



Leverage across firms, banks, and countries [☆]

Sebnem Kalemli-Ozcan ^{a,b,c,d,e,*}, Bent Sorensen ^{d,e}, Sevcan Yesiltas ^f

^a Koc University, Turkey

^b Harvard University, United States

^c NBER, United States

^d CEPR, UK

^e University of Houston, United States

^f John Hopkins University, United States

ARTICLE INFO

Article history:

Received 5 August 2011

Received in revised form 29 February 2012

Accepted 6 March 2012

Available online 13 March 2012

JEL classification:

E32

F15

F36

Keywords:

Leverage

Crisis

International

Banks

Firms

ABSTRACT

We present new stylized facts on bank and firm leverage during the period 2000–2009 using internationally comparable micro level data from many countries. We document the following patterns: a) there was an increase in leverage for investment banks prior to the sub-prime crisis; b) there was no visible increase in leverage for the typical commercial bank and non-financial firm; c) off-balance-sheet items constitute a big fraction of assets, especially for large commercial banks in the US, whereas investment banks do not report these items; d) the leverage ratio is procyclical for investment banks and for large commercial banks in the US; e) banks in emerging markets with tighter bank regulation and stronger investor protection experienced significantly less deleveraging during the crisis. The results suggest that excessive risk taking before the crisis was not easily detectable because the risk involved the quality rather than the quantity of assets.

© 2012 Elsevier B.V. All rights reserved.

1. Introduction

The 2007–2009 global crisis started in the financial sector and quickly turned into a global recession with a decline in output, employment, and trade unprecedented since the Great Depression. One lesson learned from previous emerging market crises is that banks' and firms' financing conditions are key mechanisms in turning financial crises into recessions: declining collateral values lead to higher cost of external financing which forces banks and firms to lower leverage and contract real investment leading to lower output (Kiyotaki and Moore (1997)). Procyclical leverage is therefore a potentially important amplification mechanism in propagating financial shocks to the real economy (Bernanke and Gertler (1995)). Many commentators have argued that the lending boom of the early 2000s, which fueled the run-up to the sub-prime crises, caused firms and banks to increase their leverage substantially. When the boom turned into a bust and banks deleveraged through contraction of credit, the global economic meltdown occurred.

A number of recent theoretical papers aim at understanding the endogenous leverage process (Farhi and Tirole (2010); Fostel and Geanakoplos (2008); Brunnermeier and Pedersen (2009)) but, to this date, leverage before and after the crisis has not been studied in the framework of an internationally comparative setting including listed as well as non-listed firms (financial and non-financial).¹ This is the task we undertake in this paper by documenting leverage patterns across firms, banks, and countries during the 2000s. We examine if leverage patterns differ across firms and banks, across large and small banks, and across countries with different institutional and regulatory structures. In particular, we study which types of banks and firms were highly leveraged in which countries in the run-up to the crisis.

We utilize the most comprehensive and comparable firm-level and bank-level world-wide data set; namely, ORBIS from Bureau van Dijk Electronic Publishing (BvD) for the years 2000–2009 which covers listed, private, large, and small non-financial firms, financial firms, and banks. It is important to use micro data because aggregate country-level data may mask micro level patterns. Adrian and Shin (2008, 2009, 2010) and He et al. (2010) investigate US commercial banks and investment banks mainly using aggregate sectoral Flow

[☆] We thank Charles Engel, Jeff Frankel, Kristin Forbes, Hyun Song Shin, three anonymous referees, and participants at the 2010 Cambridge and 2011 Bretton Woods meetings of the NBER-MIT Global Financial Crisis Conference.

* Corresponding author at: Koc University, Turkey.

E-mail address: Sebnem.Kalemli-Ozcan@mail.uh.edu (S. Kalemli-Ozcan).

¹ The highly influential works of Adrian and Shin (2008, 2009, 2010) and Greenlaw, Hatzius, Kashyap, and Shin (2008) focus solely on the US

of Funds data from the Federal Reserve. Sectoral data may be driven by the largest banks and it is important to know how typical investment and commercial banks behave. From a regulatory standpoint, the policy prescription will differ if aggregate leverage is driven by few large banks rather than by a large number of small and mid-size banks.

We show that leverage is procyclical for large commercial banks and investment banks in the US and to a lesser extent in Europe. Large banks have a comparative advantage in raising funds in short-term markets (overnight repurchase agreements and commercial paper) and they were able to increase leverage pre-crisis and skirt capital requirements by using off-balance sheet investment vehicles. Large banks may be somewhat more stable than investment banks due to their ability to obtain funds from depositors; nonetheless, excessive risk taking by huge “too-big-to-fail” banks, which are considered safe due to explicit deposit insurance and implicit government insurance, raises serious regulatory issues. Our main result is that excessive risk taking before the crisis was not easily detectable in aggregate data because pre-crisis increases in leverage were typical only for investment banks and very large banks in developed countries. These institutions grew their balance sheets aggressively by increasing debt and assets but the large risks taken became clear only after the crisis started. Banks in emerging markets behaved differently possibly due to tighter bank regulation. Using regression analysis, we show that banks in emerging markets had a tendency to grow leverage ratios less aggressively before the crisis and were able to better maintain their leverage ratios during the crisis.

Our results may have important policy implications especially with regards to regulatory reform. Indeed, we find that banks in countries with tighter regulation deleveraged less when the crisis hit in 2008. This result is consistent with the finding of [Beltratti and Stulz \(2011\)](#) that banks from countries with tighter regulation performed better during the crisis as measured by stock prices.²

The remainder of the article proceeds as follows. Section 2 reviews the theoretical and empirical literature on leverage while Section 3 presents our data and discusses relevant issues. Section 4 presents the empirical patterns and regression results and Section 5 presents robustness analysis. Section 6 concludes.

2. Literature on leverage

Since the celebrated paper of [Modigliani and Miller \(1958\)](#) there has been an outpouring of theoretical work on firms' capital structure but empirical work is only slowly catching up. Theoretical models pinpoint important departures from the Modigliani-Miller assumptions which make capital structure relevant for the value of firms. However, the empirical relevance of many theories is not established and the empirical evidence on capital structure outside the US is scarce because most of the literature uses data from COMPUSTAT on large listed US firms. The empirical literature is mostly cross-sectional and therefore doesn't address time-series dynamics in leverage patterns (see [Frank and Goyal \(2004\)](#) for an example).

The corporate finance literature studying US non-financial listed firms finds that the most important cross-firm determinants of leverage are size, profitability, and tangibility (collateral). [Rajan and Zingales \(1995\)](#), using data for non-financial listed firms for the year 1991, show that these factors are also important for leverage in other G7 countries and that differences in accounting practices across countries do not substantially affect firms' leverage patterns although European firms have higher average levels of leverage compared to US firms. [Booth et al. \(2001\)](#) study ten developing countries using a data set of large listed firms in a static setting and find that size, profitability, and tangibility also are important for developing countries; however, there are significant country-level differences in mean levels of

leverage. [Lemmon et al. \(2008\)](#) undertake a dynamic analysis using data from COMPUSTAT and CRSP for listed US firms and conclude that more than 90% of the variation in leverage is captured by firm-fixed effects while the determinants identified by the previous cross-sectional literature only account for 10% of the variation—leverage is remarkably stable over time for listed non-financial firms.

In simple textbook theory, bank capital is determined by regulatory capital requirements. In more sophisticated models, banks optimize their capital structure responding to prices and pressures from shareholders and debtors in the same fashion as non-financial firms in a market economy as modeled by [Flannery \(1994\)](#), [Flannery and Sorescu \(1996\)](#), [Myers and Rajan \(1998\)](#), [Diamond and Rajan \(2000\)](#), and [Allen et al. \(forthcoming\)](#). The recent theoretical literature on endogenous leverage stresses financial frictions: financial intermediaries face frictions in raising funds and when frictions worsen they sell assets and reduce liquidity provision.³ Leverage-constraint models, in which a tightening of constraints will lead to deleveraging, focus on the amount of debt financing of intermediaries; see, for example, [Fostel and Geanakoplos \(2008\)](#) and [Brunnermeier and Pedersen \(2009\)](#).

A rise in asset prices will mechanically increase the value of equity (banks' net worth) as a percentage of assets. Keeping everything else fixed, rising asset prices will lead to a lower leverage ratio, defined as the ratio of assets to equity. Conversely, in a downturn, asset prices would fall and the leverage ratio would increase. [Adrian and Shin \(2008, 2009, 2010\)](#) show that leverage patterns are countercyclical for the US non-financial sector but procyclical for investment banks. This procyclicality amplifies the business cycle, potentially leading to systemic risk, especially if asset prices do not properly reflect fundamental values (“bubbles”). Investment banks actively manage their balance sheet and leverage, typically through collateralized borrowing and lending, although this paper does not explore how leverage is managed. For example, if the intermediary targets a constant leverage it will react to changes in net worth by adjusting debt. If balance sheets are not marked to market—as is typically the case for commercial banks—leverage is measured as total book assets to book equity. Banks can react to an increase in asset prices by increasing debt and assets, in which case the relationship between balance sheet leverage growth and the balance sheet size (asset growth) can be positive.

[Flannery and Rangan \(2008\)](#) and [Gropp and Heider \(2010\)](#) find large variation in banks' capital ratios and investigate whether capital requirements are a first-order determinant of banks' capital structure. [Flannery and Rangan \(2008\)](#) show that banks increased capital holdings independently of regulatory requirements in the 1990s and interpret this as a reflection of reduced government implicit guarantees. [Gropp and Heider \(2010\)](#) undertake an analysis similar to that of [Rajan and Zingales \(1995\)](#) using BANKSCOPE data with both cross-bank and temporal variation as does the present article. They focus on the 100 largest listed European and US banks between 1991 and 2004 and find that the importance of size, profitability, and tangibility disappears once bank-fixed effects are accounted for. They also find that minimum capital requirements do not play a role in explaining banks' capital structure. Another important finding from the study of [Gropp and Heider \(2010\)](#) is that, on the margin, banks finance their balance sheet growth entirely from non-deposit liabilities. He, Khang, and [Krishnamurthy \(2010\)](#) emphasize the shifts in holdings of securitized assets within the financial sector and show that investment banks decreased leverage by selling assets during the deleveraging process of 2008–2009, commercial banks and the government increased leverage by acquiring these assets.

The empirical results of [Adrian and Shin \(2008, 2009\)](#) and [Greenlaw et al. \(2008\)](#) suggest that the largest banks manage their capital structure based on internal value at risk and not based on regulatory constraints, especially for financial intermediaries that strive to maintain

² They consider very large listed banks with assets over 50 billion dollars.

³ These models go back to the influential work of [Shleifer and Vishny \(1992\)](#).

a constant (maximal) risk exposure, often measured as Value at Risk (VaR), while maximizing earnings.⁴ Leverage is high during boom times because perceived risk is low while leverage is low during contractions because risk is high with increased volatility of asset prices.

Overall, it appears that determinants of non-financial firms' and banks' leverage are quite stable over time and across countries, though there exist significant country differences in leverage levels.

3. Data and descriptive statistics

3.1. Data

We use a unique data set composed of firm- and bank-level observations for 2000–2009 from the ORBIS database provided by BvD. This database is an umbrella product that covers other well-known databases from the same company such as AMADEUS (only European firms), ZEPHYR (worldwide mergers), BANKSCOPE (worldwide banks), and OSIRIS (worldwide listed firms). The time coverage of each firm/bank is a subset of the sample period, leading to an unbalanced panel.⁵

The database comes in two modules: "Financials," which provides financial information—both on- and off-balance-sheet and "Ownership/Corporate Tree," which provides information on foreign and domestic owners of each firm as well as all subsidiaries. In our original data set, we have 60,000 publicly quoted companies worldwide (OSIRIS), 30,000+ banks worldwide (BANKSCOPE), 29 million European companies from 46 countries (AMADEUS), 18+ million US and Canadian companies, 5+ million South and Central American companies, 6+ million companies in the Far East and Central Asia (mainly in Japan, Korea, China), and 790,000 African and Middle Eastern companies (ORBIS).

We only use banks/financial firms and "large" non-financial firms in this study because small non-financial firms played no role in the onset of the crisis. In fact, we document that even large non-financial firms did not increase leverage before the crisis. For banks and financial firms, we use a benchmark world sample because we have representative universal coverage.

However, for non-financial firms, we do not have a representative sample and coverage varies across countries so we focus on "large" firms (defined as firms with more than 150 employees) from Europe and the US which comprise the countries with best quality data and coverage. In Europe and the US, all corporations (listed or not) have to file with official registries. Our European coverage is good because companies have to file both unconsolidated and consolidated statements while the US coverage suffers from the fact that many firms only report consolidated statements.⁶ For non-financial firms, we use unconsolidated accounts to avoid double counting and to improve comparability across countries while we use consolidated accounts for investment banks because they only report these. Adding consolidated statements (holding companies) for commercial banks does not alter our results.

We use two types of samples for both banks and firms: permanent and non-permanent. The non-permanent sample is used in the regression analysis and in the investigation of cross-sectional patterns. We made sure the non-permanent sample does not suffer from survivorship bias by assembling our panel data from individual cross-sections using historical, archived releases of the database. This is important since BvD erases the data on banks in BANKSCOPE from all previous years if the bank does not exist in the current year. They apply a similar practice to firms in AMADEUS and in ORBIS where they keep a firm in the data set for 5 years after it disappears and then erase it from the data for all years. Hence, the data has to be

downloaded disk by disk for every year and not from the latest disk for all the previous years.

The permanent sample is used for time series figures. We have to use a permanent sample here otherwise we would not know if the patterns seen in leverage are due to entry and exit of banks and firms. The trade-off is that these permanent samples will suffer from survivorship bias. Permanent samples are defined as firms and banks with non-missing asset data throughout the period 2000–2009—Lemmon et al. (2008) make similar choices.

In the context of leverage, our bank data from BANKSCOPE is used by Gropp and Heider (2010). In the context of the bank competition literature, it is used by Berger et al. (2008) and Claessens and Laeven (2004). Our firm data is used by many authors in different contexts. Arellano and Bai (2010) study the relationship between leverage and financial development for one year (2004) using AMADEUS data but do not analyze dynamic properties of leverage. Coricelli et al. (2009) use AMADEUS data to study the relation between growth and leverage in 9 CEE countries during the pre-crisis period 1996–2005. ORBIS, from where we get the US firms, is identical to the well-known Dun and Bradstreet data set for the US. For example, Black and Strahan (2002) use this data to study entrepreneurial activity in the US. The firm-level data is also used in two other studies involving two of the authors of this article; namely, Kalemli-Ozcan et al. (2010) who study the relationship between growth and volatility and Fons-Rosen et al. (2011) who study financial integration and productivity spillovers.

The bank-level and firm-level data sets are suitable for international comparisons because BvD harmonizes the data. Our dynamic analysis either compares banks over time within a single country or banks over time within a group of countries using bank and country-time fixed effects which control for permanent differences between banks or countries and for global common factors. For our purpose, it is important to undertake a dynamic analysis, rather than a cross-sectional analysis which doesn't allow for fixed effects, because country-fixed effects will absorb all features that are common to all banks and firms in a country such as differences in accounting practices, balance sheet representation, and domestic regulatory adjustments. For example, using international financial reporting standards results in higher total asset amounts reported than when US generally accepted accounting principles are used because netting conditions are stricter under international standards.

Regulatory requirements might apply differently across countries; for example, in the US minimum capital requirements apply both to individual banks and to consolidated banks, whereas in other countries this may be different. Investment banks and their subsidiaries in the US are regulated by the Securities and Exchange Commission (SEC) while other countries have different regulatory systems. Again, any non-time varying bank-level changes will be absorbed by our fixed effects.

Differences between countries can be due to assets and liabilities being valued at book value (historical) versus market value (current). If different countries follow different accounting practices but all banks and firms within each country behave similarly then these differences will be absorbed by country fixed effects. If banks and firms in various countries behave differently in a fashion that changes over time then we cannot account for this with fixed effects. Therefore, we stick to book value overall as reported in balance sheets if we have a choice between the two as in the case of listed firms and banks. For private firms and banks, we have book value only.

We use country-level measures from the Bank Regulation Data Set of Barth et al. (2007). This data set comes in surveys from 2003 and 2010, respectively. We use the 2003 values of the following variables: 1) "Supervision Index," which measures the efficiency of supervision and takes a value of 1 if there are multiple independent supervisors for banks and zero otherwise and 2) "Monitoring Index," which measures the efficiency of monitoring and takes a value of 1 if the top ten banks in the country are all rated by international rating agencies, if

⁴ VaR is an estimate of a financial institution's worst case loss and is usually defined with respect to a confidence level of, say, 99%. VaR is defined such that the probability that losses on the asset portfolio exceed the value VaR is less than 1%.

⁵ We use ZEPHYR data to control for all firm mergers and acquisitions that happened during our sample.

⁶ In addition to this issue, BvD has a relatively thin coverage for the US before 2007 even for consolidated accounts.

off-balance sheet items are disclosed to the public, if banks must disclose risk management procedures to the public, and if subordinated debt is required as part of regulatory capital and zero otherwise. We expect banks in countries where the values of these indices are high to take lower risks in terms of asset quality because it is relatively harder to hide such risks on or off the balance sheet.

3.2. Descriptive statistics

The leverage ratio is measured as the ratio of assets to equity (shareholder funds).⁷ We explored other measures such as the ratio of Tier 1 capital (sum of capital and reserves minus intangible assets) to adjusted assets, the ratio of total liabilities to total assets, the ratio of total debt to total assets, and the ratio of total debt to equity. The patterns in those data series were mainly consistent with what we show in this paper and they are not reported in the present version of the article.

The leverage ratio does not reflect off-balance sheet exposure. One of the key characteristics of the sub-prime crisis is that in the pre-crisis period banks funded a growing amount of long-term assets with short-term liabilities through the use of off-balance sheet vehicles, exposing themselves to credit and liquidity risk by providing credit facilities and guarantees to these vehicles. Many have argued that this was the main amplification mechanism (see Brunnermeier, 2009; Adrian and Shin, 2009). In addition, many banks held structured credit instruments on their balance sheet, increasing the maturity mismatch of their balance sheet and their funding liquidity risk. We investigate patterns in the ratio of off-balance sheet items (guarantees and committed credit lines) to assets because a loan guarantee involves a future contingent commitment even if it does not show up on the balance sheet. Banks report these data together with the balance sheet as a separate memo line called off-balance sheet items where they report guarantees, committed credit lines, and other exposure to securitization. Very few banks report the last item and investment banks do not report any of these items.

Table 1 shows the number of bank-year and firm-year observations by country. We have over 200,000 bank observations and over one and a half million firm observations from 60+ countries. Table 2 presents the number of observations by bank type and account type. Most of our banks are commercial banks and most of our banks report unconsolidated accounts. The majority of banks are not listed. Most of the firms in our sample are non-financial, unlisted firms reporting unconsolidated accounts.

Table 3 presents descriptive statistics for the data as used in the regression analysis—this data set is winsorized at 2% and 98%. The leverage ratio is as high as 46 with a mean of about 12 while the maximum amount of off-balance sheet items is more than 11 times of assets, although the mean across banks is only 0.7%. Table 3 also shows descriptive statistics by type of bank. Investment banks have slightly higher leverage on average. “Sponsor” banks and large commercial banks have the highest leverage on average at around 23 and 17, respectively.⁸

4. Empirical patterns

4.1. Aggregate picture

In Fig. 1, we plot bank assets since 2000. Panel A shows sectoral data from the Flow of Funds accounts compiled by the US Federal

⁷ Our measure is equivalent to the measure 1-equity/assets used by Gropp and Heider.

⁸ “Sponsor banks” are large banks which have created off-balance sheet investment vehicles. We obtained the names of the sponsor banks from Acharya, Schnabl, and Suarez (2010). There are 70 conduit sponsor banks in their data set and we have located 62 of these in our data. 31 of these banks are European, 23 are American, 4 are Australian, 3 are Japanese, and 1 bank is Canadian. Only 3 out of 62 are investment banks. Non-sponsor banks statistics are similar to the statistics of all banks.

Table 1
Firms and banks across countries, 2000–2009: number of observations by country.

Country	Bank-Year	Firm-Year (Europe and US only)
ARGENTINA	1404	
AUSTRALIA	1384	
AUSTRIA	2996	5225
AZERBAIJAN	180	
BANGLADESH	412	
BELGIUM	1420	67,385
BOSNIA	249	
BRAZIL	2248	
BULGARIA	333	11,585
CANADA	963	
CHILE	547	
CHINA	993	
COLOMBIA	507	
COSTA RICA	861	
CROATIA	509	11,277
CZECH REPUBLIC	449	37,078
DENMARK	1812	23,231
EGYPT	478	
EL SALVADOR	272	
ESTONIA	160	5847
FINLAND	350	32,318
FRANCE	6809	182,857
GEORGIA	125	
GERMANY	22,981	104,191
GHANA	337	
GREECE	472	
HONG KONG	1647	
HUNGARY	553	21,703
ICELAND	262	2163
INDIA	1318	
INDONESIA	846	
IRELAND	914	13,141
ISRAEL	332	
ITALY	9891	163,632
JAPAN	10,079	
KENYA	671	
KOREA REP. OF	810	
LATVIA	365	6399
LITHUANIA	198	6564
LUXEMBOURG	1617	2592
MALAYSIA	1514	
MEXICO	770	
NETHERLANDS	1345	29,182
NEW ZEALAND	280	
NORWAY	1474	30,479
PARAGUAY	230	
PERU	395	
PHILIPPINES	718	
POLAND	695	72,030
PORTUGAL	765	34,732
ROMANIA	366	16,891
RUSSIA	5889	154,729
SERBIA	345	19,796
SINGAPORE	816	
SLOVAKIA	290	7989
SLOVENIA	337	4239
SOUTH AFRICA	980	
SPAIN	3069	133,102
SWEDEN	1343	81,489
SWITZERLAND	6104	4646
TAIWAN	1237	
THAILAND	661	
TURKEY	946	
UKRAINE	555	16,099
UNITED KINGDOM	6533	183,959
URUGUAY	464	
USA	112,116	139,026
VENEZUELA	619	
TOTAL	229,610	1,675,576

Notes: Banks are defined broadly to include financial firms such as credit card companies, private equity firms, hedge funds, broker-dealers, specialized credit institutions, etc. Firms are non-financial firms from Europe and the US with more than 150 employees.

Table 2
Firms and Banks Across Countries, 2000–2009: Observations by Type.

BANKS			
	World	Europe	US
All	30,056	14,680	13,964
Investment	975	402	138
Commercial	29,081	14,278	13,826
Consolidated	6826	2612	3246
Unconsolidated	23,201	10,978	10,606
Listed	3351	1164	1074
Unlisted	26,705	13,516	12,890
FIRMS			
		Europe	US
All		227,295	53,666
Financial		1466	6632
Non-Financial		225,829	47,034
Consolidated		42,451	16,486
Unconsolidated		184,844	37,180
Listed		10,476	8875
Unlisted		216,819	44,791

Notes: Consolidated and unconsolidated refer to the number of banks/firms with consolidated and unconsolidated statements, respectively. Listed indicates the number of banks/firms that are listed on a stock exchange. Financial firms are firms with Primary NACE Rev. 1.1 sector code J: Financial intermediation.

Reserve System. As shown, assets of commercial banks, savings institutions, and credit unions increased from about 6 trillion dollars in 2000 to over 12 trillion dollars in 2008 followed by a decline of several hundred billion since 2008. Investment banks (“brokers and dealers” in the Flow of Funds, which includes all institutions who are engaged in brokering and dealing of securities) saw tremendous growth in assets from 2000 to 2008 followed by a steep reversal of over half a trillion dollars.⁹ The travails of the US investment banks culminating in the default of Lehman Brothers have been extensively documented in many places, see for example [Duffie \(2010\)](#), [Krishnamurthy \(2010\)](#), and other papers in the *Journal of Economic Perspective's* symposium on the financial crisis in the Winter 2010 issue.

Panel B displays bank assets, aggregated from our bank-level data, for the US. In this article, we use the label “aggregated” for data summed over the banks in our sample. Total Assets of each bank is defined as total book value of intangible, tangible, and other fixed assets. Compared to the Flow of Funds data, our aggregated data overstates assets because banks’ claims on each other are not netted out. Nonetheless, the patterns in our aggregated data are similar to the patterns in the Flow of Funds data for both investment banks and non-investment banks. Using our data, we are able to break down the patterns for large banks, large banks excluding investment banks, and small banks. We define a large bank as a bank that has more than a billion dollars worth of assets at the beginning of our sample. Panel C shows aggregated assets of the European banks in our data set: assets grew marginally from 2000 till 2004 followed by a sharp acceleration to more than 20 trillion dollars in 2008 followed by an astounding drop of about 3 trillion dollars from 2008 to 2009.¹⁰

Looking at risk-weighted assets may be more informative about risk taking and we do so in [Fig. 2](#). A clear divergence in the trend between total assets and risk-weighted assets can be observed for all banks and as well as for large banks (aggregated from micro data), with risk-weighted assets growing more slowly. Risk-Weighted Assets (RWA) are defined as the sum of three components: operational risk, market risk, and a weighted sum of assets with appropriate weights determined by the regulators. The weights can be chosen in a simplified manner or in

⁹ There may be brokers and dealers in the Flow of Funds that are not “investment banks” in the BvDdata; however, there is a large overlap between the categories.

¹⁰ The European sample includes all European countries. Results with EU banks only are similar.

Table 3
Descriptive Statistics 2000–2009.

	N	Mean	Min	Max
<i>Panel A: All Banks</i>				
Leverage Ratio	180,460	12.4	1.3	46.3
Total Assets (billion USD)	180,553	11.5	0	3663.3
Adjusted Assets (billion USD)	141,669	9.3	-36.9	3318.9
Equity (billion USD)	180,504	0.8	-92.9	3472.3
Off Balance Sheet (ratio of Total Assets)	79,573	0.0	0	5.2
<i>Panel B: Investment Banks</i>				
Leverage Ratio	4101	13.6	1.3	46.3
Total Assets (billion USD)	4103	26.6	0	1599.6
Adjusted Assets (billion USD)	1890	32.2	0	1258.2
Equity (billion USD)	4103	1.1	-9	106
Off Balance Sheet (ratio of Total Assets)	34	0.1	0	1.9
<i>Panel C: Large Non-Investment Banks</i>				
Leverage Ratio	33,664	17.4	1.3	46.3
Total Assets (billion USD)	33673	38.9	0	3663.3
Adjusted Assets (billion USD)	20,837	35.4	0	2332.6
Equity (billion USD)	33,667	2.8	-92.9	543.5
Off Balance Sheet (ratio of Total Assets)	1601	0.0	0	1.7
<i>Panel D: Sponsor Banks</i>				
Leverage Ratio	404	22.7	1.3	46.3
Total Assets (billion USD)	404	490.3	0.1	3335.8
Adjusted Assets (billion USD)	366	514.2	0.1	3318.9
Equity (billion USD)	404	22.8	-1.8	198
Off Balance Sheet (ratio of Total Assets)	11	0.0	0	0.1
<i>Panel E: Non-Sponsor Banks</i>				
Leverage Ratio	180,056	12.4	1.3	46.3
Total Assets (billion USD)	180,149	10.4	0	3663.3
Adjusted Assets (billion USD)	141,303	8	-36.9	3318.8
Equity (billion USD)	180,100	0.7	-92.9	3472.3
Off Balance Sheet (ratio of Total Assets)	79,562	0.0	0	5.2

Notes: The data is winsorized at 2% and 98% before splitting into groups which explains why some extreme values are identical. In Panel A, statistics are given for all banks while Panels B and C display statistics for investment and large non-investment banks, respectively. Panel D displays statistics of conduit sponsor banks. The names of the sponsor banks are taken from [Acharya and Schnabl \(2009\)](#). There are 70 conduit sponsor banks in their data set, of which we have located 62 in our data set. 31 of these banks are European, 23 are US, 4 are Australian, 3 are Japanese and 1 bank is Canadian. In Panel E, non-sponsor bank statistics are shown separately. Leverage ratio is defined as the ratio of total assets to equity. Totals assets are composed of tangible and intangible assets. Adjusted assets exclude goodwill and intangibles. Equity is measured as shareholder funds. Off-Balance sheet items are the sum of guarantees and committed credit lines. A “large bank” has more than one billion dollars worth of assets in 2000. All non-ratio items are in 2005 dollars.

a more sophisticated manner which is typically used by large banks. The weights assigned in the simplified system are 0 for government and other public assets, 20% for liabilities of other banks and securities firms, 35% for secured mortgages, 75% for personal lending, and 100% for corporate and commercial lending. A more sophisticated system includes more subcategories based on credit rankings.¹¹ Risk-weighted assets give an indication of the degree of measured risks regulators believe banks take. however, the low rate of increase in risk-weighted assets compared to total assets imply that the risk that became evident during the crisis was not captured by the risk-weights applied to banks’ assets in the period leading up to the sub-prime crisis. [Fig. 2](#) shows that the risks that became evident during the crisis were not captured by the risk-weights applied to banks’ assets in the period leading up to the sub-prime crisis as risk weighted assets displayed lower growth rates before

¹¹ See [Blundell-Wignall and Atkinson \(2010\)](#) for more details.

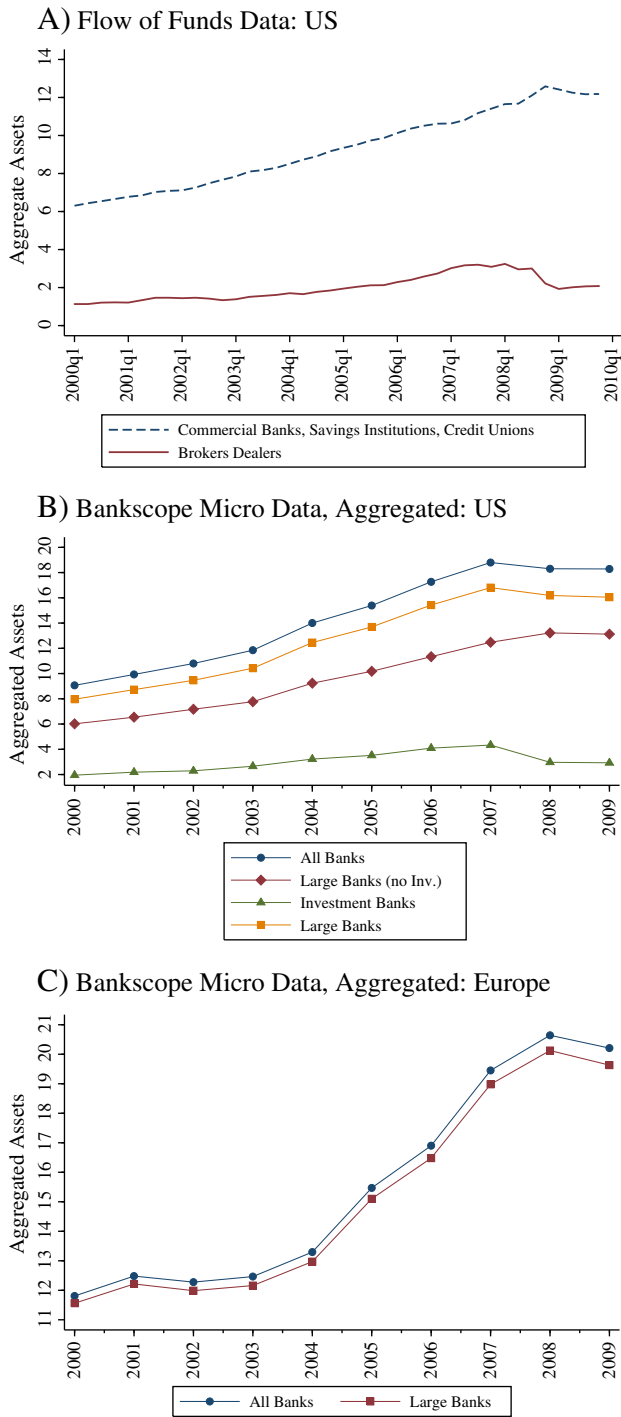


Fig. 1. Financial Sector Assets. Notes: Panel A displays financial sector assets from the Flow of Funds. The numbers are in trillion 2005 dollars, deflated by the GDP deflator. Panels B and C display total assets aggregated from our bank-level data for different group of banks for US and Europe, respectively. The numbers are in trillion 2005 dollars, deflated by the consumer price index. Total assets is defined as total book value of intangible, tangible, and other fixed assets. A “large bank” has more than one billion dollars worth of assets in 2000.

the crisis. Plotting the assets of the median bank, rather than aggregated assets, results in a similar picture.

Fig. 3 displays bank equity, in a similar fashion to Fig. 1, using the sectoral Flow of Funds data for the US in Panel A, and using aggregated data (aggregation of bank-level observations for the US banks) in Panel B. Equity of US investment banks grew sharply from 2004 to 2006 followed by a sharp drop in 2008 (the exact timing being

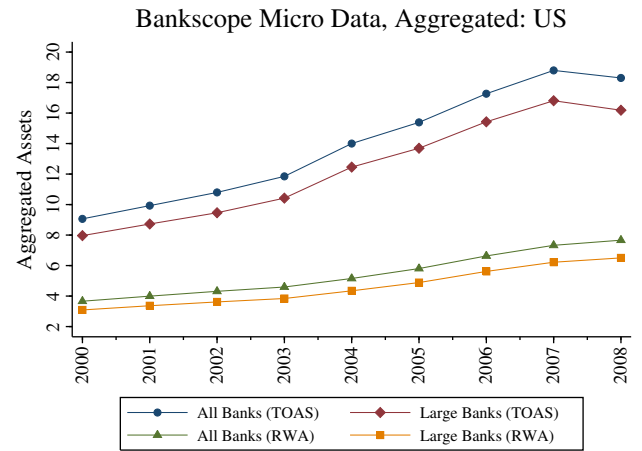


Fig. 2. Risk Weighted versus Non-Risk Weighted Assets. Notes: The data plotted is aggregated from bank-level data and is denominated in trillion 2005 dollars. Total assets (TOAS) is defined as total book value of intangible, tangible, and other fixed assets. Risk-Weighted Assets (RWA) are weighted according to riskiness with weights determined by regulators. Bank can choose weights according to a “simple rule,” for which the weights are 0 for government and other public assets, 20% for liabilities of other banks and securities firms, 35% for secured mortgages, 75% for personal lending, and 100% for corporate and commercial lending. A “sophisticated rule,” used by larger banks, includes more subcategories based on credit rankings; see [Blundell-Wignall and Atkinson \(2010\)](#) for more details. A “large bank” has more than one billion dollars worth of assets in 2000.

slightly different between the quarterly Flow of Funds data and the annual aggregated data). For large banks (excluding investment banks) there has been a steady increase in equity. For European banks, aggregated equity (displayed in Panel C of Fig. 3) increased rapidly from about 600 billion dollars in 2004 to about 800 billion in 2007 followed by a slight drop in 2008 and a recovery in 2009.

Fig. 4 compares aggregate US leverage, calculated as assets over equity, from the Flow of Funds to aggregated leverage compiled from our micro data, in Panels A and B. The US patterns from the Flow of Funds in Panel A are very similar to those of the aggregated data in Panel B which display aggregated assets divided by aggregated equity. In 2004, the SEC deregulated the minimum capital requirements for investment banks, freeing leverage ratios from direct regulatory constraints. A run-up in leverage of investment banks (“brokers and dealers” in the Flow of Funds) from 2004 to 2008 is evident in both panels although the Flow of Funds data, being quarterly, exhibits sharper peaks and valleys. The collapse in the leverage of investment banks after 2008 is clearly evident in both panels. This is mechanically explained by the sharp decline in assets combined with equity rebounding in 2009. Leverage ratios of commercial banks were quite stable from 2000 until 2008 when a steep decline occurred. This is mechanically explained by the small decline in assets and the steeper increase in equity seen in the previous figures. Panel C shows similar patterns for the European banks. [Appendix Table 1](#) shows aggregated, mean, and median leverage for 2006–2009 for other countries.

Aggregate patterns may be driven by a few mega-banks, such as Bank of America, Citibank, and JP Morgan. Our micro data allows us to examine leverage of typical banks. We plot median leverage for banks over time in Fig. 5. Panel A is visually dominated by investment banks which have pro-cyclical leverage ratios between 14 and 20. These medians are higher than those of commercial banks but much lower than the aggregate leverage ratios of investment banks—clearly, high leverage of investment banks is concentrated within the largest banks. Panel B shows that the median European bank decreased leverage steadily from around 17.5 to 15 over our sample.

The sub-prime crisis first came to the surface on July 31, 2007 with the default of two Bear Stearns hedge funds followed by BNP Paribas halting withdrawals from three investment funds. A large number of banks had created off-balance sheet conduits which mainly invested

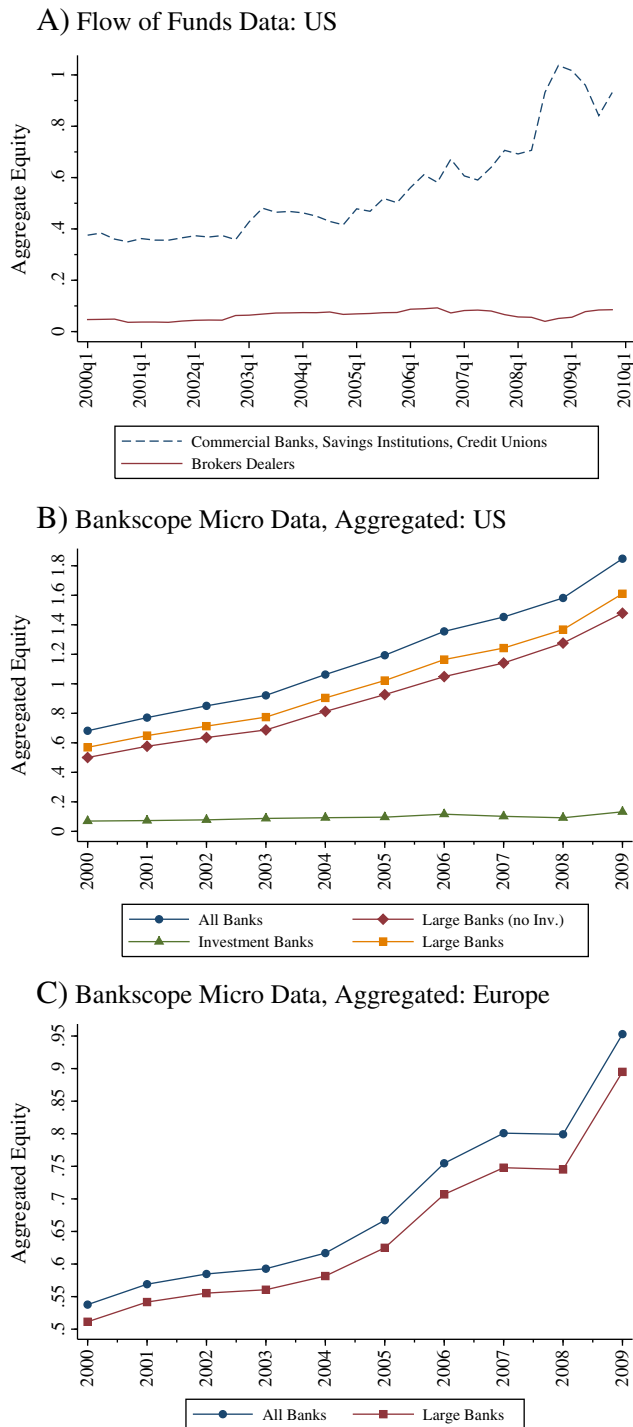


Fig. 3. Financial Sector Equity. Notes: Panel A displays financial sector equity from Flow of Funds data. The numbers are deflated by the GDP deflator and displayed in trillion 2005 dollars. Panels B and C display banks' equity aggregated from our bank-level data for different group of banks in the US and Europe, respectively. The numbers are deflated by the consumer price index and is reported in trillion dollars. Equity is measured as shareholder funds. A "large bank" has more than one billion dollars worth of assets in 2000.

in asset-backed securities in order to reduce capital requirements. However, most conduits were still fully or partially guaranteed by their sponsoring banks which also provided committed lines of credit (see Acharya et al. (2010) for more details on this). We have measures of guarantees and committed credit lines and we display the aggregated amounts relative to assets for all banks and separately for large banks in

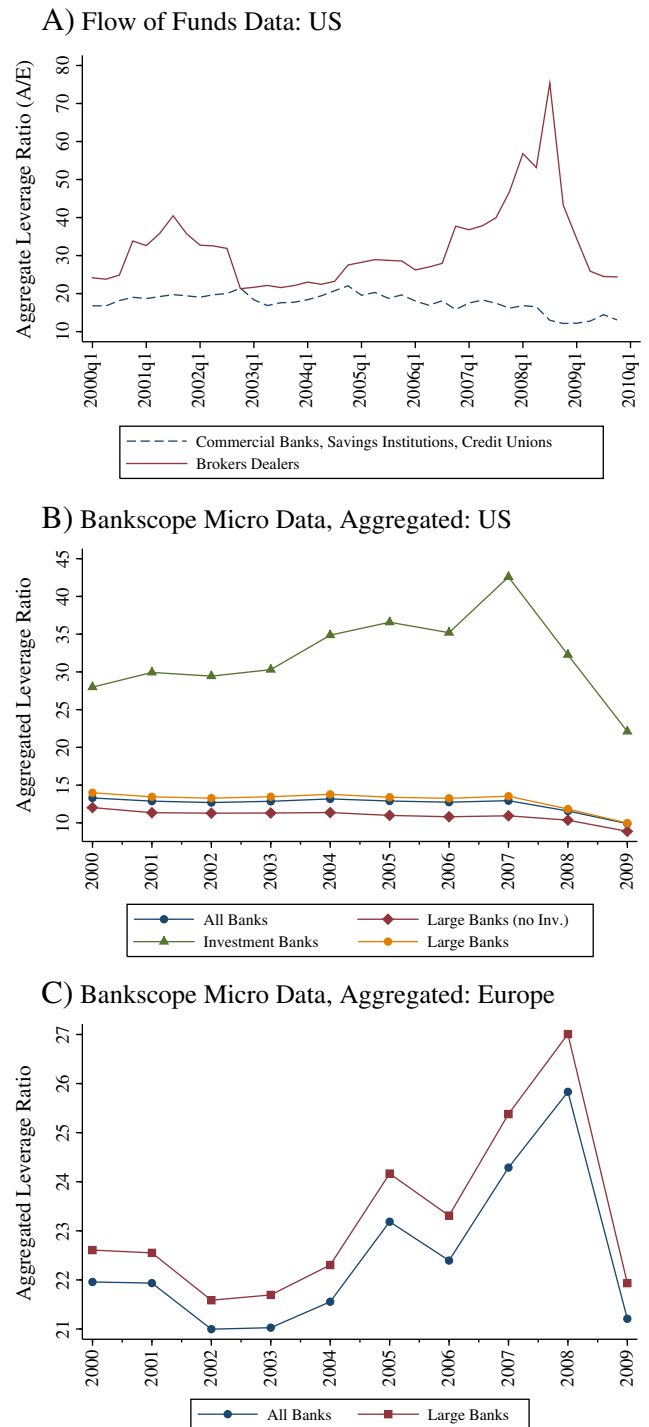


Fig. 4. Financial Sector Leverage Ratio. Notes: Panel A displays financial sector leverage ratio in the US, calculated as assets over equity, using sectoral data from the Flow of Funds. Panels B and C display leverage ratios, calculated from bank-level data for the US and Europe, respectively. We aggregate bank-level assets and equity for different group of banks and take the ratio of aggregated assets to aggregated equity. A "large bank" has more than one billion dollars worth of assets in 2000.

Fig. 6. Investment banks do not report these items. The total amount of guarantees and credit lines at 85% were almost as large as total assets from 2000 till 2007 for large banks and lower at 70% for all banks. From 2007 till 2009 there was a sharp drop with the aggregate amount falling to less than 50% of assets when banks were getting out of these commitments in the wake of the interbank lending freeze and the

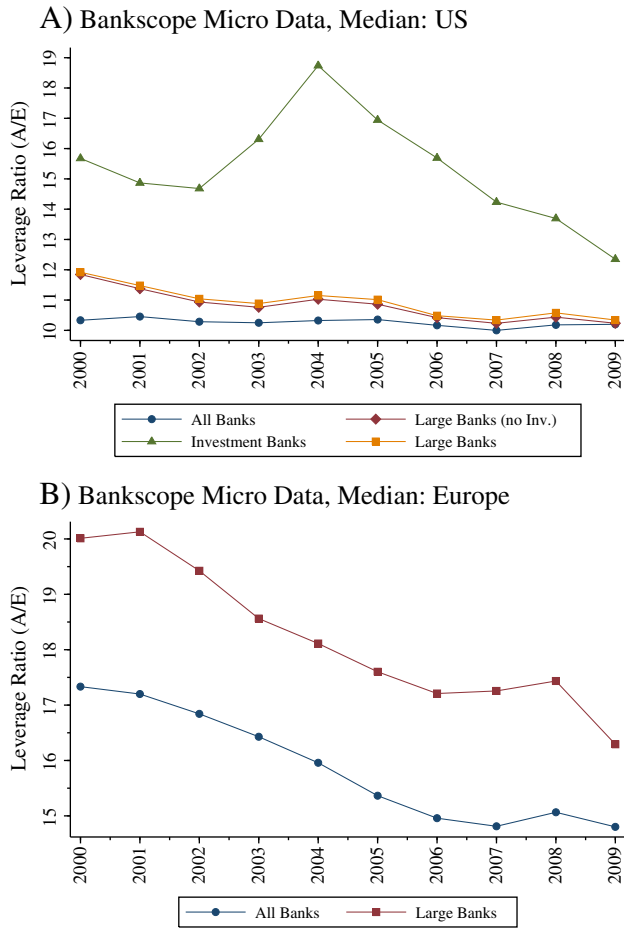


Fig. 5. Financial Sector Leverage Ratio: Typical Bank. Notes: Panels A and B display median leverage; that is, the leverage ratio for the typical bank in the US and Europe, respectively. A “large bank” has more than one billion dollars worth of assets in 2000.

difference between larger and smaller banks narrowed. Panel B shows similar patterns for Europe in terms of timing, though less pronounced in terms of scale: guarantees and committed credit lines never exceeded 22% of assets in Europe. This is partly due the differences in regulation: banks in Spain did not issue guarantees to off-balance sheet entities because Spain had imposed similar capital requirements for assets on- or off-balance sheets, leaving little incentives for Spanish banks to use such entities.

Guarantees and credit lines are not the focus of this article but it appears that banks carry a large amount of risk that is not visible from conventional leverage ratios. Ex post, major US banks were subject to increasing risk from guaranteeing enormous pools of assets of declining quality; however, the pattern of Fig. 6 does not indicate increased risk taking before 2007—only the collapse after the start of the crises reveals the risk taken. It is clear that outside of investment banks neither leverage nor guarantees and committed credit lines relative to assets (or equity) signalled excessive risk taking over time in the run-up to the crisis. It appears that the increasing risk exposure of commercial banks in 2004–2007 was hidden in the deteriorating quality of the asset pool. Fig. 7 shows median levels of guarantees and committed credit lines to assets for large banks and for all banks. The median is much smaller than the aggregate ratio for large banks and much smaller again for all banks. This holds for both the US and Europe implying that issuing of guarantees and committed credit lines was concentrated among the largest banks which disproportionately affect the mean.

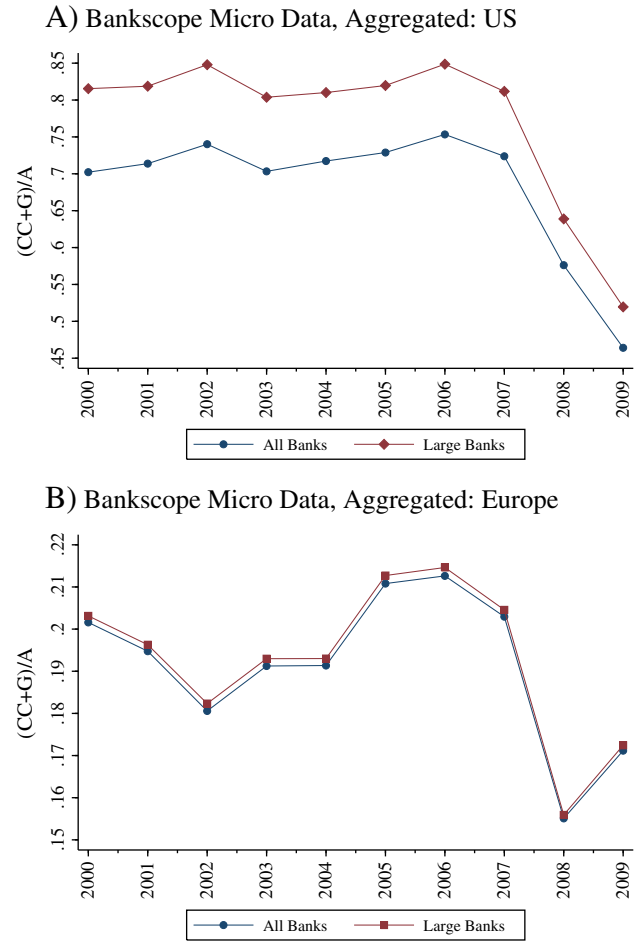


Fig. 6. Financial Sector Off-Balance Sheet Items. Notes: Off-balance sheet items (book value) come from three summary lines in the balance-sheet: acceptances, documentary credits, and guarantees. The number of banks reporting acceptances is very limited. We use committed credit lines and guarantees for off-balance sheet items. Panels A and B display aggregated off-balance sheet items, as a ratio of total assets, for all banks as well as large banks for the US and Europe, respectively. A “large bank” has more than one billion dollars worth of assets in 2000.

4.2. Bank leverage: procyclical or countercyclical?

An increase in asset values will mechanically increase the value of both the numerator and denominator of the leverage ratio but the increase in equity will be proportionally larger and the leverage ratio will fall. Such a pattern is observed for households as pointed out by Adrian and Shin (2008, 2009). However, a firm or a bank may be able to use the increased equity as basis for further lending which will increase assets (and liabilities) relative to equity with the outcome that asset appreciation and leverage is no longer inversely related. Adrian and Shin (2008, 2009) demonstrate that non-financial corporations’ asset growth and leverage is virtually uncorrelated using aggregate data from the US Flow of Funds accounts.

A non-financial firm may face decreasing marginal profitability of investments; however, banks will often be able to invest with non-decreasing marginal returns in large liquid markets, such as the market for mortgage-backed securities, while borrowing at a constant low rate through repurchase arrangements, commercial paper, or implicitly through cash management for hedge funds. If banks have target leverage ratios, leverage will not increase with asset values but if banks target a level of risk exposure, leverage may be procyclical as Adrian and Shin (2008, 2009) find for US investment banks 1963–2006. They find an acyclical pattern for commercial banks,

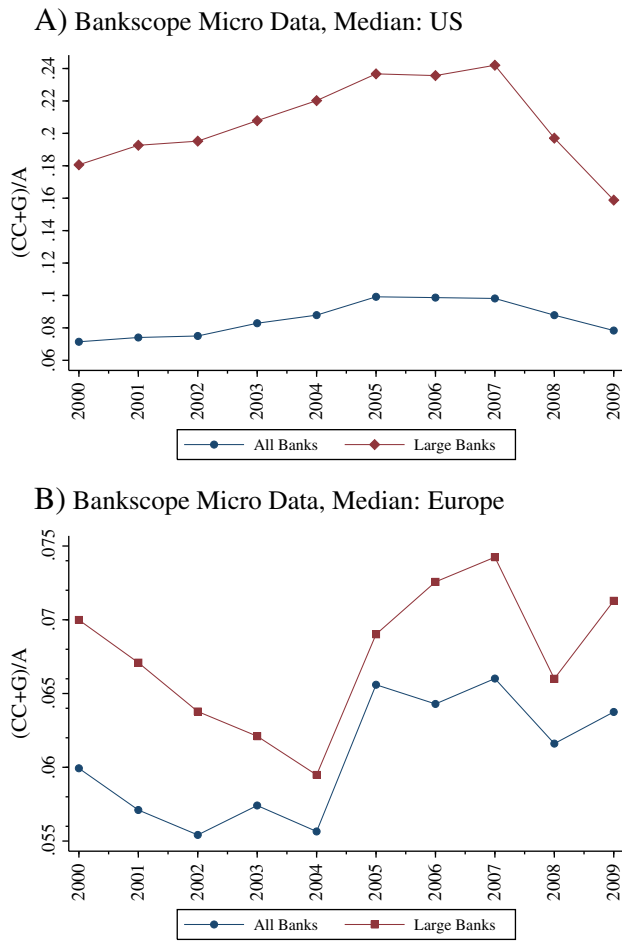


Fig. 7. Financial Sector Off-Balance Sheet Items: Typical Bank. Notes: Off-balance sheet items come from three summary lines in the balance-sheet in book value: Acceptances, documentary credits, and guarantees. The number of banks reporting acceptances is very limited. We use committed credit lines and guarantees for off-balance sheet items. Panels A and B display median off-balance sheet items as a ratio of total assets for all banks as well as large banks in the US and Europe, respectively. A “large bank” has more than one billion dollars worth of assets in 2000.

although Greenlaw et al. (2008) found a procyclical pattern for 5 big commercial banks in the US. We do not explore models of how banks determine their leverage in this paper but Fig. 12 shows that aggregate leverage tends to move inversely with the US VIX-index of risk.¹²

Fig. 8 examines potential procyclicality for US investment banks, and large commercial banks in Panels A, and B, respectively. The figure complements Adrian and Shin (2008, 2009) and Greenlaw et al. (2008), plotting average growth of leverage against average growth of assets for the sample of all (investment, and large) banks in our data set. In these figures, all banks have equal weight and the interpretation is that the figures show whether typical banks display the “Adrian-Shin pattern.”¹³ Because all banks have equal weights, the patterns are not strongly affected by a few giant banks. We include a 45 degree line along which points will cluster if banks maintain a constant level of equity implying that assets and leverage move in lockstep.

Panel A focusses on US investment banks and the “Adrian-Shin pattern” is easily visible over the full sample period. Year 2008 is an

¹² VIX is the symbol for the Chicago Board Options Exchange Market Volatility Index, which measures the implied volatility of S&P 500 index options.

¹³ This is different from saying that the median bank displays the pattern. In the time series graphs, we plotted medians against time but it is not as meaningful to plot median leverage growth against median asset growth because the medians will belong to different banks.

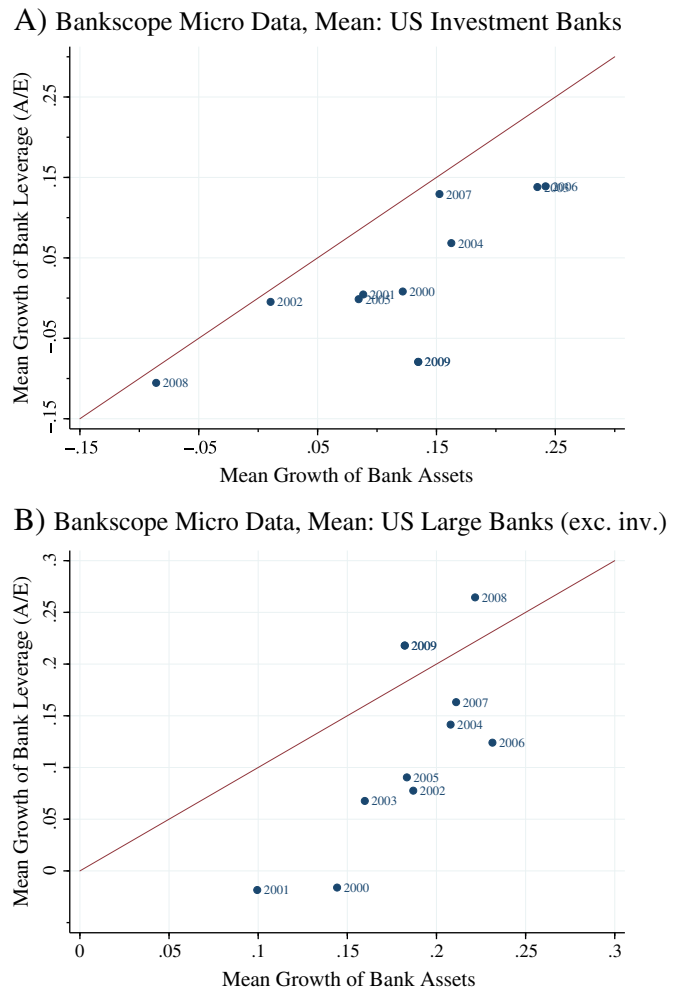


Fig. 8. Financial Sector Procyclical Leverage Ratio: US. Notes: Panels A and B plot the growth rate of bank leverage, defined as growth rate of assets over equity, against the growth rate of assets for US investment banks and large US banks excluding investment banks, respectively. A 45 degree line is plotted for easy reference. The growth rates are the mean growth rates across banks for each year. See notes to previous figures (and/or appendix) for exact definitions of the variables.

outlier with large declines in assets and leverage but it pretty much lies on the line that one can easily fit using ordinary myopic eyeballs.¹⁴ For large US (non-investment) banks in Panel B, a similar pattern is visible, maybe with an even steeper slope although the observations for 2008 and 2009, which are above the other points, probably should be interpreted with caution: many observers, see for example, Greenlaw et al. (2008), interpret the increase in bank lending in 2008 as “forced lending” where borrowers were drawing on pre-committed credit lines. Certainly, the steep decline in assets, committed credit lines, and guarantees that started in 2008 and accelerated in 2009 is consistent with banks needing time to unwind their obligations. For smaller banks, we do not find procyclicality and we omit results smaller banks for space considerations. For European banks, we observe a slight tendency for leverage to be pro-cyclical for large banks, although with a much smaller slope than found for large US banks. Smaller European banks display a surprisingly stable level of asset growth and no hint of procyclical leverage. These results are available upon request.

¹⁴ Note that in the figures in Adrian and Shin’s articles, 2008 is the peak year. This discrepancy to our results occurs because they use first quarter of 2008 where the crisis was still in its infancy. Our annual data is from end-of-year accounts.

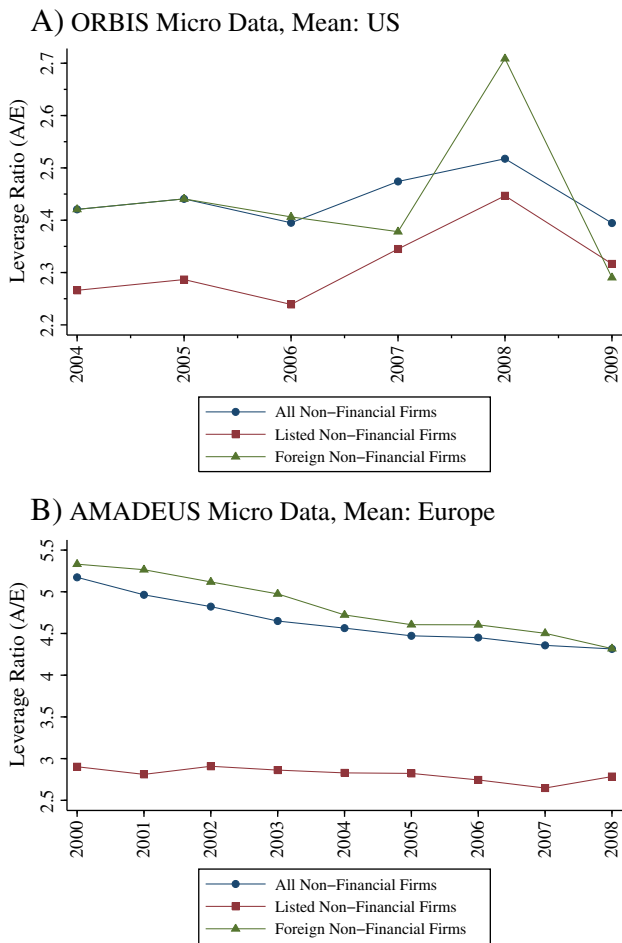


Fig. 9. Notes: Panels A and B display mean leverage for non-financial firms in US and Europe, respectively. The leverage ratio is defined as total assets over equity. Non-financial firms refer to all firms, excluding financial firms with Primary NACE Rev. 1.1 sector code J (Financial intermediation). Listed non-financial firms are those listed on a stock exchange. Foreign non-financial firms are non-financial firms which are foreign owned, defined as more than 10% of their voting shares owned by a foreign company.

4.3. Non-financial firms

Mean values of leverage for large non-financial firms over time are plotted in Fig. 9.

Mean firm leverage for listed US firms is very stable at around 2.3–2.4 while the leverage ratio is slightly larger for non-listed firms but still much lower than for banks. This pattern is consistent with firms hoarding cash in 2009; for example, Almeida et al., 2004 discuss how constrained firms may be more likely to conserve cash in a recession drawing on their bank lines of credit. For Europe, we see slightly higher leverage ratios, which may be due to differences in accounting rules, but the temporal patterns are similar to those of the US with very little variation over time except that we find a weak but steady decline in leverage for all (mainly non-listed) firms. The great recession does not register at all for European non-financial firms. Non-financial firms showed no inkling of procyclicality and very little systematic growth of leverage. We do not show these results for space issues.

4.4. Regression analysis

From the previous section, it appears that leverage at the bank and firm level did not signal an impending recession. In this section, we

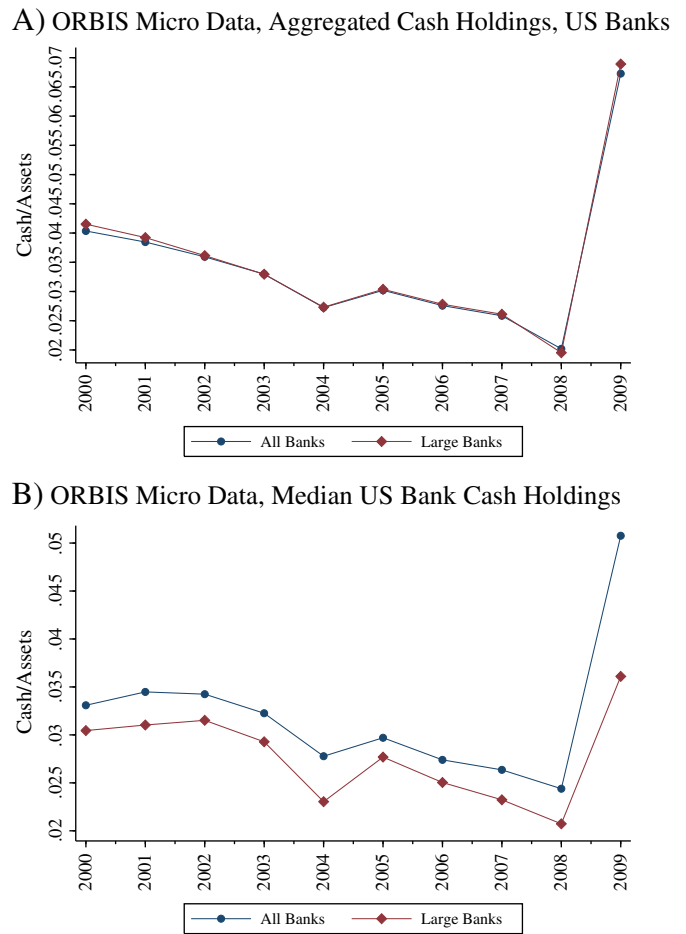


Fig. 10. Notes: Panel A displays cash holdings as a ratio of assets for all banks in the US, as well as for large banks, aggregated from bank-level data. Panel B displays the median of the cash holdings ratio for all banks and large banks. A “large bank” has more than one billion dollars worth of assets in 2000.

examine if leverage patterns differed between countries with looser or stricter regulation.

We estimate the relation

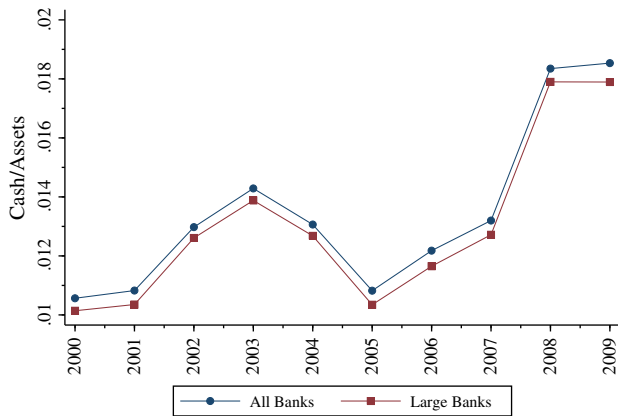
$$\text{Leverage}_{it} = \mu_i + \sum_t \gamma_t D_t + \sum_t \beta_t D_t * X_{c(i)},$$

where the left-hand side is firm-level leverage, μ_i indicates firm-level dummies (“fixed effects”), D_t is a set of time dummies (with 2000 left out to avoid collinearity), and $X_{c(i)}$ is one of the regulatory variables that captures intensity of bank regulation in country c in which bank i is located.¹⁵ The bank-level dummies capture any constant bank-level (and therefore also country-level) variables and the non-interacted time dummies capture worldwide impacts in each year. The objects of interest are the β_t coefficients which show whether countries with particular regulatory environments experience different temporal patterns in leverage.

The temporal patterns in Table 4 are revealing: the time-dummy interaction terms are in general not significant for 2001 to 2008 (meaning these years are similar to 2000) except for the Monitoring Index (for all banks) for which leverage is lower during 2001–2008

¹⁵ In a previous version, we controlled for size (log assets), profitability, and collateral because these were found by Gropp and Heider (2010) to be predictors of bank leverage but because those variables may be endogenous, we include only the variables of interest in this version, including bank fixed effects to account for unobserved bank heterogeneity.

A) ORBIS Micro Data, Aggregate Cash Holdings, European Banks



B) ORBIS Micro Data, Median European Bank Cash Holdings

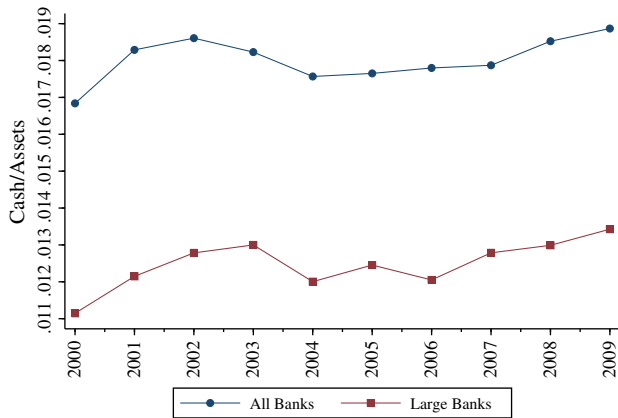


Fig. 11. Notes: Panel A displays cash holdings as a ratio of total assets for all banks in Europe, as well as for large banks, aggregated from bank-level data. Panel B displays the median of cash holdings of all banks as well as of large banks. A “large bank” has more than one billion dollars worth of assets in 2000.

than 2000 in countries where these variables are higher (meaning stricter regulation). More interesting is the result that more restrictive regulation is associated with a relatively higher leverage in 2009.¹⁶ We interpret this in the light of the time series patterns observed in the figures. Banks with high leverage and relatively risky assets displayed strongly declining leverage after 2008 when assets were written down. As discussed previously, standard leverage measures did not flag that the assets on many banks’ balance sheets were questionable—this only became apparent when assets lost significant value in 2008 and 2009. If a restrictive regulatory environment helped banks stay on a straight and narrow path in terms of asset quality, this should be visible only when the banks in lightly regulated countries were deleveraging during the crisis. The positive coefficient associated with strict regulation implies that countries with strict regulation deleveraged less which we interpret to mean that banks in those countries on average held higher quality assets and/or avoided risk exposure through guarantees to off-balance sheet entities. The coefficient to, say, Supervision Index of 0.291 implies that a change from less restrictive to more restrictive leads to a change in the leverage ratio of about 0.3. If the initial leverage ratio was 0.9 the new

¹⁶ At the time of this writing, the data set is not complete for 2009 where our sample is significantly smaller than in the other years, so the results are subject to this caveat.

leverage predicted ratio is 1.2—a rather substantial increase in leverage. Or rather, substantially less deleveraging because all results are relative. The implication is that the underlying problems in asset quality and, therefore, the vulnerability of the real economy may be significantly impacted by regulatory constraint.

5. Robustness and other issues

5.1. Other determinants of leverage: banks and firms

What about the role of cash holdings? Figs. 10 and 11 display median and aggregate cash holdings of US banks and European banks, respectively. For the US, cash holdings increased slower than aggregate assets before the crisis but this would not have signalled an increase in risk taking. The US data displays a highly pronounced spike in 2009 which reflects the breakdown of interbank lending during the crisis when the interbank lending market froze as banks’ feared that counter-parties might be in danger of failure. The banks, therefore, held assets on their books leading to the spike in cash while the Federal Reserve lent directly to banks needing short-term financing.¹⁷ For Europe, the picture is one of steadily increasing cash holdings, roughly mirroring the increase in assets.

We performed firm-level regressions for non-financial firms but there was no visible increase or decrease in leverage of the non-financial firms before and/or after the crisis. We have checked whether this can be explained by firms’ cash holdings but cash holdings do not display significant time variation. These results are available upon request.

5.2. The role of conduits

Acharya et al. (2010) show that commercial banks set up conduits to securitize assets—specifically Asset Backed Commercial Paper (ABCP)—without transferring risk to outside investors. These conduits were designed to avoid capital requirements and commercial banks facing more stringent capital requirements were more likely to set up conduits with guarantees implying that risk was not transferred outside of the banking system.

Conduits are independent shell companies sponsored by large financial institutions. Acharya et al. (2010) use a hand-collected data set on the universe of conduits from January 2001 to December 2008 and their sponsors. They show that almost all conduits have credit guarantees issued by large financial institutions. We do not have these conduits in our data but we have the sponsors. The data on guarantees and committed credit lines displayed previously include the credit guarantees to conduits because these are explicit commitments of the sponsor banks. Acharya et al. (2010) report that investors in conduits only lost 1.7% of their investments in ABCP because guarantees were called and the assets were liquidated and losses absorbed by the sponsoring banks. Our figures are consistent with this fact. Thus, it is clear that much of the deleveraging process is closely linked to these conduits and their sponsor banks.

Did banks with conduits have different leverage? Most conduit sponsor banks are large commercial banks: only 3 out of 62 sponsors in our data are investment banks. In order to investigate if sponsor banks had different leverage on their balance sheets, we plotted all our figures dropping all conduit sponsor banks from our permanent sample. This had very little effect on the figures which therefore are not reported.

¹⁷ In order to limit any potential inflationary impact of the large cash holdings the Federal Reserve, for the first time in its history, began paying interest on reserves in October 2008. In effect, the Federal Reserve acts as an intermediary between banks with excess funds and banks wishing to lend. This mechanism is explained in detail in Keister and McAndrews (2009).

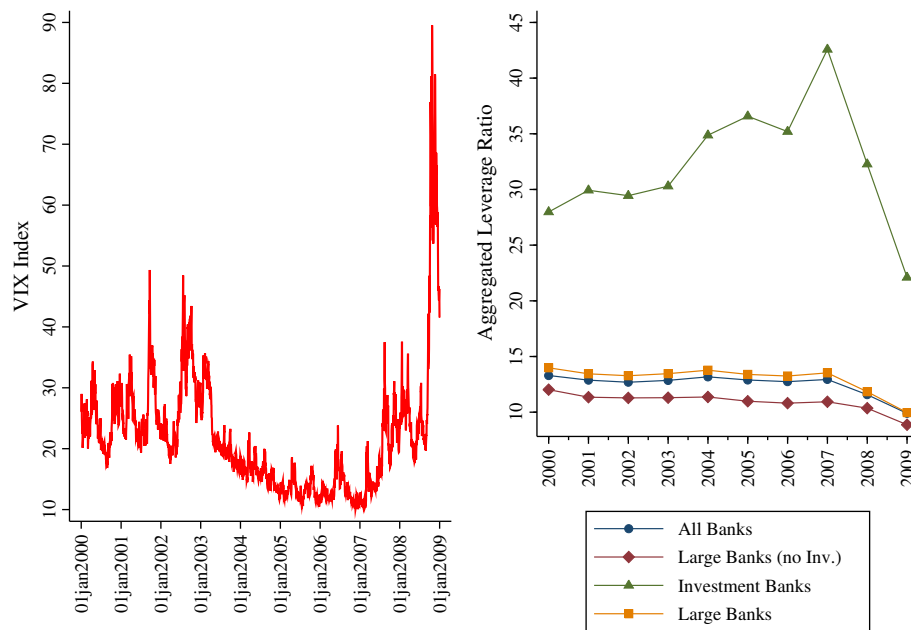


Fig. 12. Notes: The figure shows the US VIX index and aggregated US leverage. The VIX index is the Chicago Board Options Exchange Market Volatility Index which measures the implied volatility of S&P 500 index options. A high value corresponds to a more volatile market. Daily VIX data is obtained from the website of the Chicago Board Options Exchange (<http://www.cboe.com/micro/vix>). The leverage figure repeats Panel B of Fig. 4.

Table 4
Bank Leverage: 2000–2009, World Sample.

Dependent Variable:	Bank Leverage		
	(1)	(2)	(3)
Bank Sample	All	All	Large
Regulatory/Institutional (R/I) Framework	Supervision Index	Monitoring Index	Monitoring Index
2001 × R/I Framework	0.012** (0.005)	−0.005* (0.003)	−0.007 (0.005)
2002 × R/I Framework	0.006 (0.006)	−0.011*** (0.003)	−0.006 (0.006)
2003 × R/I Framework	−0.010 (0.007)	−0.014*** (0.004)	0.001 (0.006)
2004 × R/I Framework	−0.003 (0.007)	−0.011*** (0.004)	−0.002 (0.007)
2005 × R/I Framework	−0.013* (0.008)	−0.011** (0.004)	−0.009 (0.009)
2006 × R/I Framework	−0.048*** (0.009)	−0.021*** (0.005)	−0.017 (0.011)
2007 × R/I Framework	−0.054*** (0.009)	−0.024*** (0.005)	−0.016 (0.011)
2008 × R/I Framework	−0.011 (0.01)	−0.009 (0.007)	0.007 (0.012)
2009 × R/I Framework	0.291*** (0.056)	0.140*** (0.051)	0.073*** (0.019)
Bank dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
R ²	0.008	0.008	0.015
N	172344	136360	22116

Notes: Leverage is the logarithm of total assets over equity. Standard errors in parentheses, clustered at the bank level. The main regressors are country-level variables that capture the regulatory and institutional framework (the exact variable name is given in each column's heading), interacted with time dummies. Column (3) limits the sample to large banks with more than a billion dollars in assets in 2000. All regression variables are winsorized at 2% and 98%. 2000 is the omitted year. Supervision index measures the efficiency of supervision and takes a value of 1 if there are multiple independent supervisors for banks and zero otherwise. Monitoring index measures the efficiency of monitoring and takes a value of 1 if top ten banks in the country are all rated by international rating agencies, if off-balance sheet items are disclosed to public, if banks must disclose risk management procedures to the public, and if subordinated debt is required as part of regulatory capital. This index is zero otherwise. These variables are from the Barth, Caprio, and Levine (2010), Bank Regulation and Supervision Data Set. See Table 1 for the set of countries in the world sample.

5.3. The role of mergers and government

During the crisis, several large commercial banks acquired investment banks, notably JP Morgan's takeover of Bear Stearns in 2008 and Bank of America's takeover of Merrill Lynch in January 2009. We do not control for these mergers which took place mid to end of 2008/ beginning of 2009. It is most likely the case that the mergers will not cause an immediate increase in the assets of the commercial bank but over time, as the securities held by the acquired banks are transferred, we should see a rise in the assets of the commercial bank. Thus, this is a potentially important issue if we want to trace changes in leverage and assets through the end of 2010 since Bank of America's and JP Morgan's assets may increase as a result of the acquisitions. The same issue may affect the acquired banks but He, Khang, and Krishnamurthy (2010) do not observe any change in Merrill Lynch's asset holdings in the first quarter of 2009. Other investment banks were not acquired but ceased to be investment banks and converted into bank holding companies, in particular Goldman Sachs and Morgan Stanley but even after being converted into holding company status, the commercial banking operations represent a very small fraction of the business of these banks.

The government played a very active role in recapitalizing banks. He, Khang, and Krishnamurthy (2010) suggest that the preferred stock owned by the government must be subtracted from equity in calculating "true leverage." They find, using data from the Federal Deposit Insurance Corporation, that such a correction raises the leverage of the top 19 commercial banks in the US from 10.0 to 14.4 in the first quarter of 2009. They further argue that "true leverage" may have been as high as 30 if assets were marked to market. While they were able to roughly impute the fall in the value of banks' asset during the peak of the crises for the commercial banking sector as a whole and for some major banks, it is not easy to do so systematically bank-by-bank over our sample and hence we do not perform such an exercise. We also do not perform an adjustment on the government owned stock because if the purpose of measuring leverage is to gauge the riskiness of banks, surely government owned preferred equity helps buffer risk. We report asset and equity holdings and leverage of big investment and commercial banks from the US and Europe in Table 5. Our numbers match He, Khang, and Krishnamurthy (2010) for investment banks but for commercial

Table 5
Leverage of Very Large Banks.

	(2007)			(2008)		
	Assets	Equity	Leverage	Assets	Equity	Leverage
Bank of America	1616	138.3	11.7	1648.9	160.6	10.3
Bear Stearns	372.4	11.1	33.5	N.A.	N.A.	N.A.
Citigroup	2060.5	112	18.4	1758.2	130.6	13.5
Goldman Sachs	1054.7	47.2	22.4	802.3	59.9	13.4
JP Morgan	1471.4	116.9	12.6	1972.8	152.4	12.9
Lehman Brothers	650.9	21.2	30.7	N.A.	N.A.	N.A.
Merrill Lynch	960.8	30.1	31.9	605.5	18.1	33.4
Morgan Stanley	984.7	29.5	33.4	597.6	46.1	13
Wells Fargo	542	45.1	12	1187.9	92.8	12.8
BNP Paribas	2052.4	71.9	28.5	2445.3	69.5	35.2
Barclays	2073.8	54.1	38.3	3335.7	77	43.3
Deutsche Bank	2315.9	47.3	49	N.A.	N.A.	N.A.
Fortis Bank	331.3	27.3	12.1	N.A.	N.A.	N.A.
RBS	3211.1	154.5	20.8	3051.3	76.8	39.7
UBS	1787.7	34.4	51.9	1545.8	31.1	49.7

Notes: Leverage is defined as the ratio of total assets to equity. Total assets are composed of tangible and intangible assets. Equity is measured as shareholder funds. All non-ratio items are in billion 2005 dollars.

banks we find a smaller increase in 2008 because we do not adjust for government owned equity. A final difference is that they focus on subsidiaries and, most likely unconsolidated statements, since they drop holding companies. (One has to use either consolidated or the non-consolidated statements in order to avoid double counting.) In our empirical analysis, we use unconsolidated accounts for non-investment (commercial) banks and for investment banks we use consolidated accounts throughout because these banks only report consolidated statements. For the purpose of Table 5, we use consolidated statements and include holding companies for both commercial and investment banks in order to make a meaningful comparison between the two groups.

6. Conclusion

Traditional leverage ratios and off-balance sheet exposure did not signal high levels of risk taking by commercial banks the US and other countries before the sub-prime financial crises. However, investment banks in the US and large European banks with investment banking arms aggressively increased leverage, especially after the SEC 2004 de-regulation in the US.

Our results are not informative about whether banks knowingly took high risk. Nonetheless, when the crisis broke in 2007–2008, the banks in countries with large exposure to sub-prime assets suffered large declines in assets. There was little relation between leverage and restrictiveness of regulation across countries before 2008 but the countries with stricter bank regulation were less affected by the crises implying that regulation may well have benefits even if these benefits are invisible until the economy faces a major stress event.

Appendix A. Data Appendix

We use permanent and non-permanent samples both for banks and firms. The non-permanent samples are used in regression analysis and in the investigation of cross-sectional patterns. The permanent samples are used for time-series plots.

A.1. Bank Selection Criteria

The data is from BANKSCOPE for the period 1990–2010. We exclude the first 6 years and the last year because of poor coverage. We apply

the following sample selection criteria to obtain the samples used in the regression analysis:

- We drop central banks.
- We drop banks with faulty records such as inconsistent information on any generic variables: date of establishment/type of company/template etc.
- We drop bank-year observations with negative values of assets/capital/reserves or deposits.

In addition to the criteria mentioned, we drop banks that do not report total assets continuously for 2000–2009. The sample of European banks has 1123 banks with 11,230 observations while the sample of US banks has 7334 banks with 73,340 observations—both for the period 2000–2009.

For other countries, in addition to above selection criteria:

- We drop countries with less than 20 banks in non-permanent sample.

The final sample has 9437 banks with 85,383 observations for the period 2000–2008.

A.2. Firm Selection Criteria

The time period covered in firm-level data downloaded from the ORBIS and AMADEUS databases is 1996–2010, however we exclude the last year because of poor coverage.

- We drop firms with faulty records and firms with inconsistent information on any generic variables such as date of establishment/type of company/template etc.
- We drop firm-year observations with negative values of all types of assets/capital/reserves and deposits.

The following sample selection criteria are applied to obtain the final samples used in the regression analysis:

- We drop firms if any of total assets, current liabilities, and non-current liabilities is missing in all years between 1996 and 2009.
- We drop firms if any of total assets, employment, sales, operating revenue, current liabilities, and non-current liabilities is negative.
- We drop firms if total assets are less than 100,000 in PPP dollars.
- We drop firms if sales are less than 1000 in PPP dollars.
- We drop firms if operating revenue are less than 1000 in PPP dollars.
- We drop firm-year observations beyond the 0.1% and 99.9% tails of ratios employment/sales, sales/total assets, operating revenue/total assets, and shareholders' funds/total assets
- In the data that covers European firms, we drop countries having less than 100 firms for at least 6 years between 1996 and 2009.
- We drop firm-year observations beyond the 0.1% and 99.9% tails of all leverage measures.
- We drop firm-year observations beyond the 0.1% and 99.9% tails for collateral variable defined as total fixed assets/total assets.
- We drop firm-year observations beyond the 0.1% and 99.9% tails for all profitability measures.

The resulting samples consist of 54,108 firms with 152,124 observations and 234,380 firms with 1,495,671 observations for the US firm-level sample and the European firm-level sample, respectively.

A.3. Bank-Level Variables

Total Assets: Total book value of intangible, tangible, and other fixed assets.

Shareholder's Funds: Book value of equity (issued share capital plus other shareholders fund)

Off-Balance Sheet Items: In the financial statement of banks, off-balance sheet volumes are listed in three summary lines of acceptances, documentary credits, and guarantees.

Guarantees : Total amount guaranteed by the bank.

Acceptances (reported off-balance sheet): Total amounts the bank "accepts" to pay, usually under international trade finance arrangements where reported off-balance sheet.

Committed credit lines: Total committed and undrawn lines of credit extended by the bank.

Adjusted Assets: Book value of total assets excluding goodwill and intangibles.

A.4. Firm-Level Variables

Total Assets: Total book value of intangible, tangible, and other fixed assets.

Shareholder's Funds: Book value of equity (issued share capital plus other shareholder funds).

Total Liabilities: Total book value of current and non-current liabilities. Current liabilities comprises "Loans," "Creditors," and "Other

Appendix Table 1

International Comparison of Leverage Ratios: Descriptive Statistics.

Panel A: US & European Banks													
	2006			2007			2008			2009			2006–2009
	Aggregated	Mean	Median	Aggregated	Mean	Median	Aggregated	Mean	Median	Aggregated	Mean	Median	N
US	12.7	10.2	10.2	12.9	10	10	11.6	10.2	10.2	9.9	10.7	10.2	7372
Austria	20.5	71.1	16.2	19	60.3	16.3	20.1	63.2	15.4	19.4	50.9	16.9	49
Belgium	15.1	14.3	15.3	12.1	12.2	14	12.6	12.5	12.9	13.2	12.7	12.5	3
Bulgaria	7.9	7.9	7.7	8.4	9.8	8.8	7.4	9.6	9.4	6.1	8.4	7.8	6
Croatia	7.2	9.2	9.9	7.2	9	10.2	6.4	7.6	8.1	6.1	7.1	7.6	6
Cyprus	19.8	19.8	19.8	16.1	16.1	16.1	15.2	15.2	15.2	15	15.3	15.3	2
Czech Republic	3.9	3.9	3.9	4	4	4	4.1	4.1	4.1	5.9	5.9	5.9	1
Denmark	16.6	9.8	7.9	17	10.2	8.3	17.9	11.2	8.6	17.8	11.5	9.8	67
Estonia	12.3	13.5	13.5	11.4	12.8	12.8	10.2	12.2	12.3	11.2	16.9	17.1	4
Finland	20.4	56.5	23.4	22.7	81.2	22.6	30.3	327.1	28.2	25.1	58.3	26.1	4
France	20.7	21.7	12.8	23.8	22.3	12.3	24.4	23.5	12.3	21.3	34.2	11.6	173
Germany	30.7	19.7	17.5	31.7	19.5	17.4	35.8	20.4	17.9	28.5	19.2	17.1	471
Hungary	16.7	16.8	13.9	16.8	17.6	15.1	19.3	18.5	17.3	18.9	16.8	15.7	4
Ireland	9.5	99.1	8.1	11.4	69.1	10.4	12.2	47	11.4	7.1	30.1	6.3	5
Latvia	12.6	11.6	11	10.8	11.8	10	10.3	11.9	12.1	9.6	11.5	11.4	9
Lithuania	16.2	16.2	16.2	14.5	14.5	14.5	13.9	13.9	13.9	14.2	14.2	14.2	1
Luxembourg	27	33.7	24.2	25.1	33.3	24.1	25.1	31.7	25.1	20.2	23.2	18.8	29
Netherlands	3.3	11	10.4	3.6	10.9	9	4	14	10.9	3.5	11.1	9.5	5
Romania	9.7	6.3	5.1	11.4	7.5	6.7	9.8	6.2	4.7	9.4	7.7	9.6	3
Russia	7	8.3	8.1	7.3	8	7.9	8.6	9.2	9	7.6	8.3	8.9	23
Sweden	18.1	23.3	18.7	19.2	24.6	13.8	19.7	18.1	16	19.9	24.4	17.9	11
Switzerland	7.7	14.4	10.5	8.2	13.7	10.4	8.8	13.5	10.8	9.2	13.9	11	179
Ukraine	9.3	8.5	8.4	11.4	11.3	11.3	11.9	11.7	12.1	7.6	11.4	7.7	5
United Kingdom	30.4	17.4	15.6	32.3	18	15.5	32.1	16.7	14.5	16.8	12.5	13.4	67

Panel B: Countries in Rest of the World											
	2006			2007			2008			2006–2008	
	Aggregated	Mean	Median	Aggregated	Mean	Median	Aggregated	Mean	Median	N	
Argentina	7.5	6.9	6.7	7.7	7.2	6.5	8.3	7.4	7.2	58	
Azerbaijan	12.5	10.4	11.6	11	10.1	10.6	9.7	8.7	9.2	3	
Bangladesh	33.8	12.3	16.5	18.8	17.6	15	17	16.1	15.5	11	
Brazil	11.6	10	8.8	11.3	10.1	7.7	12.7	10.2	9.1	46	
Canada	20.5	20.5	13.1	21.6	18.9	14.1	21.8	28.2	13.4	39	
China	44.7	30.8	27.9	–21.8	19	18.3	23.7	20.5	20.8	13	
Colombia	7.8	8.5	9.1	8	8.7	9.9	8.3	8.6	9.1	17	
Costa Rica	9	9.8	10.9	9.4	9.6	10	9	9.1	9.2	25	
El Salvador	8.3	7.9	8.3	8.2	8.4	8.7	7.6	8	8.1	13	
Georgia	3.2	3.2	3.2	5.3	5.3	5.3	4.5	4.5	4.5	1	
India	14.8	14.8	15.6	15.6	15.2	15.6	13.6	14.8	15.2	63	
Indonesia	9.4	8.8	9.7	9.6	8.6	9.3	10.6	9.7	10.2	16	
Israel	16.3	17	17.1	15.6	16.3	15.9	16.8	17.6	16.5	7	
Japan	18	35.2	18.8	16.8	19.8	18.2	18.5	25.9	19.9	710	
Kenya	8.9	8.3	8.7	8.5	7.6	7.8	8	7.6	7.4	12	
Korea	14	14.5	14.9	14.1	14.3	15.5	16.4	15.7	16.6	19	
Malaysia	12.7	11	12.7	13	11.6	13	12.6	10.8	13.1	31	
Mexico	7.7	8	8.5	7.5	8.5	8.5	10.8	13.3	13.4	15	
Norway	6.6	10.7	9.4	7.9	11.4	9.9	8.8	11.8	10.7	10	
Paraguay	7.9	8	7.9	9	9.3	9.2	8.9	9.3	8.9	12	
Peru	10.2	10.1	10.3	11.5	10.9	11.9	12.6	12.4	11.8	13	
Slovakia	12.2	18.3	16.2	13.3	17.3	15.8	13.5	19.6	14.1	3	
Slovenia	11.8	12.1	12.5	12.2	11.4	11.2	12.5	11.8	11.8	4	
Thailand	11.5	13.5	10.8	10.6	27.2	10.1	10.8	13.1	10.8	24	
Turkey	9.3	10.7	8.9	8.2	9.3	7.8	8.6	8.7	8.7	11	
Uruguay	2.4	2.4	2.4	3.1	3.1	3.1	5.3	5.3	5.3	1	
Venezuela	11.8	11.5	11.5	11.3	11.8	11.9	11.1	11.5	11.2	8	

Notes: Aggregate, mean, and median leverage ratios and number of banks in the sample are reported by country. Leverage is calculated as total assets over equity where total assets is defined as total book value of intangible, tangible, and other fixed assets. Aggregate leverage is calculated as aggregated assets over aggregated equity, with bank-level observations aggregated by the authors. The number of banks reported are lower than the number of banks used in the regression analysis because they refer to the permanent bank sample, defined as banks with non-missing asset data throughout the sample period.

Current Liabilities." Non-current liabilities comprises "Long Term Financial Debt," "Provisions," and "Other Long Term Liabilities."

A.5. Country-Level Data

We use the Barth, Caprio, and Levine data set on Bank Regulation. It provides information on bank regulation and supervisory practice for 107 countries and provides aggregate indexes based on responses to a survey.¹⁸ We use the 2003 values of the following variables: 1) "Supervision Index," which measures the efficiency of supervision and takes a value of 1 if there are multiple independent supervisors for banks and zero otherwise and 2) "Monitoring Index," which measures the efficiency of monitoring and takes a value of 1 if the top ten banks in the country are all rated by international rating agencies, if off-balance sheet items are disclosed to the public, if banks must disclose risk management procedures to the public, and if subordinated debt is required as part of regulatory capital and zero otherwise.

References

- Acharya, V.V., Schnabl, P., 2009. How Banks Played the Leverage 'Game'. chapter 2 In: Acharya, V.V., Richardson, M. (Eds.), *Restoring Financial Stability: How to Repair a Failed System*. John Wiley & Sons, New York, pp. 83–100.
- Acharya, V.V., Schnabl, P., Suarez, G., 2010. Securitization without Risk Transfer. NBER working paper no. 15730.
- Adrian, T., Shin, H., 2008. Financial Intermediary Leverage and Value-at-Risk. Federal Reserve Bank of New York Staff Reports no. 338.
- Adrian, T., Shin, H., 2009. Money, Liquidity, and Monetary Policy. *American Economic Review* 99, 600–605.
- Adrian, T., Shin, H., 2010. Liquidity and Leverage. *Journal of Financial Intermediation* 19, 418–437.
- Allen, F., Carletti, E., Marquez, R., forthcoming. Credit Market Competition and Capital Regulation. *Review of Financial Studies*.
- Almeida, H., Campello, M., Weisbach, M., 2004. The Cash Flow Sensitivity of Cash. *Journal of Finance* 59, 1777–1804.
- Arellano, C., Bai, Y., 2010. Financial Markets and Fluctuations in Uncertainty. Federal Reserve Bank of Minneapolis Research Department Staff Report.
- Barth, J., Caprio, G., Levine, R., 2007. Bank Regulation and Supervision (updated data set). working paper series no. 2588. World Bank.
- Beltratti, A., Stulz, R.M., 2011. The Credit Crises Around the Globe: Why Did Some Banks Perform Better? Fisher College of Business. working paper no. 2010–05.
- Berger, A., Klapper, L.F., Turk-Ariss, R., 2008. Bank Competition and Financial Stability. World Bank working paper no. 4696.
- Bernanke, B.S., Gertler, M., 1995. Inside the Black Box: The Credit Channel of Monetary Policy Transmission. *Journal of Economic Perspectives* 9, 27–48.
- Black, S., Strahan, E., 2002. Entrepreneurship and Bank Credit Availability. *Journal of Finance* 57, 2807–2833.
- Blundell-Wignall, A., Atkinson, P., 2010. Thinking Beyond Basel III: Necessary Solutions for Capital and Liquidity. *OECD Journal: Financial Market Trends*.
- Booth, L., Aivazian, V., Demirgüç-Kunt, A., Maksimovic, V., 2001. Capital Structures in Developing Countries. *Journal of Finance* 56, 87–130.
- Brunnermeier, M., 2009. Deciphering the 2007/8 Liquidity and Credit Crunch. *Journal of Economic Perspectives* 23, 77–100.
- Brunnermeier, M., Pedersen, L., 2009. Market Liquidity and Funding Liquidity. *Review of Financial Studies* 22, 2201–2238.
- Claessens, S., Laeven, L., 2004. What Drives Bank Competition? Some International Evidence. *Journal of Money, Credit, and Banking* 36, 563–583.
- Coricelli, F., Driffield, N., Pal, S., Roland, I., 2009. Excess Leverage and Productivity Growth in Emerging Economies: Is There a Threshold Effect? CEPR discussion paper no. 7617.
- Diamond, D., Rajan, R., 2000. A Theory of Bank Capital. *Journal of Finance* 55, 2431–2465.
- Duffie, D., 2010. The Failure Mechanics of Dealer Banks. *Journal of Economic Perspectives* 24, 51–72.
- Farhi, E., Tirole, J., 2010. Bubbly Liquidity. NBER working paper no. 16750.
- Flannery, M., 1994. Debt Maturity and the Deadweight Cost of Leverage: Optimally Financing Banking Firms. *American Economic Review* 84, 320–331.
- Flannery, M., Sorescu, M., 1996. Evidence of Bank Market Discipline in Subordinated Debenture Yields: 1983–1991. *Journal of Finance* 51, 1347–1377.
- Flannery, M., Rangan, K., 2008. What Caused the Bank Capital Build-Up of the 1990s? *Review of Finance* 12, 391–429.
- Fons-Rosen, C., Kalemli-Ozcan, S., Sørensen, B.E., Villegas-Sanchez, C., Volosovych, V., 2011. Productivity versus Competition Effects of Foreign Investment Within and Across Countries. University of Houston working paper.
- Fostel, A., Geanakoplos, J., 2008. Leverage Cycles and the Anxious Economy. *American Economic Review* 98, 1211–1244.
- Frank, M., Goyal, V., 2004. Capital structure decisions: Which factors are reliably important? *Financial Management* 38, 1–37.
- Greenlaw, D., Hatzius, J., Kashyap, A., Shin, H., 2008. Leveraged Losses: Lessons from the Mortgage Market Meltdown. U.S. Monetary Policy Forum report no. 2.
- Gropp, R., Heider, F., 2010. The Determinants of Bank Capital Structure. *Review of Finance* 14, 587–622.
- He, Z., Khang, I.G., Krishnamurthy, A., 2010. Balance Sheet Adjustment during the 2008 Crisis. *IMF Economic Review* 58, 118–156.
- Kalemli-Ozcan, S., Sørensen, B.E., Volosovych, V., 2010. Deep Financial Integration and Volatility. CEPR discussion paper no. 7784.
- Keister, T., McAndrews, J., 2009. Why Are Banks Holding So Many Excess Reserves? Federal Reserve Bank of New York. Staff Reports no. 380.
- Kiyotaki, N., Moore, J., 1997. Credit Cycles. *Journal of Political Economy* 105, 211–248.
- Krishnamurthy, A., 2010. How Debt Markets Have Malfunctioned in the Crisis. *Journal of Economic Perspectives* 24, 3–28.
- Lemmon, M.L., Roberts, M.R., Zender, J.F., 2008. Back to the Beginning: Persistence and the Cross-Section of Corporate Capital Structure. *Journal of Finance* 63, 1575–1608.
- Myers, S., Rajan, R., 1998. The Paradox of Liquidity. *Quarterly Journal of Economics* 113, 733–771.
- Modigliani, F., Miller, M., 1958. The Cost of Capital, Corporation Finance and the Theory of Investment. *American Economic Review* 48, 261–297.
- Rajan, R., Zingales, L., 1995. What Do We Know About Capital Structure? Some Evidence From International Data. *Journal of Finance* 50, 1421–1460.
- Shleifer, A., Vishny, R.W., 1992. Liquidation Values and Debt Capacity: A Market Equilibrium Approach. *Journal of Finance* 47, 1343–1366.

¹⁸ For the details on the survey questions and data collection process, see Barth, Caprio, and Levine (2007).