (1)$$

where *F*(.) is the logistic distribution and **X** is a vector of control variables reported in Panel B of Table 1. This specification, estimated by clustering the standard errors at the bank level, allows us to evaluate how the effect of crisis varies given different levels of bank efficiency and how the effect of efficiency on bank exit differs across normal times, the S&L crisis and the GFC. Nevertheless, as the sign and magnitude of the interaction terms are not informative in non-linear models (Berger and Bouwman, 2013), we use marginal effects to interpret our results.

The vector of controls includes bank-specific characteristics and State-specific characteristics. Following Liu and Ngo (2014), the group of bank characteristics consists of bank **ROA** (net income to total assets), **Size** (the natural logarithm of bank assets measured in constant US dollars at 2009 prices), **Capital** (total equity divided by total assets), **NPL** (the ratio of non-performing loans to total loans), and **M_Share** (a bank's assets to total state banks' assets). As in Wheelock and Wilson (2000) we control for a bank focusing on lending via the ratio of loans to assets (**Loans**). Furthermore, we include two dummy variables – **Young** and **Adolescent** to control for bank age that, following Berger et al. (2001), is equal to one for banks operating for less than 6 years in the industry and between 6 and 20 years, respectively.

Similar to Cole and White (2012), we have no a priori expectations on how bank size affects exit via failure or acquisition. Liu and Ngo (2014) find a lower probability to fail in large US banks, reflecting the fact that large banks have a more diversified investment opportunity set. In contrast, Jin et al. (2011), in an analysis based on the global crisis, find an opposite result and suggest that larger banks are more likely to engage in riskier lending and securitization. As for the impact of bank size on the probability that a bank is acquired, larger institutions may be more difficult to integrate with the acquiring firm's business and as such are less likely to be acquired (Hernando et al., 2009). However, acquirers seeking economies of scale may be more likely to acquire larger firms (Hernando et al., 2009).

Higher ROA, higher capital ratios and lower non-performing loans should decrease a bank's probability of failure (Berger and Bouwman, 2013; Cole and White, 2012). The relationship between these variables and the probability of a bank being acquired is, however, less clear. Worse performing banks (namely, banks with lower ROA and capital ratios and higher levels of non-performing loans) being closer to a distress condition, may be more likely acquisition targets (Hannan and Rhoades, 1987; Wheelock and Wilson, 2000). Nevertheless, the findings in Agrawal and Jaffe (2003) and Hannan and Rhoades (1987) do not support this view.

A high bank market share could reflect the presence of a too-big-to-fail status and thus reduce the probability of failure (Liu and Ngo, 2014), but there is evidence of a higher likelihood of failure associated with this variable (driven by the inclusion

and more importantly, the proportionality assumption in competing risks models sets the hazards proportionately over time. Hence, the effects of the covariates are assumed to be fixed over time (Box-Steffensmeier, 2004). While in our setting, the proportional-hazard assumption is violated for the majority of the covariates, including the main explanatory variables, it is also against the main hypotheses we aim to test.

Table 2
Bank exits by sub-periods and average cost efficiency in normal times.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Number of failures (scaled by total number of banks)						Number of acquisitions (scaled by total number of banks)					
	Normal Times	S&L crisis	GFC	z-stat (2) = (1)	z-stat (3) = (1)	z-stat (3) = (2)	Normal Times	S&L crisis	GFC	z-stat (8) = (7)	z-stat (9) = (7)	z-stat (9) = (8)
A) Below the median	247 (1.39%)	770 (5.12%)	149 (1.99%)	**3.73%*** (19.41)**	**0.60%*** (3.49)**	**3.13%*** (11.20)**	3433 (19.34%)	1380 (9.18%)	379 (5.06%)	**10.16%*** (25.91)**	**14.28%*** (28.95)**	**4.12%*** (10.86)**
B) Above the median	148 (0.83%)	291 (1.94%)	130 (1.74%)	**1.10%*** (8.65)**	**0.90%*** (6.27)**	0.20% (1.04)	2965 (16.70%)	1305 (8.68%)	399 (5.33%)	**8.02%*** (21.51)**	**11.38%*** (24.30)**	**3.35%*** (8.97)**
A = B (z-stat)	**0.56%*** (5.01)**	**3.19%*** (14.97)**	0.25% (1.15)				**2.64%*** (6.46)**	0.50% (1.52)	0.27% (0.74)			

Notes. This Table presents the distribution of bank failures and acquisitions. The values in Columns (1), (2) and (3) (Columns (7), (8) and (9)) show the total number of failures (acquisitions) in the sample, and the proportion of the number of failures (acquisitions) to the total number of banks in the period for banks with average cost efficiency levels below the median (row A) and above the median (row B), separately. The median is calculated for all banks in the sample in normal times. The values in Columns (4) to (6) (Columns (10) to (12)) show the differences between the proportions of failures (acquisitions) in each of the crisis periods and normal times as well as between the two crises. The test values of the equality tests are provided in parentheses. The last row shows the test-statistics of the equality tests between the proportions of the exits for banks with efficiency levels above and below the median. * Significant at 10%. ** Significant at 5%. *** Significant at 1%.

of government-assisted banks in the group of failed banks). In terms of acquisition likelihood, banks with larger market shares are more likely to be acquisition targets as they significantly contribute to expanding the market position of the acquiring institution (Hannan and Rhoades, 1987).

Goddard et al. (2014) and Wheelock and Wilson (2000) show that Loans are positively related to the failure probability because a higher value indicates less liquid and more risky assets in a bank's balance sheet. Following Goddard et al. (2014), however, we do not have a clear prediction on the relation between Loans and the acquisition likelihood, as their findings show that the relationship is dependent on the size of the target bank.[7] In terms of bank age, there is a widespread view that young banks are more likely to fail or be acquired (DeYoung, 2003; Wheelock and Wilson, 2000). Young and Adolescent banks should then show a greater failure likelihood than is the case for mature banks (which represent the omitted category).

The quarterly state unemployment rate and the quarterly change in aggregate state economic activity (**ΔCoincident Index**) control for the economic cycle, as in Khan and Ozel (2016). Better local economic conditions should reduce the likelihood of bank failures and might also favor expansionary strategies by banks thus increasing acquisition activities. Nevertheless, better economic conditions might also positively influence the performance of potential targets, making the acquisitions relatively more costly for the bidders and thus discouraging them.

Finally, we include time fixed effects using year dummies and control for potential seasonality effects with quarter of the year dummies Q1 (Q2/Q3), taking a value of 1 for every observation that falls under the first (second/third) quarter of a given year.

3. Empirical results on bank exit

3.1. Is the exit of less efficient banks more frequent during financial crises?

The cleansing view of financial crises requires that crisis periods facilitate the removal of less efficient banks as compared to normal times. This section presents a simplified analysis of the differences in bank exits in normal, S&L crisis and GFC periods by the degree of bank efficiency. This analysis offers a rationale for the multivariate tests discussed in the following sections.

More precisely, we focus on the average degree of cost efficiency that the banks in our sample show during normal times and calculate the number of bank exits and the exit rates by failure and acquisition in normal periods and during the two crisis periods separately for two groups of banks.[8] The first group includes banks with a degree of average efficiency (computed in normal times) below the sample median in normal times and the second group comprises the remaining sampled banks. Our purpose is to test in which group bank exit is more likely and whether there is any difference between normal periods, the S&L crisis and the GFC in each group.

Table 2 reports the results of this analysis. We find that the proportion of banks that fail increases from 1.39% to 5.12% (1.99%) in the group of the less efficient banks when we move from normal to the S&L crisis (GFC). In the group of the more efficient banks we find an increase from 0.83% to 1.94% (1.74%). All the increases we observe moving from normal to crisis periods are significant at customary levels (according to a z-test of proportion equality). Furthermore, as shown in the last row of Table 2, both in normal times and in the S&L crisis less efficient banks are more likely to exit via failure.

A different result emerges, however, for the GFC, for which the failure rates of more and less efficient banks do not differ. Finally, column (6) – where the failure rates between the two crises are compared – shows that a higher proportion of failures is evident for the S&L crisis period when less efficient banks are compared, whereas there is no difference in the failure rates in the group of more efficient banks. Taken together these results indicate that, as compared to normal times, crises lead to a general increase in bank failures. However, while this increase is more pronounced in the group of less efficient banks during the S&L crisis (in line with the cleansing effect of crises), there is no evidence of any significant difference in the failure rates between the two groups of banks in terms of efficiency during the GFC.

In terms of bank exit via acquisitions, we find a substantially different picture as compared to bank exit via failure. Moving from normal times to the two crisis periods, we find a significant decrease in exit rates both in the group of the least and most efficient banks, with a greater difference observed for the GFC. Furthermore, we also find that the exit rates for the least and most efficient banks differ significantly in normal times but not during

[7] Specifically, Goddard et al. (2014) find a negative relationship between the loans to assets ratio and the likelihood of being acquired for small banks; whereas for the largest banks, a higher loans to assets ratio is found to increase the probability of being acquired.

[8] The exit rates are calculated using the number of failed/acquired banks in normal times/S&L crisis/GFC and expressed as a ratio of the total number of banks in the corresponding time period. 170 failed (208 acquired) banks are removed from this analysis due to the absence of data in normal times.

Table 3
Marginal effects of the S&L crisis and the GFC on the probability of bank exit at different values of cost efficiency.

	(1) S&L crisis	(2)	(3) GFC	(4)	(5) Test of Equality	(6)
	Failure	Acquisition	Failure	Acquisition	Failure	Acquisition
Panel A. Marginal effects of financial crises at different levels of cost efficiencies (p.p.)						
p25	0.0888***	0.3315***	0.1983***	−0.0493	8.31***	23.18***
	(4.34)	(4.55)	(6.19)	(−0.91)		
p50	0.0637***	0.2852***	0.1915***	0.0583	11.05***	9.14***
	(3.39)	(4.37)	(5.84)	(1.07)		
p75	0.0444**	0.2478***	0.1856***	0.1542**	9.88***	1.25
	(2.25)	(3.88)	(4.54)	(2.31)		
Panel B. Tests of the equality of the probability of bank exit between the 75th and 25th percentile of cost efficiency						
effect of Crisis given p75 bank efficiency level	0.0444***	0.0837**	0.0127	0.2035***		
effect of Crisis given p25 bank efficiency level	(9.45)	(4.68)	(0.13)	(14.27)		

Notes. This Table shows the marginal effects of the **S&L crisis** and the **GFC** on banks' probability of failure and acquisition. The dependent variable, **Exit**, has values of 0, 1 or 2, depending, respectively, on one of the potential outcomes in a given quarter: bank survives, bank fails, bank is acquired. The base outcome is a bank survives in a given quarter. The S&L crisis is a dummy that equals one for periods of savings and loans crisis in the period between 1986 and 1992, and 0 otherwise. GFC is a dummy that equals one for periods of the global financial crisis in the period between 2007 and 2010, and 0 otherwise. Panel A shows the results of marginal S&L crisis and GFC effects on banks' probability of failure and acquisition given the first (p25), second (p50) and third (p75) quartile of the sample cost efficiencies, and the equality tests of the marginal S&L and GFC effects at the respective quartiles of the cost efficiencies. Panel B presents the differences and equality tests of the marginal S&L crisis and GFC effects between the last and the first quartile of sample efficiencies. Test values are provided in parentheses. * Significant at 10%. ** Significant at 5%. *** Significant at 1%.

either of the crisis periods. In general, it does not seem that when bank exit is defined in terms of acquisitions, financial crises overly penalize the least efficient banks.

Overall, this section offers some preliminary evidence of a potential cleansing effect produced by the S&L crisis (but not by the GFC) at least when bank exit is defined in terms of failure. In contrast, the findings for the GFC seem to be aligned with a scarring effect whereby crises exercise a similar effect on efficient and inefficient banks.

3.2. The impact of the S&L crisis and the GFC on bank exit by degree of bank efficiency

We next evaluate whether financial crises accelerate the exit of the most inefficient banks under a multivariate setting based on Eq. (1) estimated via a multinomial logit regression. The key variables include CE, S&L crisis, GFC and their interactions and the base outcome is bank survival to which we compare other exit mechanisms. As the interpretation of interaction terms in a multinomial logit model cannot be based on the sign, magnitude or significance levels of the reported coefficients (Berger and Bouwman, 2013), we focus our discussion on the marginal effects that we report in Table 3. [9]

We start by examining how the S&L crisis and the GFC impact on the probability of bank exit when banks show different levels of cost efficiency. Essentially, we compute the marginal effects of the variables S&L crisis and GFC on bank exit by fixing cost efficiency at the first three quartiles of the sample distribution. This setting allows us to examine the possibility that the materialization of a cleansing/scarring effect in the banking industry in periods of distress depends on the type of financial crisis that hits the banking industry. Inspection of the marginal effects shows that the two crises differ substantially as to how they affect banks with different degrees of cost efficiency.

As shown in columns (1) and (2) of Panels A and B, we find that the S&L crisis increases the probability that the least efficient banks exit the market because of failure (or due to an acquisition) significantly more than for the group of the most efficient banks. Although the difference between the magnitudes of these effects appears relatively small (as shown in Panel B), they do have economic significance. Specifically, given that the likelihood of failure (acquisition) in a quarter is 0.18% (0.95%), being in the third rather than the first quartile of sample efficiency reduces the probability to fail (be acquired) by 24.67% (8.81%).

In the case of the GFC, the results reported in column (3) of Table 3 show that the increase in the probability of failure is similar for all levels of bank efficiency. Furthermore, again differently from the S&L crisis, the GFC favors an increase in the likelihood that the most efficient banks in the industry are acquired (see column (4)).

Notably, the different effects we observe between the two crises in terms of acquisition likelihood are not surprising given that, during the late 1980s and early 1990s, the US banking industry experienced a large wave of consolidation (Berger et al., 1999). Consequently, the S&L crisis might have provided further opportunities for relatively healthy and efficient banks (that have been less affected by the crisis as shown by our analysis) to take over troubled institutions at a cheaper cost.

In addition, as compared to the S&L crisis, the GFC has a much stronger impact on all banks in terms of failure probability and this might have discouraged banks from engaging in expansionary strategies in a period of high uncertainty.

The results reported in columns (5) and (6) of Panel A of Table 3, where we test for equality between the marginal effects computed for each of the two crises and for each exit mechanism at different levels of efficiency, confirm the validity of the above interpretation. We find that the GFC had a significantly greater impact on the exit likelihood via failure than the S&L crisis at any

[9] In the interest of brevity we provide the full output of the multinomial logistic regression in the Online Appendix. The effects of the control variables are in most cases as expected and in line with prior studies. Specifically, we show that banks are less likely to exit the market when their ROA and capitalisation levels are higher. A few variables do not have a similar effect on the two exit mechanisms we analyse. Smaller banks, banks with higher levels of non-performing loans and higher loan to asset levels are more likely to fail whereas they are less likely to be acquired. In addition, while better economic conditions reduce the likelihood of a bank failing they increase the chances of acquisition. Furthermore, while none of the age dummies play a significant role in terms of bank failure, adolescent banks have a higher likelihood of exiting the market via acquisition.

Table 4
The effect of cost efficiency on the probability of bank exit: sub-period analysis.

	(1) Normal Times	(2)	(3) S&L crisis	(4)	(5) GFC	(6)
	Failure	Acquisition	Failure	Acquisition	Failure	Acquisition
Panel A. Multinomial logistic model results for sub-periods						
CE_{t-2}	−0.006*	−0.004***	−0.014***	−0.006***	0.007	0.001
	(−1.708)	(−5.100)	(−6.162)	(−4.880)	(1.599)	(0.657)
ROA $_{t-2}$	−1.477***	−0.785***	−0.673***	−0.437***	−1.442***	−0.760***
	(−10.581)	(−16.547)	(−10.442)	(−8.116)	(−8.981)	(−8.675)
Size $_{t-2}$	−0.300***	0.193***	−0.221***	0.051**	0.287***	0.127***
	(−4.701)	(14.404)	(−5.089)	(2.186)	(3.914)	(3.280)
Capital $_{t-2}$	−0.573***	−0.006	−0.939***	−0.142***	−0.768***	0.028**
	(−8.244)	(−1.326)	(−16.375)	(−12.075)	(−9.945)	(2.422)
NPL $_{t-2}$	0.237***	−0.069***	0.237***	−0.087***	0.209***	0.035
	(7.357)	(−4.912)	(13.853)	(−6.022)	(5.905)	(0.999)
M_Share $_{t-2}$	0.063	−0.008	−0.051	−0.006	−0.095*	−0.013
	(1.049)	(−0.785)	(−1.069)	(−0.306)	(−1.659)	(−0.434)
Loans $_{t-2}$	0.030***	−0.000	0.026***	−0.010***	0.009*	−0.003
	(5.201)	(−0.207)	(8.227)	(−6.370)	(1.662)	(−1.234)
Young	−0.219	−0.197***	−0.027	0.254***	0.510**	−0.550***
	(−0.988)	(−3.132)	(−0.305)	(3.770)	(2.364)	(−2.994)
Adolescent	0.122	0.486***	−0.025	0.418***	−0.005	0.503***
	(1.000)	(15.327)	(−0.349)	(8.562)	(−0.031)	(5.513)
Unemployment $_{t-2}$	0.042	−0.040***	0.120***	0.003	0.115***	−0.096***
	(1.231)	(−3.739)	(5.726)	(0.233)	(3.307)	(−5.435)
ΔCoincident Index $_{t-2}$	0.014	0.014	0.062	−0.090***	0.072	−0.005
	(0.137)	(0.588)	(1.082)	(−2.907)	(1.304)	(−0.115)
Year dummies/ Quarter of year dummies	YES/YES	YES/YES	YES/YES	YES/YES	YES/YES	YES/YES
Constant	−1.897**	−6.547***	0.156	−2.939***	−6.645***	−5.795***
	(−1.963)	(−32.654)	(0.264)	(−8.850)	(−5.187)	(−10.338)
Pseudo R-Squared	0.06		0.15		0.17	
Observations	618,883	618,883	332,278	332,278	107,114	107,114
Panel B. Marginal effects of cost efficiency in different periods (p.p.)						
CE	−0.0004*	−0.0037***	−0.0043***	−0.0054***	0.0015	0.0010
	(−1.69)	(−5.09)	(−6.04)	(−4.80)	(1.59)	(0.64)
Panel C. Tests of the equality of the cost efficiency effects on the probability of bank exit between normal times and crises						
t value: effect of efficiency during the S&L Crisis = effect of efficiency during normal times					140.00***	320.00***
t value: effect of efficiency during the GFC = effect of efficiency during normal times					105.44***	758.10***
t value: effect of efficiency during the S&L Crisis = effect of efficiency during GFC					84.31***	697.52***

Notes. This Table shows the results of how bank cost efficiency (**CE**) affects banks' probability of failure and being acquired at different time periods. The method employed is a multinomial logistic model and the output is provided in Panel A. The dependent variable, **Exit**, has values of 0, 1 or 2, depending, respectively, on one of the potential outcomes in a given quarter: bank survives, bank fails, bank is acquired. The base outcome is a bank survives in a given quarter. CE is measured using DEA and shows banks' ability to effectively utilize resources for a given level of outputs (see Section 2.3 for CE estimation details). Normal times include the quarters when no crisis took place (1984:Q2–1985:Q4; 1993:Q1–2006:Q4; 2011:Q1–2013:Q4), the S&L crisis includes the period of the savings and loans crisis (1986:Q1–1992:Q4) and the GFC includes the quarters of the global financial crisis (2007:Q1–2010:Q4). **Bank-specific controls** include **ROA** (the ratio between bank net income and bank total assets), **Size** (the log of bank total assets measured in thousands of US dollars and in real terms), **Capital** (the ratio between bank book value of equity and bank total assets), **NPL** (the ratio between non-performing loans and total loans), **M_Share** (the ratio between bank total assets and the volume of bank total assets in the State where the bank is chartered), **Loans** (the ratio between bank total loans and leases and bank total assets), **Young** (a dummy variable that equals one if a bank is young, and 0 otherwise, where Young is defined as a bank, which has been operating for less than six years) and **Adolescent** (a dummy variable that equals one if a bank is adolescent, and 0 otherwise, where Adolescent is defined as a bank, which has been operating for six to twenty years). **Macroeconomic controls** include **Unemployment** (the rate of unemployment in the State where the bank is chartered) and **ΔCoincident Index** (the percentage change in the coincident index in the State where the bank is chartered). For brevity **Year dummies** and **Quarter of year dummies** are excluded from the output. All independent variables apart from Young and Adolescent are lagged by two quarters to avoid possible endogeneity. All models are estimated with robust standard errors clustered by bank. Panel B shows marginal CE effects on the bank probability of exit; and Panel C shows equality tests of CE effects between different time periods. Test values are provided in parentheses. * Significant at 10%. ** Significant at 5%. *** Significant at 1%.

level of bank efficiency. For instance, for the banks with a degree of efficiency equal to the sample median, the marginal effect of the GFC on the probability of failure is more than three times larger than the marginal effect produced by the S&L crisis. Interestingly, when considering acquisition as an exit mechanism, we find no difference between the two crises in terms of marginal effects for the group consisting of the most efficient banks (namely, for the only group significantly affected by the GFC).

To recap, our results show that during the S&L crisis, bank exit from the market primarily involves the least efficient institutions via both failure and acquisition. In contrast, during the GFC, banks fail independently of their level of efficiency, while acquisitions primarily involve efficient targets. In short, only bank exits in the period of the S&L crisis conform to the cleansing effect, whereas bank exits during the GFC are supportive of a scarring effect where a crisis exercises a similar effect on all firms regardless of their efficiency.

3.3. An alternative comparison of the effects of the S&L crisis and the GFC

While our empirical setting based on interaction terms eases the analysis of the impact of different financial crises on banks with different levels of efficiency, it implicitly assumes that all other bank characteristics have a similar effect across different sub-periods. However, this assumption is not necessarily plausible. In Panel A of Table 4 we relax this assumption and present the results of three multinomial logit models that we estimate separately for three sub-periods: i) normal periods; ii) the S&L crisis period; and iii) the GFC period.

Table 5
Additional tests to control for endogeneity.

	(1) S&L crisis	(2)	(3) GFC	(4)	(5) Test of Equality	(6)
	Failure	Acquisition	Failure	Acquisition	Failure	Acquisition
Panel A. Marginal effects of financial crises at different levels of pre-crisis cost efficiencies (p.p.)						
p25	0.0630***	0.4994***	0.1539***	−0.0316	5.17**	31.86***
	(2.78)	(5.61)	(4.89)	(−0.58)		
p50	0.0435**	0.3336***	0.1865***	0.0981*	13.07***	8.07***
	(2.19)	(4.61)	(5.76)	(1.71)		
p75	0.0281	0.2102***	0.2177***	0.2182***	14.35***	0.01
	(1.37)	(3.12)	(4.85)	(2.91)		
Panel B. Tests of the equality of the probability of bank exit between the 75th and 25th percentile of pre-crisis cost efficiency						
effect of Crisis given p75 bank efficiency level =	0.0349**	0.2892***	0.0638	0.2498***		
effect of Crisis given p25 bank efficiency level	(4.39)	(26.55)	(2.26)	(15.48)		
Panel C. Marginal effects of financial crises at different levels of 3-year lag cost efficiencies (p.p.)						
p25	0.4386***	0.0336	0.2963***	−0.2110***	5.85**	10.67***
	(6.76)	(0.46)	(6.03)	(−3.42)		
p50	0.3550***	−0.0145	0.3173***	−0.1130*	0.48	1.87
	(6.37)	(−0.21)	(6.30)	(−1.86)		
p75	0.2923	−0.0520	0.3370***	−0.0263	0.56	0.09
	(5.75)	(−0.76)	(5.87)	(−0.36)		
Panel D. Tests of the equality of the probability of bank exit between the 75th and 25th percentile of 3-year lag cost efficiency						
effect of Crisis given p75 bank efficiency level =	0.1463***	0.0856**	0.0407	0.1847***		
effect of Crisis given p25 bank efficiency level	(24.78)	(4.13)	(1.28)	(10.17)		
Panel E. Marginal effects of financial crises at different levels of average cost efficiencies (p.p.)						
p25	0.0899***	0.3675***	0.1697***	−0.1479***	4.64**	35.90***
	(4.27)	(4.40)	(5.45)	(−2.81)		
p50	0.0706***	0.2525***	0.1660***	−0.0368	7.92***	14.38***
	(3.97)	(3.58)	(5.84)	(−0.70)		
p75	0.0561***	0.1662**	0.1623***	0.0614	7.76***	1.64
	(3.23)	(2.53)	(4.73)	(0.95)		
Panel F. Tests of the equality of the probability of bank exit between the 75th and 25th percentile of average cost efficiency						
effect of Crisis given p75 bank efficiency level =	0.0338**	0.2013***	0.0074	0.2093***		
effect of Crisis given p25 bank efficiency level	(5.67)	(19.19)	(0.05)	(14.81)		

Notes. This Table shows the marginal effects of the **S&L crisis**, and the **GFC** on banks' probability of failure and acquisition. The dependent variable, **Exit**, has values of 0, 1 or 2, depending, respectively, on one of the potential outcomes in a given quarter: bank survives, bank fails, bank is acquired. The base outcome is a bank survives in a given quarter. The S&L crisis is a dummy that equals one for periods of savings and loans crisis in the period between 1986 and 1992, and 0 otherwise. GFC is a dummy that equals one for periods of the global financial crisis in the period between 2007 and 2010, and 0 otherwise. Panels A, C and E show the results of marginal S&L and GFC effects on banks' probability of failure and acquisition given the first (p25), second (p50) and third (p75) quartile of the sample cost efficiencies, and the equality tests of the marginal S&L and GFC effects at the respective quartiles of the cost efficiencies. Panels B, D and F present the differences and equality tests of the marginal S&L crisis and GFC effects between the last and the first quartile of sample efficiencies. For the respective multinomial logit models, different alterations of cost efficiency (CE) values are employed: CE reported in Panels A and B is set to an average 4-quarter pre-crisis value for the respective crisis periods, and the original lagged values are used for normal times. A 3-quarter rolling CE average is reported in Panels C and D. CE in Panels E and F is lagged by 3 years (12 quarters). Test values are provided in parentheses.
* Significant at 10%. ** Significant at 5%. *** Significant at 1%.

The results in Panel A suggest that bank efficiency plays a significant role in reducing the bank probability of exit in normal times and during the S&L crisis. However, it has no significant effect during the GFC. The findings for the two crises, therefore, confirm the results discussed in the previous section. The sub-period analysis allows us to highlight further differences between the three different periods not only in terms of efficiency but also in terms of control variables. For instance, in the failure equation we find a negative and significant coefficient for bank size only during normal times and the S&L crisis, whereas the size variable becomes positive and significant during the GFC. At least in the case of failure, the two crises (and also the normal times period) show similar effects for ROA and Capital (that reduce failure probabilities), and Loans and NPL (that increase failure probabilities).

Next, Panels B and C of Table 4 compare the marginal effects of bank efficiency on bank exit in the three periods. The focus on marginal effects is necessary to understand whether the impact of efficiency on bank exit is stronger in the S&L crisis than during normal periods, as suggested by our earlier analysis. Further, given the limitations that characterize any test for differences in the coefficients obtained from different non-linear models (Paternoster et al., 1998), this type of inference cannot simply rely on the estimated coefficient. We find that the marginal effects of cost efficiency are stronger during the S&L crisis than in normal times for both exit via failure and acquisition, as indicated by the larger magnitude of the negative coefficients of the marginal effect of bank efficiency during the S&L crisis.

All in all, we again find that the period of the S&L crisis, and not the GFC, accelerated the removal of the least efficient banks in the industry as compared to normal times.

3.4. Controlling for endogeneity

While we use two-quarter lags of our efficiency measure as an explanatory variable, it might still be suggested that our findings suffer from endogeneity. To further rule out the potential influence of endogeneity, we conduct three additional tests that we report in Table 5.

First, we adopt a similar setting as in Berger and Bouwman (2013) and use average bank efficiency values in normal times to predict bank exits during crises. More specifically, to conduct this test we proceed as follows. For each normal times period (namely, 1984:Q2–1985:Q4, 1987:Q1–2006:Q4 and 2011:Q1–2013:Q4) we use the existing 2-quarter-lagged efficiency values as predictors of bank exit. For each crisis we employ the average pre-crisis cost efficiency values (computed over the four quarters before each crisis erupts) as a predictor of exit. Other explanatory variables remain as in the initial models (see Panels A and B). Second, we employ the efficiency observed with 3-year (12-quarter) lags as a predictor of bank exit (see Panels C and D). Third, we estimate the model with the average bank efficiency computed over a three-quarter period, starting from *q-2* and to *q-4,* as a key explanatory variable (see Panels E and F).

All of these tests show that our results for the two crises remain qualitatively similar.

3.5. Additional tests: The importance of bank age and other specifications

In this section we discuss additional tests (reported in the Online Appendix in the interest of brevity). Several studies highlight it is necessary to account for firm age when considering the cleansing effect of financial crises (see, for instance, Ouyang, 2009). If financial crises primarily accelerate the removal of younger unproductive institutions from the market, they might favor the exit of firms that have not had sufficient time to exploit their full potential (Ouyang, 2009). Therefore, for a cleansing effect to be truly effective the crisis should focus primarily on the exit of non-young, unproductive banks. Accordingly, we interact the dummy variable Young with the two Crisis dummies and Efficiency and with the cross product between the Crisis dummies and Efficiency. As in our earlier tests we report the marginal effects for different levels of bank efficiency in the Online Appendix.

Overall, we find that the cleansing effect assigned to the S&L crisis is not visible in the group of young banks and confirm the presence of a general scarring effect during the GFC. More generally, however, and in line with Ouyang (2009), both crises have a larger impact on the exit probability of young banks at any level of cost efficiency; namely, the two crises overly penalize young banks. How these young banks exit the market is, however, different in the two crises. The S&L crisis favors primarily an increase in the likelihood that young banks are acquired, whereas the GFC increases the failure risk of young banks.

We next consider alternative measures of bank cost efficiency. In particular, cost efficiency can be decomposed into technical and allocative efficiencies. The two efficiency measures reflect different managerial skills and/or a bank's technological advances. Technical efficiency measures the ability of a bank to employ the least amount of inputs to produce a certain level of output, whereas allocative efficiency measures the ability of selecting the correct input choice, given input prices (see, for instance, Farrell, 1957). Therefore, we investigate whether we can identify a source of bank cost efficiency that drives our findings on the impact of financial crises on bank exit. Our results for both efficiency components remain consistent with the analysis based on overall cost efficiency.

We then employ an alternative econometric approach to estimate cost efficiency by relying on a stochastic frontier model (SFA). For the cost function we choose the standard translog specification with a truncated-normal error distribution and estimate the model using the same set of inputs and outputs and the same estimation approach by size group we followed for DEA. As before, the results are consistent with our initial analysis, with the exception of the marginal effect of GFC on the most efficient banks, which becomes insignificant.

In terms of the choice of dummy variables that identify crisis periods, our approach does not account for the fact that bank exits originating from financial crises might materialize with a lag as compared to the shock period. We, therefore, repeat the analysis by also identifying as bank exits due to crises those failures and acquisitions occurring in a four-quarter post-crisis period. We do not find any major changes in our results.

Due to their systemic importance in the economy, large financial institutions are different, and their probability of failing is not dependent directly on their performance (see, for instance, Berger and Bouwman, 2013; Berger et al., 2012; Cole and White, 2012; DeYoung and Torna, 2013; Liu and Ngo, 2014). As in Berger and Bouwman (2013), we perform additional tests excluding the largest banking firms (with real total assets above US $50bn) in each quarter. Again, the results remain qualitatively similar.

Finally, while we employ a parsimonious model, the literature identifies other variables that can affect a bank's probability of failure and the acquisition likelihood (see Liu and Ngo, 2014). We repeat, therefore, the tests by including as additional controls the ratio between non-interest income and total operating income and the ratio of non-interest expenses to total assets as in Chen et al. (2017), asset growth as in DeYoung (2003) and the ratio of total assets held in foreign offices to total assets as in Berger et al. (2017). Again, we do not find major changes in our results.

3.6. Why do the results for the two crises differ in terms of exit?

A key conclusion of our analysis is that efficiency primarily matters for bank exit only during the S&L crisis. One possible explanation for this result is related to the differences in magnitude between the two crises.

As shown in Fig. 2, during the GFC the share of the banking industry under distress conditions was larger as compared to the S&L crisis. The different results we observe could then be aligned with the view that widespread crises might affect healthier and more productive institutions by generating panic amongst uninformed depositors (see, for instance, Chari and Jagannathan, 1988; Chen, 1999; Iyer and Puri, 2012; Saunders and Wilson, 1996). This interpretation, therefore, would imply that the GFC had a disproportionate effect on the most efficient banks as compared to the other crisis.

While it is difficult to fully validate the interpretations above, Panel A of Table 6 offers evidence on the potential importance of crisis severity for our results. This Table shows the degree of efficiency of failed and acquired banks in the crisis periods classified in quartiles based on the ratio between exit bank deposits and total deposits. A larger ratio thus indicates a larger exit magnitude in the banking system in a crisis period. We find that when we move from the first to the fourth quartile of this ratio, the mean

Table 6
Exit magnitude, TARP support and bank efficiency.

	(1)	(2)	(3)	(4)
Panel A. Mean and median failed and acquired bank efficiency at the 25th and 75th percentiles of exit magnitude				
	Failed bank efficiency		Acquired bank efficiency	
	Mean	Median	Mean	Median
q1	37.64	35.50	40.66	40.10
q4	44.08	44.50	42.11	42.70
Difference	6.44***	9.00***	1.45**	2.60***
	(5.16)	(5.85)	(2.47)	(2.84)

Panel B. Mean and median cost efficiency of banks affiliated with TARP support and non-supported banks

	Mean	Median
Supported Banks	31.59	30.90
Non-Supported Banks	44.08	40.90
Difference	12.49***	10.00
	(8.09)	(7.40)

Notes. This Table shows the relation between Exit Magnitude, TARP Support and Bank Efficiency. Exit magnitude is computed as the ratio between exit bank deposits and the total deposits at the time of the exit. Banks affiliated with TARP support are defined as banks that either received TARP support directly or the support was provided for the bank's parent company. Non-supported banks are defined as the remaining banks that do not exit the market. The cost efficiency levels are taken from the last quarter before the GFC, i.e. in 2006:Q4. Panel A shows the mean and median failed and acquired bank efficiency for the first (q1) and fourth (q4) quartiles of sample exit magnitudes. The differences and equality tests of the mean and median cost efficiencies between the last and the first quartile of sample exit magnitudes are provided below. Panel B shows the mean and median cost efficiency levels for banks that received TARP support and the non-supported banks. The mean and median differences as well as their corresponding test statistics are provided in the last row. Test values are provided in parentheses. * Significant at 10%. ** Significant at 5%. *** Significant at 1%.

(median) efficiency of exit banks tend to increase significantly. Essentially, when the exit is more pronounced, relatively more efficient banks are also affected. Notably, unreported tests show that the largest quartile in terms of shock magnitude includes periods of both crises; namely, it does not only refer to the GFC. Furthermore, we find similar results if we repeat the same analysis separately for the two crises.

The above results do not rule out a further, and not necessarily mutually exclusive, explanation for our findings related to differences in the regulatory setting and responses during the two crises that should especially matter for the failure rates. For instance, it has been suggested that during the period of the S&L crisis, supervisory oversight was ineffective and slow in reacting (Federal Deposit Insurance Corporation, 1997), with Prompt Corrective Actions being available to the FDIC only post the 1991 reform. In contrast, the GFC was characterized by a large scale and timely public intervention to rescue banks and avoid widespread systemic effects. Specifically, the implementation of the TARP program from September 2008 gave banks the possibility to improve their capital levels via public funds under the Capital Purchase Program (CPP) and the Capital Assistance Program (CAP). As a result, if these regulatory interventions have contributed to sheltering inefficient banks from failure, the GFC has resulted in an increase in the survival probability of these banks, with a consequent decline in the difference in terms of exit (failure) rates between inefficient and efficient banks during this crisis.

Bayazitova and Shivdasani (2012) provide some support for this interpretation by showing that there was strong self-selection bias in the decision of banks to participate in the CPP. More importantly, especially strong banks, namely banks with a strong capital ratio, more stable funding profiles, strong asset quality, and operating in better-performing regions opted out of the CPP. It appears likely, therefore, that the benefit of the CPP went to relatively weaker banks with plausibly lower levels of efficiency. Along these lines, Bayazitova and Shivdasani (2012) also show that some banks declined to receive CPP funds although the U.S. Treasury originally approved their applications to the recapitalization program. These banks exhibited higher-quality assets and operated in better-performing regions than those that finally received capital injections. In short, better-performing banks admitted to the program did not see the capital injections as beneficial and opted out of the program.

Panel B of Table 6 offers evidence in line with the above discussion by comparing the efficiency of banks that received TARP support directly or indirectly (via their holding companies) as compared to the surviving banks in the last quarter before the eruption of the global financial crisis.[10] We find that supported banks were significantly less efficient than other banks. In essence, government intervention might have sheltered inefficient banks from exit.

Finally, other differences between the two crises refer to the potential role played by monetary policy. Only during the GFC did the Federal Reserve employ, in addition to conventional monetary policy tools to lower interest rates and offer liquidity, unconventional tools via the adoption of broad quantitative easing programs. These programs benefited bank lending and liquidity, and contributed to boosting local economic growth (Luck and Zimmerman, 2018; Rodnyansky and Darmouni, 2017). As a result, the extent to which the highlighted effects also benefit inefficient banks might explain a decline in their exit rates.

4. Other effects of financial crises

4.1. The impact of the S&L crisis and the GFC on surviving banks

While our primary focus is on bank exit, financial crises might also have a negative impact on surviving banks. In this section, we investigate the effect of the two crises in terms of changes in market share at the bank level with the purpose to understand if there is any differential effect depending on bank efficiency. To this end we estimate fixed effects panel data regression models, with standard errors clustered at the bank level, where the dependent variables are the changes in a bank's market share in terms of total assets or total deposits. The explanatory variables are those employed in the main analysis and where the two crisis dummies are interacted with bank efficiency. We report the regression results in Panel A of Table 7, whereas Panel B shows the marginal effects of the two crisis dummies for different levels of bank efficiency.

[10] In our sample we identify117 banks that received TARP support either directly or indirectly (via their parent company) with non-missing cost efficiency data. This is equivalent to 5% (14%) of inefficient banks defined as banks with cost efficiency less than the first quartile (decile) of the sample distribution before the GFC. Although it is an arguably small proportion of banks, had they failed it would have contributed to nearly 20% (26%) of inefficient exit banks during the GFC.

Table 7
Effects of the S&L and the GFC on the market share of surviving banks.

Panel A. Results of the fixed effects panel data regression model	(1) Market share by assets	(2) Market share by deposits
CE_{t-2}	0.003***	0.004***
	(2.901)	(4.015)
S&L crisis	−2.222***	−2.170***
	(−26.646)	(−25.031)
GFC	0.084	0.085
	(0.818)	(0.749)
S&L crisis*CE_{t-2}	0.037***	0.038***
	(26.744)	(26.576)
GFC*CE_{t-2}	−0.001	0.000
	(−0.687)	(0.204)
Controls/ Year dummies/ Quarter of year dummies	YES/YES/YES	YES/YES/YES
Constant	11.309***	11.407***
	(21.040)	(18.767)
Observations	848,287	848,287
R-squared	0.04	0.04

Panel B. Marginal effects of financial crises at different levels of cost efficiencies (p.p.)

	S&L crisis	GFC	S&L crisis	GFC
p25	−1.0683***	0.0400	−0.9737***	0.0994*
	(−20.48)	(0.72)	(−17.95)	(1.72)
p50	−0.5304***	0.0195	−0.4158***	0.1063**
	(−11.80)	(0.40)	(−8.88)	(2.13)
p75	−0.0477	0.0010	0.0848*	0.1125*
	(−1.05)	(0.02)	(1.78)	(1.86)

Panel C. Tests of the equality between change at the state level market share and real asset growth at first and last quartiles of bank efficiency

effect of Crisis given p75 bank efficiency level =	1.0206***	0.0390	1.0585***	0.0131
effect of Crisis given p25 bank efficiency level	(715.26)	(0.47)	(706.31)	(0.04)

Notes. This Table shows the results of how bank cost efficiency (**CE**), the **S&L crisis**, and the **GFC** affect survived banks' market share using fixed effects panel data regression model. The dependent variable in Column (1) (Column (2)) is market share by assets (deposits) (**MSA** (**MSD**)) and measures a quarterly change in a bank's market share (bank total assets (deposits) to total bank assets (deposits) in a state, where the bank is chartered, and in a given quarter) and expressed in percentages. The independent variable CE is bank cost efficiency, calculated using DEA, and expressed in percentages. The S&L crisis is a dummy that equals one for periods of savings and loans crisis in the period between 1986 and 1992, and 0 otherwise. GFC is a dummy that equals one for periods of the global financial crisis in the period between 2007 and 2010, and 0 otherwise. Survived banks are defined as banks that do not exit the market via failure or acquisition in one of the three normal times periods (between 1984 and 1985, 1993 and 2006 as well as 2010 and 2013) and the two crisis periods (S&L crisis and the GFC). Control variables (**Controls**) are the ones reported in Panel B of Table 1. Year fixed effects (**Year dummies**) and **Quarter of year dummies** are included in the model. Panel A shows the results of the regression models and Panel B shows the marginal S&L crisis and GFC effects on banks' change in market share given the first (p25), second (p50) and third (p75) quartile of the sample cost efficiencies. The differences and equality tests of the marginal S&L crisis and GFC effects between the last and the first quartile of sample efficiencies are presented in Panel C. All models are estimated with robust standard errors clustered by bank. Test values are provided in parentheses. *Significant at 10%. **Significant at 5%. ***Significant at 1%.

The findings reported in Panel B show that the S&L crisis has a negative effect on bank market share for the least efficient banks, whereas we observe no effect on the most efficient institutions or even a positive effect when the market share is defined in terms of deposits. The GFC, however, has no differential effects on survived banks' market share depending on efficiency. In general, we find that the negative effects of the S&L crisis were primarily confined to surviving banks with lower levels of efficiency, while the GFC had no effect on surviving banks in terms of their ability to achieve higher market share.

Furthermore, our empirical strategy offers indications on which banks were more likely to be acquisition targets in the two crises but says little on the implications of the deals for the acquiring banks. It might be suggested, however, that some benefits accrue to acquiring banks because of the opportunity to complete deals under favorable conditions in times of crisis. To assess this possibility, in the Online Appendix we compare the acquiring bank industry-adjusted average efficiency for the periods before and after the crisis. Specifically, we split the sample of acquiring banks into two groups – the ones that acquired in the S&L crisis and the ones that acquired in the GFC. We then calculate their average industry-adjusted cost efficiency levels for the period before and after the respective crises. The industry adjustment in based on the average bank efficiency of all non-acquiring banks in the given state and quarter. This adjustment allows us to exclude the influence of general industry trends.

The results suggest that acquirers' efficiency relative to their peers deteriorates significantly post-crises. This negative effect, however, is more pronounced for the banks that acquired during the S&L crisis, which suggests that the scarring effect of the GFC is partly counteracted by the benefits to the acquirers stemming from acquiring *'more efficient'* institutions.

4.2. Post-crises and bank efficiency: Average effects and effects on entry banks

The literature highlights a number of possible positive implications stemming from the exit of inefficient banks. By accelerating the exit of these banks, crises could not only be a cause of social and economic costs but also a source of longer-term benefits for the banking industry and the whole economy. For instance, the value of the investments of failed banks might be captured by surviving banks via spillovers (Knott and Posen, 2005). Furthermore, under the cleansing view, since outdated production units become unprofitable and the incentives to undertake productivity-improving activities increase, new entry firms should show improved levels of innovation and achieve a higher degree of productivity over the longer-term (see Knott and Posen, 2005). Other

Table 8
Post-crises and bank efficiency.

	(1) Post-crises effect on efficiency	(2) Entry effect
S&L crisis	−7.672***	−7.010***
	(−36.832)	(−33.763)
GFC	−21.605***	−14.364***
	(−66.125)	(−47.663)
Post S&L Crisis	−10.276***	−11.082***
	(−40.843)	(−43.236)
Post GFC	−24.230***	−19.634***
	(−73.533)	(−68.161)
Entered in NT		7.396***
		(18.790)
Entered in S&L crisis		3.721***
		(8.103)
Entered in GFC		11.015***
		(11.108)
Post S&L crisis*Entered in S&L crisis		2.671***
		(5.376)
Post GFC*Entered in GFC		2.224***
		(2.766)
Control variables/Year dummies/ Quarter of year dummies	YES/YES/YES	YES/YES/YES
Constant	90.132***	129.679***
	(43.043)	(103.865)
R-Squared	0.18	0.26
Observations	1,046,680	1,046,680

Notes. This Table shows the results of how **Post S&L crisis** and **Post GFC** affect bank efficiency. The method employed in Column (1) (Column (2)) is a fixed effects panel data (an OLS) regression model. The dependent variable, cost efficiency (**CE**), is measured using DEA and shows banks' ability to effectively utilize resources for a given level of outputs (see Section 2.3 for CE estimation details). The S&L crisis is a dummy that equals one for periods of savings and loans crisis in the period between 1986 and 1992, and 0 otherwise. GFC is a dummy that equals one for periods of the global financial crisis in the period between 2007 and 2010, and 0 otherwise. Post S&L Crisis (Post GFC) is a dummy variable that equals one for the 12-quarter period following the S&L crisis (GFC), and 0 otherwise. **Entered in NT** (**Entered in S&L crisis**/**Entered in GFC**) is a dummy variable equal to one if a bank began its operations in Normal Times (S&L crisis/GFC), and 0 otherwise. Control variables (**Controls**) are the ones reported in Panel B of Table 1. Year fixed effects (**Year dummies**) and **Quarter of year dummies** are included in the model. All independent control variables apart from Young and Adolescent are lagged by two quarters to avoid possible endogeneity. All models are estimated with robust standard errors clustered by bank. Test values are provided in parentheses. * Significant at 10%. ** Significant at 5%. *** Significant at 1%.

banking studies highlight the benefits for the whole economy from the removal of inefficient banks as these banks are detrimental to the real economy due to an inherent nexus between the development of the banking sector and economic growth (see, Berger et al., 2004; Bernini and Brighi, 2018; Hasan et al., 2009; Mirzaei and Moore, 2018, 2019).

Our analysis provides some evidence that a cleansing effect materializes in the banking industry but only under some specific scenarios; namely, for one of the two crises and merely in the group of older banks. Whether the observed limited cleansing effect is indeed sufficient to facilitate an overall long-term improvement in bank efficiency post crisis (as suggested by Knott and Posen, 2005) is, therefore, questionable. Furthermore, it is a priori unclear whether the observed effects are sufficient to free resources that can facilitate efficiency gains by new entry banks.

In this section we investigate the above aspects by comparing the crisis and post-crisis effects on bank efficiency and by examining the "entry effect" of the two crises.

We start by estimating a model where the dependent variable is bank efficiency and that includes a similar set of control variables as in the rest of our empirical tests. Two post-crisis dummies (**Post S&L Crisis** and **Post GFC**), taking a value of one for the 12 quarters post the S&L crisis and the GFC, respectively, are our key explanatory variables. Positive values of these dummies would indicate efficiency gains post-crisis.

The results, presented in the first column of Table 8, show that both crisis and post-crisis periods are detrimental to bank efficiency: average CE becomes lower not only during the S&L crisis and the GFC, but also in the subsequent post-crisis periods. The negative post-crisis effects are more pronounced, however, after the GFC than the S&L crisis. More specifically, while the S&L post-crisis period has an average negative effect on bank efficiency of 10.276 percentage points (pp.), the post-GFC exhibits a drop in the average bank efficiency of 24.230 pp. This difference is also statistically significant.[11] Our results remain similar if we extend the post-crisis period (for the S&L crisis) to 5 years. Notably, the results for the GFC do not imply that government interventions were worthless for the banking industry. In fact, we cannot observe the counterfactual; namely, the GFC effects without these interventions.

Overall, these results confirm the presence of key differences between the two crises, but, regardless of the crisis, bank efficiency does not seem to revert to the pre-crisis levels in the three years following the shock.

Finally, we account for the potential benefits of crises for new entry banks. To this end, we define three dummy variables taking the value of one depending on when a new bank entered the banking market (namely, during normal times, the S&L crisis and the GFC). We next interact the latter two dummies with the post-crisis dummies referring to their entry period.

The results, reported in column (2) of Table 8 indicate that new entry banks show on average greater efficiency than other banks, especially those banks entering during the GFC. Furthermore, new entry banks gain in efficiency in the post crisis periods as compared to the rest of the sample period.

[11] Specifically, we find that the coefficients are different at the 1% significance level according to an F-test.

All in all, there seem to be some reallocation benefits in favor of new entry banks despite the average post-crisis bank efficiency remaining below pre-crisis levels.

5. Conclusions

We show that the cleansing effect of financial crises on bank exits is confined to some specific scenarios. More specifically, we find that only during the S&L crisis does the systemic shock primarily accelerate the exit of the less efficient banks (via both failure and acquisition) as required by the cleansing effect. The GFC offers a contrasting picture with banks failing regardless of their efficiency levels and the most efficient banks being more likely to be acquired than the least efficient institutions. These latter findings are, therefore, in line with the scarring view of financial crises, where firms are penalized by financial shocks independently of their efficiency.

Furthermore, additional tests show that the cleansing effect of the S&L crisis did not materialize for young banks and both crises overly penalized younger institutions, thus reducing the chances that these banks achieved their full potential.

Given the findings above, it is not surprising, that we find via further tests a significant decline in bank efficiency in the three years following the two crises, although we observe some benefits for new entry banks.

Overall, our analysis shows that financial crises do not necessarily produce meaningful cleansing effects in the banking industry and are indeed detrimental to the post-crisis productivity of the industry. This finding has two key implications.

First, the purpose of mitigating the short-term effect of systemic shocks does not appear to go against the long-term productivity of the banking industry. Second, our finding highlights that forms of prudential regulation aimed at strengthening bank resilience in good times, in anticipation of future systemic shocks, such as the conservation buffer introduced by Basel III, might also contribute to mitigating the effects of crisis on the longer-term productivity of the banking industry. This might then benefit economic recovery post-crisis.

Supplementary material

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jbankfin.2018.12.010.

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