Default Risk and Contagion in the US Financial Sector: An Empirical Analysis of the Commercial and Investment Banking, and Insurance Sectors

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Abstract

An asset pricing perspective is taken to examine contagion and the consequences of default risk for banks' and insurers' stock prices in the US financial sector. First, US financial institutions' default risk is analyzed to determine whether it is sector specific and/or systematic. In contrast to most previous papers dealing with interconnectedness and financial institutions, sector-specific risk is disentangled from systematic risk. Second, we analyze contagion effects stemming from the overall market or other financial sectors at the sector and firm-level during the financial crisis of 2007-2009. The data consist of 11,189 firm-quarter observations from 2004 until 2012. The findings indicate that default risk in the commercial and investment banking sector is systematic, sector-specific and idiosyncratic while it is mostly idiosyncratic in the insurance industry. Moreover, we find strong evidence of contagion during the period of the financial crisis, i.e., an increased co-movement between all financial firms and the overall economy and the commercial banking industry. Evidence for contagion from the insurance sector is limited, as the commercial banking and investment banking sectors' factor exposures to the insurance sector did not increase. The contagion effects are strongly driven by firm-specific factors in the analysis, indicating that investors discriminated between individual firms during the financial crisis based on their fundamentals. Our results have implications for regulators regarding the macro-regulation of financial firms and for investors regarding diversifiable and non-diversifiable risks in their portfolio.

Introduction

The recent financial crisis showed that the failure of financial institutions can endanger other financial firms and the overall economy. Strong linkages within the financial sector led to contagion effects that endangered the financial health of a large number of financial institutions. For example, Billio et al. (2012) find that the US financial sector has become highly integrated in recent years and that a high degree of interconnectedness during the recent financial crisis occurred. In addition, previous papers (e.g., Bekaert, Harvey and Ng, 2005; Bekaert et al., 2014; Phylaktis and Xia, 2009; and Baur, 2012) indicate that sectors' performances move more closely together in times of crisis, leading to contagion[4] effects. These high co-movements during crises reduce the effectiveness of diversification when it is needed most.

To better understand the behavior of stock prices, especially during a crisis, it is useful to consider the components of stock price risk: market (systematic) risk, sector-specific risk, and idiosyncratic risk (Campbell et al., 2001 and Fiordelisi and Marques-Ibanez, 2013). Previous studies of interconnectedness in the financial sector do not disentangle sector-specific, idiosyncratic, and systematic risk from each other except for Fiordelisi and Marques-Ibanez, (2013) who study EU commercial banking; and no studies concentrating on the U.S. insurance or banking industry consider this approach. Fiordelisi and Marques-Ibanez (2013) show that measures of individual commercial bank risk in the EU are sector-specific and systematic in the European banking sector.[5]

[4] We follow related papers (e.g., Bekaert, Harvey and Ng, 2005; and Bekaert et al., 2014) and define contagion as the co-movement of stock prices during crises in excess of what is implied by economic fundamentals.

[5] Fiordelisi and Marques-Ibanez refer to "systemic risk" instead of "sector-specific risk when analyzing if the default risk of a single bank can affect the stock price of other banks. However, the term "systemic risk" in most research is described as a risk that not only affects a single sector, but also adversely affects the real economy (Cummins and Weiss, 2014; and Group of Ten, 2001. Therefore, we follow Campbell et al. (2001), who denote the factor exposure to the firms' own sector as "industry-specific" or "sector-specific" risk.

Further, contagion might be affected by firm-specific characteristics such as default risk. If contagion is fundamentals-based, investors do not treat all stocks from a sector identically during a crisis (Baur, 2012; De Bruyckere, 2013). Instead, investors discriminate among firms so that stock prices of relatively stronger financial firms are not affected as severely as the stocks of firms more prone to default. Altunbas, Manganelli and Marques-Ibanez (2011) show that financial institutions' business models strongly affected their risk exposure during the financial crisis. Alternatively, contagion may occur without investors discriminating among firms in a sector; instead, investor reactions may be driven by herding behavior (Bekaert et al., 2014). In this case, the effectiveness of diversification would be further decreased compared to the case of fundamentals-based contagion.

The purpose of this research is two-fold. First, we break down four types of financial institutions' stock risk into their components: systematic, sector-specific, and idiosyncratic (Campbell et al., 2001; Fiordelisi and Marques-Ibanez, 2013). The four types of financial institutions are commercial banks, investment banks, property-casualty (PC) insurers, and life insurers. We then determine the relationship between default risk of these institutions and the sector-specific, systematic and idiosyncratic risk measures. Second, we use our framework to analyze contagion at the sector- and firm-level *during the recent crisis* for our sample of financial firms. We use a factor model including a market factor and three financial sector factors (commercial banking, investment banking and insurance) to set a benchmark for the expected co-movement of financial firms with these factors. Following Bekaert et al. (2014), we then define contagion as the co-movement in excess of that implied by the factor model. We document contagion and the extent to which it is fundamentals-driven during the crisis.

Data from SNL are used in the study, and these data include all US listed banks, investment banks, property-casualty and life insurers for the years 2004-2012 with the required data. In total the sample includes 11,189 firm-quarter observations. We use a factor model that includes a market factor for all financial institutions; in addition, a banking industry factor (for commercial banks), an investment banking factor (for investment banks), a property-casualty insurer factor (for PC insurers) and a life insurer factor (for life insurers) are used for each (separate) type of institution. Firm-level factors are analyzed by regression over the entire sample period as well as over the period of the financial crisis only. The regression analysis using data during the financial crisis only allows us to determine whether contagion is fundamentals-based or not.

The research most related to ours is that of Fiordelisi and Marques-Ibanez (2013).[6] However, this study extends/differs from theirs in several ways. First, while Fiordelisi and Marques-Ibanez (2013) analyzes commercial banks only, insurance companies and investment banks are included in this analysis. With respect to investment banks, these firms have different models than commercial banks but still played a prominent role during the crisis and the surrounding years (e.g., Bordo, 2008).[7] With respect to insurers, debate exists as to the importance of the insurance sectors in contributing to the crisis, especially for life insurance.[8]

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[6] Many studies exist that consider whether default risk is systematic (e.g., Lang and Stulz, 1992; Denis and Denis, 1995; Opler and Titman, 1994; Asquith et al., 1994; Altman, 1993; Dichev, 1998, Campbell et al., 2008), but most don't differentiate between financial and nonfinancial firms. Two exceptions are Bijlsma and Muns (2011) and Buhler and Propopczuk (2010), who analyze systematic risk across both the financial and nonfinancial sectors.

[7] Prior to the crisis, investment banking activities were considered less connected to other parts of the financial sector (Billio et al., 2012).

[8] In contrast to commercial banks' default risk, the prevalent opinion is that default risk in the insurance industry might not endanger firms from other sectors due to a lack of connectedness between these firms and the rest of the economy. This is consistent with previous papers that examine systemic risk in the insurance sector. For example, Chen et al. (2013) and Cummins and Weiss (2014) state that the insurance sector is a victim of financial crises (at least with respect to their core activities) and do not pose a danger to other sectors of the economy. However, in the life insurance sector, the fact that most life insurers hold similar asset portfolios may make them vulnerable to the same shocks, thus default risk within the life insurance sector might be highly correlated. In this case, default risk would be sector-specific, but not systematic.

Fiordelisi and Marques-Ibanez restrict their analysis to the years 1997 to 2007 while we include the full crisis period in our sample. Finally, we examine contagion effects between the subsectors of the overall financial sector during the recent crisis period, while Fiordelisi and Marques-Ibanez (2013) do not.

The literature on contagion effects during crises is vast and growing, but mostly focused on aggregate stock market indices (e.g., Forbes and Rigobon, 2002; Bekaert, Harvey and Ng, 2005; Bekaert et al., 2014) or on different economic sectors (Baur, 2012; Phlaktis and Xia, 2009). In contrast, we focus on a single sector (the US financial sector) and its components (commercial banks, investment banks, life insurers and property-casualty insurers) and add an analysis of factors that are linked to contagion at the firm-level. This allows us to analyze if contagion effects are fundamentals-based or non-fundamentals-based (Baur, 2012). To the best of our knowledge this is the first paper to analyze contagion effects within the US financial sector during the recent financial crisis and factors that affect contagion at the firm level.

By way of preview, our results indicate that commercial banks' and investment banks' default risk is systematic, sector-specific and idiosyncratic. For property-casualty insurers, we find that default risk is idiosyncratic only, while it is sector-specific and idiosyncratic in the life insurance sector. In addition, we find strong evidence for contagion effects stemming from the overall economy and the commercial banking sector, evidence for contagion from the insurance sector is limited, as the commercial banking and investment banking sectors' factor exposures to the insurance sector did not increase during the crisis. The contagion effects are highly related to firm-specific variables in our analysis, indicating that investors discriminate between individual firms during crises based on the firms' fundamentals (and, in particular, the firms' default risk).

The findings contribute to the literature in several ways. We use a different methodology to examine interconnectedness in the U.S. banking and insurance sectors from all other U.S. studies. Also, the fact that a single bank's distress can affect other firms in its sector and the overall economy strengthens the argument for macro-prudential regulation in the commercial and investment banking sectors. Macro-prudential regulation might take the form of capital surcharges or other measures to reduce the threat posed by these firms. On the other hand, given the insurance sector's limited ability to pose systematic risk and its comparably low degree of sector-specific risk, new macro-prudential measures seem less necessary in the insurance sector. We analyze contagion channels in the financial sector by disentangling between sector-specific and systematic effects thereby providing regulators with valuable information as to whether to concentrate on specific sectors or the overall financial industry.

This research also is within the scope of studies that consider volatility of (individual) stocks. In theory, investors are rewarded for systematic risk only. But industry level and idiosyncratic firm-level shocks are also important components of individual stock returns (e.g., Campbell et al., 2001).[9] Thus this research provides information for asset managers and other investors regarding the benefits of portfolio diversification. For example, the results indicate that banking risk is not diversifiable (because it is systematic), while insurance risk does not appear to be systematic, making it diversifiable.

The remainder of this paper is organized as follows: The next section formulates the hypotheses to be tested. This is followed by the Data and Methodology sections, respectively. The Results appear in the succeeding section, and the Conclusion follows.

[9] There are investors who are affected by idiosyncratic and industry level risk. For example, investors may be limited by corporate compensation policies to concentrate at least part of their portfolio in the corporation, and of course there may be investors who choose to hold undiversified portfolios. Option pricing, also, depends on volatility of stock returns, and the stock returns include industry-level and idiosyncratic volatility as well as market volatility.

Hypotheses Development

Previous research indicates the importance of interconnectedness in the financial sector, contagion effects and disentangling overall firm risk into its components (systematic risk, sector-specific risk, and idiosyncratic risk). In this section hypotheses are developed regarding the relationship between default risk and systematic risk and sector-specific risk in the banking industry. Next, analogous hypotheses for the investment banking sector and for the insurance sector are presented. Finally hypotheses are formulated concerning contagion and whether firm-related characteristics are related to contagion effects in the financial sector during the financial crisis of 2007 to 2009.

Commercial Banking Focused Hypotheses

Due to commercial banks' role as a credit supplier for the economy, the banking sector is likely to be highly integrated with firms in the overall economy (as well as other financial institutions). Additionally, the recent financial crisis provided evidence of significant spillover effects from banks to other sectors of the overall economy, providing an indication that a bank's default risk is systematic. These arguments are consistent with Fiordelisi and Marques-Ibanez (2013) findings that commercial banking default risk is systematic for the European Union. Thus our first hypothesis states,

Hypothesis 1: Commercial banks' default risk is systematic.

Moreover, commercial banks are usually closely interconnected with each other e.g., due to interbank activities and security lending (Cummins and Weiss, 2014). Thus given this strong connection between commercial banks, default risk of one or several commercial banks is likely to affect other banks. This would indicate that default risk is sector-specific in the commercial banking sector (i.e., it can lead to higher levels of stock price risk in the whole commercial banking sector). Again, in line with our reasoning, Fiordelisi and Marques-Ibanez (2013) find that bank default risk is sector-specific for the European Union. Hypothesis 2 states,

Hypothesis 2: Commercial banks' default risk is sector-specific.

Investment Banking Focused Hypotheses

Another important part of the financial sector is the investment banking sector. In general, investment banks' business models differ from commercial banks because lending traditionally plays a smaller role in their operations. Thus, default risk in the investment banking sector may neither be systematic nor sector-specific.

However, previous literature (Billio et al., 2012) indicates that the role of investment banks changed significantly in recent years, as these firms showed strong linkages with firms from other sectors of the economy.[10] Moreover, problems in the interbank lending and the commercial paper market that started in 2007 created a "run" on the shadow banking system and investment banks (Cummins and Weiss, 2014; Bordo, 2008). Thus, these prior studies indicate a changing role for the investment banking sector. This changing role might potentially have led to significant co-movements with other firms in the same sector (sector-specific risk) or even in the entire economy (systematic risk). For example, given increases in security lending and participation in the interbanking market via "shadow-banking," investment banking risk might have become sector-specific and/or systematic. Thus our third and fourth hypotheses state,

Hypothesis 3: Investment banks' default risk is systematic.

Hypothesis 4: Investment banks' default risk is sector-specific.

[10] For example, Adrian and Shin (2009) state that investment banking firms traditionally were engaged in market-making and underwriting securities, but their role in the supply of credit increased with the emergence of securitization.

Insurance Focused Hypotheses

Compared to commercial banks, the insurance sector is smaller and does not suffer as much from a lack of suitable substitutes as the banking sector does (Cummins and Weiss, 2014). This suggests that default risk within the insurance sector is not systematic, at least compared to banks.[11] Hypothesis 5 states:

Hypothesis 5: Insurers' default risk is not systematic.

The question of whether default risk in the insurance sector is sector-specific is much harder to gauge and may vary between life and property-casualty insurers. First, insurers are less interconnected with each other than banks, due to the lack of an equivalent to the interbank activities among banks (e.g., interbank lending).[12] Thus one possible conclusion is that default risk in the insurance sector is not sector-specific. However, upon closer examination by insurance sector, some reasons may exist for default risk to be sector-specific. For example, life insurers invest in similar asset portfolios and otherwise follow similar strategies resulting in herding behavior (Schwarcz and Schwarcz, 2014). Thus the default of one life insurer may signify that other insurers are in financial distress or likely to default. That is, default risk may be sector-specific. Because we do not have a strong prediction concerning whether life insurers risk is sector-specific, we state the following hypothesis in the null form:

Hypothesis 6a: Life insurer default risk is not sector-specific.

In the property-casualty insurance sector, many firms may be exposed to the occurrence of a catastrophic event. Depending on the severity and spread of coverage (Cummins et al.,

[11] Schwarcz and Schwarcz (2014), however, states that even though individual insurers may not endanger the overall economy, the insurance sector as a whole might be a source of systemic risk due to correlation among outcomes among individual insurers. In addition, while insurers' core business activities are not considered as systemically relevant, non-core activities such as underwriting CDSs can contribute to systemic risk (Cummins and Weiss, 2014).
[12] Some liken the reinsurance market as analogous to the interbank market for commercial banks. However, studies of reinsurance do not find it to be systemic (e.g., Swiss Re, 2003, and the Group of Thirty, 2006).

2002), many insurers may be hit with high claims at the same time, potentially making default risk sector-specific. However, crises such as the liability crisis in the property-casualty insurance sector in the 1980s had a large effect on liability insurers, but this did not affect other property-casualty insurers, other life insurers, or other financial sectors (or the economy in general). Therefore, we do not have a clear prediction as to whether property-casualty insurers' default risk is sector specific. Thus Hypothesis 6b is stated in null form:

Hypothesis 6b: Property-casualty insurer default risk is not sector specific.

Financial Crisis Contagion Hypotheses

The recent financial crisis is associated with a strong increase in the co-movement of stock returns within the financial sector and with the overall stock market. Thus, we expect that contagion effects existed in all sectors of the financial industry. For each sector we measure contagion stemming from four different sources: the aggregate stock market, the commercial banking sector, the investment banking sector, and the insurance sector during the financial crisis.

Hypothesis 7a (Market contagion): Co-movement of each sector with the aggregate market increased during the crisis.

Hypothesis 7b (Commercial banking contagion): Co-movement of each sector with the commercial banking sector increased during the crisis.

Hypothesis 7c (Investment banking contagion): Co-movement of each sector with the investment banking sector increased during the crisis.

Hypothesis 7d (Insurance contagion): Co-movement of each sector with the insurance sector increased during the crisis.

Finally, we analyze whether firm-level variables are related to a firm's degree of contagion during the financial crisis. If the contagion effects do not depend on a firm's characteristics, this indicates that investors pool sectors and treat firms within the same sector similarly (non-fundamentals-based contagion) (Baur, 2012). In this case, investors would tend to perceive higher risk to a similar degree for all of the stocks in the sector simultaneously in times of crises, which leads to increased co-movement of stock returns. That is, without discrimination by investors regarding a firm's fundamentals, contagion is driven by herding behavior (Bekaert et al., 2014). If fundamentals-based contagion occurs, investors consider an individual firm's characteristics and their business model (including default risk) in gauging the risk of a firm. Prior research (e.g. Bekaert et al., 2014; de Bruyckere et al., 2013; and Baur, 2012) has tended to find contagion to be fundamentals-driven, and that is what we propose as well:

Hypothesis 8: Contagion in the financial sector was fundamentals-driven in the financial crisis.

Data and Methodology

In this section the source of our data is provided. In addition, the methodology used to break down a stock's risk into components is described. This is followed by specification of the regression models used to determine whether a firm's distress risk is related to the stock's risk components as well as other explanatory variables. Finally, we specify the model used to determine whether contagion effects stemming from the individual financial sectors occurred during the crisis period and whether a firm's stock price risk factors are related to firm-specific variables such as default risk (among others). That is, we determine whether contagion is fundamentals-based.

Data

We use daily stock price returns and quarterly financial statement data for all US publicly traded banks (excluding thrifts), investment banks, life insurers, and property-casualty insurers provided by SNL Financial.[13] The sample period covers the years 2004 to 2012. We drop firms

[13] Some analyses are conducted with monthly data as well.

with negative or missing total assets, equity, and revenue. Furthermore, the data is winsorized at the 1 and 99 percentiles in the case of extreme outliers.[14] Moreover, we drop firms if the stock prices are not available during our sample period, as the estimation of the sector-specific and systematic risk components requires daily stock returns for each firm individually.

Breakdown and Analysis of Stock Price Risk into Components

We follow Fiordelisi and Marques-Ibanez (2013) and Campbell et al. (2001) to estimate the sector-specific, systematic, and idiosyncratic components of risk for each firm in the financial sectors (i.e., commercial banking, investment banking, life insurance, and property-casualty insurance) studied in the analysis. The risk components are estimated with the following regression model:

$$R_{i,t} = \alpha + \beta_{i,q}^{MKT} R_{i,t}^{MKT} + \beta_{i,q}^{Bank} R_{i,t}^{Bank} + \beta_{i,q}^{HML} R_{i,t}^{HML} + \beta_{i,q}^{SMB} R_{i,t}^{SMB} + e_{i,t} \quad (1)$$

if firm i is a commercial bank;

$$R_{i,t} = \alpha + \beta_{i,q}^{MKT} R_{i,t}^{MKT} + \beta_{i,q}^{InvB} R_{i,t}^{InvB} + \beta_{i,q}^{HML} R_{i,t}^{HML} + \beta_{i,q}^{SMB} R_{i,t}^{SMB} + e_{i,t} \quad (2)$$

if firm i is an investment bank;

$$R_{i,t} = \alpha + \beta_{i,q}^{MKT} R_{i,t}^{MKT} + \beta_{i,q}^{Life} R_{i,t}^{Life} + \beta_{i,q}^{HML} R_{i,t}^{HML} + \beta_{i,q}^{SMB} R_{i,t}^{SMB} + e_{i,t} \quad (3)$$

if firm i is a life insurer; and

$$R_{i,t} = \alpha + \beta_{i,q}^{MKT} R_{i,t}^{MKT} + \beta_{i,q}^{PC} R_{i,t}^{PC} + \beta_{i,q}^{HML} R_{i,t}^{HML} + \beta_{i,q}^{SMB} R_{i,t}^{SMB} + e_{i,t} \quad (4)$$

[14]The following variables were winsorized due to outliers: Z-Score, Lerner Index, Cost-Income Ratio, Income Diversification (and the respective line of business measures for insurers) and Liability Diversification.

if firm i is a property-casualty insurer. $R_{i,t}$ are the daily (t) stock market logarithmic abnormal returns[15] from each type of bank (type of insurer) i. $R_{i,t}^{MKT}$ are the daily stock market abnormal returns from the broad stock market index (proxied by the S&P 500).[16] $R_{i,t}^{Bank}$, $R_{i,t}^{InvB}$, $R_{i,t}^{Life}$ and $R_{i,t}^{PC}$ are the daily stock market abnormal returns from the commercial banking, investment banking, life insurance and pc insurance industry listed stocks, using indices from the respective sector.[17]

In addition, we include the Fama and French (1993) High-minus-Low (HML) and Small-minus-Big (SMB) factors (Bartram, Brown and Stulz, 2012; Beckaert, Hodrick and Zhang, 2012). The term $e_{i,t}$ is the bank (insurance) specific residual. For each firm i, our systematic ($\beta_{i,q}^{MKT}$) and sector-specific risk components ($\beta_{i,q}^{Bank}$, $\beta_{i,q}^{InvB}$, $\beta_{i,q}^{Life}$ and $\beta_{i,q}^{PC}$) are calculated by running separate regressions on daily data for each quarter (q), using the last 250 trading days to calculate the beta factor for the respective quarter.[18] In this way we can match our risk proxies with the other individual bank (insurer) variables (which are also reported on a quarterly basis). Moreover, following e.g. Brandt et al. (2009) or Campbell et al. (2001), we measure idiosyncratic risk $\sigma_{i,q} = \sigma(e_{i,t})$ as firm-specific volatility of the respective stock for the respective quarter.[19]

[15] We use the US 3 month T-bill yields to calculate abnormal returns throughout our analysis.

[16] Given that Fiordelisi and Marqués-Ibañez (2013) use a sample of commercial banks from different countries of the European Union, their broad stock market indices and banking industry indices vary between countries, denoted by subscript "c". As we focus on firms from the US only, country indices are not needed.

[17] For the commercial banking sector index, we use the S&P 500 Bank index; for investment banks the SNL U.S. Securities & Investments index is used. For life insurers, the S&P 500 Life Insurance index is used; and for property-casualty insurers the S&P 500 Property-Liability Insurance index is used.

[18] For example, to obtain a beta for Q3 2006 we regress the returns of the stock on market and sector returns between Q4 2005 and Q3 2006. A beta for Q4 2006 would be estimated similarly using data from Q1 2006 to Q4 2006.

[19] Consistent with the beta estimates, σ_q denotes the idiosyncratic risk of the stock of that respective quarter q which is based on the residual volatility of the last 250 trading days.

To allow an intuitive interpretation of the beta factors and to avoid the problem of mutlicollinearity in our analyses, all factors are orthogonalized by regressing the sector return ($R_{i,t}^{Bank}$, $R_{i,t}^{InvB}$, $R_{i,t}^{Life}$ and $R_{i,t}^{PC}$) on the market return and using this regression's residuals as the sector return (e.g. Bekaert et al., 2014; Beckaert, Hodrick and Zhang, 2009). For example, for the commercial banking index we first conduct the following regression:

$$R_{i,t}^{Bank} = \alpha + \beta_{i,q}^{MKT} R_{i,t}^{MKT} + \mu_{i,t} \quad (5)$$

and use $\mu_{i,t}$ as the banking index return ($R_{i,t}^{Bank}$) in equation (1). The same analysis is conducted for all other indices.[20]

To analyze if measures of a financial institutions' distress risk is related to systematic ($\beta_{i,q}^{MKT}$), sector-specific ($\beta_{i,q}^{Bank}$, $\beta_{i,q}^{InvB}$, $\beta_{i,q}^{Life}$, $\beta_{i,q}^{PC}$) and idiosyncratic ($\sigma_{i,q}$) risk, we follow Fiordelisi and Marqués-Ibañez (2013) and estimate the following models for the years 2004 to 2012:

$$\beta_{i,q}^{MKT} = \alpha + \delta * \text{Z-SCORE}_{i,q-1} + \Sigma\gamma_j * X'_{j,i,q-1} + \varepsilon_{i,q} \quad (6)$$

$$\beta_{i,q}^{Sector} = \alpha + \delta * \text{Z- SCORE}_{i,q-1} + \Sigma\gamma_j * X'_{j,i,q-1} + \varepsilon_{i,q} \quad (7)$$

$$\sigma_{i,q} = \alpha + \delta * \text{Z- SCORE}_{i,q-1} + \Sigma\gamma_j * X'_{j,i,q-1} + \varepsilon_{i,q} \quad (8)$$

using the firms' Z-score[21] as an indicator for default risk[22]; it is included to shed light on Hypotheses 1 through 6b. A negative and significant coefficient for the Z-Score indicates that the risk component used as the dependent variable is directly related to default risk. Given that

[20] Orthogonalization simplifies the interpretation of the betas, but otherwise does not affect the analysis (Beckaert, Hodrick and Zhang, 2009).

[21] The Z-Score has been used in various papers to measure a financial institution's default risk (see e.g. Boyd et al., 2006; Berger, Klapper and Turk-Ariss, 2009; Uhde and Heimeshoff, 2009). The Z-Score is defined as the firm's return on asset plus its capital ratio divided by the standard deviation of its return on assets for the previous 5 years.

[22] Fiordelisi and Marqués-Ibañez (2013) use Moody's probability of default ratings (PDR) and 1-Year ahead Expected Default Frequency as alternative measures of firm risk. However, as these measures are not available for most firms in our analysis, we mainly rely on the Z-Score in order to have an adequate number of observations to conduct the analyses.

our dataset has a panel structure, we use fixed effects regression analyses including firm and quarter fixed effects dummies.

A vector of control variables (X') that may influence sector-specific and systematic risk is included in the regression model. The control variables are designed to control for size of the financial institution, firm cost efficiency, firm market power (proxied by the efficiency-adjusted Lerner index),[23] income diversification, liability diversification, and market share. The control variables are the same as those used by Fiordelisi and Marques-Ibanez (2013),[24] and these are described more fully for each type of financial institution in Table 1.[25] Prior research indicates that banks' market power (Lerner Index), and cost efficiency (cost-income ratio) should have a positive relationship with volatility in firm risk (e.g., Turk-Ariss, 2010). The financial institution's business model (proxied by income diversification and liability diversification) is expected to be related to volatility in firm returns (i.e., risk) (e.g., Fiordelisi, 2011). Size reflects the relative weight the financial institution has on the financial sector, and the expectation is that size is associated with more interconnectedness.

To mitigate potential causality problems (default risk might be driven by systematic and sector-specific risk, not the other way around), all independent variables are lagged by one period. $\beta_{i,q}^{Sector}$ denotes the sector-specific risk component for the respective sector ($\beta_{i,q}^{Bank}, \beta_{i,q}^{InvB}, \beta_{i,q}^{Life}, \beta_{i,q}^{PC}$). If firm i is a bank (investment bank, life insurer, pc insurer), then $\beta_{i,q}^{Sector} = \beta_{i,q}^{Bank}$ ($\beta_{i,q}^{InvB}, \beta_{i,q}^{Life}, \beta_{i,q}^{PC}$). Equations (6) to (8) are estimated separately for each sector, i.e. separate regressions are run for commercial banks, investment banks, life insurers and

[23] The calculation of the efficiency-adjusted Lerner index is described in Appendix A.
[24] Because Fiordelisi and Marques-Ibanez use a sample containing different countries, some country-related control variables that are relevant in their analysis are not used here (e.g., internet usage).
[25] We do not use a herfindahl index to measure concentration among countries since only the US is analyzed. Market share for each firm is used instead.

pc insurers to analyze if there are differences between the sectors regarding the relation between default risk and stock price risk.

Estimation of Contagion During Financial Crisis

To measure contagion in the US financial sector during the financial crisis, a framework comparable to Bekaert et al. (2014) is used. That is, a regression model is estimated that includes the four factors (market risk, commercial banking risk, investment banking risk, and insurance risk) and that also allows for the capture of contagion effects stemming from these sectors:

$$R_{i,t} = \alpha + \beta_{i,m}^{MKT} R_{i,t}^{MKT} + \beta_{i,m}^{Bank} R_{i,t}^{Bank} + \beta_{i,m}^{InvB} R_{i,t}^{invB} + \beta_{i,m}^{Ins} R_{i,t}^{Ins} + \beta_{i,m}^{HML} R_{i,t}^{HML} + \beta_{i,m}^{SMB} R_{i,t}^{SMB} + e_{i,t} \quad (9)$$

$R_{i,t}^{MKT}$, $R_{i,t}^{Bank}$ and $R_{i,t}^{InvB}$ are defined as in equation (1), while $R_{i,t}^{Ins}$ is proxied by the daily return of the S&P 500 insurance index.[26] The observation period starts in January 2001 and ends in March 2009.The model allows us to set a benchmark of co-movements in normal times. Note that, in contrast to equations (1) to (4), the betas are now time-varying betas that change each month (m) instead of every quarter. Equation (9) is estimated every month based on the last 250 trading days (one year). For example, to estimate the risk components for January 2001 ($\beta_{i,m}^{MKT}, \beta_{i,m}^{Bank}, \beta_{i,m}^{InvB}, \beta_{i,m}^{Ins}$ for m=1, i.e. January 2001), we regress each firm's daily return $R_{i,t}$ on the daily return of the market ($R_{i,t}^{MKT}$), all indices ($R_{i,t}^{Bank}, R_{i,t}^{invB}, R_{i,t}^{Ins}$) and the Fama and French factors ($R_{i,t}^{HML}, R_{i,t}^{SMB}$) between February 2000 and January 2001. For February 2001, we estimate the same model using returns from March 2000 till February 2001. This allows us to

[26] Alternatively, we could include the life and property-casualty sector individually as in equations (3) and (4). This provides very similar results. For the sake of simplicity, we therefore include a measure of the overall insurance sector ($R_{i,t}^{Ins}$).

analyze changes in factor exposures more granularly during the months in which the crisis affected stock markets.

Next, we are interested in the changes in the factor exposures during the financial crisis, i.e. contagion effects. Contagion might stem from 4 sources (market risk, commercial banking risk, investment banking risk, and insurance risk) in our model, indicated by an increase in its factor loading during the crisis. Equations (10) to (13) capture contagion via the four factors during the financial crisis in the coefficient terms γ^{MKT}, γ^{Bank}, γ^{InvB} and γ^{Ins} for each sector. These models are estimated from January 2001 until March 2009. Following Bekaert et al. (2014) and Baur (2012), CR_m is a crisis dummy equal to one if the month is between August 2007 and March 2009.[27] Thus, we use the period from January 2001 to July 2007 to set a benchmark of co-movements in "normal" times. Thus, γ^{MKT}, γ^{Bank}, γ^{InvB} and γ^{Ins} indicate increases in the respective co-movements during the crisis compared to more normal times.

$$\beta_{i,m}^{MKT} = \gamma_0 + \gamma^{MKT} CR_m \tag{10}$$

$$\beta_{i,m}^{Bank} = \gamma_0 + \gamma^{Bank} CR_m \tag{11}$$

$$\beta_{i,m}^{InvB} = \gamma_0 + \gamma^{InvB} CR_m \tag{12}$$

$$\beta_{i,m}^{Ins} = \gamma_0 + \gamma^{Ins} CR_m \tag{13}$$

These equations are used to estimate Hypotheses 7a through 7d.

[27] The exact starting and ending point of the financial crisis are difficult to determine and subject to discussion within the literature. Following Baur (2012) and the Bank for International Settlements (BIS, 2009), we include a timeframe that includes all major financial and economic events during the crisis. This includes the phase of "initial financial turmoil" (Q3 2007-mid-September 2008), "sharp financial market deterioration" (until late 2008) and the phase of "macroeconomic deterioration" (until Q1 2009). This is followed by a period of "stabilization and tentative signs of recovery," which is not part of our analysis here.

Following Baur (2012) and Bekaert et al. (2014), a significant, positive coefficient denotes that the respective sector (commercial banking, investment banking, or insurance) experienced contagion during the crisis, which might stem from the overall market or the other financial sectors. Moreover, we are interested not only in how the different sectors of the financial industry were affected, but also on contagion effects at the firm-level, and if these effects are driven by firm-specific factors (fundamentals-based contagion). Thus, in contrast to equations (10) to (13), which estimate contagion at the sector-level, we also estimate firm-level measures of contagion. Following De Bruyckere et al. (2013), we calculate contagion effects at quarterly frequency to analyze firm-level contagion, as this is the highest frequency for which accounting information are available. Thus, $\varphi_{i,q}^{MKT}$, $\varphi_{i,q}^{Bank}$, $\varphi_{i,q}^{InvB}$ and $\varphi_{i,q}^{Ins}$ in equations (14) to (17) indicate the increase in co-movement (the contagion effect) in a given quarter (q) for each firm (i) individually, whereas equations (10)-(13) indicate the individual *sectors'* degree of contagion for the whole duration of the crisis. CR_q is a dummy variable equal to one if the quarter q is between Q3/2007 and Q1/2009, i.e. the crisis period.

$$\beta_{i,m}^{MKT} = \varphi_0 + \varphi_{i,q}^{MKT} CR_q \tag{14}$$

$$\beta_{i,m}^{Bank} = \varphi_0 + \varphi_{i,q}^{Bank} CR_q \tag{15}$$

$$\beta_{i,m}^{InvB} = \varphi_0 + \varphi_{i,q}^{InvB} CR_q \tag{16}$$

$$\beta_{i,m}^{Ins} = \varphi_0 + \varphi_{i,q}^{Ins} CR_q \tag{17}$$

Equations (18) to (21) examine fundamentals-based contagion vs. non-fundamentals-based contagion, i.e. whether the contagion from each factor is driven by firm-specific factors, in particular default risk.[28] The independent variables (Z-Score and X', a vector of control variables) are the same as in equations (6) to (8). We regress quarterly, firm-specific contagion effects ($\varphi_{i,q}^{MKT}$, $\varphi_{i,q}^{Bank}$, $\varphi_{i,q}^{InvB}$ and $\varphi_{i,q}^{Ins}$) on a set of firm-specific factors between Q3/2007 and Q1/2009 (i.e. the crisis period). Again, we use quarterly data for our independent variables and all variables are lagged by one quarter.[29] We estimate the following regressions for all commercial banks, investment banks, life insurers and property-casualty insurers separately:

$$\varphi_{i,q}^{MKT} = \alpha + \delta * \text{Z- SCORE}_{i,q-1} + \Sigma\gamma_j * X'_{j,i,q-1} + \varepsilon_{i,q} \quad (18)$$

$$\varphi_{i,q}^{Bank} = \alpha + \delta * \text{Z- SCORE}_{i,q-1} + \Sigma\gamma_j * X'_{j,i,q-1} + \varepsilon_{i,q} \quad (19)$$

$$\varphi_{i,q}^{InvB} = \alpha + \delta * \text{Z- SCORE}_{i,q-1} + \Sigma\gamma_j * X'_{j,i,q-1} + \varepsilon_{i,q} \quad (20)$$

$$\varphi_{i,q}^{Ins} = \alpha + \delta * \text{Z- SCORE}_{i,q-1} + \Sigma\gamma_j * X'_{j,i,q-1} + \varepsilon_{i,q} \quad (21)$$

Significant signs for the Z-Score or the other control variables would signify that these variables are significantly related to contagion, supporting the notion that contagion is fundamentals-driven (Hypothesis 8).

Results

In this section, descriptive statistics are provided as well as the results of equations (1) to (4). Equations (1) to (4) are used to test Hypotheses 1 to 6b. Next the results of the financial crisis contagion models are discussed; these are used to test Hypotheses 7a to 8.

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[28] Note that alternative measures of contagion, as for example used by Bekaert, Harvey and Ng (2005) or Phylaktis and Xia (2009), measure contagion via residual correlation. However, given that we aim to analyze changes in co-movement, focusing on changes in the systematic co-movement in crisis times (Baur, 2012), we follow the approaches used by Bekaert et al. (2014) and Baur (2012), who take into consideration changes in the factor exposures during crises. This approach is denoted as "systematic contagion" as compared to "idiosyncratic contagion."

[29] Our regression includes firm-fixed effects and quarter-fixed effects.

Descriptive Statistics

Table 2 presents the summary statistics for all variables used in our regression analyses for the years 2004-2012 for all commercial banks, investment banks, life insurers, and property-casualty insurers. The main variable of interest, the Z-Score, has average values between 35.25 (investment banks) and 162.18 (commercial banks). In addition, the average size of the financial institutions (Asset Size) is comparable across financial sectors.

Sector-Focused Results (Tests of Hypotheses 1 through 6b)

Tables 3 through 6 present the results of equations (1) to (4) for commercial banking, investment banking, life insurance and property-casualty insurance, respectively. Each of these tables contains the results of regressing the Z-Score and other control variables on (1) β_i^{MKT} (a measure of systematic risk), (2) β_i^{Bank} (a measure of sector-specific risk) and (3) $\sigma_{i,q}$ (a measure of idiosyncratic risk). The results in Table 3 indicate that, for the commercial banking sector, the Z-Score is negative and significant in all three regressions. That is, a higher degree of financial stability (a higher Z-Score) is associated with a decrease in the three risk components (the beta factors and idiosyncratic risk). Therefore, we find support for our first and second hypotheses. This is consistent with the findings in previous literature (Fiordelisi and Marques-Ibanez, 2013).

Regarding investment banking, Table 4 indicates that the Z-score is negatively and significantly related to the risk measure for all three equations. This provides evidence in support for Hypotheses 3 and 4 which state that investment banking risk is systematic and sector-specific. These results indicate the important role that investment banks played during recent years (including the financial crisis years).

The results in Tables 5 and 6 for life and property-casualty insurers, respectively, indicate that risk in these financial sectors is not systematic. Thus default of an insurer is not related to the performance of the overall economy in accordance with Hypothesis 5. That is, the coefficient for the Z-score in the β_i^{MKT} equation is not significant in either table. The life insurance factor β_i^{Life} is negative and significant in Table 5. This indicates that sector-specific risk exists in the life insurance sector such that an increase in the default of one life insurer reverberates through the sector, increasing the stock price risk of all life insurers simultaneously. One potential explanation for this is that life insurers exhibit herding behavior with respect to asset commonalities. But the property-casualty insurance factor β_i^{PC} is not significantly related to the Z-score in Table 6, suggesting that sector-specific risk does not exist for the property-casualty insurance sector. Recall that we had no priors on the significance of the β_i^{Life} and β_i^{PC} factors in Hypotheses 6a and 6b.

Contagion Results (Tests of Hypotheses 7a to 8)

Next, contagion effects in the US financial sector are analyzed. First, we analyze contagion effects (i.e., increased co-movements in stock prices) in the overall sectors (Panels A-D) stemming from the four factors (γ^{MKT}, γ^{Bank}, γ^{InvB} and γ^{Ins}). The results are reported in Table 7. Significant, *positive* coefficients denote that the respective sector (commercial banking, investment banking, life insurance or property-casualty insurance) experienced contagion during the crisis, which might stem from the overall market or the other financial sectors (Baur, 2012). Negative coefficients indicate a decoupling effect with respect to the sectors. The results indicate a statistically and economically significant degree of market contagion (γ^{MKT}) for commercial banking (0.234), investment banking (0.215), life insurance (0.366) and property-casualty insurance (0.394). All sectors' stock prices significantly increased their co-movement with the market during the crisis, thereby reducing the effectiveness of diversification.

In addition, commercial banking contagion (γ^{Bank}) was significant for most sectors, and, in particular, for commercial banks (0.221) and investment banks (0.155). This indicates the important role of the commercial banking sector during the financial crisis. Interestingly, the coefficient for γ^{Bank} is negative and significant for life insurers, indicating some decoupling of life insurers from the results of the commercial banking sector; however, the effect is not very large (0.044) when compared to the other coefficients for γ^{Bank}. Investment banking contagion (γ^{InvB}) was not significant and positive for other banks or investment banks, indicating a comparably unimportant role for this sector during the crisis, when compared to the commercial banking sector. However, life (0.079) and property-casualty insurers (0.081) had strong stock price co-movement with investment banks, thereby providing evidence for closer linkages between these sectors compared to previous years (Billio et al., 2012).

Finally, insurance contagion (γ^{Ins}) was irrelevant for commercial and investment banks, but property-casualty insurers (0.035) and, in particular, life insurers were affected by contagion. That is, the coefficients for γ^{Ins} are positive and significant for property-casualty insurers and life insurers. We find a relatively large and statistically significant coefficient (0.205) for γ^{Ins}, probably indicating a high level of co-movement among life insurers' stock prices during the crisis, potentially due to asset commonalities (Schwarcz and Schwarcz, 2014).

Tables 8 to 11 report the results of equations (18) to (21), i.e., firm level determinants of contagion related to the four factors ($\varphi_{i,q}^{MKT}$, $\varphi_{i,q}^{Bank}$, $\varphi_{i,q}^{InvB}$ and $\varphi_{i,q}^{Ins}$) for commercial banks (Table 8), investment banks (Table 9), life insurers (Table 10) and property-casualty insurers (Table 11). For commercial banks, each firm-level contagion factor used as a dependent variable is significantly and negatively related to default risk in Table 8, indicating that higher levels of default risk are positively related to firm-specific contagion. In other words, investors discriminated among commercial banks on the basis of default risk, such that stock price risk contagion was higher for commercial banks with a smaller distance to default (Z-score). These results support Hypothesis 8. In addition, a few other control variables are significant in Table 8. For example, income diversification is negatively related to $\varphi_{i,q}^{MKT}$, $\varphi_{i,q}^{Bank}$, and $\varphi_{i,q}^{InvB}$, contrary to expectations. Market share is positively related to $\varphi_{i,q}^{MKT}$ and $\varphi_{i,q}^{Bank}$, and the signs of these coefficients are as expected.

Table 9 reports the results of equations (18) to(21) for investment banks. The results show that firm-level contagion factors for market contagion ($\varphi_{i,q}^{MKT}$) and banking contagion ($\varphi_{i,q}^{Bank}$) are significantly and negatively related to default risk, as was the case for commercial banks. The same does not hold for investment banking contagion ($\varphi_{i,q}^{InvB}$) and insurance contagion ($\varphi_{i,q}^{Ins}$). However, Table 7 did not indicate significant investment banking or insurance contagion for investment banks, as the coefficients on (γ^{InvB}) and (γ^{Ins}) were not positive and significant. Again, a few other control variables are significant. The coefficients for the efficiency-adjusted Lerner Index is positive and significant in the $\varphi_{i,q}^{MKT}$, $\varphi_{i,q}^{Bank}$, and $\varphi_{i,q}^{Ins}$ equations, contrary to expectations. However the coefficients for market share are positive and significant in the $\varphi_{i,q}^{MKT}$, $\varphi_{i,q}^{InvB}$, and $\varphi_{i,q}^{Ins}$ equations as expected.

For life insurers (Table 10) and property-casualty insurers (Table 11), we find again that firm-level contagion factors for the market are significantly and negatively related to default risk. That is, the coefficients for the Z-Score are negative and significant in the $\varphi_{i,q}^{MKT}$equation, as expected. In addition, the same holds for insurance contagion ($\varphi_{i,q}^{Ins}$), which affected the insurance sector. A few coefficients for the other control variables are also significant between the two tables.

Concluding, we find that fundamental-based contagion in the form of default risk was particularly pronounced in cases where significant sector contagion effects existed. That is, Table 7 indicated statistically and economically significant market contagion (γ^{MKT}) for all sectors, as indicated by coefficients ranging between 0.215 and 0.394. At the firm-level, we find evidence that market contagion was significantly driven by default risk, indicating that investors perceived firms with higher distress probabilities as relatively more risky. The coefficients for the Z-Score in Tables 8 to11 indicate a significant relation between Z-Score and market contagion ($\varphi_{i,q}^{MKT}$) for all types of financial firms This provides evidence of fundamentals-based contagion for those sectors that experienced a high level of contagion. In addition, the results in Table 7 indicate economically high levels of banking contagion existed for commercial banks (γ^{Bank} = 0.221), and investment banks (γ^{Bank} = 0.155) and for insurance contagion for life insurers (γ^{Ins} = 0.205). All of them lead to fundamentals-based contagion in the form of default risk at the firm-level, as indicated by significantly negative estimates for the Z-Score for banks in Table 8 ($\varphi_{i,q}^{Bank}$), investment banks in Table 9 ($\varphi_{i,q}^{Bank}$) and insurers in Table 10 ($\varphi_{i,q}^{Ins}$). In case of lower or insignificant levels of contagion, investors do not differentiate between the riskiness of firms in the sector, but rather treat firms in a sector homogenously.[30]

[30] As an example, the degree of insurance contagion (γ^{Ins}) was low and insignificant for investment banks. Thus, the coefficient for the Z-Score in Table 9 for firm-level insurance contagion ($\varphi_{i,q}^{Ins}$) is insignificant, indicating non-fundamentals-based contagion in this case.

Conclusion

We break down four types of financial institutions' (commercial banks, investment banks, property-casualty insurers, and life insurers) stock risk into their components: systematic, sector-specific, and idiosyncratic (Campbell et al., 2001; Fiordelisi and Marques-Ibanez, 2013). We then determine the relationship between default risk of these institutions and the sector-specific, systematic and idiosyncratic risk measures. Second, we use our framework to analyze contagion at the sector- and firm-level *during the recent crisis* for our sample of financial firms. We use a factor model including a market factor and three financial sector factors (commercial banking, investment banking and insurance) to set a benchmark for what the co-movement of financial firms with these factors should be. We then test for contagion and the extent to which it is fundamentals-driven during the crisis.

Using a sample of 11,189 firm-quarter observations of US listed banks, investment banks, property-casualty and life insurers for the years 2004-2012, our regression analyses indicate that commercial banks' and investment banks' default risk is systematic, sector-specific and idiosyncratic. For insurance firms, we find that property-casualty insurers' default risk is idiosyncratic only, while it is sector-specific and idiosyncratic in the life insurance sector. In addition, we find strong evidence for contagion effects stemming from the overall economy and the commercial banking sector. Evidence for contagion from the insurance sector is limited, as the commercial banking and investment banking sectors' factor exposures to the insurance sector did not increase.

Our results indicate that these contagion effects are highly related to firm-specific variables in our analysis, indicating that investors discriminate between individual firms during crises based on the firms' fundamentals. This holds in particular in cases of economically significant contagion effects stemming from the overall market and the banking sector. In these cases, the contagion effects at the firm-level are significantly driven by default risk.

Our research contributes to the literature in several ways. Given that the default risk of a single commercial or investment banks can endanger other banks and the overall economy, we provide evidence for the necessity of macro-prudential regulation in the commercial and investment banking sectors, e.g. capital surcharges or other measures to reduce the threat posed by these firms. For insurance firms, our results indicate a limited ability to pose systematic risk and a comparably low degree of sector-specific risk. Hence, new macro-prudential measures seem less necessary in the insurance sector.

Moreover, while previous studies on contagion effects during the recent financial crisis analyzed contagion effects at the market- or industry-level, we focus on a single industry and its components at the firm-level. Given that market- or industry-level analyses can ignore heterogeneous performances of firms during crises, we provide evidence that investors differentiated among firms in the same sector during the crisis. That is, even though a sector might suffer from a high degree of contagion, some firms from this sector might be less prone to contagion. This provides valuable information for investors, because it indicates that some benefits of diversification might still be attainable during the crisis.

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Appendix A

This section describes the calculation of the Lerner Index of Monopoly Power for each financial institution's.[31] This index measures the firm's ability to set prices above marginal costs. A Lerner index equal to 0 indicates perfect competition, while a Lerner index of 1 indicates a price-monopoly. We follow Fiordelisi and Marqués-Ibañez (2013) and Turk-Ariss (2010) and calculate the Lerner index (LER) as

$$LER = \frac{p - MC}{p}$$

With p as the price of output Q, and MC is the marginal cost. To calculate MC, the following translog function is estimated:

$$lnTC_{it} = \alpha_0 + \alpha_1 lnQ_1 + \sum_{j=1}^{3} \beta_j lnP_j + \frac{1}{2} + \left[\delta_1 lnQ_1 lnQ_1 + \sum_{j=1}^{3} \times \sum_{i=1}^{3} \gamma_{ij} lnP_j P_j\right] + \sum_{j=1}^{3} \rho_{1j}$$

$$\times lnQ_1 lnP_j + t_1 T \times \frac{1}{2} t_1 T^2 + \theta_{ti} T lnQ_1 + \sum_{j=1}^{3} \psi_{tj} T \times lnP_j + \varepsilon_{it}$$

Where TC is total cost; α, β, δ, γ, ρ, t, θ, ψ are coefficients to be estimated; ε_{it} is an error term. P_j are the firm's input prices. MC are finally defined as

$$MC = \frac{TC_{it}}{Q_{it}} = \left(\alpha_1 + \delta_1 lnQ_{it} + \rho_j lnQ_{it} + \theta_t T + \varepsilon_{it}\right)$$

Following Fiordelisi and Marqués-Ibañez (2013) and Turk-Ariss (2010), we calculate the efficiency-adjusted Lerner index to avoid endogeneity bias that results from a single structural model as

$$ELER = \frac{AR_{TA} - MC_{TA}}{AR_{TA}}$$

where AR denotes the firm's average revenues.

For banks and investment banks, we use the approach in Fiordelisi and Marquéz-Ibañez (2013) and use the same set of variables in our analysis. We use total revenue (interest plus non-interest income) divided by the firm's total assets for p and total assets as Q (assuming a single output). For P_j, three input prices are defined: P_1 is the price of labor; P_2 is the price of physical capital; and P_3 is the price of funds. Appendix Table 1 provides an overview on the variables

[31] A detailed discussion on the Lerner index is beyond the scope of this paper. Please refer to Turk-Ariss (2010) for further information.

included and Appendix Table 2 provides definitions of these variables for banks (Panel A) and investment banks (Panel B).

[insert Appendix Table 1 here]

[insert Appendix Table 2 here]

For insurance firms, we use a different set of variables, given the large amount of literature on efficiency studies in the insurance sector (see Cummins and Weiss, 2012, for a comprehensive literature review.). Hence, detailed information on the insurers' prices and quantities for inputs and outputs are available. This allows us to capture the specific characteristics of insurance business and will increase the quality of our estimation results. Following Cummins and Weiss (2012), we use 6 different types of output quantities and prices for life insurers in our analysis: one for each major line of business offered by life insurers – individual life insurance, individual annuities, group life insurance, group annuities, and accident and health insurance – and one for intermediation. We use 4 different input quantities and prices for life insurers: We account for administrative labor, agent labor, materials and financial capital. For property-casualty insurers, we use different output quantities and prices for personal lines short-tail losses, personal lines long-tail losses, commercial lines short-tail losses, and commercial lines long-tail losses, and one for intermediation.[32] For Inputs, we use the same types of quantities and prices as for life insurers. Appendix Table 3 provides an overview on the variables included and Appendix Table 4 provides definitions of these variables for life insurers (Panel A) and property-casualty insurers (Panel B).

[insert Appendix Table 3 here]

[insert Appendix Table 4 here]

[32] We do not provide detailed description or discussion on the variables that we include in our calculation as this would be beyond the scope of this paper. Please refer to Cummins and Weiss (2012) for a detailed discussion and literature review on efficiency studies and inputs and outputs in the insurance industry.

Table 1: Variables for Regression Analyses – Definitions

This table shows the definitions of the variables for banks (Panel A), investment banks (Panel B), life insurers (Panel C) and property-liability insurers (Panel D) used in the regression analyses.

Panel A

Variable - Banks	Exp. Direction	Description
Z-Score	-	Ratio of the sum of each bank's return on assets (ROA) and its capital ratio (E/TA) divided by the standard deviation of the return on assets (σ_{ROA})
Lerner Index	-	Indicator of bank market power, measuring the extent to which a bank is able to fix a price above its marginal cost. To address endogeneity concerns, we calculate the efficiency-adjusted Lerner index estimating bank efficiency and market power simultaneously
Cost-Income Ratio	+	Operating costs to operating income ratio
Income Diversification	+	Non-interest to operating income ratio
Liability Diversification	+	Non-deposit to total deposits ratio
Asset Size	+	Natural logarithm of total assets
Market Share	+	Firm revenue divided by industry revenue

Panel B

Variable - Investment Banks	Exp. Direction	Description
Z-Score	-	Ratio of the sum of each bank's return on assets (ROA) and its capital ratio (E/TA) divided by the standard deviation of the return on assets (σ_{ROA})
Lerner Index	-	Indicator of bank market power, measuring the extent to which a bank is able to fix a price above its marginal cost. To address endogeneity concerns, we calculate the efficiency-adjusted Lerner index estimating bank efficiency and market power simultaneously
Cost-Income Ratio	+	Operating costs to operating income ratio
Income Diversification	+	A Herfindahl index based on different sources of revenue (e.g. underwriting fees, underwriting fees, interest income…)
Liability Diversification	+	Non-deposit to total deposits ratio
Asset Size	+	Natural logarithm of total assets
Market Share	+	Firm revenue divided by industry revenue

Panel C

Variable - Life Insurers	Exp. Direction	Description
Z-Score	-	Ratio of the sum of each insurer's return on assets (ROA) and its capital ratio (E/TA) divided by the standard deviation of the return on assets (σ_{ROA})
Lerner Index	-	Indicator of insurer market power, measuring the extent to which an insurer is able to fix a price above its marginal cost. To address endogeneity concerns, we calculate the efficiency-adjusted Lerner index estimating insurer efficiency and market power simultaneously
Cost-Income Ratio	+	The insurer's expense ratio.
% Ind. Annuities	+ / -	Proportion of premiums written in individual annuities of total premiums (life and annuity).
% Grp. Annuities	+ / -	Proportion of premiums written in group annuities of total premiums (life and annuity).
Liability Diversification	+	A Herfindahl index based on reserves from the different major lines of life insurer business.
Asset Size	+	Natural logarithm of total assets
Market Share	+	Firm revenue divided by industry revenue

Panel D

Variable - PC Insurers	Exp. Direction	Description
Z-Score	-	Ratio of the sum of each insurer's return on assets (ROA) and its capital ratio (E/TA) divided by the standard deviation of the return on assets (σ_{ROA})
Lerner Index	-	Indicator of insurer market power, measuring the extent to which an insurer is able to fix a price above its marginal cost. To address endogeneity concerns, we calculate the efficiency-adjusted Lerner index estimating insurer efficiency and market power simultaneously
Cost-Income Ratio	+	The insurer's combined ratio.
% Auto Premium	+ / -	Proportion of premiums written in auto premiums of total premiums (all lines).
% Homeowner Premium	+ / -	Proportion of premiums written in homeowner premiums of total premiums (all lines).
% Liability Premium	+ / -	Proportion of premiums written in liability premiums of total premiums (all lines).
Liability Diversification	+	A Herfindahl index based on reserves from the different major lines of p-c insurer business.
Asset Size	+	Natural logarithm of total assets
Market Share	+	Firm revenue divided by industry revenue

Table 2: Variables for Regression Analyses – Summary Statistics

This table shows the summary statistics for commercial banks (Panel A), investment banks (Panel B), life insurers (Panel C) and property-casualty insurers (Panel D) used in our regression analyses. The variables are defined in Table 1. All variables are reported quarterly from Q1/2004 – Q4/2012.

Panel A			
Variable - Banks	Obs	Mean	Std. Dev.
Z-Score	6,857	162.18	135.07
Lerner Index	6,857	0.58	0.10
Cost-Income Ratio	6,857	0.63	0.16
Income Diversification	6,857	0.26	0.14
Liability Diversification	6,857	0.40	0.21
Asset Size	6,857	15.38	1.53
Market Share	6,857	0.00	0.00
Panel B			
Variable - Investment Banks	Obs	Mean	Std. Dev.
Z-Score	889	35.23	36.82
Lerner Index	889	0.41	0.34
Cost-Income Ratio	889	-4.50	36.60
Income Diversification	889	0.20	0.31
Liability Diversification	889	0.19	0.38
Asset Size	889	14.61	2.80
Market Share	889	0.04	0.10
Panel C			
Variable - PC Insurers	Obs	Mean	Std. Dev.
Z-Score	2,234	72.02	68.18
Lerner Index	2,234	0.97	0.14
Cost-Income Ratio	2,234	71.98	37.23
% Auto Premium	2,234	0.28	0.32
% Homeowner Premium	2,234	0.08	0.16
% Liability Premium	2,234	0.21	0.21
Liability Diversification	2,234	0.53	0.20
Asset Size	2,234	15.08	1.58
Market Share	2,234	0.01	0.03
Panel D			
Variable - Life Insurers	Obs	Mean	Std. Dev.
Z-Score	1,209	40.59	32.03
Lerner Index	1,209	0.60	0.30
Cost-Income Ratio	1,209	13.92	9.28
% Ind. Annuities	1,209	0.26	0.28
% Grp. Annuities	1,209	0.10	0.17
Liability Diversification	1,209	0.88	0.17
Asset Size	1,209	16.61	1.89
Market Share	1,209	0.02	0.03

Table 3: Regression Results – Commercial Banks

This table shows the results of fixed effects regressions from Q1/2004 – Q4/2012 for commercial banks. The variables are defined in Table 1. β_i^{MKT} denotes market-wide risk, β_i^{Bank} the risk of the commercial banking sector and $\sigma_{i,q}$ denotes the idiosyncratic risk of a firm from the respective sector. ***, ** and * denotes significance at the 1%, 5% and 10% level. Independent variables are lagged by one quarter.

	β_i^{MKT}	β_i^{Bank}	$\sigma_{i,q}$
Z-Score	**-0.000*** **	**-0.000*** **	**-0.000*** **
	(0.000)	**(0.000)**	**(0.000)**
Lerner Index	-0.019	0.134**	0.004***
	(0.083)	(0.058)	(0.002)
Cost-Income Ratio	-0.046	0.072**	0.013***
	(0.050)	(0.035)	(0.001)
Income Diversification	-0.090	-0.037	-0.004***
	(0.063)	(0.044)	(0.001)
Liability Diversification	-0.326***	0.050	-0.009***
	(0.049)	(0.034)	(0.001)
Asset Size	0.205***	0.129***	-0.004***
	(0.025)	(0.017)	(0.000)
Market Share	-29.536***	-11.749***	0.157
	(5.594)	(3.908)	(0.107)
Constant	-1.952***	-1.753***	0.071***
	(0.377)	(0.263)	(0.007)
Fixed Effects	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes
R^2	0.179	0.218	0.668
Observations	6857	6857	6857

Table 4: Regression Results – Investment Banks

This table shows the results of fixed effects regressions from Q1/2004 – Q4/2012 for investment banks. The variables are defined in Table 1. β_i^{MKT} denotes market-wide risk, β_i^{InvB} the risk of the investment banking sector and $\sigma_{i,q}$ denotes the idiosyncratic risk of a firm from the respective sector. ***, ** and * denotes significance at the 1%, 5% and 10% level. Independent variables are lagged by one quarter.

	β_i^{MKT}	β_i^{InvB}	$\sigma_{i,q}$
Z-Score	**-0.004*** **	**-0.001** **	**-0.000*** **
	(0.001)	**(0.001)**	**(0.000)**
Lerner Index	-0.126*	0.032	-0.002
	(0.066)	(0.075)	(0.002)
Cost-Income Ratio	0.001**	0.001	-0.000***
	(0.001)	(0.001)	(0.000)
Income Diversification	0.033	0.183*	0.009***
	(0.083)	(0.094)	(0.002)
Liability Diversification	0.003	0.176**	-0.001
	(0.078)	(0.088)	(0.002)
Asset Size	0.067***	0.054**	-0.008***
	(0.024)	(0.027)	(0.001)
Market Share	0.436	0.245	-0.001
	(0.269)	(0.307)	(0.007)
Constant	0.369	-0.038	0.142***
	(0.333)	(0.379)	(0.009)
Fixed Effects	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes
R^2	0.245	0.158	0.540
Observations	889	889	889

Table 5: Regression Results – Life Insurers

This table shows the results of fixed effects regressions from Q1/2004 – Q4/2012 for life insurers. The variables are defined in Table 1. β_i^{MKT} denotes market-wide risk, β_i^{Life} the risk of the life insurance sector and $\sigma_{i,q}$ denotes the idiosyncratic risk of a firm from the respective sector. ***, ** and * denotes significance at the 1%, 5% and 10% level. Independent variables are lagged by one quarter.

	β_i^{MKT}	β_i^{Life}	$\sigma_{i,q}$
Z-Score	**-0.000**	**-0.001*** **	**-0.000** **
	(0.000)	**(0.000)**	**(0.000)**
Lerner Index	-0.712***	-0.100	-0.004*
	(0.095)	(0.066)	(0.002)
Cost-Income Ratio	0.003	-0.004**	-0.000**
	(0.002)	(0.002)	(0.000)
% Ind. Annuities	0.213	-0.015	-0.002
	(0.133)	(0.092)	(0.003)
% Grp. Annuities	0.152	-0.040	-0.006
	(0.158)	(0.110)	(0.004)
Liability Diversification	-0.148	0.376***	0.008
	(0.207)	(0.144)	(0.005)
Asset Size	-0.126*	0.018	-0.006***
	(0.074)	(0.052)	(0.002)
Market Share	-1.717	-3.924***	-0.096**
	(1.541)	(1.071)	(0.039)
Constant	3.578***	0.202	0.108***
	(1.281)	(0.891)	(0.032)
Fixed Effects	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes
R^2	0.423	0.105	0.583
Observations	1209	1209	1209

Table 6: Regression Results – PC Insurers

This table shows the results of fixed effects regressions from Q1/2004 – Q4/2012 for property-casualty insurers. The variables are defined in Table 1. β_i^{MKT} denotes market-wide risk, β_i^{PC} the risk of the property-casualty insurance sector and $\sigma_{i,q}$ denotes the idiosyncratic risk of a firm from the respective sector. ***, ** and * denotes significance at the 1%, 5% and 10% level. Independent variables are lagged by one quarter.

	β_i^{MKT}	β_i^{PC}	$\sigma_{i,q}$
Z-Score	**-0.000**	**-0.000**	**-0.000***
	(0.000)	**(0.000)**	**(0.000)**
Lerner Index	-0.051	0.167**	-0.004*
	(0.079)	(0.075)	(0.002)
Cost-Income Ratio	0.002***	0.000	0.000***
	(0.000)	(0.000)	(0.000)
% Auto Premium	0.426**	-0.189	-0.000
	(0.202)	(0.192)	(0.006)
% Homeowner Premium	-1.028***	0.332	-0.020**
	(0.361)	(0.343)	(0.010)
% Liability Premium	0.210	0.309**	-0.002
	(0.165)	(0.157)	(0.005)
Liability Diversification	0.479***	0.006	-0.005**
	(0.086)	(0.082)	(0.002)
Asset Size	-0.065*	0.094***	-0.004***
	(0.034)	(0.032)	(0.001)
Market Share	7.942***	-3.447*	0.120**
	(2.129)	(2.022)	(0.061)
Constant	0.805	-1.019**	0.078***
	(0.536)	(0.509)	(0.015)
Fixed Effects	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes
R^2	0.187	0.109	0.426
Observations	2234	2234	2234

Table 7: Contagion Effects – Sector-Level

This table reports the estimates of equations (11) – (13) at the sector-level for the commercial banking (Panel A), investment banking (Panel B), life insurance (Panel C) and property-casualty insurance (Panel D) sectors separately. γ^{MKT} denotes market contagion to the sector. γ^{Bank} denotes commercial banking contagion to the sector. γ^{InvB} denotes investment banking contagion to the sector. γ^{Ins} denotes insurance contagion to the sector. ***, ** and * denotes significance at the 1%, 5% and 10% level.

	Panel A			
	γ^{MKT}	γ^{Bank}	γ^{InvB}	γ^{Ins}
Banks	0.234***	0.221***	-0.057***	-0.001
Standard Error	0.010	0.007	0.003	0.005
	Panel B			
	γ^{MKT}	γ^{Bank}	γ^{InvB}	γ^{Ins}
Investment Banks	0.215***	0.155*	-0.032	-0.046*
Standard Error	0.064	0.089	0.028	0.026
	Panel C			
	γ^{MKT}	γ^{Bank}	γ^{InvB}	γ^{Ins}
Life Insurers	0.366***	-0.044***	0.079***	0.205***
Standard Error	0.019	0.012	0.007	0.024
	Panel D			
	γ^{MKT}	γ^{Bank}	γ^{InvB}	γ^{Ins}
PC Insurers	0.394***	0.100***	0.081***	0.035**
Standard Error	0.013	0.014	0.005	0.016

Table 8: Contagion Effects – Firm-Level – Commercial Banks

This table reports the estimates of equation (18) – (21) using fixed effects regressions from Q3/2007 – Q1/2009 at the firm-level for the commercial banking sector. The variables are defined in Table 1. $\varphi_{i,q}^{MKT}$ denotes market contagion to the sector. $\varphi_{i,q}^{Bank}$ denotes commercial banking contagion to the sector. $\varphi_{i,q}^{InvB}$ denotes investment banking contagion to the sector. $\varphi_{i,q}^{Ins}$ denotes insurance contagion to the sector. ***, ** and * denotes significance at the 1%, 5% and 10% level. Independent variables are lagged by one quarter.

	$\varphi_{i,q}^{MKT}$	$\varphi_{i,q}^{Bank}$	$\varphi_{i,q}^{InvB}$	$\varphi_{i,q}^{Ins}$
Z-Score	**-0.000*****	**-0.000*****	**-0.000****	**-0.000****
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**
Lerner Index	0.113	-0.102	0.111	-0.027
	(0.169)	(0.170)	(0.079)	(0.200)
Cost-Income Ratio	0.107	0.092	0.136***	0.043
	(0.094)	(0.095)	(0.044)	(0.111)
Income Diversification	-0.166*	-0.314***	-0.128***	0.173
	(0.096)	(0.096)	(0.045)	(0.113)
Liability Diversification	-0.189	-0.021	0.108**	0.131
	(0.116)	(0.117)	(0.054)	(0.138)
Asset Size	0.108	0.011	-0.044	0.024
	(0.088)	(0.088)	(0.041)	(0.104)
Market Share	31.265**	26.039*	7.643	-11.255
	(14.807)	(14.933)	(6.943)	(17.551)
Constant	-1.209	0.404	0.532	-0.314
	(1.345)	(1.357)	(0.631)	(1.595)
Fixed Effects	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes	Yes
R^2	0.068	0.299	0.163	0.092
Observations	1261	1261	1261	1261

Table 9: Contagion Effects – Firm-Level – Investment Banks

This table reports the estimates of equation (18) – (21) using fixed effects regressions from Q3/2007 – Q1/2009 oat the firm-level for the investment banking sector. The variables are defined in Table 1. $\varphi_{i,q}^{MKT}$ denotes market contagion to the sector. $\varphi_{i,q}^{Bank}$ denotes banking contagion to the sector. $\varphi_{i,q}^{InvB}$ denotes investment banking contagion to the sector. $\varphi_{i,q}^{Ins}$ denotes insurance contagion to the sector. ***, ** and * denotes significance at the 1%, 5% and 10% level. Independent variables are lagged by one quarter.

	$\varphi_{i,q}^{MKT}$	$\varphi_{i,q}^{Bank}$	$\varphi_{i,q}^{InvB}$	$\varphi_{i,q}^{Ins}$
Z-Score	**-0.004****	**-0.003***	**-0.001**	**-0.001**
	(0.002)	**(0.002)**	**(0.001)**	**(0.003)**
Lerner Index	0.297**	0.608***	0.043	0.797***
	(0.148)	(0.187)	(0.102)	(0.261)
Cost-Income Ratio	0.000	-0.002***	0.000	-0.001
	(0.001)	(0.001)	(0.000)	(0.001)
Income Diversification	-0.023	-0.052	0.044	0.516**
	(0.135)	(0.170)	(0.093)	(0.237)
Liability Diversification	-0.852	-1.278	-0.428	-0.358
	(0.744)	(0.940)	(0.515)	(1.313)
Asset Size	0.206***	0.235***	-0.016	-0.003
	(0.044)	(0.055)	(0.030)	(0.077)
Market Share	0.943**	0.336	0.447*	1.867***
	(0.367)	(0.463)	(0.254)	(0.647)
Constant	-2.842***	-3.450***	0.230	-0.771
	(0.659)	(0.832)	(0.456)	(1.163)
Fixed Effects	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes	Yes
R^2	0.239	0.292	0.244	0.280
Observations	179	179	179	179

Table 10: Contagion Effects – Firm-Level – Life Insurers

This table reports the estimates of equations (18) – (21) using fixed effects regressions from Q3/2007 – Q1/2009 on firm-level for the life insurance sector. The variables are defined in Table 1. $\varphi_{i,q}^{MKT}$ denotes market contagion to the sector. $\varphi_{i,q}^{Bank}$ denotes banking contagion to the sector. $\varphi_{i,q}^{InvB}$ denotes investment banking contagion to the sector. $\varphi_{i,q}^{Ins}$ denotes insurance contagion to the sector. ***, ** and * denotes significance at the 1%, 5% and 10% level. Independent variables are lagged by one quarter.

	$\varphi_{i,q}^{MKT}$	$\varphi_{i,q}^{Bank}$	$\varphi_{i,q}^{InvB}$	$\varphi_{i,q}^{Ins}$
Z-Score	**-0.005*****	**-0.001**	**0.000**	**-0.004***
	(0.001)	**(0.001)**	**(0.001)**	**(0.002)**
Lerner Index	-0.293	-0.024	0.201*	0.378
	(0.235)	(0.187)	(0.111)	(0.376)
Cost-Income Ratio	-0.010**	-0.007*	0.000	-0.004
	(0.004)	(0.003)	(0.002)	(0.007)
% Ind. Annuities	3.297***	1.820***	0.882**	1.770
	(0.873)	(0.695)	(0.413)	(1.392)
% Grp. Annuities	1.648	4.436***	-0.452	0.430
	(1.068)	(0.850)	(0.505)	(1.703)
Liability Diversification	0.569	0.085	-0.024	1.431**
	(0.436)	(0.347)	(0.206)	(0.696)
Asset Size	-0.642**	-0.073	-0.168	-0.676
	(0.304)	(0.242)	(0.144)	(0.485)
Market Share	2.125	-0.108	-0.643	1.143
	(2.290)	(1.822)	(1.082)	(3.652)
Constant	9.860*	0.383	2.465	9.728
	(5.084)	(4.047)	(2.403)	(8.109)
Fixed Effects	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes	Yes
R2	0.418	0.168	0.370	0.166
Observations	242	242	242	242

Table 11: Contagion Effects – Firm-Level – PC Insurers

This table reports the estimates of equation (18) – (21) using fixed effects regressions from Q3/2007 – Q1/2009 at the firm-level for the property-casualty sector. The variables are defined in Table 1. $\varphi_{i,q}^{MKT}$ denotes market contagion to the sector. $\varphi_{i,q}^{Bank}$ denotes banking contagion to the sector. $\varphi_{i,q}^{InvB}$ denotes investment banking contagion to the sector. $\varphi_{i,q}^{Ins}$ denotes insurance contagion to the sector. ***, ** and * denotes significance at the 1%, 5% and 10% level. Independent variables are lagged by one quarter.

	$\varphi_{i,q}^{MKT}$	$\varphi_{i,q}^{Bank}$	$\varphi_{i,q}^{InvB}$	$\varphi_{i,q}^{Ins}$
Z-Score	**-0.001***	**0.001**	**0.001****	**-0.002***
	(0.001)	**(0.001)**	**(0.000)**	**(0.001)**
Lerner Index	0.079	0.389***	0.032	0.059
	(0.144)	(0.123)	(0.077)	(0.237)
Cost-Income Ratio	0.000	-0.000	0.001**	0.000
	(0.001)	(0.001)	(0.000)	(0.001)
% Auto Premium	1.396	1.927**	0.314	2.033
	(0.984)	(0.843)	(0.526)	(1.625)
% Homeowner Premium	-3.825**	-6.797***	-1.394	-4.147
	(1.629)	(1.396)	(0.871)	(2.689)
% Liability Premium	-0.579*	-0.169	-0.136	-0.841*
	(0.303)	(0.260)	(0.162)	(0.501)
Liability Diversification	0.909***	-0.720***	0.208	-0.487
	(0.313)	(0.268)	(0.167)	(0.516)
Asset Size	0.199**	-0.154**	0.046	-0.199
	(0.084)	(0.072)	(0.045)	(0.139)
Market Share	14.012**	-5.860	2.767	5.200
	(5.822)	(4.988)	(3.111)	(9.608)
Constant	-3.400**	2.443**	-0.892	3.258
	(1.416)	(1.213)	(0.757)	(2.337)
Fixed Effects	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes	Yes
R^2	0.202	0.180	0.130	0.065
Observations	443	443	443	443

Appendix Table 1: Commercial Banks' and Investment Banks' Variables to create Lerner Indices – Summary Statistics

This table shows the summary statistics for commercial banks (Panel A) and investment banks (Panel B) to create Lerner indices. The variables are defined in Appendix Table 2.

Panel A					
Variable - Banks	Obs	Mean	Std. Dev.	Min	Max
Output (000$)	6,857	45,835	236,744	0	2,368,384
Price of Output Q	6,856	0.01	0.00	-0.02	0.07
Total Cost (000$)	6,857	266	1,411	0	17,621
Price of labor	6,857	0.00	0.00	0.00	0.01
Pricef physical capital	6,857	0.14	0.19	-0.05	9.76
Price of funds	6,857	1.55	1.15	0.00	5.64
Panel B					
Variable - Investment Banks	Obs	Mean	Std. Dev.	Min	Max
Output (000$)	889	71,921	227,053	5	1,199,993
Price of Output Q	889	0.40	2.15	-0.06	42.21
Total Cost (000$)	889	792	2,327	-1	24,052
Price of labor	889	0.08	0.19	-0.02	1.46
Price of physical capital	889	47.40	332.00	0.00	4972.03
Price of funds	889	0.03	0.12	-0.24	2.50

Appendix Table 2: Commercial Banks' and Investment Banks' Variables to create Lerner Indices – Definitions

The table shows the definitions of the variables for banks (Panel A) and investment banks (Panel B) to create Lerner indices.

Panel A

Variable - Banks	Description
Output	Total assets.
Price of Output	Total revenue (interest plus non-interest income) divided by total assets.
Total Cost	The sum of personnel expenses, other administrative expenses, other operating expenses and price of funds
Price of labor	Personnel expenses over total assets.
Price of physical capital	Other administrative expenses plus other operating expenses over total fixed assets.
Price of funds	Interest expenses over total funds.

Panel B

Variable - Investment Banks	Description
Output	Total assets.
Price of Output	Total revenue (interest plus non-interest income) divided by total assets.
Total Cost	The sum of personnel expenses, other administrative expenses, other operating expenses and price of funds.
Price of labor	Personnel expenses over total assets.
Price of physical capital	Other administrative expenses plus other operating expenses over total fixed assets.
Price of funds	Interest expenses over total funds.

Appendix Table 3: Life and PC Insurers Variables to Create Lerner Indices – Summary Statistics

This table shows the summary statistics for life insurers (Panel A) and property-casualty insurers (Panel B) to create Lerner indices. The variables are defined in Table 2.

Panel A					
Variable - Life Insurers	Obs	Mean	Std. Dev.	Min	Max
Output Price Life Individual Life P1	1,209	0.55	0.73	0.013	6.79
Output Price Life Group Life P2	1,209	0.63	1.34	0.040	21.75
Output Price Life Individual Annuities P3	1,209	0.32	0.65	0.002	4.07
Output Price Life Group Annuities P4	1,209	0.10	0.32	0.004	3.36
Output Price Life Accident Health P5	1,209	1.05	1.49	0.117	10.21
Output Price Life Intermediary P6	1,209	0.06	0.01	0.030	0.13
Output Quantity Life Individual Life Y1 (000$)	1,209	800	1,104	0	4,225
Output Quantity Life Group Life Y2 (000$)	1,209	226	370	0	1,421
Output Quantity Life Individual Annuities Y3 (000$)	1,209	1,869	2,983	0	12,100
Output Quantity Life Group Annuities Y4 (000$)	1,209	1,448	2,995	0	12,800
Output Quantity Life Accident Health Y5 (000$)	1,209	1,420	2,294	0	8,764
Output Quantity Life Intermediary Y6 (000$)	1,209	33,651	58,169	269	310,927
Input Price Life Labor W1	1,209	1,593.67	392.83	635.00	2,686.00
Input Price Life Agent W2	1,209	1,153.45	67.01	1,026.00	1,253.00
Input Price Life Material W3	1,209	110.32	8.98	91.65	220.07
Input Price Life Financial Capital W4	1,209	0.12	0.02	0.082	0.17
Input Quantity Life Labor X1	1,209	291	318	7	1,254
Input Quantity Life Agent X2	1,209	186	238	3	1,595
Input Quantity Life Material X3	1,209	3,243	3,984	42	17,584
Input Quantity Life Financial Capital X4 (000$)	1,209	2,559	2,656	14	10,900
Panel B					
Variable - PC Insurers	Obs	Mean	Std. Dev.	Min	Max
Output Price PL Personal Short Tail P1	2,234	1.52	2.33	0.22	19.30
Output Price PL Personal Long Tail P2	2,234	0.56	0.44	0.10	2.77
Output Price PL Commercial Long Tail P3	2,234	0.33	0.50	0.01	4.54
Output Price PL Commercial Short Tail P4	2,234	1.21	1.20	0.11	11.04
Output Price PL Intermediary P5	2,234	0.04	0.01	0.00	0.10
Output Quantity PL Personal Short Tail Y1 (000$)	2,234	137.06	238.45	0.02	1,002.79
Output Quantity PL Personal Long Tail Y2 (000$)	2,234	324.25	670.09	0.08	3,603.84
Output Quantity PL Commercial Long Tail Y3 (000$)	2,234	498.95	853.91	0.14	4,594.01
Output Quantity PL Commercial Short Tail Y4 (000$)	2,234	190.37	305.79	0.17	1,547.13
Output Quantity PL Intermediary Y5 (000$)	2,234	8,438.75	18,138.88	0	1,43558.50
Input Price PL Labor W1	2,234	1,287.80	222.49	847.22	1,930.20
Input Price PL Agent W2	2,234	1,001.33	10.58	982.68	1,024.17
Input Price PL Material W3	2,234	95.12	8.18	-58.91	136.80
Input Price PL Financial Capital W4	2,234	0.12	0.02	0.08	0.17
Input Quantity PL Labor X1	2,234	217	343	2	1,468
Input Quantity PL Agent X2	2,234	271	405	1	1,733
Input Quantity PL Material X3	2,234	2,596	4,352	41	17,313
Input Quantity PL Financial Capital X4 (000$)	2,234	2,299	3,369	27	13,600

Appendix Table 4: Life and PC Insurers Variables to Create Lerner Indices – Definitions

This table shows the definitions of the variables for life insurers (Panel A) and property-casualty insurers (Panel B) to create Lerner indices.

Panel A

Variable - Life Insurers	Description
Output Price Life Individual Life P1	The sum of premiums and investment income minus output for each line divided by output.
Output Price Life Group Life P2	The sum of premiums and investment income minus output for each line divided by output.
Output Price Life Individual Annuities P3	The sum of premiums and investment income minus output for each line divided by output.
Output Price Life Group Annuities P4	The sum of premiums and investment income minus output for each line divided by output.
Output Price Life Accident Health P5	The sum of premiums and investment income minus output for each line divided by output.
Output Price Life Intermediary P6	The expected portfolio rate of return is the weighted average of the debt and equity returns, weighted by the proportion of the portfolio invested in debt securities and stocks.
Output Quantity Life Individual Life Y1	The sum of incurred benefits and additions to reserves for the major lines of business offered by life insurers.
Output Quantity Life Group Life Y2	The sum of incurred benefits and additions to reserves for the major lines of business offered by life insurers.
Output Quantity Life Individual Annuities Y3	The sum of incurred benefits and additions to reserves for the major lines of business offered by life insurers.
Output Quantity Life Group Annuities Y4	The sum of incurred benefits and additions to reserves for the major lines of business offered by life insurers.
Output Quantity Life Accident Health Y5	The sum of incurred benefits and additions to reserves for the major lines of business offered by life insurers.
Output Quantity Life Intermediary Y6	Average real invested assets are used to measure the quantity of the intermediation output for life insurers.
Input Price Life Labor W1	U.S. Department of Labor (DOL) data on average weekly wages for Standard Industrial Classification (SIC) class 6311 before 2001 and North American Industry Classification System (NAICS) class 524113 since 2001.
Input Price Life Agent W2	DOL average weekly wage rate for insurance agencies and brokerages (SIC class 6411 and NAICS class 524210).
Input Price Life Material W3	The weighted average of price indices for business services from the component indices representing the various categories of expenditures from the expense page of Best's Aggregates and Averages. The component price indices are from the DOL and the U.S. Department of Commerce, Bureau of Economic Analysis.
Input Price Life Financial Capital W4	The cost of capital for year t is calculated as the 30-day Treasury bill rate at the end of year t-1, plus the long-term (1926 to the end of year t-1) average market risk premium on large company stocks, plus the long-term (the 1926 through end of year t-1) average size premium from Ibbotson Associates.
Input Quantity Life Labor X1	Total expenditures on labor from the regulatory annual statement.
Input Quantity Life Agent X2	Total expenditures on agent labor from the regulatory annual statement.
Input Quantity Life Material X3	Total expenditures on materials from the regulatory annual statement.
Input Quantity Life Financial Capital X4	The average of the beginning and end-of-year equity capital, plus the asset valuation reserve.

Appendix Table 4: Life and PC Insurers' Variables to Create Lerner Indices – Definitions (continued)

This table shows the definitions of the variables for life insurers (Panel A) and property-casualty insurers (Panel B) to create Lerner indices.

Panel B

Variable - PC Insurers	Description
Output Price PL Personal Short Tail P1	Output price is pi = [Pi - PV(Li)]/PV(Li), where pi is the price of output i, Pi = premiums in line i, Li = incurred losses in line i, and PV is the present value operator.
Output Price PL Personal Long Tail P2	Output price is pi = [Pi - PV(Li)]/PV(Li), where pi is the price of output i, Pi = premiums in line i, Li = incurred losses in line i, and PV is the present value operator.
Output Price PL Commercial Long Tail P3	Output price is pi = [Pi - PV(Li)]/PV(Li), where pi is the price of output i, Pi = premiums in line i, Li = incurred losses in line i, and PV is the present value operator.
Output Price PL Commercial Short Tail P4	Output price is pi = [Pi - PV(Li)]/PV(Li), where pi is the price of output i, Pi = premiums in line i, Li = incurred losses in line i, and PV is the present value operator.
Output Price PL Intermediary P5	The expected portfolio rate of return is the weighted average of the debt and equity returns, weighted by the proportion of the portfolio invested in debt securities and stocks.
Output Quantity PL Personal Short Tail Y1	Present value of real losses incurred by line of P-L insurance.
Output Quantity PL Personal Long Tail Y2	Present value of real losses incurred by line of P-L insurance.
Output Quantity PL Commercial Long Tail Y3	Present value of real losses incurred by line of P-L insurance.
Output Quantity PL Commercial Short Tail Y4	Present value of real losses incurred by line of P-L insurance.
Output Quantity PL Intermediary Y5	Average real invested assets are used to measure the quantity of the intermediation output for P-L insurers.
Input Price PL Labor W1	DOL data on SIC class 6331 before 2001 and NAICS class 524126 since 2001.
Input Price PL Agent W2	DOL average weekly wage rate for insurance agencies and brokerages (SIC class 6411 and NAICS class 524210).
Input Price PL Material W3	The weighted average of price indices for business services from the component indices representing the various categories of expenditures from the expense page of Best's Aggregates and Averages. The component price indices are from the DOL and the U.S. Department of Commerce, Bureau of Economic Analysis.
Input Price PL Financial Capital W4	The cost of capital for year t is calculated as the 30-day Treasury bill rate at the end of year t-1, plus the long-term (1926 to the end of year t-1) average market risk premium on large company stocks, plus the long-term (the 1926 through end of year t-1) average size premium from Ibbotson Associates
Input Quantity PL Labor X1	Total expenditures on labor from the regulatory annual statement.
Input Quantity PL Agent X2	Total expenditures on agent labor from the regulatory annual statement.
Input Quantity PL Material X3	Total expenditures on materials from the regulatory annual statement.
Input Quantity PL Financial Capital X4	The average of the beginning and end-of-year equity capital, plus unearned premium reserves.