Contagion Effects in the Aftermath of *Lehman*'s Collapse: Measuring the Collateral Damage*

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Abstract: The spectacular failure of the 150-year old investment bank *Lehman Brothers* has been perceived as a major turning point in the global financial crisis that broke out in the Summer 2007. The specter of systemic risk raised fears of a full-scale collapse of the US financial sector due to financial contagion and concerns about significant disturbances outside the US, in international financial markets. Through the use of stock market data, this paper examines the investors' reaction to *Lehman*'s collapse in an attempt to identify a contagion effect on the surviving financial institutions. Our main research question is whether the contagion effect, if it was statistically significant, affected the other financial firms indiscriminately, that is regardless of potential differences in their risk profiles, financial conditions or physical exposures to *Lehman*. The empirical analysis indicates that (*i*) the collateral damages were limited to the largest financial firms; (*ii*) the most affected institutions were the surviving "non-bank" financial services firms (mortgage and specialty finance, investment services, and diversified financial services firms); (*iii*) the negative effect was strongly correlated with financial conditions of the surviving institutions. Overall, these findings suggest that the observed contagious effects were rational/discriminating rather than panic-driven/undifferentiated and tend to weaken the case for the bailout of *Lehman Brothers*.

Keywords: bank failures; systemic risk; financial crisis; contagion; bailout; regulation.

JEL Classification: G14; G21; G28

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Executive summary

Since the beginning of the global financial crisis in August 2007, many large institutions at the core of the financial systems have been bailed out by the public authorities in the name of contagion and systemic risk. In the US, for instance, financial institutions like *Bear Sterns*, *Fannie Mae*, *Freddy Mac*, *American Insurance Group*, and *Citigroup* were all considered systemically important or "too big to fail" and the government decided to protect them from failure by injecting huge amounts of taxpayers' money. However, in the particular case of *Lehman Brothers*, the outcome was drastically different: instead of conceiving an emergency rescue plan, the government allowed the nation's fourth-largest investment bank to collapse when no viable private-sector solution could be found. The government justified its no-bail-out decision on the grounds that, unlike in the case of *Bear Sterns*, market participants have had sufficient time to prepare themselves to absorb the collateral damages eventually caused by the imminent collapse of *Lehman*. Moreover, in contrast to *Bear Sterns*, *Lehman* had direct access to short-term facilities (PDCF) from the Federal Reserve. Top government officials also pointed out that they viewed *Fannie Mae* and *Freddie Mac* as far more systemically important than *Lehman* because the two mortgage giants own or guarantee about half of home loans originated in the US.

In contrast to the government officials' view, for many observers the failure of *Lehman* was an event triggering systemic risk and panic in financial markets. For instance, Acharya, Philippon, Richardson, and Roubini (2009) mention the *Lehman* failure as a clear example of systemic risk that materialized during the global financial crisis of 2007-2009. They note, with the benefits of hindsight, that *Lehman* contained "*considerable systemic risk*" and led to "*the near collapse of the financial system*." Portes (2008) takes a more sanguine view suggesting that the government decision not to rescue *Lehman* was a policy error that exacerbated the adverse effects of the financial crisis. The critics generally share the view that the systemic crisis that has emerged in the aftermath of *Lehman*'s failure could have been mitigated if the government had intervened.

Other influential economists embraced the opposite view, arguing that it was not *Lehman*'s failure but the uncertainty surrounding the ill-conceived $2\frac{1}{2}$-page draft of legislation regarding the *Troubled Asset Relief Program* (TARP) released several days afterward that effectively trigger the global panic of the fall 2008. Taylor (2009b) and Cochrane and Zingales (2009) are highly representative of this view. They use event studies based on graphical analysis to show that basic risk indicators of stress in the financial sector, such as the Libor-OIS spread, reacted apathetically to *Lehman*'s collapse. By contrast, the same stress indicators exhibited very strong and negative responses just after the Federal Reserve Board Chairman Ben Bernanke and Treasury Secretary Henry Paulson testified at the Senate Banking Committee about the TARP, several days later, on Tuesday, September 23rd, 2008. In the same vein, Rogoff (2008) contends that in the case of *Lehman* the government applied the right medicine at the right moment and approves its decision to deny taxpayers money to rescue the troubled investment bank.

The present paper contributes to the debate by focusing on two main research questions related to the systemic nature of the collapse of *Lehman Brothers* viewed as a turning point in the current financial crisis. First, through the use of stock market data, we examine the

investors' reaction to *Lehman*'s failure in an attempt to identify an eventual contagion effect on the surviving financial institutions. Absent a rigorous operational definition of systemic risk, it is difficult to infer from an event study analysis whether *Lehman* was indeed a "*systemically important*" institution. However, a necessary condition for this special qualification is that the failure should have significant adverse knock-on effects on a *large* number of financial institutions. Our findings indicates that the collateral damages associated to *Lehman*'s collapse – the "*financial tsunami*" or "*Armageddon*", as has been called in the press – were not *generalized* but rather *limited* to a specified subsample of firms: (*i*) the largest banks and financial institutions, presumably the most exposed to the failure of the investment bank; (*ii*) the financial services firms operating in the same product area as the failed investment bank; and (*iii*) firms providing mortgages, mortgage insurance, and other related services, i.e. operating in the most shaky sector after the summer 2007 and at the core of the current financial crisis. While the collateral damages were not generalized to all or a large number of FIs, it is worth mentioning that the biggest firms, which play a crucial role in the financial system, were however the most affected by the *Lehman* crisis. Whether *Lehman*'s collapse was a "*systemic event*" highly depends on how one defines the boundaries of the "*systemic risk*" concept.

Our second research question is whether the contagion effect affected the other surviving financial firms indiscriminately, that is regardless of potential differences in their risk profiles, financial conditions or physical exposures to *Lehman*. Overall, the results lend empirical support to the thesis that the observed contagious effects were consistent with the rational pricing / information-based contagion effect hypothesis. Otherwise stated, the contagion was firm-specific, rational and discriminating rather than industry-wide-specific, "pure" panic-driven or undifferentiated. The most affected financial firms were those having common characteristics with *Lehman*, i.e. operating in the same market, subsector or product area. Even more importantly, the individual abnormal stock returns are found to be strongly correlated with financial firms' fundamentals (risk profile, leverage, and profitability), suggesting that the market reaction to *Lehman*'s failure was selective and well-informed, rather than random and indiscriminate. Taken together, the findings tend to weaken the case for a regulatory bailout.

The results have broad policy implications and help shed light on an unsolved debate about the nature of the events triggering systemic risk during the recent global financial crisis. We conclude by reaffirming Taylor's (2009a) and others' urgent call for a rigorous operational framework to analyze and assess systemic events. Absent such a framework, it will be very difficult for policy makers to deal with the bailout mentality in the post-*Lehman* financial world.

"*To some people, virtually everything is systemic. To others, it remains very rare.*"
John B. Taylor (2009)

1. Introduction and motivation

The spectacular failure of the 150-year old investment bank Lehman Brothers has been perceived by many as a major turning point in the global financial crisis that broke out in the Summer 2007. The specter of systemic risk raised widespread fears of a full-scale collapse of the US financial sector due to financial contagion and concerns about significant disturbances outside the US, in international financial markets. According to the bankruptcy petition – no. #08-13555 – filled on Monday, September 15$^{\text{th}}$, 2008, Lehman's total assets of $639 billion made it the largest failure in US history, about six times larger than the largest previous failure (see Table 1). The complexity of the case relies in part on the billions of dollars in claims from creditors and counterparties located in various corners of the financial system. According to Lehman's bankruptcy administrator, the mass of creditors filled more than 60,000 claims against the failed investment bank before the deadline imposed by the court, September 22$^{\text{nd}}$, 2009.

{Table 1}

Financial media extensively discussed the case during the week that followed the bankruptcy announcement date, often using a broad array of metaphors and bombastic terms: "*a tsunami sweeping the financial industry*" and "*sending tremors worldwide*"; "*a financial Armageddon*" having "*a massive effect on hundreds of other businesses, from real estate to restaurants*"; "*a perfect storm*" sparking "*a chain reaction that sent credit markets into disarray*"; "*the biggest economic firestorm since the Great Depression*" that "*presented too great a threat to the financial system and the economy*" and "*set off a cascade of events around the globe*"; "*a devastating blow to the global financial world.*"[1] However, as noted by Kaufman (2000), it is not uncommon that the adverse implications of large financial firms' failures are largely exaggerated in the press, the resulting "tales of horror" being often taken as "facts." He attributes this propensity of the financial media to exaggerate to the veil of ignorance that deter the general public to understand very well the functioning and complexity of the financial system. As a consequence, the financial sector is somewhat steeped in mysticism and exposed to fictitious accounts of its operations, particularly the adverse effects of large failures, widespread financial problems and generalized breakdowns.

Among academics and researchers, there was considerable debate about the nature, triggering events, and extent of systemic risk during the recent global financial crisis. This

[1] The representative sample of terms quoted here was extracted from articles published by leading financial newspapers in the US (*Wall Street Journal*, *New York Times*, *Washington Post*, *New York Daily News* etc.) or reports issued by world-class publishers of business and financial information like *Dow Jones*, *Reuters*, and *Bloomberg* on days following September 15$^{\text{th}}$, 2008.

debate reflects undoubtedly more general difficulties to define properly the concept of systemic risk and the absence of a broad consensus in the financial literature. Kaufman (1994, 2000), De Bandt and Hartmann (2002), and Kaufman and Scott (2003) propose excellent surveys on contagion and systemic risk in banking and financial systems. Taylor (2009) provides an updated and interesting discussion of systemic risk in the context of the current financial crisis and highlights the urgent need for an *operational* definition of the concept. According to Kaufman and Scott (2003), systemic risk – referring to the risk or probability of widespread breakdowns in the entire financial system and evidenced by an extreme clustering of failures – is one of the most feared events by banking regulators and supervisors. De Bandt and Hartmann (2002) make a useful distinction between *narrowly*- vs. *broadly*-defined "systemic events." The first notion refers to occurrences where the failure of a financial institution or simply the release of adverse information about its conditions propagates through a "domino effect" to other financial institutions and markets. The latter definition include both systemic events in the narrow sense *and* simultaneous adverse effects on a large number of financial institutions caused by a widespread big or systematic (macro)shock. The various definitions place at the core of the concept of systemic risk the notion of contagion, which describes the propagation mechanisms of the effects of shocks from one or more financial firms to others. The phenomenon of contagion is widely perceived as being more dangerous in the financial sector than in other industries because (*i*) it occurs generally faster; (*ii*) it spreads more broadly within the industry; (*iii*) it results in a greater number of failures and larger losses to creditors; (*iv*) it can affects otherwise solvent financial institutions (see Kaufman, 1994). For all these reasons, it is widely considered that systemic risk is the strongest argument justifying the intervention of public authorities in the financial sector.

Since the beginning of the global financial crisis in August 2007, many large institutions at the core of the financial systems in developed and developing countries have been bailed out by the public authorities in the name of contagion and systemic risk. In the US, for instance, financial institutions like *Bear Sterns*, *Fannie Mae*, *Freddy Mac*, *American Insurance Group*, and *Citigroup* were all considered systemically important or "too big to fail" and the government decided to protect them from failure by injecting huge amounts of taxpayers' money. However, in the particular case of Lehman, the outcome was drastically different: instead of conceiving an emergency rescue plan, the government allowed the nation's fourth-largest investment bank to collapse when no viable private-sector solution could be found.[2] The government justified its no-bail-out decision on the grounds that, unlike in the case of *Bear Sterns*, market participants have had sufficient time to prepare themselves to absorb the collateral damages eventually caused by the imminent collapse of Lehman. Moreover, in contrast to *Bear Sterns*, Lehman had direct access to short-term facilities from the Fed-

[2] The failure to find a white knight ready to assume Lehman's liabilities is clearly due to the government decision to refuse any financial facilities to potential interested parties, as it has been the case for instance in March 2008 when *JP Morgan Chase* acquired the troubled investment bank *Bear Sterns*.

eral Reserve.[3] Top government officials also pointed out that they viewed *Fannie Mae* and *Freddie Mac* as far more systemically important than Lehman because the two mortgage giants own or guarantee about half of home loans originated in the US.[4]

In contrast to the government officials' view, for many observers the failure of Lehman was an event triggering systemic risk and panic in financial markets. For instance, Acharya, Philippon, Richardson, and Roubini (2009) mention the Lehman failure as a clear example of systemic risk that materialized during the global financial crisis of 2007-2009. They note, with the benefits of hindsight, that Lehman contained "considerable systemic risk" and led to "the near collapse of the financial system." Portes (2008) takes a more sanguine view suggesting that the government decision not to rescue Lehman was a policy error that exacerbated the adverse effects of the financial crisis. The critics generally share the view that the systemic crisis that has emerged in the aftermath of Lehman's failure could have been mitigated if the government had intervened.

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The main objective of the present study is to answer two main research questions related to the systemic nature of the collapse of Lehman Brothers viewed as a turning point in the current financial crisis. First, through the use of stock market data, we examine the investors' reaction to Lehman's failure in an attempt to identify an eventual contagion effect on the surviving financial institutions. Absent a rigorous operational definition of systemic risk, it is difficult to infer from an event study analysis whether Lehman was indeed a "systemically important" institution. However, a *necessary* condition for this special quali-

[3] Immediately after the near-failure of *Bear Stern*, on March 17$^{\text{th}}$, 2008, the Federal Reserve created an exceptional lending facility (the *Primary Dealer Credit Facility*, PDCF) that enabled investment banks and other primary dealers for the first time to access liquidity in the overnight loans market for short-term needs. The PDCF was intended to mitigate adverse effects from future failures of investment banks (see Adrian, Burke, and McAndrews, 2009, for further details).

[4] In his press conference on Monday, September 15$^{\text{th}}$ 2008, the US Secretary of the Treasury Henry M. Paulson Jr. clearly stated: "*The actions with respect to Fannie Mae and Freddie Mac are so extraordinarily important, not only to our capital markets, but to making sure we have plenty of finance in housing, because that is going to be the key to turning the corner here.*" (*Dow Jones Newswire*, September 15$^{\text{th}}$, 2008)

fication is that the failure should have significant adverse knock-on effects on a *large* number of financial institutions. Our second research question is whether the contagion effect, if it was statistically significant, affected the other surviving financial firms *indiscriminately*, that is regardless of potential differences in their risk profiles, financial conditions or physical exposures to Lehman. The answers to these questions have broad policy implications and help shed light on an unsolved debate about the nature of the events triggering systemic risk during the recent global financial crisis.

The rest of the paper is organized as follows. Section 2 presents the research methodology and Section 3 describes the data sources used in our study, as well as the sampling procedure. The main results concerning the market's reaction to the Lehman's failure announcement are presented in Section 4. Finally, Section 5 concludes and discusses some policy implications.

2. Methodology

To determine whether Lehman's collapse had a significant impact on the performance of the surviving financial firms, we begin by investigating the reaction of the stock market to the failure event. For that purpose, we use two variations of the conventional event study methodology. This section briefly describes our two choices for estimating abnormal stock returns and compares the benefits and drawbacks of each method.

The first modelling choice has been commonly employed in the financial literature to examine the reaction of the stock market to a significant event, such as a regulatory change, affecting *all* firms in the same industry (see e.g. Binder, 1985, 1998; Schipper and Thompson, 1983; Cornett and Tehranian, 1990; Karafiath et al., 1991; Brewer et al., 2003). Since all firms in our sample come from the financial services industry and share common event dates, we have to avoid the well-known misspecification problems in the conventional event study methodology due to extreme clustering. Indeed, failure to take into account the cross-sectional dependence might induce a systematic underestimation of the standard deviation of the mean abnormal returns, implying that the standardized test statistic is no longer applicable.[5]

According to the first method, what we call the "collateral damage" of Lehman's failure is quantified within a multivariate regression framework that takes the following form:

$$\tilde{R}_{it} = \alpha_{i0} + \beta_{im} R_{mt} + \sum_{\tau=0}^{1} \beta_{i\tau} D_{\tau t} + \tilde{\epsilon}_{it} \tag{1}$$

where

$\tilde{R}_{it}$ is the stock return of financial institution i ($i = 1, 2, \ldots, N$) on day t ($t = 1, 2, \ldots, T$);

[5] According to Schwert (1981), the cross-sectional dependence in returns around the underlying event date is mainly due to the fact that firms in the same industry tend to react in the same way to the event of interest. Traditional event study methodology assumes independent abnormal returns. An alternative solution would have been to adopt a portfolio approach as in Wall and Peterson (1990) or to use a test statistic recommended by Brown and Warner (1985), which is free of cross-sectional dependence in the security-specific excess returns.

R_{mt} is the corresponding broad market index (S&P 500) return for day t;

α_{i0} is the intercept coefficient, an event-independent constant term for financial firm i;

β_{im} is the systematic risk coefficient or the sensitivity of the firm i's rate of return to changes in the market's rate of return;

$D_{\tau t}$ is a binary variable that equals 1 if the event of interest occurred on day τ or during the window τ ($\tau \in [0, +1]$) and zero otherwise;

$\beta_{i\tau}$ is the event coefficient or the sensitivity of bank i's rate of return to the event of interest;

$\tilde{\epsilon}_{it}$ is a random error which is assumed to be independent of the market return, serially independent and normally distributed.

The equation from which the various models are developed can equally be written as

$$\begin{bmatrix} \tilde{\mathbf{R}}_1 \\ \tilde{\mathbf{R}}_2 \\ \vdots \\ \tilde{\mathbf{R}}_N \end{bmatrix} = \begin{bmatrix} \mathbf{X} & 0 & \dots & 0 \\ 0 & \mathbf{X} & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \dots & \mathbf{X} \end{bmatrix} \boldsymbol{\beta} + \begin{bmatrix} \tilde{\boldsymbol{\epsilon}}_1 \\ \tilde{\boldsymbol{\epsilon}}_2 \\ \vdots \\ \tilde{\boldsymbol{\epsilon}}_N \end{bmatrix} \tag{2}$$

or more simply

$$\tilde{\mathbf{R}} = \mathbf{X}\boldsymbol{\beta} + \tilde{\boldsymbol{\epsilon}} \tag{3}$$

The regression model assumes that the coefficient vector $\boldsymbol{\beta}_{NJ\times 1}$ is the same for all panels and the matrix of independent variables $\mathbf{X}_{NT\times NJ}$ is the same for each equation in the system. We also assume that the error terms are i.i.d. within each equation (firm), in addition to having different scale variance, i.e. we allow the disturbance variance to differ across equations. Finally, following the discussion at the beginning of this section, we assume that the contemporaneous covariance of the error terms can differ from zero, $Cov[\tilde{\epsilon}_{it}, \tilde{\epsilon}_{jt}] \neq 0$ if $i \neq j$, although the noncontemporaneous covariances are all zero, $Cov[\tilde{\epsilon}_{it}, \tilde{\epsilon}_{js}] = 0$ if $t \neq s$. These various assumptions imply that the variance matrix of the disturbance terms can be written as

$$\boldsymbol{\Omega} = \mathbf{E}[\tilde{\boldsymbol{\epsilon}}\tilde{\boldsymbol{\epsilon}}'] = \boldsymbol{\Sigma}_{N\times N} \otimes \mathbf{I}_{T\times T} = \begin{bmatrix} \sigma_1^2\mathbf{I} & \sigma_{12}\mathbf{I} & \dots & \sigma_{1N}\mathbf{I} \\ \sigma_{21}\mathbf{I} & \sigma_2^2\mathbf{I} & \dots & \sigma_{2N}\mathbf{I} \\ \vdots & \vdots & \ddots & \vdots \\ \sigma_{N1}\mathbf{I} & \sigma_{N2}\mathbf{I} & \dots & \sigma_N^2\mathbf{I} \end{bmatrix} \tag{4}$$

where $\boldsymbol{\Sigma}$ is the covariance matrix of $(\tilde{\epsilon}_{1t}, \tilde{\epsilon}_{2t}, \dots, \tilde{\epsilon}_{Nt})$, $\mathbf{I}$ is the identity matrix and $\otimes$ is the Kronecker product.

Equation [3] can be viewed as a linear system of equations in which a separate equation is estimated for each financial institution i included in the final sample. The regression parameters are estimated based on Zellner's (1962) seemingly unrelated regression (SUR) model using the generalized least squares (GLS) estimation method. The values of the parameters $\beta_{i\tau}$ in equation [1] capture the individual banks' estimated "abnormal" returns

associated with the failure announcement on day τ or during the window $\tau \in [0, +1]$. They are estimated using daily data before and after the event date over an estimation period sufficiently long to obtain meaningful statistical inferences. Precisely, we use stock market data for 235 days prior to the event date ($t = -235$ to $t = -1$) to 18 days after the event date ($t = +18$), i.e. from October 9$^{\text{th}}$, 2007 to October 9$^{\text{th}}$, 2008.

While the SUR methodology takes into account the cross-sectional dependence in returns and results in more efficient estimates than ordinary least squares (OLS) estimation, it has its own drawbacks. Particularly, this modeling choice for calculating abnormal returns is based on the estimation of the parameters of equation [1] using time-series of non-event period data, typically a 150-day or longer period. The main problem in our context is that the estimation period was characterized by extremely high levels of volatility in the stock market, yielding to very imprecise estimates of excess returns and significance tests with relatively low power.

The merit of using a factor model is that by extracting the fraction of the total return related to the market return's variability, the variance of the excess return may be significantly reduced, yielding to an increased ability to detect event-related effects. The benefit from using such an approach depends upon the goodness of fit of the models implied by equation [1]. Generally, the higher the goodness-of-fit measure, the greater is the variance reduction of the excess return, and the higher is the power of the significance tests. In our case, the vast majority of coefficient estimates in equation [1] are not statistically distinguishable from zero and almost all models exhibit very low R-squared coefficients. Consequently, it is of interest to consider an alternative procedure for the estimation of excess returns, which is less sensitive to the reliance on past returns. A natural candidate is the *market-adjusted model*, which is the second method for estimating excess returns used in this paper. Precisely, for each security the expected return is defined to be equal to the return of the market portfolio. Thus, abnormal returns AR_{it} are defined as the difference between the daily returns of security i on day t, R_{it}, and the daily returns of the market portfolio on day t, R_{mt} (the market portfolio returns are proxied here by the total returns of the S&P 500 Index):

$$AR_{it} = R_{it} - R_{mt} \tag{5}$$

Results from simulations with daily data confirm that the market-adjusted returns procedure does a reasonably good job in identifying event-related effects and has high power even in cases involving event-date clustering (see Brown and Warner, 1985). Therefore, all the results discussed at length in Section 4 are based on the market-adjusted procedure. The significance tests are conducted using standard procedures described in Brown and Warner (1985). For the sake of comparison, we also briefly mention the estimations obtained using the first method, i.e. the SUR framework, particularly when the results obtained by applying both modeling choices improve the overall interpretation.[6]

[6]It is worth noting that estimating abnormal returns with SUR requires that the time dimension (i.e.

3. Data description

To document empirically the potential contagion effects related to Lehman's failure on the other large financial firms, we collect detailed pricing-relevant information from the US stock market. This section briefly describes the sampling procedures and data sources used in our empirical analysis.

Our dataset is built using financial information reported in *Bloomberg* database. We collect daily stock price data from January 1st, 2008, to December 31st, 2008, for all *large* publicly traded *financial* firms. By "large" we mean every institution that reported total assets higher than US$ 1 billion in the last audited financial report before the event date. By "financial" we mean every institution operating in the same industry as Lehman's (Finance-Investment, SIC code 6211) or primarily in other fields of finance (banking; equity investment instruments; asset management; consumer finance; investment services, mortgage finance, specialty finance...). For stocks that were simultaneously listed on more than one exchange, pricing information is collected from the most actively traded exchange or the primary exchange for the stock. *Bloomberg* reports daily opening, closing, high/low, bid/ask prices, as well as historical series of trading volumes. The price data are adjusted to reflect major capital events that include scrip issues/rights offerings, open offers, stock splits and consolidations, reductions of capital, scrip (stock) dividends etc.[7] Our initial sample includes 413 financial institutions. However, our final sample satisfies the following additional selection criteria:

- using *Dow Jones Factiva* database, we imposed that major capital events such as stock splits, stock dividends, and other significant news did not occur on the event day;
- we dropped all banks that had "thinly" traded stocks during the sample period, defined as those for which daily stock price data were missing for more than six consecutive trading days;
- finally, for a financial firm to be included in our sample, it must have no missing stock return data on the event day.

These selection criteria reduced our final sample to 382 financial institutions: 305 "banks" (of which 60 S&Ls) and 77 "non-bank" financial services firms (including Lehman).

the number of days in the estimation period) be larger than the number of firms for the large-sample approximations to be reliable. In addition, for computational reasons, the number of observations per firm should exceed the total number of firms, to render the variance matrix of the disturbance terms, $\mathbf{\Omega}$, of full rank and invertible. Consequently, when applying SUR the number of firms included in the estimation sample is limited to 250; for that reason, we selected the 250 largest US financial institutions among the 382 firms included in our final sample. For the sake of comparability between the two methods, we re-estimate all the market-adjusted abnormal returns and compute the significance tests for the sub-sample containing the largest 250 financial firms.

[7] The general principle upon which *Bloomberg* makes all adjustments is to render past data fully comparable with current data.

To explain better the stock market reaction to the failure event, we also collected financial information from *Bloomberg* for each firm included in our final sample. Credit rating information for a sub-sample of rated financial institutions was collected from *Reuters* and *Bloomberg*, while physical exposures to Lehman and its subsidiaries are obtained from *Epiq Systems*, the corporate restructuring company that administrate Lehman's bankruptcy.[8]

4. Empirical results

4.1. *Evidence of contagion effects in stock market prices*

Did the failure announcement have a significant impact on the surviving financial firm stock returns? Did the shareholder reactions to Lehman's collapse vary across individual financial firms? To answer these questions, Table 2 reports the small sample F-statistic for the following two hypotheses:

- H_0^1: $\beta_1 = \ldots = \beta_N = 0$, i.e. the individual abnormal returns are jointly equal to zero for each day in the event window $[-2; +2]$ and each sub-sample of financial firms;
- H_0^2: $\beta_1 = \ldots = \beta_N$, i.e. the individual abnormal returns are jointly equal to each other.

The abnormal returns for a five-day period surrounding the failure announcement date (day 0 or September 15$^{\text{th}}$, 2008) are derived from the SUR framework described in the methodology section. The full sample of US financial firms was partitioned into various sub-samples with respect to size (*Panel A*) and type of activity (*Panel B*). Inspecting Tabel 2, in the vast majority of cases, both hypotheses are soundly rejected: the failure announcement triggered a significant reaction in the stock market and shareholder responses varied substantially across individual financial firms.

{Table 2}

The refine this preliminary finding, we also report in Tables 3a, 3b and 4 the results of the event study analysis described in Section 2, separately for the global sample ($N = 382$), as well as for various subsamples defined with respect to size (small, medium, and large) or type of activity (banking firms; non-bank FIs; commercial banks; S&Ls; diversified financial services firms; investment services firms; mortgage and specialty finance firms; and consumer finance firms). On average, the abnormal returns calculated over the event window $[-2; +2]$ are not statistically significant for the entire sample of FIs. The negative average abnormal return of -0.48% reported on day $t = 0$ (September 15$^{\text{th}}$, 2008) is due to the inclusion of Lehman in the global sample. When we exclude the failed investment bank from the sample, the average abnormal return of the surviving FIs on day $t = 0$ is positive ($+0.25\%$), albeit not statistically distinguishable from zero.[9]

[8] We are grateful to Tina Wheelon for help with data.

[9] This result is confirmed when we employ the alternative modeling choice for estimating abnormal returns, based on the SUR methodology (*omitted output*).

{Table 3a}

One may be tempted to infer that the bankruptcy filling by Lehman on Monday, September 15th, did not trigger any significant reaction in the stock market. However, aggregating all data into a single global sample could mask significant heterogeneity among listed FIs. Scrutinizing Table 3a, we can observe that the smallest FIs ($1,000 mil. < TA < $1,600 mil.) experience a significantly *positive* abnormal return of +3.65% according to the parametric t-test (p-value < 0.01) on the event day. This result suggests that at least for the smallest FIs, the stock market reaction was driven by factors other than "contagion." To strengthen our argument, it is worth noting that the vast majority (almost 90%) of FIs included in the "small-size" subsample are small commercial banks and S&Ls, without any significant exposure to Lehman. The "medium-size" FIs are not affected on average by the event, while the largest FIs – whose total assets are higher than the third quartile of the distribution or $8,200 mil. – show negative abnormal returns, significant at the 1% level. However, the statistical significance of the negative average abnormal return for the largest FIs is not robust to the exclusion of Lehman from the "big-size" subsample.

To refine the interpretation of the results obtained for the largest FIs, we use two alternative cut-off values of total assets to define the "big-size" sample: (1) if TA > $20,000 mil., the big-size subsample contain the Top 50 US financial firms; (2) if TA > $140,000 mil., the big-size sample is limited to the Top 20 US financial institutions.[10] After replicating the significance tests on the two alternative big-size samples, we are able to confirm that the Top 50 "surviving" financial firms show a significantly *negative* abnormal return of approximately −3.73% on day $t = 0$ (p-value < 0.10, *output omitted*). Not surprisingly, the reaction is even stronger when we restrict the big-size sample to the Top 20 "surviving" FIs: the average abnormal return on day 0 is equal in this case to −7.87%, significant at the 1% level (see Table 3b). These findings imply that the collateral damages associated with Lehman's failure were limited to the largest financial firms. These results are reinforced by the analysis of the cumulative abnormal returns (CAR). The CARs computed over whatever window are not significantly different from zero neither for the full sample nor for the "medium-size" sample. Yet, the Top 50 / Top 20 largest banks show a significant *negative* CAR over various short windows surrounding the event date.[11]

[10] Notice that, in contrast to the "small-size" sample, among the Top 50 / Top 20 FIs composing the "big-size" sample there are a significant number of "non-bank" diversified financial services firms.

[11] We selected relatively short windows because during the days surrounding the event date there were many significant events that may have affected the perception of the Lehman failure in the stock market. For instance, on Tuesday, September 16th (day +1), the US Federal Reserve agrees to lend the *American International Group* (AIG) $85 billion in return for a 79.9% equity stake. Consequently, the CAR over the window [0; +1] should be interpreted as the *net* effect of two opposite regulatory policies: a *laissez-faire* approach (Lehman) and a bailout decision (AIG). On Wednesday, September 17th (day +2), the *Securities and Exchange Commission* restricted short selling in an attempt to decelerate the rapid fall of the largest firms' share value; an emergency ban on shorting FIs' stocks was pronounced one day later, on September 18th (day +3). On September 19th (day +4), the US Treasury announced its decision to guarantee money market mutual funds up to an amount of $50 billion to ensure their viability. The proposed $700 billion

{Table 3b}

After providing evidence that at least the largest US financial firms were hit by the Lehman failure, we turn now to the question whether the contagion effect was firm- or industry-specific. We have already mentioned in the introduction the distinction between the two types of failure contagion and noticed its relevance from a regulatory perspective. To test the hypothesis that the most affected financial firms are those having common characteristics with Lehman (i.e. operating in the same market or product area), we partitioned the full sample into eight subsamples according to the *Industry Classification Benchmark* (ICB) and *Bloomberg Industry Group* classifications: (1) banks and savings and loans ($N = 305$); (2) commercial banks ($N = 249$); (3) savings and loans ($N = 60$); (4) mortgage and specialty finance ($N = 18$); (5) "non-bank" financial institutions ($N = 77$); (6) diversified financial services firms ($N = 54$); (7) investment services firms ($N = 18$); and (8) consumer finance ($N = 14$). It is worth noting that according to these classifications, Lehman belongs to three subsamples, namely "non-bank FIs", "diversified financial services", and "investment services." The results reported in Table 4 lend support to the thesis that the collateral damage was firm-specific rather than industry-wide-specific. The highest and most significant *negative* abnormal returns are observed for the "surviving" financial firms providing mortgages, mortgage insurance, and other related services (–7.15%, significant at the 5% level) or operating in the same subsectors as Lehman: diversified financial services (–4.16%, p-value < 0.05); non-bank financial activities (–3.69%, p-value < 0.05); and investment services (–3.33%, p-value < 0.05). Among the firms operating in the banking sector (commercial banks and S&Ls), only the largest ones show significant negative abnormal returns (–4.38, significant at the 5% level).

{Table 4}

Overall, the preliminary findings discussed in this section indicates that the collateral damages associated to Lehman's collapse were limited to (*i*) the largest financial institutions (presumably the most exposed to the failure of the investment bank); (*ii*) the financial services firms operating in the same product area as the failed investment bank (non-bank activities, diversified financial services, and investment services); and (*iii*) firms providing mortgages, mortgage insurance, and other related services (i.e. operating in perhaps the most shaky sector after the summer 2007 and at the core of the current financial crisis). In the next section, we attempt to refine these findings by investigating more deeply the link between individual abnormal returns and various proxies for the FIs' risk profile.

4.2. *Weakening the case for a regulatory bailout of Lehman Brothers*

To gain further insights into the results reported in the previous section, we examine in this section the economic determinants of the stock market reaction to the Lehman failure

bailout package to rescue the US financial system was debated by the Congress on September 22-24 (days +5 to +7).

announcement. In this respect, we focus our analysis on a broad set of financial variables capturing three main dimensions of financial firms' performance, namely, risk profile, leverage, and profitability. All balance-sheet variables are measured by using accounting data reported in the interim financial statements disclosed by each firm in our sample at the end of June 2008.

The *risk* profile is proxied by the ratio of loan loss reserves to total loans, the loan loss provisions divided by the total loans, and the ratio of non-performing assets as a fraction of total assets. Higher values of these ratios indicate a deteriorated credit risk profile. Alternatively, as a broad market measure of the risk profile and financial conditions, we also use the credit ratings assigned by the two main rating agencies (*Moody's* and *S&P*) during the week preceding the Lehman failure announcement. These ratings represent an appreciation of the capacity of a FI to honor its senior unsecured long term financial commitments, denominated in local/foreign currency. The two agencies use similar scales and criteria, and assign comparable ratings. The credit ratings are converted to cardinal value according to the following scale: AAA/Aaa = 1, AA+/Aa1 = 2, AA/Aa2=3 etc., and then averaged across the two rating agencies. Hence, a lower cardinal value corresponds to a higher credit quality. Finally, an interesting risk proxy to be considered in our analysis is the physical exposure to Lehman of each financial firm included in our final sample.[12] We conjecture that creditors having a significant exposure to Lehman (in relative terms) and not well diversified assets portfolios should experience adverse valuation effects. It is worth noting that the physical exposures to Lehman were disclosed progressively, in most cases *after* the end of our short event window. Consequently, we suppose implicitly that information on exposures is already distilled in stock market prices during the several days surrounding the bankruptcy announcement date. Our tests would then be biased against finding a significant relationship between the stock market reaction and the physical exposures to Lehman.

The degree of operating *leverage* is measured by the total debt / total assets ratio, the common equity / total asset ratio, and a bank-specific measure of the capital adequacy, the risk-based capital ratio. To distinguish between the impact of potential solvency problems and liquidity shortages, we also considered two additional gearing ratios that take into account the debt maturity structure: the ratio of long-term debt to total assets and short-term borrowings divided by the total liabilities and equity. We expect that FIs whose financing model is similar to Lehman, i.e. relying on rolling-over substantial amounts of short-term debt on a long-term basis, would be more affected by the failure.

Finally, the *profitability* dimension is proxied by conventional ratios: the return on equity

[12] We considered the total amount of exposure, including different kinds of claims: loans, letters of credit, derivative and swap contracts, commercial papers obligations, bonds etc. The mass of Lehman's creditors filled more than 60,000 claims against the failed investment bank before the deadline imposed by the bankruptcy court, September 22nd, 2009. Note however that some of the claims are duplicates, i.e. claims filed for the same amount against several different Lehman units. According to Lehman claim administrator *Epiq Systems*, many of the duplicate or erroneous claims have been corrected.

(ROE), return on assets (ROA), and the net income to total assets ratio. We also considered an efficiency ratio computed as the total revenues divided by operating expenses, expressed in percentages. Our conjecture is that FIs in better shape than their peers may have an improved shock-absorbing capacity and would be less affected by the Lehman failure.

Besides the size and industry classification, we ask the question whether there is any other significant difference between the four sub-samples of financial firms (small- vs. big-size; banks vs. non-banks FIs) that could explain the reaction of the stock market to the failure announcement. To answer this question, Table 5 summarizes the results of bivariate comparisons of the above mentioned risk, leverage, and profitability variables. Specifically, we compare the distribution of each performance variable in the four sub-samples of banks by performing standard mean tests and two non-parametric tests: a chi-square two-sample test on the equality of medians and a Wilcoxon-Mann-Whitney test for the hypothesis that two independent samples are from populations with the same distribution.

{Table 5}

As far as the risk profile is concerned, it is apparent that the credit quality is significantly more deteriorated in the big-size ($TA > Q_3$) and non-banks sub-samples. Note however, that the number of "non-bank" financial services firms reporting bank-specific variables, such as loan loss reserves and provisions, is quite low, rendering the comparisons less informative. [The bivariate analysis of credit ratings and Lehman exposure to be discussed here]. As revealed by the data, the largest FIs and the non-bank financial firms are also more leveraged on average than their smaller peers and competitors operating in the banking sector. As before, the number of "non-bank" financial services firms reporting bank-specific capital adequacy measures like the risk-based capital ratio is very low, yielding to little informative comparisons. Finally, the bivariate analysis of the various profitability measures does not allow us to infer clear conclusions, except that the smaller FIs are somewhat more efficient than their largest competitors. We attribute this surprising result to the peculiar composition of the two sub-samples defined with respect to size. The small-size subsample contains mostly commercial banks and S&Ls, while the big-size sub-sample includes a high number of investment services firms, presumably more exposed to the sub-prime crisis.

We also report in Table 5 descriptive statistics for other control variables: firm size (total assets and total market value, expressed in million US dollars), price-to-book ratio, the fraction of the core banking activities (net loans to total assets ratio), and the extent to which the asset portfolio contains large amounts of market securities (the ratio of market securities to total assets). By design, the total assets and market values are significantly higher in the big-size sample ($170-180 billion against $45-46 billion). Moreover, the "non-bank" FIs are significantly larger than their "bank" peers ($92-93 billion against $33-34 billion). Not surprisingly, the fraction of net loans is higher for small FIs, given the composition of the two subsamples defined with respect to size, and for firms operating in the banking sector. At the other extreme, the largest FIs and "non-bank" financial firms invest a higher fraction of their asset portfolios in marketable securities.

To determine whether the observed contagious effects were rational and discriminating rather than panic-driven or undifferentiated, we report in Table 6 the pairwise correlation coefficients between standardized abnormal returns on day $t = 0$ (SAR_0) and standardized cumulative abnormal returns over the window $[0; +1]$ ($SCAR_{[0;+1]}$), on the one side, and a group of factors that could explain the market's reaction to the Lehman failure. The correlation coefficients are computed for the global sample, as well as for the two sub-samples defined with respect to the industry classification: banks *vs.* non-banks. Both measures of abnormal returns are negatively correlated with all the risk measures and positively correlated with the profitability variables, especially for the FIs included in the "banks" sub-sample. That is, the more deteriorated the banking performance, the more negative and stronger the reaction of stock market prices to the bankruptcy announcement. [The correlation coefficients between credit ratings / Lehman exposure and SAR / SCAR to be discussed here]. We also find strong correlations between the degree of operating leverage and abnormal returns: the higher the leverage, the more negative the reaction of the stock market, irrespective of the (sub)sample used in the analysis.

{Table 6}

As previously anticipated, the two proxies for firm size and the "non-banks" dummy are strongly and negatively correlated with both measures of abnormal returns. This result is fully consistent with the preliminary findings discussed in the preceding section. Interestingly, the fraction of total assets invested in marketable securities is positively correlated with abnormal returns in the "banks" sample and negatively correlated in the "non-bank" sample. This means that for banks the portfolio of marketable securities is viewed as a liquidity cushion, while in the case of non-bank FIs, the marketable securities are perceived as a significant source of concern and uncertainty.

Overall, the results presented in this section lend empirical support to the thesis that the observed contagious effects in the aftermath of Lehman's collapse were consistent with a rational pricing and the information-based contagion effect hypothesis. Put differently, the contagion was firm-specific, rational and discriminating rather than industry-wide-specific, "pure" panic-driven or undifferentiated: the most affected financial firms were those having common characteristics with Lehman, i.e. operating in the same market, subsector or product area. Even more importantly, the individual abnormal stock returns are found to be strongly correlated with financial firms' fundamentals (risk profile, leverage, and profitability). These findings have important policy implications since they tend to weaken the case for a regulatory bailout.

5. Conclusion

After the spectacular failure of the 150-year old investment bank Lehman Brothers on September 15$^{\text{th}}$ 2008, a broad debate about the nature, triggering events, and extent of systemic risk during the recent global financial crisis has sharply divided economists and

underlined the urgent need for an operational framework to analyze and assess systemic events. For many observers, the failure of Lehman was a clear example of systemic risk that materialized during the current global financial crisis. The critics generally share the view that the government decision not to rescue the troubled investment bank was a big mistake that exacerbated the adverse effects of the financial crisis. Other influential economists embraced the opposite view, arguing that it was not Lehman's failure but the uncertainty surrounding the first draft of legislation regarding the TARP released several days afterward that effectively trigger the global panic of the fall 2008. The defenders of the no-bail-out thesis contend that the government applied in the case of Lehman the right medicine at the right moment and approved its decision to deny taxpayers money to rescue the nation's fourth-largest investment bank.

The present paper contributes to the debate by focusing on two main research questions related to the systemic nature of the collapse of Lehman Brothers. First, through the use of stock market data, we examine the investors' reaction to Lehman's failure in an attempt to identify an eventual contagion effect on the surviving financial institutions. Absent a rigorous operational definition of systemic risk, it is difficult to infer from an event study analysis whether Lehman was "systemically important." However, a *necessary* condition for this special qualification is that the failure should have *significant* adverse knock-on effects on a *large* number of surviving financial institutions. Our findings indicates that the collateral damages associated to Lehman's collapse – the "*financial tsunami*" or "*Armageddon*", as has been called in the press – were not *generalized* but rather limited to a specified subsample of firms: (*i*) the largest banks and financial institutions, presumably the most exposed to the failure of the investment bank; (*ii*) the financial services firms operating in the same product area as the failed investment bank; and (*iii*) firms providing mortgages, mortgage insurance, and other related services, i.e. operating in the most shaky sector after the summer 2007 and at the core of the current financial crisis. While the collateral damages were not generalized to *all* or a *large* number of FIs, it is worth mentioning that the *biggest* firms, which play a crucial role in the financial system, were however the most affected by the Lehman crisis. Whether Lehman's collapse was a "systemic event" highly depends on how one defines the boundaries of the "systemic risk" concept.

Our second research question is whether the observed contagion effect affected the other surviving financial firms *indiscriminately*, that is regardless of potential differences in their risk profiles, financial conditions or physical exposures to Lehman. Overall, the results lend empirical support to the thesis that the observed contagious effects were consistent with the rational pricing / information-based contagion effect hypothesis. Otherwise stated, the contagion was firm-specific, rational and discriminating rather than industry-wide-specific, "pure" panic-driven or undifferentiated. The most affected financial firms were those having common characteristics with Lehman, i.e. operating in the same market, subsector or product area. Even more importantly, the individual abnormal stock returns are found to be strongly correlated with financial firms' fundamentals (risk profile, leverage, and profitability), suggesting that the market reaction to Lehman's failure was selective and well-informed,

rather than random and indiscriminate. Taken together, the findings tend to considerably weaken the case for the bailout of Lehman Brothers.

The results have broad policy implications and help shed light on an unsolved debate about the nature of the events triggering systemic risk during the recent global financial crisis. We conclude by reaffirming Taylor's (2009a) and others' urgent call for a rigorous operational framework to analyze and assess systemic events. Absent such a framework, it will be very difficult for policy makers to deal with the bailout mentality in the post-Lehman financial world.

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Table 1: The largest US public company bankruptcy filings (1980--2009)

No.	Company name[a]	Description	Bankruptcy date	Assets[b]
1	***Lehman Brothers Holdings Inc.***	Investment Bank	09/15/2008	691,063
2	***Washington Mutual, Inc.***	Savings & Loan Holding Co.	09/26/2008	327,913
3	WorldCom, Inc.	Telecommunications	07/21/2002	103,914
4	General Motors Corporation	Manufactures & Sells Cars	06/01/2009	91,047
5	***CIT Group Inc.***	Banking Holding Company	11/01/2009	80,448
6	Enron Corp.	Energy Trading, Natural Gas	12/02/2001	65,503
7	***Conseco, Inc.***	Financial Services Holding Co.	12/17/2002	61,392
8	Chrysler LLC	Manufactures & Sells Cars	04/30/2009	39,300
9	***Thornburg Mortgage, Inc.***	Residential Mortgage Lending Co.	05/01/2009	36,521
10	Pacific Gas and Electric Company	Electricity & Natural Gas	04/06/2001	36,152
11	Texaco, Inc.	Petroleum & Petrochemicals	04/12/1987	34,940
12	***Financial Corp. of America***	Financial Services & Savings and Loans	09/09/1988	33,864
13	***Refco Inc.***	Brokerage Services	10/17/2005	33,333
14	***IndyMac Bancorp, Inc.***	Bank Holding Company	07/31/2008	32,734
15	Global Crossing, Ltd.	Global Telecommunications Carrier	01/28/2002	30,185
16	***Bank of New England Corp.***	Interstate Bank Holding Company	01/07/1991	29,773
17	***General Growth Properties, Inc.***	Real Estate Investment Company	04/16/2009	29,557
18	Lyondell Chemical Company	Global Manufacturer of Chemicals	01/06/2009	27,392
19	Calpine Corporation	Integrated Power Company	12/20/2005	27,216
20	***New Century Financial Corporation***	Real Estate Investment Trust	04/02/2007	26,147

[a] financial services firms in bold

[b] pre-petition total assets, expressed in US$ million

Source: New Generation Research, Inc. Boston, MA

Table 2: Testing the nullity and equality of abnormal returns within the SUR framework

	Day –2	Day –1	Day 0	Day +1	Day +2
Panel A: Various sub-samples by size					
Small size (*N*=95) $\bar{\beta}_{i\tau}$	***–0.65%***	***–0.66%***	***0.76%***	***0.02%***	***2.72%***
H_0^1: β_1=…=β_N=0; *F*-statistic	1.80***	3.31***	3.74***	6.20***	7.38***
H_0^2: β_1=…=β_N; *F*-statistic	1.73***	3.15***	3.55***	6.26***	7.46***
Medium size (*N*=192) $\bar{\beta}_{i\tau}$	***–1.82%***	***0.04%***	***1.83%***	***1.73%***	***1.19%***
H_0^1: β_1=…=β_N=0; *F*-statistic	5.39***	11.43***	7.68***	11.92***	14.33***
H_0^2: β_1=…=β_N; *F*-statistic	5.28***	11.48***	7.06***	11.97***	14.35***
Big size (*N*=95) $\bar{\beta}_{i\tau}$	***–2.82%***	***–4.72%***	***–3.65%***	***–6.04%***	***7.34%***
H_0^1: β_1=…=β_N=0; *F*-statistic	3.63***	3.20***	32.30***	9.83***	6.38***
H_0^2: β_1=…=β_N; *F*-statistic	3.63***	3.24***	32.60***	9.68***	6.07***
Big size (*N*=20) $\bar{\beta}_{i\tau}$	***–5.17%***	***–3.46%***	***–14.35%***	***–0.34%***	***–2.85%***
H_0^1: β_1=…=β_N=0; *F*-statistic	5.16***	2.48***	48.42***	13.87***	6.9***
H_0^2: β_1=…=β_N; *F*-statistic	5.31***	2.57***	45.97***	14.34***	7.02***
Panel B: Various sub-samples by type of activity					
	Day –2	Day –1	Day 0	Day +1	Day +2
Mortgage & Specialty Finance (*N*=18) $\bar{\beta}_{i\tau}$	***–2.82%***	***–4.72%***	***–3.65%***	***–6.04%***	***7.34%***
H_0^1: β_1=…=β_N=0; *F*-statistic	1.13	3.79***	2.23***	3.70***	2.38***
H_0^2: β_1=…=β_N; *F*-statistic	1.17	3.89***	2.17***	3.88***	2.52***
Non-bank FIs (*N*=77) $\bar{\beta}_{i\tau}$	***–2.81%***	***–1.80%***	***–4.12%***	***–1.23%***	***0.16%***
H_0^1: β_1=…=β_N=0; *F*-statistic	2.82***	4.26***	20.81***	6.52***	5.31***
H_0^2: β_1=…=β_N; *F*-statistic	2.86***	4.31***	20.67***	6.53***	5.06***
Investment Services (*N*=25) $\bar{\beta}_{i\tau}$	***–4.41%***	***–1.97%***	***–10.89%***	***1.20%***	***–2.31%***
H_0^1: β_1=…=β_N=0; *F*-statistic	3.89***	1.65**	31.97***	9.86***	4.94***
H_0^2: β_1=…=β_N; *F*-statistic	3.88***	1.72**	31.02***	10.06***	5.08***
Consumer Finance (*N*=14) $\bar{\beta}_{i\tau}$	***–1.99%***	***0.96%***	***0.70%***	***–1.80%***	***–2.12%***
H_0^1: β_1=…=β_N=0; *F*-statistic	0.60	0.54	1.50*	1.28	1.47
H_0^2: β_1=…=β_N; *F*-statistic	0.58	0.52	1.52*	1.21	1.47

Notes: This table reports the small sample *F*-statistic for the following two hypotheses: H_0^1 β_1=…=β_N=0 according to which the individual abnormal returns are jointly equal to zero for each day in the event window [-2; +2] and each sub-sample of financial firms; H_0^2 β_1=…=β_N according to which the individual abnormal returns are jointly equal to each other. The abnormal returns for a five-day period surrounding the failure announcement date (day 0 = September 15th, 2008) are derived from the SUR framework described in the text. The full sample of US financial firms was partitioned into various sub-samples by size (Panel A) and type of activity (Panel B).

***, **, * indicate statistical significance at the 1%,5%, and 10% level, respectively

Table 3a: Abnormal returns on days surrounding Lehman's collapse, US FIs -- by size (I)

	Global sample (N=382)				Small size (N=95)		Medium size (N=192)		Big size Q3<TA (N=95)			
	Including Lehman		Excluding Lehman		TA<Q1		Q1<TA<Q3		Including Lehman		Excluding Lehman	
Day	AR (%)	% (<0)	AR (%)	% (<0)	AR (%)	% (<0)	AR (%)	% (<0)	AR (%)	% (<0)	AR (%)	% (<0)
–2	–1.32	65.97	–1.18	65.88	–1.39	72.63	–1.52	71.35	–0.84	48.42	–0.26	47.87
–1	–0.02	47.12	0.02	46.98	–1.20	56.84	0.04	47.92	1.04	35.79	1.20	35.11
0	–0.48	40.31	0.25	40.16	3.65***	24.21	–0.14	43.75	–5.32***	49.47	–2.39	48.94
+1	1.63	33.51	1.55	33.60	–0.99	55.79	2.09	29.69	3.33	18.95	3.00	19.15
+2	0.30	51.83	0.51	51.71	4.11***	27.37	0.10	53.65	–3.11	72.63	–2.30	72.34
Window												
[–1; 0]	–0.50	43.72	0.27	43.57	2.45*	40.53	–0.10	45.83	–4.28	42.63	–1.18	42.02
[0; +1]	1.15	36.91	1.80	36.88	2.67**	40.00	1.95	36.72	–1.99	34.21	0.62	34.04
[0; +2]	1.45	41.88	2.31	41.82	6.77***	35.79	2.05	42.36	–5.10	47.02	–1.69	46.81
[–1; +1]	1.13	40.31	1.82	40.24	1.46	45.61	1.99	40.45	–0.95	34.74	1.82	34.40
[–2; +2]	0.11	47.75	1.15	47.66	4.18**	47.37	0.57	49.27	–4.90	45.05	–0.74	44.68

Notes: This table presents the abnormal returns for a five-day period surrounding the failure announcement date (day 0 = September 15th, 2008), derived from the market-adjusted model described in the text. The full sample of US financial firms was partitioned into three sub-samples: "Small size" (*N*=95); "Medium size" (*N*=192); and Big size (*N*=95). We also report the mean cumulative abnormal returns computed over various event windows, parametric test statistics, and percentage of negative abnormal returns.

***, **, * indicate statistical significance at the 1%,5%, and 10% level, respectively

Table 3b: Abnormal returns on days surrounding Lehman's collapse, US FIs -- by size (II)

	Global sample (N=382)				Small size		Medium size		Big size (N=20)			
	Including Lehman		Excluding Lehman		(N=20)		(N=342)		Including Lehman		Excluding Lehman	
Day	AR (%)	% (<0)	AR (%)	% (<0)	AR (%)	% (<0)	AR (%)	% (<0)	AR (%)	% (<0)	AR (%)	% (<0)
–2	–1.32	65.97	–1.18	65.88	–2.75	70.00	–1.12	66.96	–3.28	45.00	–0.53	42.11
–1	–0.02	47.12	0.02	46.98	–1.13	80.00	0.25	44.15	–3.54	65.00	–2.95	63.16
0	–0.48	40.31	0.25	40.16	3.28**	20.00	0.53	39.47	–21.51***	75.00	–7.87***	73.68
+1	1.63	33.51	1.55	33.60	–4.33***	60.00	1.97	32.16	1.75	30.00	0.05	31.58
+2	0.30	51.83	0.51	51.71	7.32***	10.00	0.48	52.34	–9.80***	85.00	–6.17**	84.21
Window												
[–1; 0]	–0.50	43.72	0.27	43.57	2.15	50.00	0.78	41.81	–25.05***	70.00	–10.82***	68.42
[0; +1]	1.15	36.91	1.80	36.88	–1.05	40.00	2.50	35.82	–19.76***	52.50	–7.81**	52.63
[0; +2]	1.45	41.88	2.31	41.82	6.27**	30.00	2.98	41.33	–29.56***	63.33	–13.98***	63.16
[–1; +1]	1.13	40.31	1.82	40.24	–2.18	53.33	2.75	38.60	–23.30***	56.67	–10.77**	56.14
[–2; +2]	0.11	47.75	1.15	47.66	2.38	48.00	2.11	47.02	–36.39***	60.00	–17.47***	58.95

Notes: This table presents the abnormal returns for a five-day period surrounding the failure announcement date (day 0 = September 15th, 2008), derived from the market-adjusted model described in the text. The full sample of US financial firms was partitioned into three sub-samples: "Small size" (*N*=20); "Medium size" (*N*=342); and Big size (*N*=20). We also report the mean cumulative abnormal returns computed over various event windows, parametric test statistics, and percentage of negative abnormal returns.

***, **, * indicate statistical significance at the 1%,5%, and 10% level, respectively

Table 4: Abnormal returns on days surrounding Lehman's collapse, US FIs -- by type of activity

	Banks and S&Ls (N=305)				Commercial Banks (N=249)				S&Ls (N=60)				Mortgage & Specialty Finance (N=18)	
	All		Top20		All		Top20		All		Top20			
Day	AR (%)	% (<0)	AR (%)	% (<0)	AR (%)	% (<0)	AR (%)	% (<0)	AR (%)	% (<0)	AR (%)	% (<0)	AR (%)	% (<0)
–2	–1.13	68.85	1.60	35.00	–1.08	66.27	0.50	40.00	–1.12	76.67	–1.52	80.00	–2.25	55.00
–1	0.43	42.95	1.51	35.00	0.55	41.37	0.48	45.00	–0.30	53.33	–0.40	40.00	–4.91	55.00
0	1.24	33.44	–4.89**	55.00	1.30	33.73	–4.38**	55.00	0.75	33.33	–1.99	40.00	–7.15**	55.00
+1	2.11*	30.16	4.06*	20.00	2.10*	30.92	2.71	20.00	1.71	28.33	3.90*	10.00	–5.23*	45.00
+2	1.13	46.56	–3.70	70.00	0.95	49.80	–5.09**	80.00	1.16	36.67	–0.21	35.00	3.84	45.00
Window														
[–1; 0]	1.66	38.20	–3.38	45.00	1.84	37.55	–3.90	50.00	0.44	43.33	–2.39	40.00	–12.07***	55.00
[0; +1]	3.35**	31.80	–0.83	37.50	3.39*	32.33	–1.67	37.50	2.46	30.83	1.91	25.00	–12.39***	50.00
[0; +2]	4.48**	36.72	–4.53	48.33	4.34**	38.15	–6.76*	51.67	3.62*	32.78	1.71	28.33	–8.55	48.33
[–1; +1]	3.78*	35.52	0.68	36.67	3.94*	35.34	–1.18	40.00	2.15	38.33	1.51	30.00	–17.30***	51.67
[–2; +2]	3.79	44.39	–1.41	43.00	3.81	44.42	–5.77	48.00	2.19	45.67	–0.22	41.00	–15.72**	51.00

	Non-bank FIs (N=77)				Diversified Financial Services (N=54)				Investment Services (N=25)				Consumer Finance (N=14)	
	Including Lehman		Excluding Lehman		Including Lehman		Excluding Lehman		Including Lehman		Excluding Lehman			
Day	AR (%)	% (<0)	AR (%)	% (<0)	AR (%)	% (<0)	AR (%)	% (<0)	AR (%)	% (<0)	AR (%)	% (<0)	AR (%)	% (<0)
–2	–2.08	54.55	–1.38	53.95	–3.10*	59.26	–2.11	58.49	–3.36*	48.00	–1.19	45.83	–1.37	57.14
–1	–1.80	63.64	–1.63	63.16	–2.85*	64.81	–2.62	64.15	–1.77	68.00	–1.24	66.67	0.89	57.14
0	–7.28***	67.53	–3.69**	67.11	–9.28***	70.37	–4.16**	69.81	–14.42***	76.00	–3.33**	75.00	–2.33	64.29
+1	–0.28	46.75	–0.73	47.37	–0.17	44.44	–0.81	45.28	2.52	44.00	1.21	45.83	–0.97	71.43
+2	–3.01*	72.73	–2.01	72.37	–2.35	70.37	–0.90	69.81	–5.84***	68.00	–2.80*	66.67	–5.15**	92.86
Window														
[–1; 0]	–9.09***	65.58	–5.32**	65.13	–12.12***	67.59	–6.78***	66.98	–16.20***	72.00	–4.56**	70.83	–1.44	60.71
[0; +1]	–7.56***	57.14	–4.41**	57.24	–9.45***	57.41	–4.97**	57.55	–11.91***	60.00	–2.12	60.42	–3.30	67.86
[0; +2]	–10.57***	62.34	–6.43**	62.28	–11.79***	61.73	–5.87**	61.64	–17.75***	62.67	–4.92*	62.50	–8.45**	76.19
[–1; +1]	–9.36***	59.31	–6.05**	59.21	–12.29***	59.88	–7.59***	59.75	–13.68***	62.67	–3.35	62.50	–2.40	64.29
[–2; +2]	–14.45***	61.04	–9.44***	60.79	–17.74***	61.85	–10.61***	61.51	–22.89***	60.80	–7.35**	60.00	–8.93*	68.57

Notes: This table presents the abnormal returns for a five-day period surrounding the failure announcement date (day 0 = September 15th, 2008), derived from the market-adjusted model described in the text. The full sample of US financial firms was partitioned into various sub-samples with respect to the type of activity. We also report the mean cumulative abnormal returns computed over various event windows, parametric test statistics, and percentage of negative abnormal returns.

***, **, * indicate statistical significance at the 1%,5%, and 10% level, respectively

Table 5: Bivariate comparisons of risk, profitability, and leverage measures across various sub-samples

Variable	Global			Small size			Big size			Small vs. Big			Banks			Non-banks			Banks vs. Non-banks		
	N	Mean	Med.	N	Mean	Med.	N	Mean	Med.	*t*-stat[a]	Chi2[b]	*z*-stat[c]	N	Mean	Med.	N	Mean	Med.	*t*-stat[a]	Chi2[b]	*z*-stat[c]
Risk measures																					
Loan loss res/Tot loans	329	1.62	1.28	84	1.25	1.16	79	1.55	1.33	–2.05**	5.89**	–1.79*	302	1.40	1.28	27	4.06	0.88	–1.90*	0.34	0.92
Loan loss prov/Tot loans	324	0.48	0.20	84	0.26	0.14	76	0.59	0.35	–3.64***	16.94***	–4.36***	303	0.36	0.20	21	2.24	0.88	–2.26**	4.12**	–3.41***
Non-perf ass/Tot ass	317	1.71	0.97	83	1.62	0.98	72	1.56	0.96	0.18	0.32	0.75	299	1.66	0.97	18	2.63	0.63	–0.77	0.22	0.41
Credit ratings	in	pro-	gress	in	pro-	gress	in	pro-	gress				in	pro-	gress	in	pro-	gress			
Lehman exposure	in	pro-	gress	in	pro-	gress	in	pro-	gress				in	pro-	gress	in	pro-	gress			
Leverage																					
Tot debt/Tot assets	380	23.75	18.36	95	17.27	16.68	94	31.14	24.36	–5.15***	12.70***	–4.40***	304	18.85	17.37	76	43.33	39.78	–6.40***	11.12***	–5.22***
LT debt/Total assets	380	14.52	11.19	95	11.87	10.76	94	16.67	12.62	–2.40***	2.33	–1.24	304	11.90	11.08	76	24.97	13.17	–4.07***	0.59	–2.34**
ST borr/Tot liab & eq	364	9.57	6.12	92	5.57	3.79	92	14.43	10.67	–5.22***	28.17***	–5.47***	294	7.08	5.78	70	20.06	9.25	–4.59***	1.77	–2.00**
Comm eq/Total assets	380	12.35	9.09	95	12.65	8.90	94	12.53	9.21	0.06	0.89	0.57	304	9.50	8.89	76	23.77	16.77	–4.78***	7.96***	–4.11***
Risk-based capital	300	13.15	11.70	79	13.55	11.56	72	14.33	12.28	–0.52	1.91	–1.96**	288	12.79	11.67	12	21.91	14.19	–1.16	5.56**	–2.48**
Profitability																					
Return on equity	370	2.59	7.45	95	5.17	7.10	91	2.43	7.20	0.99	0.19	0.44	301	4.01	7.47	69	–3.61	7.10	1.73*	0.02	0.77
Return on assets	377	0.17	0.68	95	0.25	0.72	92	0.42	0.69	–0.24	0.05	0.11	302	0.37	0.70	75	–0.63	0.50	0.74	0.77	0.19
Efficiency ratio	362	57.01	62.97	91	63.04	66.26	91	51.70	58.31	1.74	11.63***	3.17***	303	63.73	62.89	59	22.47	63.74	1.53	0.02	0.76
Net inc/Total assets	379	–0.16	0.15	95	–0.09	0.14	93	0.02	0.15	–0.47	0.19	0.07	303	–0.03	0.14	76	–0.66	0.16	1.21	1.11	–1.31
Other control variables																					
Total assets(†)	379	46.00	3.05	95	1.34	1.29	93	180.00	22.44	–4.39***	184.04***	–11.84***	303	34.33	2.75	76	92.51	6.04	–1.89*	8.11***	–3.61***
Total market value(†)	379	45.17	3.06	95	1.37	1.26	93	170.00	25.92	–4.46***	184.04***	–11.84***	303	33.01	2.82	76	93.64	6.08	–2.00**	11.30***	–3.96***
Price-to-book ratio	371	3.26	0.96	92	1.25	0.93	93	1.47	1.00	–0.69	1.22	–0.28	300	1.04	0.95	71	12.67	1.21	–1.17	3.03*	–2.67***
Net loans/Tot assets	347	66.80	71.57	89	69.94	73.44	87	59.31	67.61	3.29***	6.57***	3.91***	303	70.60	72.21	44	40.63	30.58	6.11***	12.45***	5.20***
Mkt securities/Tot ass	379	18.13	14.26	95	17.19	14.62	93	22.37	15.93	–1.98**	1.04	–1.48	303	15.82	14.33	76	27.34	11.79	–3.31***	0.05	0.16

Notes: This table presents several key financial variables measuring three dimensions of the banking performance (risk, operating leverage, and profitability), as well as other control variables (mean and median values) calculated separately for the full sample and various sub-samples of banks ("Small" vs. "Big" size; "Banks" vs. "Non-bank" FIs). See text for the definition of variables.

(a) *t*-test on the equality of means

(b) nonparametric two-sample test on the equality of medians

(c) Wilcoxon-Mann-Whitney rank-sum test for the hypothesis that the two independent sub-samples (i.e., unmatched data) are from populations with the same distribution

(†) $x10^3$

***, **, * indicate statistical significance at the 1%,5%, and 10% level, respectively

Table 6: Correlation coefficients between abnormal returns and proxies for risk and performance

Variable	Global sample			Banks subsample			Non-banks subsample		
	N	SAR0	SCAR[0;+1]	N	SAR0	SCAR[0;+1]	N	SAR0	SCAR[0;+1]
Risk measures									
Loan loss reserves/Tot loans	329	–0.116**	–0.153***	302	–0.187***	–0.184***	27	0.064	–0.044
Loan loss provisions/Tot loans	324	–0.126**	–0.211***	303	–0.117**	–0.162***	21	0.101	–0.102
Non-performing assets/Tot assets	317	–0.070	–0.191***	299	–0.100*	–0.249***	18	0.218	0.116
Credit ratings	in	progress		in	progress		in	progress	
Lehman exposure	in	progress		in	progress		in	progress	
Leverage									
Total debt/Total assets	380	–0.299***	–0.352***	304	–0.252***	–0.120**	76	–0.200*	–0.299***
Long-term debt/Total assets	380	–0.130**	–0.194***	304	–0.157***	–0.122**	76	–0.020	–0.096
Short-term borr/Tot liab & equity	364	–0.306***	–0.313***	294	–0.171***	–0.021	70	–0.245**	–0.293**
Common equity/Total assets	380	0.007	0.047	304	0.124**	0.196***	76	0.130	0.219*
Risk-based capital ratio		--	--	288	0.148**	0.081		--	--
Profitability									
Return on equity	370	0.073	0.151***	301	0.093*	0.233***	69	0.018	0.044
Return on assets	377	0.069	0.116**	302	0.132**	0.232***	75	0.045	0.084
Efficiency ratio	362	0.239***	0.197***	303	–0.065	–0.183***	59	0.237*	0.213*
Net income/Total assets	379	0.053	0.106**	303	0.064	0.126**	76	0.018	0.064
Other control variables									
Total assets	379	–0.315***	–0.266***	303	–0.406***	–0.199***	76	–0.301***	–0.338***
Total market value	379	–0.318***	–0.270***	303	–0.405***	–0.197***	76	–0.298***	–0.336***
"Non-banks" dummy	382	–0.245***	–0.298***		--	--		--	--
Price-to-book ratio	371	0.043	0.010	300	0.279***	0.344***	71	0.082	0.054
Net loans/Tot assets	347	0.241***	0.243***	303	–0.008	–0.054	44	0.173	0.170
Market securities/Total assets	379	–0.227***	–0.199***	303	0.093*	0.114**	76	–0.257**	–0.235**

Notes: This table presents correlation coefficients between standardized abnormal returns on day 0 (SAR0) and standardized cumulative abnormal returns over the event window [0;+1] (SCAR[0;+1]), on the one side, and several key financial variables measuring three dimensions of the banking performance (risk, operating leverage, and profitability) and other control variables, on the other side. The correlation coefficients are computed for the global sample, as well as for two sub-samples: "Banks" and "Non-bank" FIs. See text for the definition of variables.

***, **, * indicate statistical significance at the 1%,5%, and 10% level, respectively