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Institut für Volkswirtschaftslehre (ECON)

Bachelor Thesis in Macroeconomics

„US commercial banks“

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(Topic 1)

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1 Introduction

Explorative journey through financial filings of us commercial banks.

Different perspectives: - banking sector as whole (Aggregated) - Median banks

Analysis timeseries and cross section

2 Main part

2.1 Data

Data from http://pages.stern.nyu.edu/~pschnabl/data/data_allreport.htm, originally from FIEC031 Reports. Schneider adjust for variables change and so on

Timeframe: 1976Q1-2013Q4, data per year and quarter for each individual bank

We take our crisis data from the official documentation of the National Bureau of Economic Research(NBER). One can also differentiate between a so called "banking" (originated in the banking sector) vs "market" (originated from outside banking sector) crisis as in Berger and Bouwman (2013). The assumption here is that banking crisis could be reflected stronger in the data. The crisis will be marked on the graphs as red zones. Crisis:

- 1980Q1-1980Q3 early 1980s recession (market crisis)
- 1981Q3-1982Q4 early 1980s recession (market crisis)
- 1990Q3-1991Q2 credit crunch (banking crisis)
- 2001Q2-2001Q4 dotcom bubble (market crisis)
- 2007Q4-2009Q3 financial crisis (banking crisis)

Following the convention of the Federal Reserve Bulletin, banks are allocated by size into following categories:

- 10 largest banks
- large banks (those ranked 11 through 100)
- medium-sized banks (those ranked 101 through 1,000)
- small banks (those ranked 1,001 and higher)

Other important structural events to consider:

- Repeal of Glass-Steagall act

negative equity removed

Investment banks becoming commercial banks in 2009 removed
bank mergers removed by growth of assets above 40%
for risk analysis: commercial banks aggregated to bhcs
Values are in thousands

2.2 Methods

No inflation adjustment

Transformations: Log

Timeseries analysis:

Detrending with HP Filter 1600

Deseasonalize with X11 procedure

Correlation/Autocorrelation

Significance levels: ***: <0.01 **: <0.05 *: <0.1

2.3 General look at us banks

The following two sections divided into assets and liabilities will guide us through the distribution of financial components held by the us commercial banks sector as a whole. We will see what the types and amounts of financial instruments banks are holding and how they evolved over time.

2.3.1 Assets Liabilities

The following section will show some insights about the asset side of the whole us commercial banking sector. We want to describe and analyse how it evolved over time and find anomalies. The typical positions a commercial bank is holding on the asset side of its balance sheet are:

- Cash
- Fed funds sold and securities purchased under agreements to resell (fedfundsrepoassets)
- Securities
 - Treasury
 - Mortage backed security
 - Other

- Loans net¹
- Trading assets
 - Interest rate derivatives
 - Other fixed income
 - Other trading
- Other assets ²

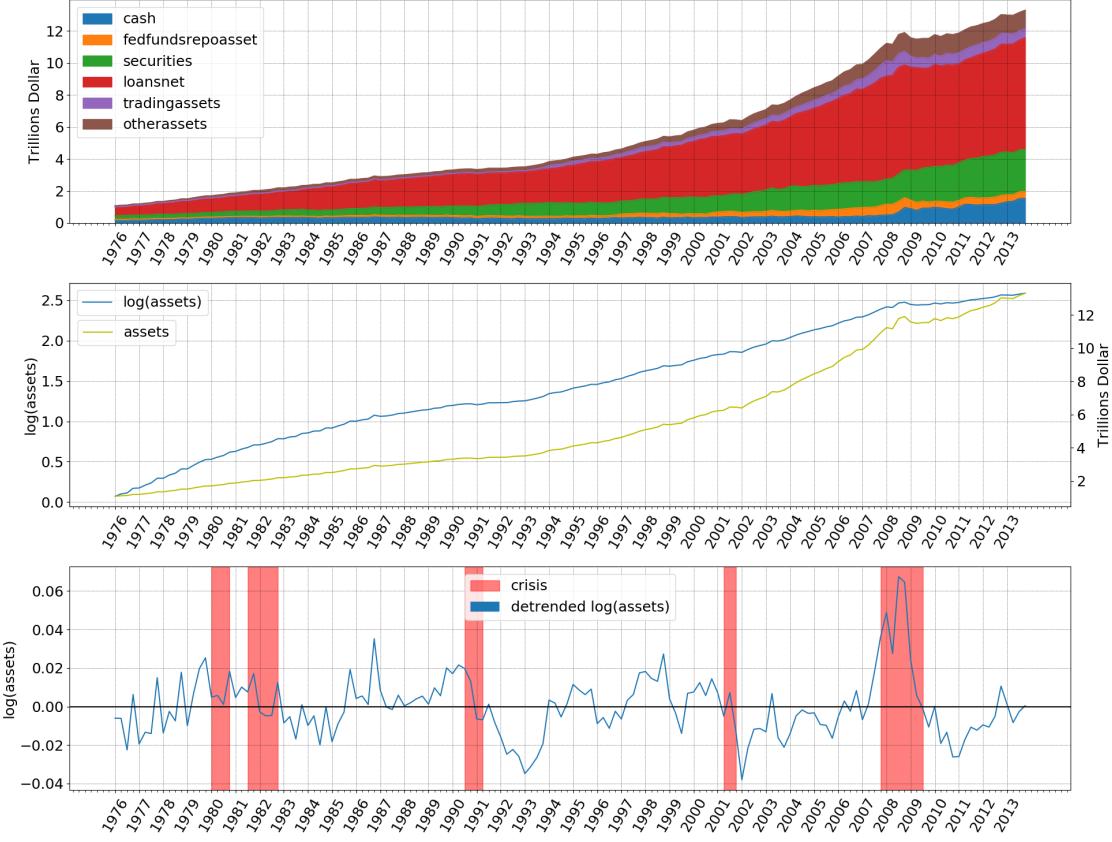
Every position beside the trading assets are hold "not for trading purposes". Meaning for instance the securities position and loans position are not held for trading. Figure 1 gives a general overview how the total assets held by all banks per year and quarter evolved over time. The value of assets rose from below 2 trillion to above 13 trillions dollars of assets. In comparison, the GDP of US in 2013 was at 16.78 trillions. We can also see a period of flatness/low growth from year 1990-1993, a drop in 2002 and 2008/Q2. While the absolute values give us some indications of where anomalies occur, we will perform time-series analysis by decomposing the logarithmised data in trend, cyclical components. As seen within Figure 1, the value of assets has a clear trend with no indication of existing seasonality over the given timeframe. The second graph within Figure 1 compares the development of assets transformed by natural logarithm to the absolute values. Both are drawn within their own vertical axis. While the growth of absolute assets is more exponential over time, the logarithm of assets grows more linear. This linear trend tells us that the relative growth rate stays constant over time. In the third part of Figure 1 we can see the de-trended part of the asset timeseries. Here we can see variations that significantly differ from the trend. As mentioned in the data section the red areas show crisis periods. The alignment of crisis periods with us banks total assets variations is limited. We can see that the impact of the early 1980s recession did not lead to more volatility than other normal periods. The dotcom bubble in 2001 lead to a downward variation of us commercial banks assets away from the trend. In regards to the financial crisis in 2008 we see a huge positive variation with a rapid drop back to the trend. Assuming we have set the most fitting filtering parameters for the HP-Filter, it is interesting to see that the assets did not fall significantly below the trend. The loss was rather caused by an overheated market falling back to normal.

Diving into more detailed analysis of the balance sheet positions, Figure 2 gives us the detrended development of each individual position for both the asset side(left column) and liabilities side(right column) of a balance sheet. The cash position shows some clear spike in 2008, beside then the movements show no clear sign of irregularity. With the

¹Loans and leases net of unearned income and allowance for loan and lease losses

²composed of derivatives "not for trading" and other items

Figure 1: Asset side



background of the 2008 crisis it makes sense that banks liquidated some of their assets to increase cash. The rise in cash comes along with a significant fall in securities. Figure 7 showing the share of the positions further supports our thesis of sold securities to raise cash. While the share of securities fell until 2008, share of cash rose. The position other borrowed money also gets to its highest point in 2008, indicating differences in a banks financing behaviour in crisis. Trading assets follow the same behaviour as total assets in crisis 2008, but its variation in crisis periods do not significantly differ to other periods. We know from 7 that the share of trading assets continuously rose over time. In addition, we can observe a spike of trading assets in the period from 1992-1996. Equity has its lowest downward variation in 2004 Another interesting observation is that some positions show larger fluctuations in more recent times. The volatility of fedfundsrepoasset increased from 1996 onwards and of foreign deposits from 1992 onwards. We also see an interesting contradictory relationship between loans and securities. When securities fall, loans rise and vice versa. Figure 3 confirms this relationship with a negative correlation coefficient of $r = -0.73$ and high significance according to the p-value. The scatter plot in Figure 5 illustrates this negative relationship. As a result, the two asset categories could be seen as substitutes to each other. There is a small positive relationship between fedfundsrepoassets and trading assets. This could indicate that banks lending out excess federal funds or purchasing repurchase agreements are in such a healthy position to be

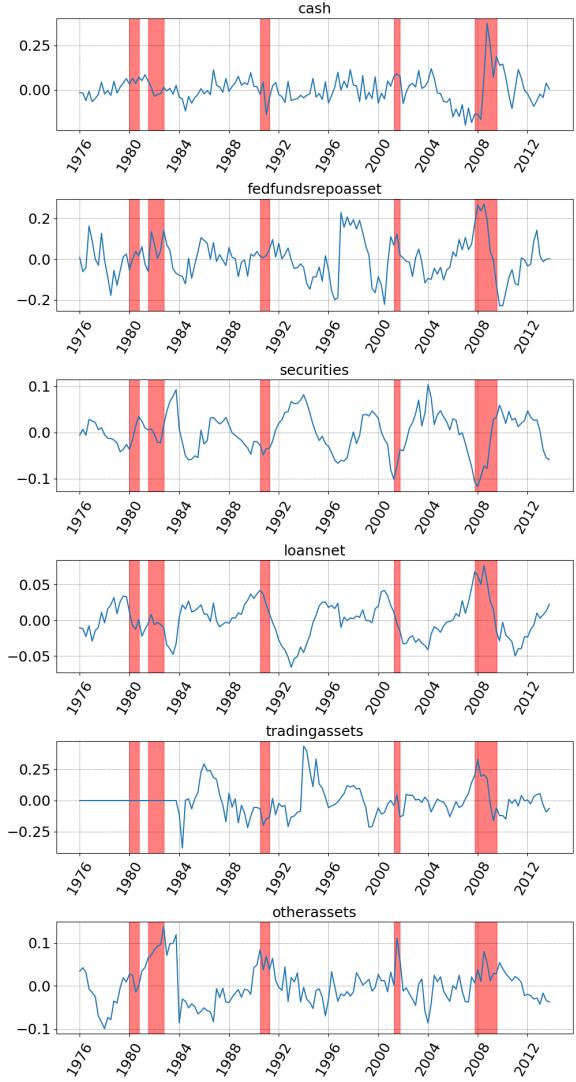
able to increase trading assets as well. The scatterplot of this relationship in Figure 5 confirms a possible linear relationship. Similar positive relationship can be seen between fedfundsrepoassets and loans. However, the scatterplot in Figure 5 does not support a clear relationship. Quite surprising is the slightly negative correlation between domestic deposits and foreign deposits of $r = -0.34$. In addition, there is a positive correlation of $r = 0.37$ between equity and trading assets, indicating that increasing equity leads to increased trading. Another observation is the strong positive relationship between loans and foreign deposits of $r = 0.59$.

Graph description: Figure 1 shows the aggregates of the main variables from the asset side of the balance sheet over time. Figure 2 shows the share of each aggregated balance sheet position of all commercial banks over time. Figure 3 plots the share of each balance sheet position unstacked.

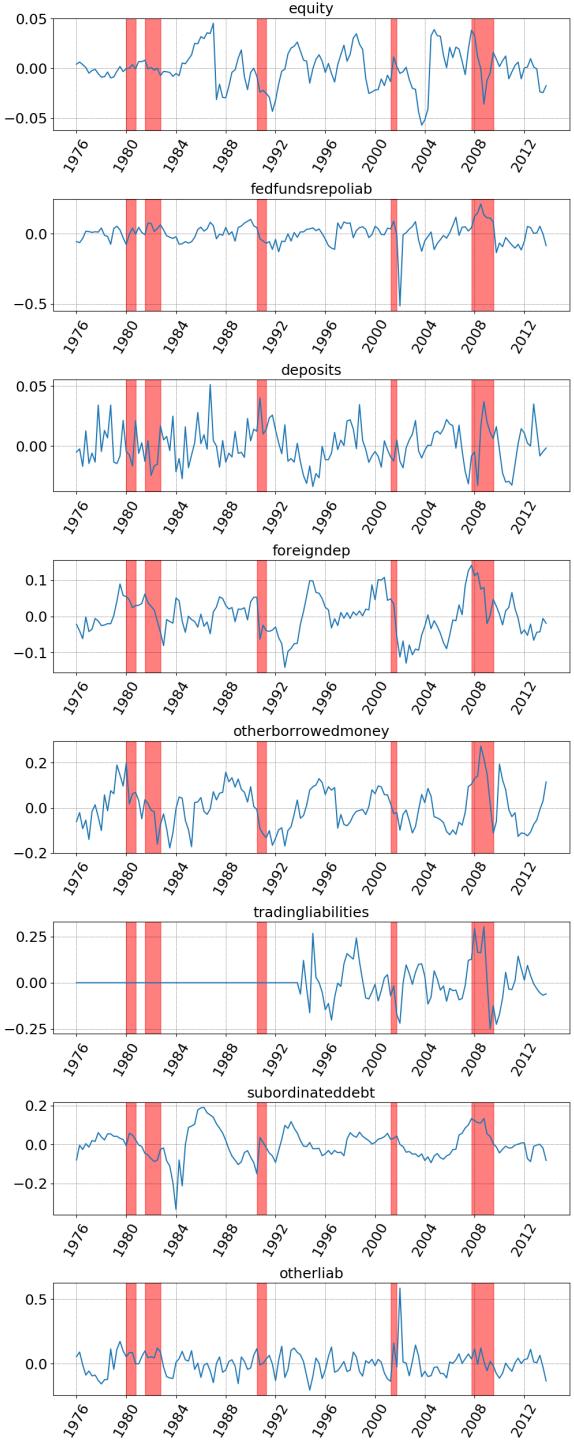
Key Observations:

- loans make up the largest share of assets
- share of trading assets have risen as well as interest rate derivatives
- loans and trading assets have risen more than securities in timeframe year 2000-2009
- Share of trading assets peaked in 2008 while securities fell.
- There is a noticeable anomaly in year 2002. Significant amounts of repo lending is transferred into other assets. Other assets are derivatives not available for sale.
- drop in assets in 2002 and 2008
- share in cash has fallen until 2008 and then increased again
- Share of cash continuously fell until 2008, and then it increased significantly again

Figure 2: Detrended asset positions(left column)



Detrended liability positions(right column)^a



^aData is aggregated in the cross section over all banks, transformed with natural logarithm and detrended with HP-Filter. See details in the data section. Trading assets and liabilities have missing data in the beginning of the time period. The anomaly in year 2002 for other liabilities and fedfundsrepoassets is caused by an accounting change.

Figure 3: Correlation assets^a

	cash	fedfundsrepoasset	securities	loansnet	tradingassets	otherassets
cash	1.0***	-0.07	0.06	-0.01	-0.08	0.1
fedfundsrepoasset	-0.07	1.0***	-0.34***	0.23***	0.34***	0.15*
securities	0.06	-0.34***	1.0***	-0.73***	-0.12	-0.01
loansnet	-0.01	0.23***	-0.73***	1.0***	0.11	-0.06
tradingassets	-0.08	0.34***	-0.12	0.11	1.0***	-0.12
otherassets	0.1	0.15*	-0.01	-0.06	-0.12	1.0***

^aPearson's correlation coefficient based on the detrended data used in Figure 2.

Figure 4: Correlation liabilities^a

	equity	fedfundsrepolab	deposits	foreigndep	otherborrowedmoney	tradingliabilities	subordinateddebt	otherliab
equity	1.0***	0.17**	-0.02	0.04	-0.06	0.12	0.27***	0.07
fedfundsrepolab	0.17**	1.0***	0.06	0.34***	0.23***	0.34***	0.2**	-0.25***
deposits	-0.02	0.06	1.0***	-0.34***	-0.23***	0.04	0.11	-0.12
foreigndep	0.04	0.34***	-0.34***	1.0***	0.59***	0.16**	0.13	-0.03
otherborrowedmoney	-0.06	0.23***	-0.23***	0.59***	1.0***	0.08	0.15*	-0.04
tradingliabilities	0.12	0.34***	0.04	0.16**	0.08	1.0***	0.18**	0.02
subordinateddebt	0.27***	0.2**	0.11	0.13	0.15*	0.18**	1.0***	0.04
otherliab	0.07	-0.25***	-0.12	-0.03	-0.04	0.02	0.04	1.0***

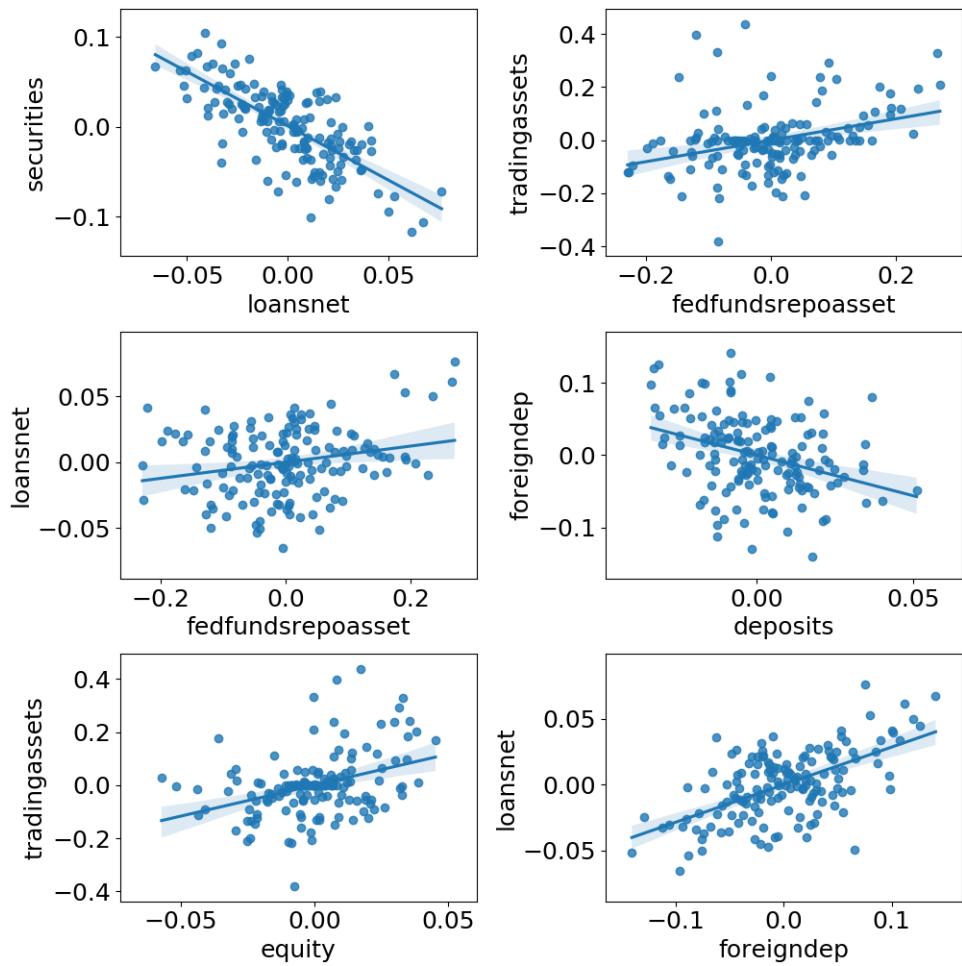
^aPearson's correlation coefficient based on the detrended data used in Figure 2.

Figure 5: Correlation assets with liabilities^a

	equity	fedfundsrepolab	deposits	foreigndep	otherborrowedmoney	tradingliabilities	subordinateddebt	otherliab
cash	-0.25***	0.1	0.38***	0.04	0.28***	-0.03	0.03	-0.18**
fedfundsrepoasset	0.21***	0.46***	0.32***	0.03	-0.12	0.48***	0.3***	0.13
securities	-0.06	-0.15*	0.08	-0.38***	-0.33***	-0.16**	-0.18**	-0.2**
loansnet	0.06	0.38***	0.17**	0.59***	0.54***	0.15*	0.21**	0.07
tradingassets	0.37***	0.33***	-0.09	0.23***	0.14*	0.49***	0.35***	-0.03
otherassets	0.02	0.1	-0.01	0.12	-0.07	0.04	-0.18**	0.29***

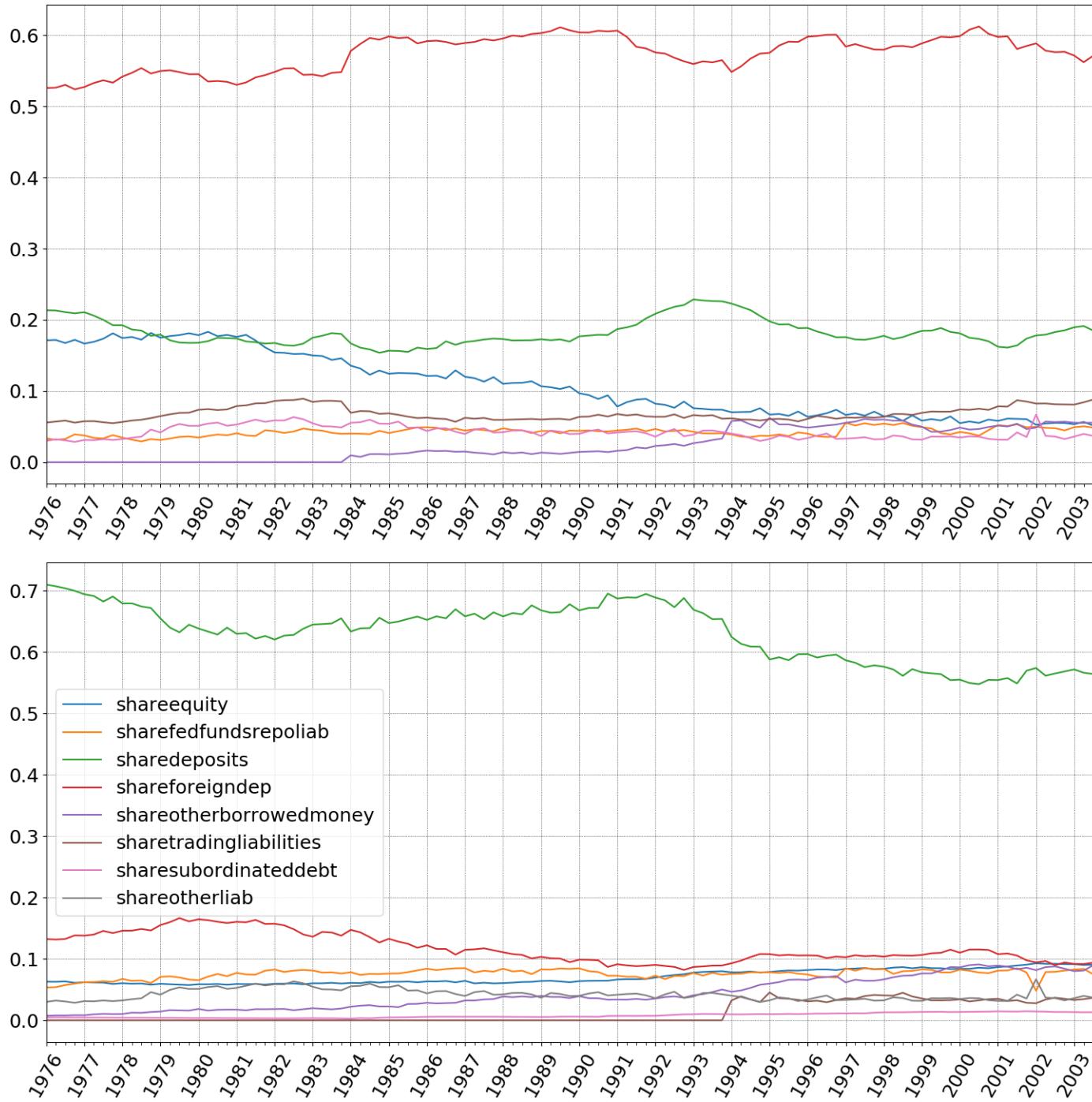
^aPearson's correlation coefficient based on the detrended data used in Figure 2.

Figure 6: Scatterplot for selected positions^a



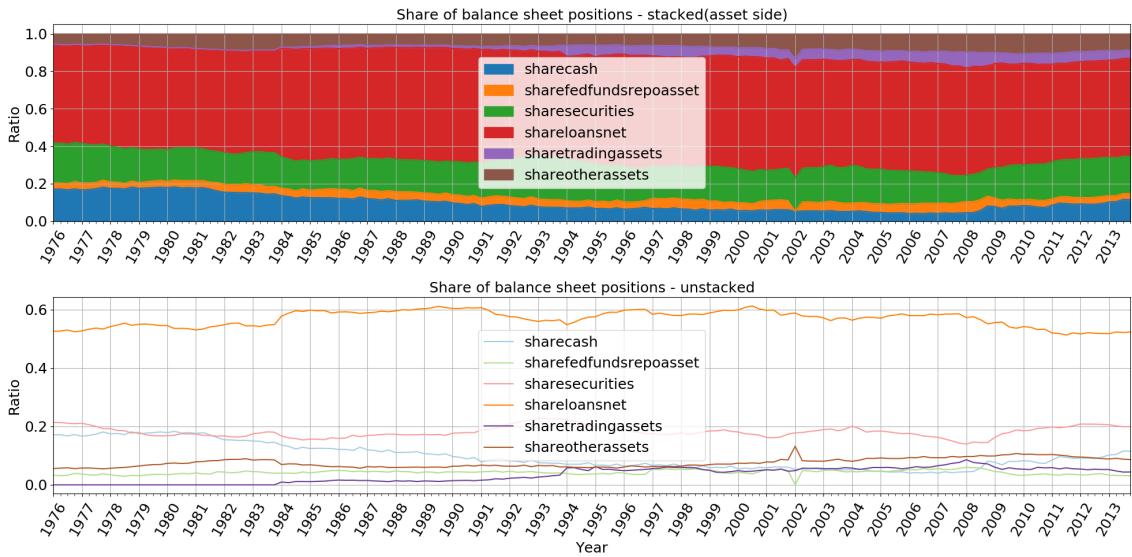
^aLinear regression based on the detrended data used in Figure 2.

Figure 7: Share of balance sheet positions ^a



^a

Figure 8: Share of asset positions - unstacked



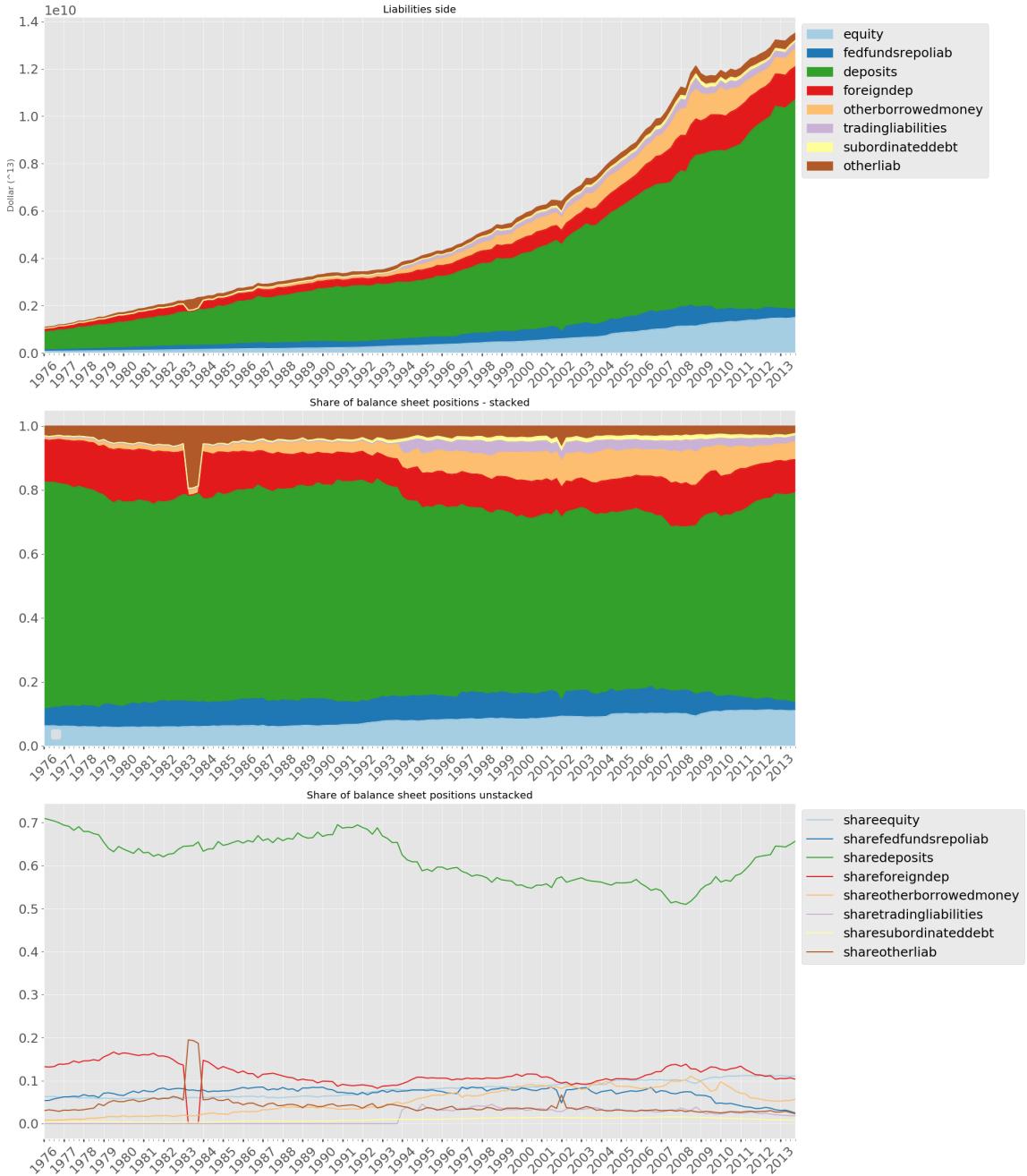
2.3.2 Liabilities

Graph description: The graph shows the aggregates of the main variables from the liabilities side of the balance sheet over time.

Key Observations:

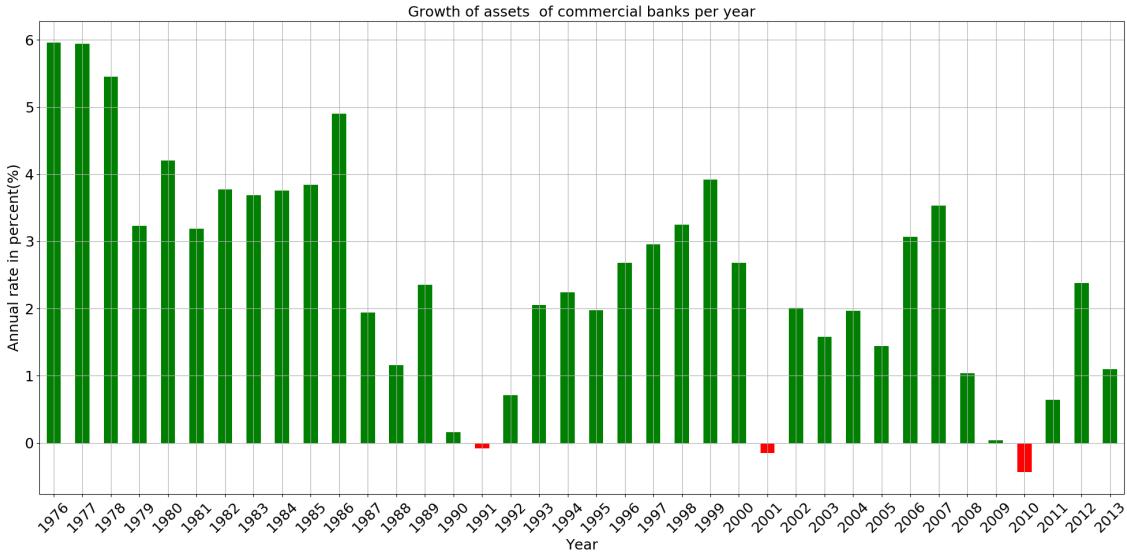
- Deposits as main source of funding
- Irregularities in year 2002: repos drop while other liabilities rise
- Irregularity in year 1983 might be caused by measuring/reporting differences
- In 2008 share of deposits at lowest point. Although the aggregated assets peaked at that time.
- Deposits continuously decreased from 1990 onwards. Other financing such as "Other borrowed money" and "trading liabilities" rose
- repos share decreased significantly until end of 2013

Figure 9: Share of liabilities positions



2.4 Growth

Figure 10: Growth of assets

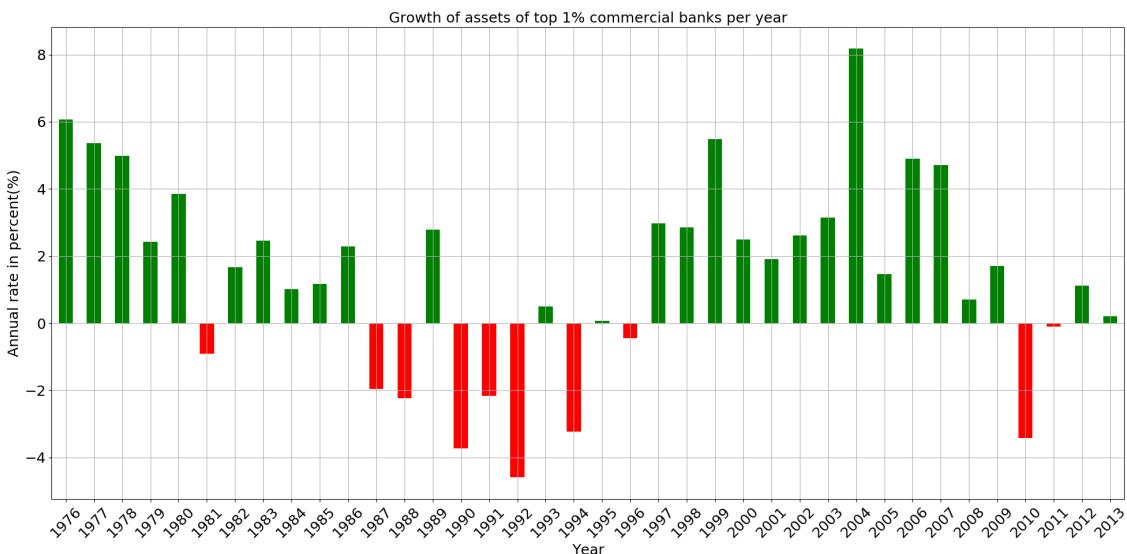


Graph description: The graph shows the annual growth rate of aggregated assets of all commercial banks. Two investment banks, who did become commercial banks in 2009, are excluded.

Key Observations:

- Three negative growth rates in year 1991, 2001, 2010

Figure 11: Growth of top 1 percent banks assets



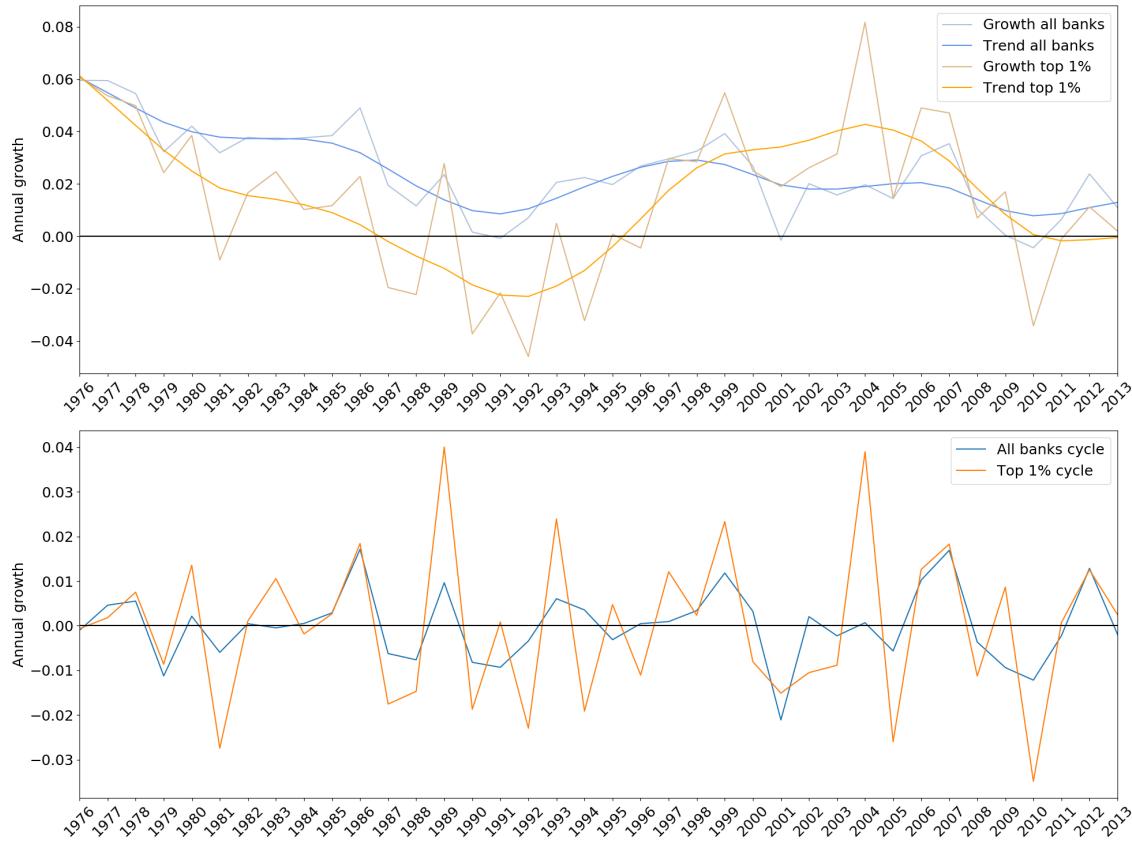
Graph description: The graph shows the annual growth rate of aggregated assets of top 1% commercial banks. Two investment banks, who did become commercial banks in

2009, are excluded.

Key Observations:

- More negative growth rates in 1990 and 2010
- No negative growth in 2001

Figure 12: Growth of all banks vs top 1 percent

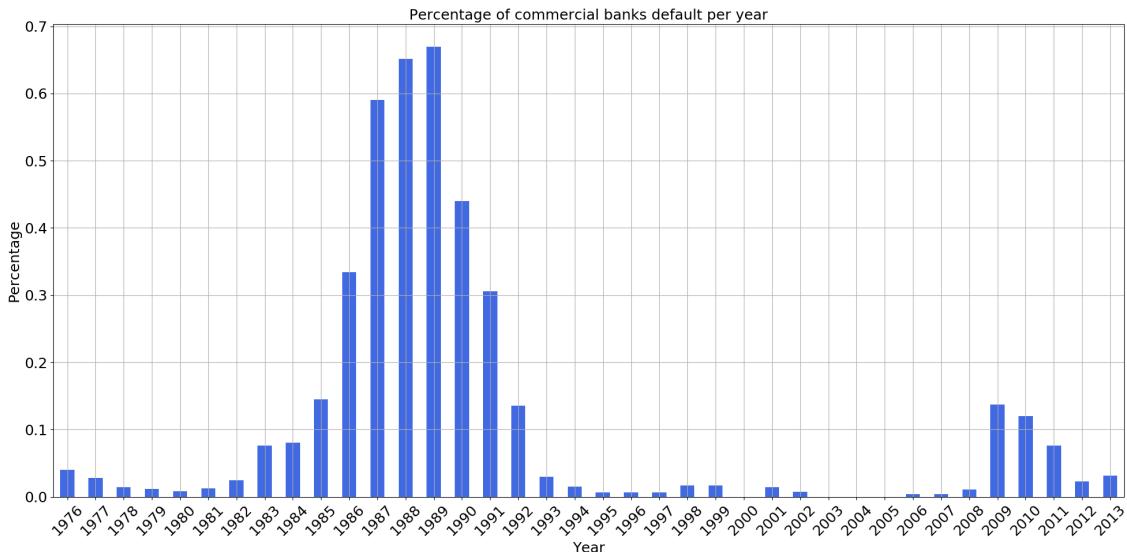


Graph description: Annual growth rate with trend for all banks and top 1%. The second graph shows the cycle part from the time series filter.

Key Observations:

- Top 1% growth rates are more volatile
- Pearson Correlation between all banks vs top 1%, Significance: (0.6371607133788253, 1.696703469447756e-05)
- 1986, 2001, 2006 almost 0,02 difference toward trend

Figure 13: Banks default



Graph description: The graph shows an estimation of how many banks have defaulted at a certain time (year,quarter). It is based on the negative equity recorded by banks. Hence, it is not exact and some banks might continue to exist in case of mergers or bailouts. Also sometimes banks are double counted, if a negative equity does not immediately result in bankruptcy.

Key Observations:

- main defaults in years 1986-1991 and 2009-2011
- long stable period from 1991-2008
- In 1990 there were many more smaller banks. Smaller banks might have a higher likelihood to fail. In 1990: 74% small banks, 2010: 35% small banks

2.5 Loans

Graph description: It shows the share of loan types of total loans over time.

Key Observations:

- real estate loans has largest share

Figure 14: Loans

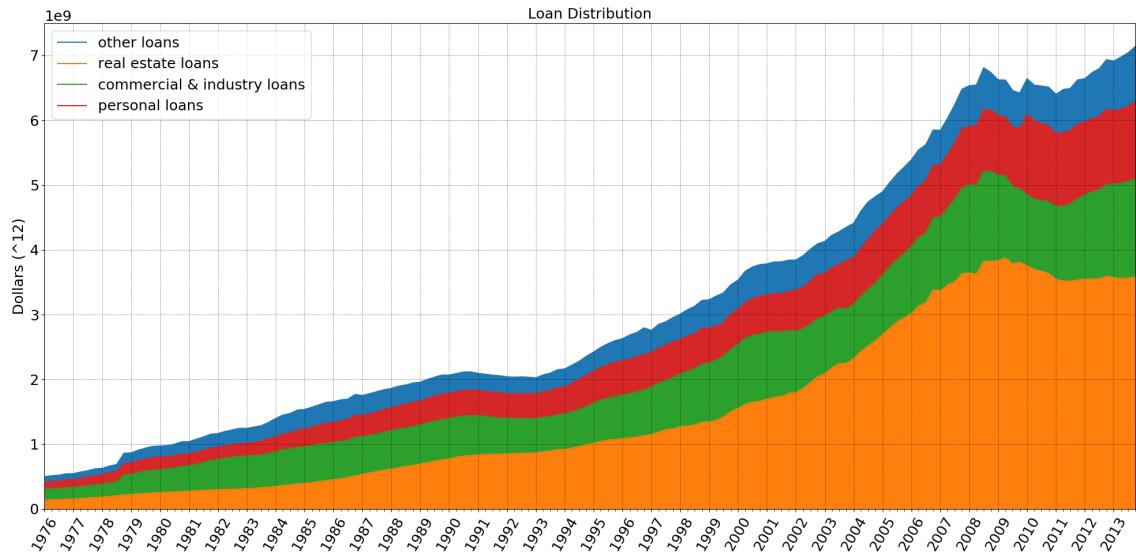


Figure 15: Loans by repricing maturity

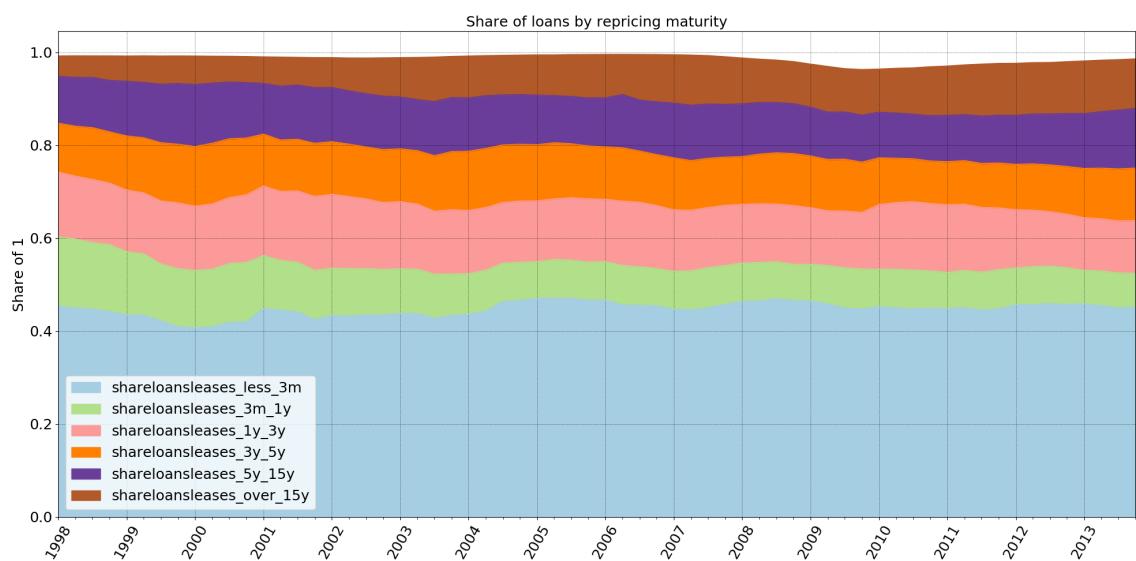
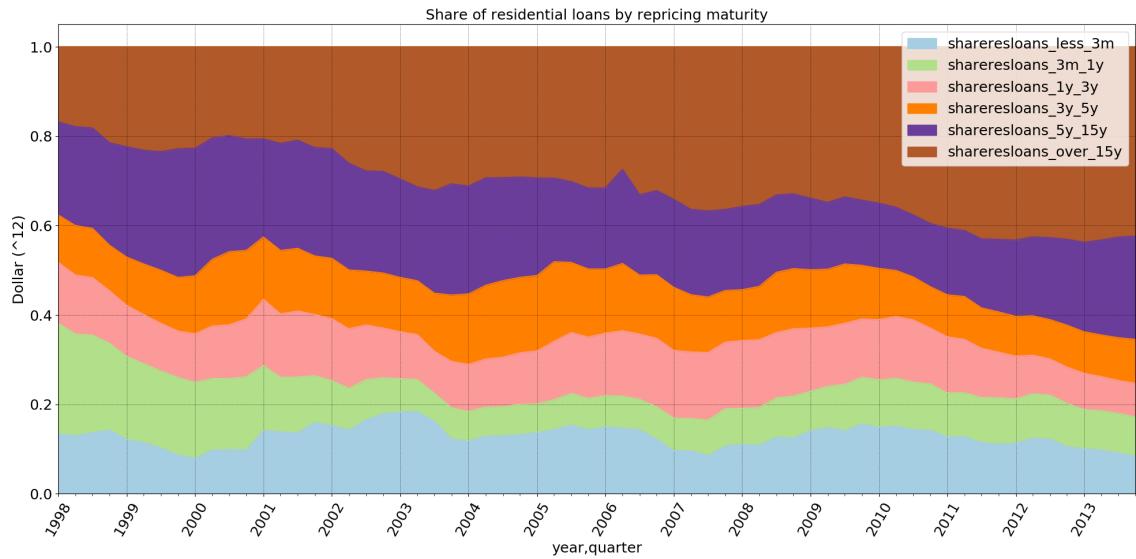


Figure 16: Residential Loans by repricing maturity

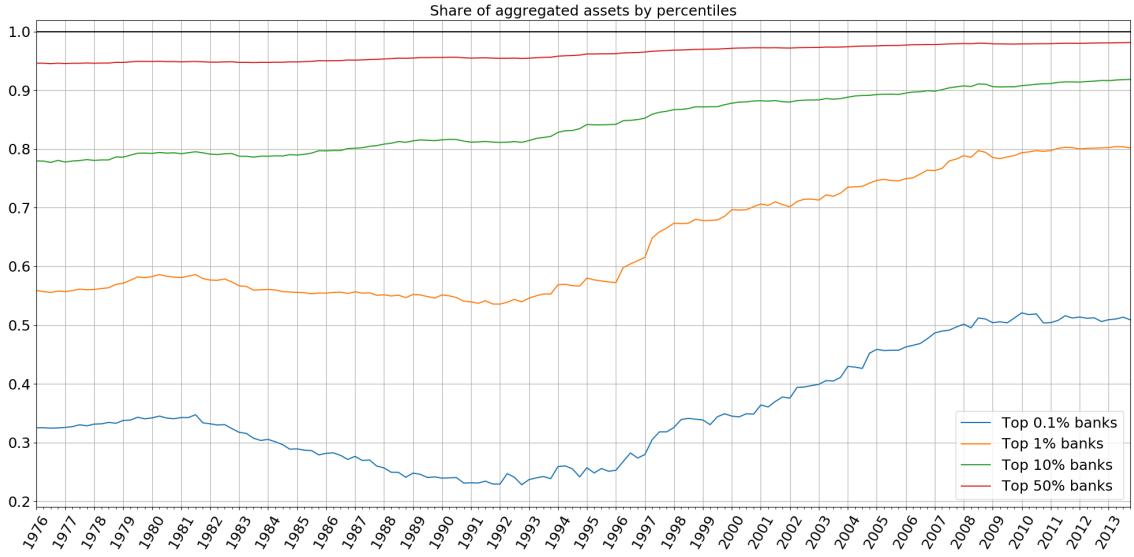


2.6 Distribution of asset sizes among banks - To Big to Fail

Figure 17: Count of banks by percentiles

	Top 0.1%	01Share	Top 1%	1PercentShare	Top 10%	10PercentShare	Top 50%	50PercentShare	Total all banks
1976	14	0.324922	144	0.558099	1442	0.780650	7210	0.946214	14419
1980	14	0.340622	144	0.581818	1442	0.793497	7208	0.948957	14417
1984	14	0.288709	144	0.556493	1439	0.790446	7194	0.948429	14389
1988	13	0.240856	130	0.546860	1298	0.811423	6491	0.954550	12982
1992	11	0.228150	114	0.539679	1136	0.811301	5682	0.954310	11363
1996	9	0.273671	95	0.609738	946	0.850118	4732	0.964386	9464
2000	8	0.348473	83	0.701729	825	0.881838	4126	0.972520	8252
2004	8	0.452258	76	0.741929	757	0.891446	3784	0.975372	7567
2008	7	0.510510	70	0.794367	702	0.910356	3511	0.980069	7022
2012	6	0.506170	60	0.801828	604	0.916754	3018	0.980764	6035

Figure 18: Aggregate assets by percentiles



2.7 Median banks by asset size

In Figure 15, we have in the left column the asset interval size and in the corresponding row the number of banks per year.

Figure 19: Banks count by asset size

	1980	1985	1990	1995	2000	2005	2010
(-0.001, 100000.0]	12717.0	11674.0	9145.0	6613.0	4810.0	3435.0	2313.0
(100000.0, 1000000.0]	1507.0	2287.0	2693.0	2843.0	3055.0	3562.0	3670.0
(1000000.0, 10000000.0]	174.0	287.0	325.0	342.0	307.0	381.0	413.0
(10000000.0, 100000000000.0]	18.0	27.0	49.0	75.0	80.0	80.0	83.0

Typical small/medium/large bank

Banks are assigned three different buckets (small/medium/large) depending on asset size.

Small bank: $0 < \text{assets} \leq 10^5$

Medium bank: $10^5 < \text{assets} \leq 10^6$

Large bank: $10^6 < \text{assets}$

Figure 20: Asset size by bank

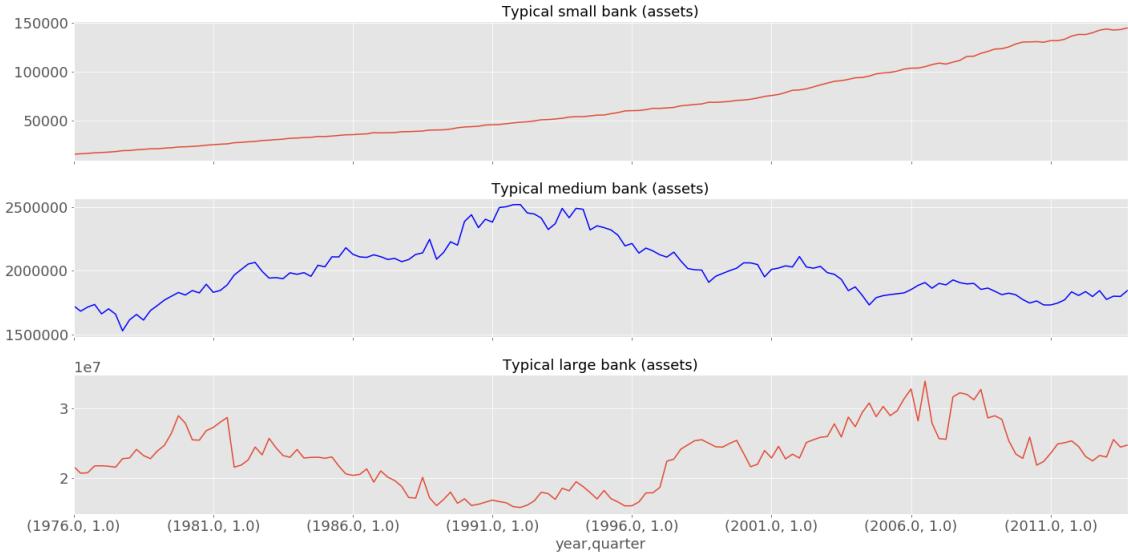


Figure 21: Medium vs large bank by asset size

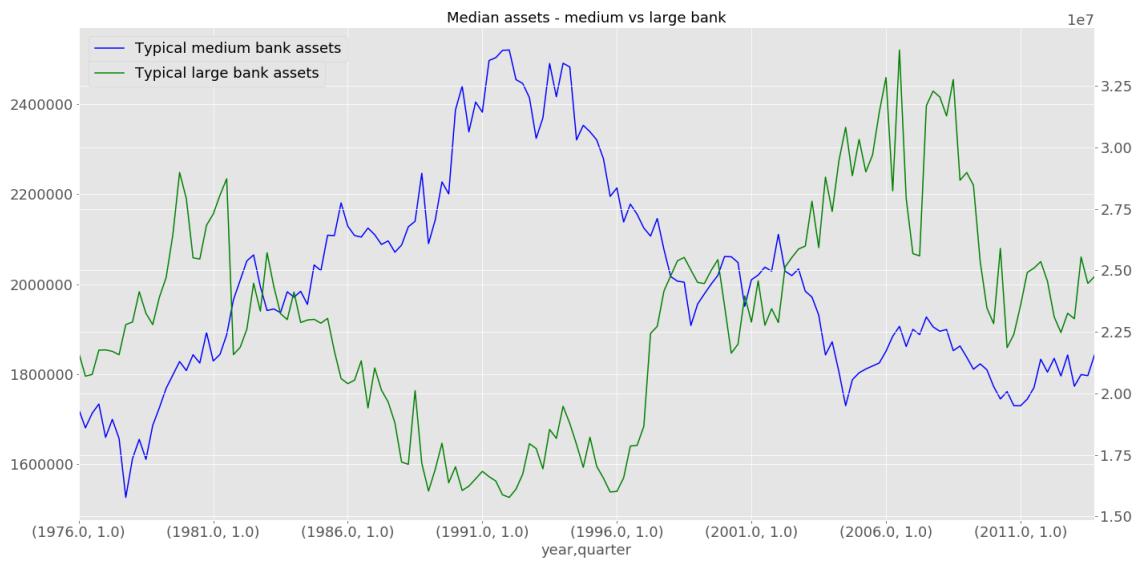


Figure 22: Small bank: liability side

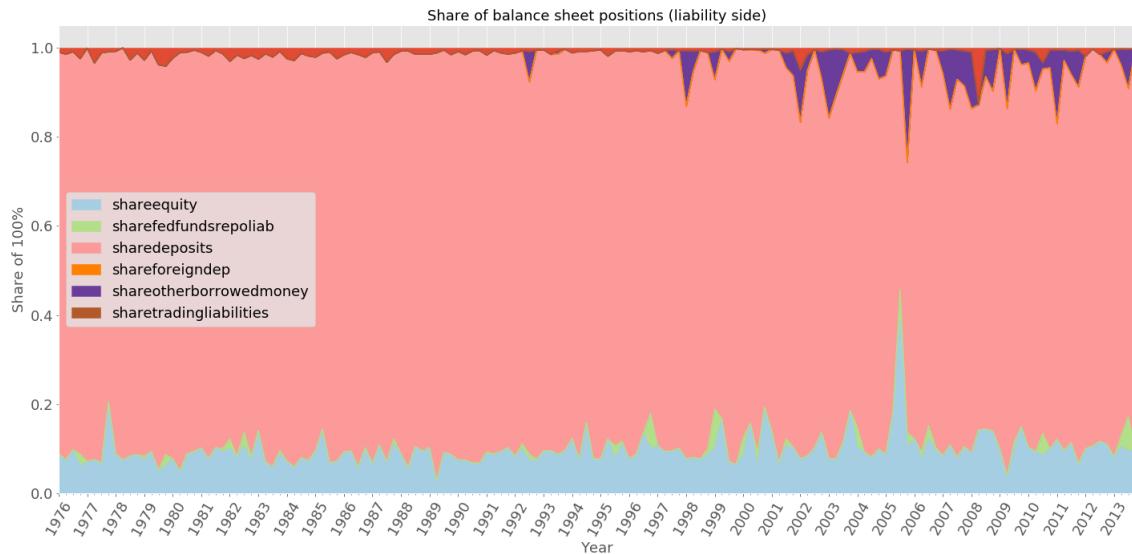


Figure 23: Medium bank: liability side

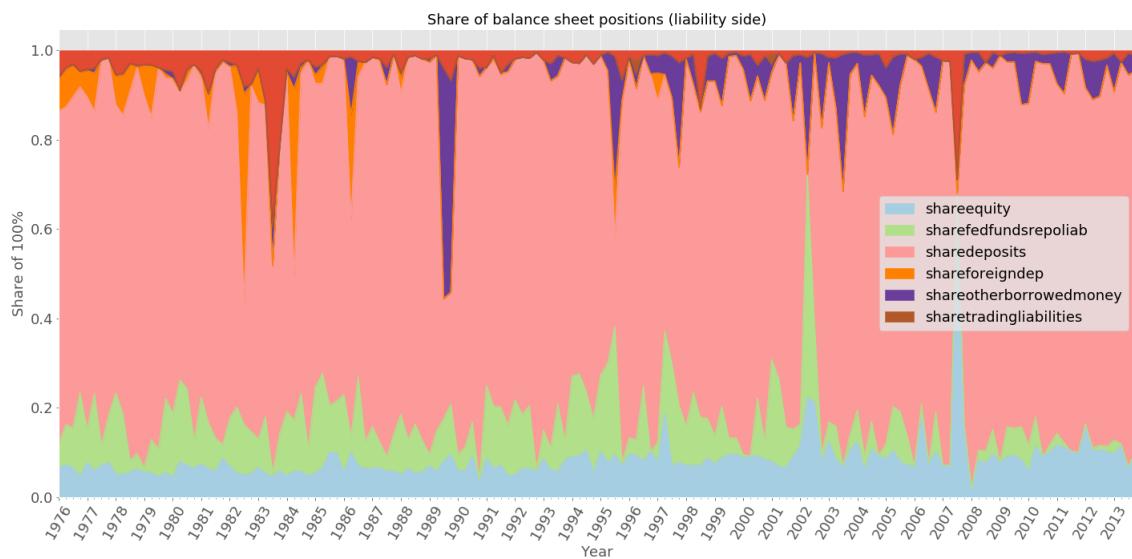
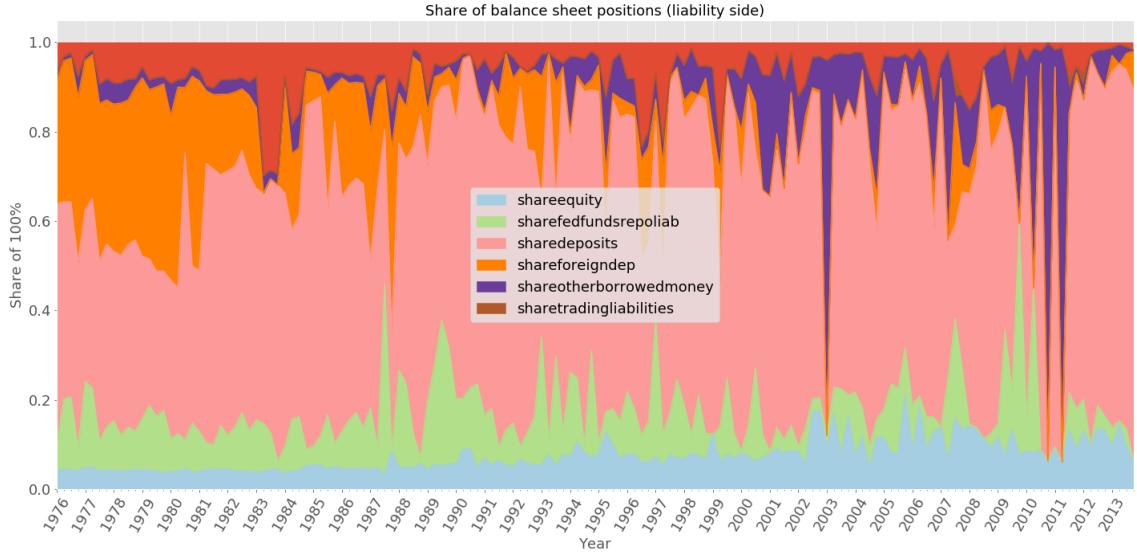


Figure 24: Large bank: liability side



2.8 Leverage

Throughout the analysis the definition of accounting leverage (assets/equity) is used. Equity is calculated by total assets minus total liabilities. In addition, for risk analysis banks belonging a bank holding company were aggregated. Hence, the dataset which was used contained bhcs and independent banks. Figure 21 below shows the mean, median and weighted-average leverage by asset size for each point in time. The weighted-average leverage ratio is calculated by taking into account the asset size for each bank every point in time. Every leverage ratio for each individual bank is only accounted in the weighted-average by its share of assets compared to the total assets of all banks at that point of time.

Figure 25: Median and Average leverage for all banks

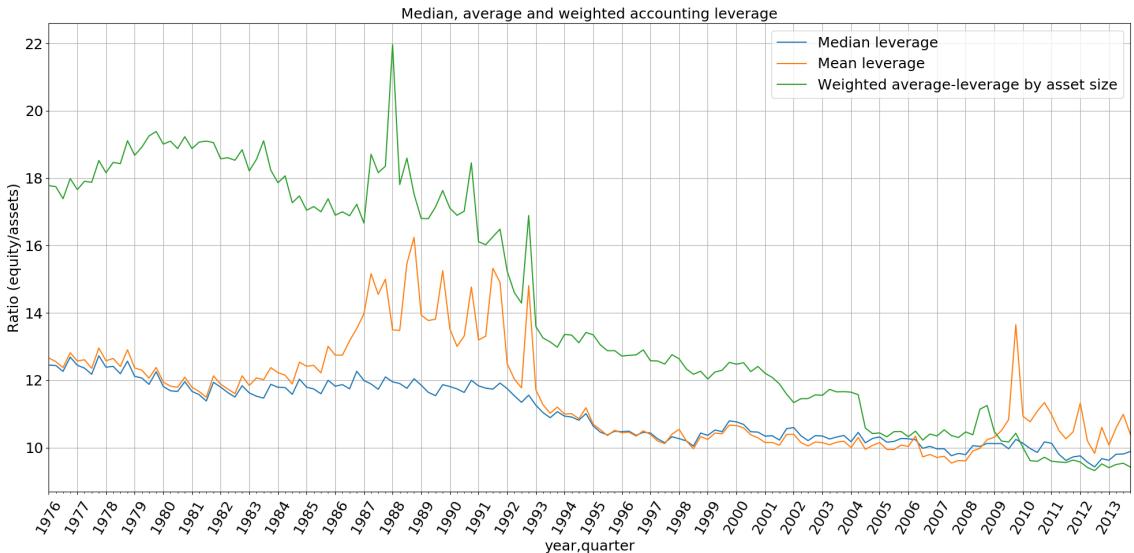


Figure 26: Average/Mean leverage plots

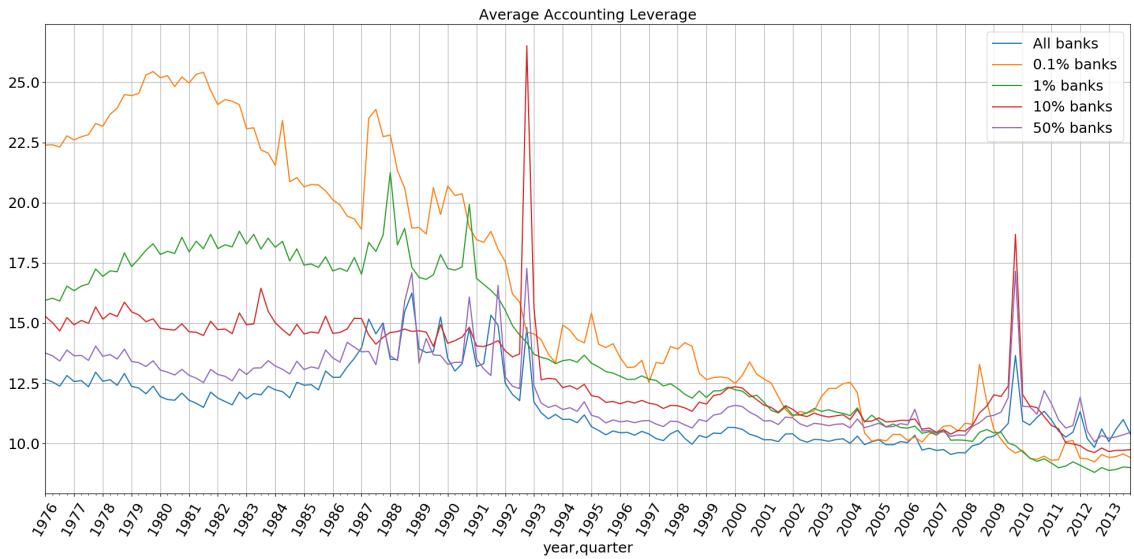


Figure 27: Median leverage plots

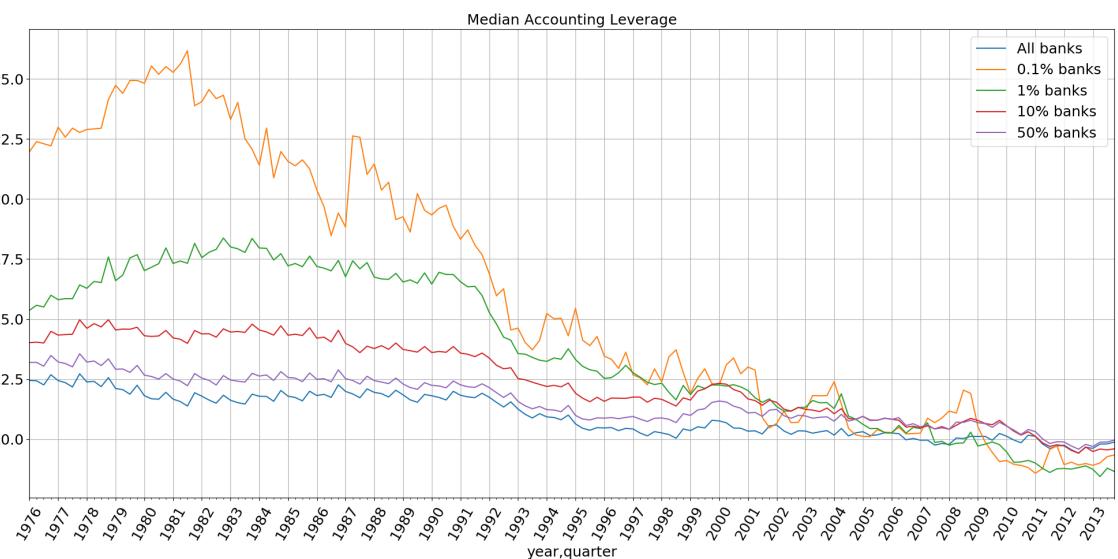


Figure 28: Trend plots

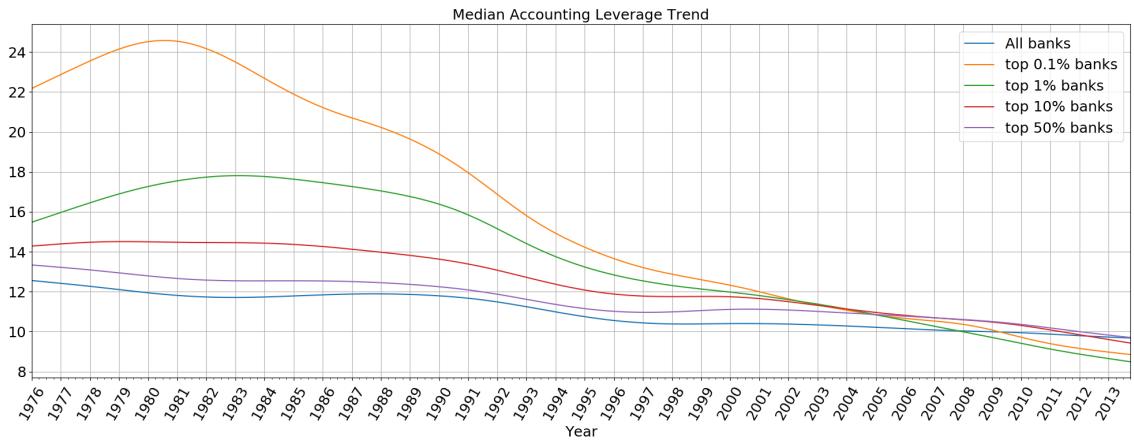


Figure 29: Cyclical plots



Figure 30: Correlation cyclical leverage

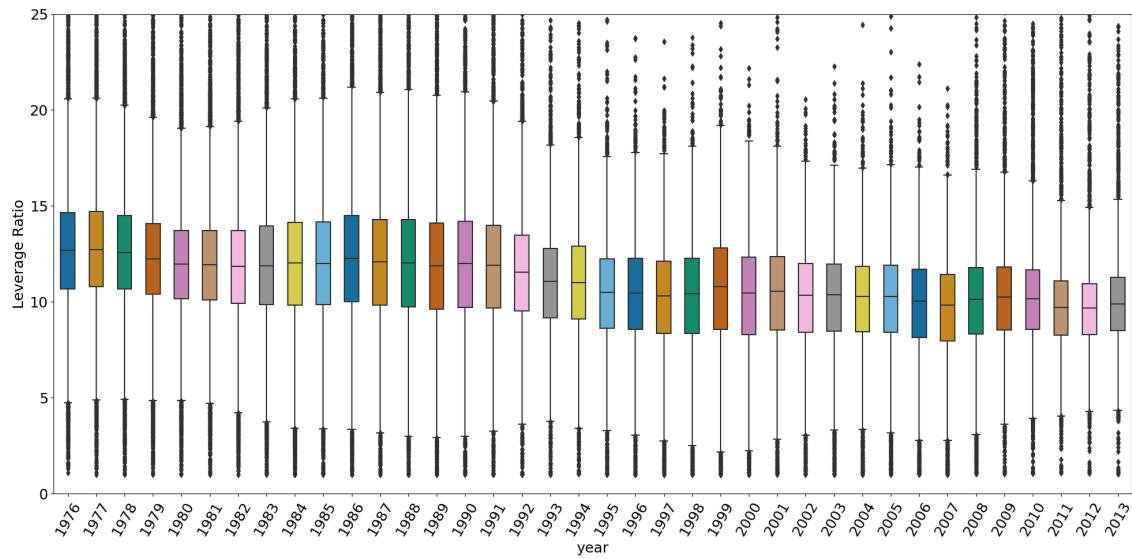
	Top 0.1%	Top 1%	Top 10%	Top 50%	all
Top 0.1%	1.000000	0.389020	-0.035984	-0.066798	-0.139484
Top 1%	0.389020	1.000000	0.567942	0.509148	0.454866
Top 10%	-0.035984	0.567942	1.000000	0.910975	0.816169
Top 50%	-0.066798	0.509148	0.910975	1.000000	0.951795
all	-0.139484	0.454866	0.816169	0.951795	1.000000

Graph description: Figures 21-25 focus on leverage ratios for every year and quarter over all banks. Banks with equity or assets below zero are excluded.

Key Observations:

- Extreme outliers of leverage in year 1992/93 and 2009 lead to spikes in average leverage.
- Average-weighted leverage significantly higher from 1976 to 2004. Aligns with higher leverage of top 0.1% and 1% banks. Hence, the overall risk from year 1976-2004, was driven high by the larger banks.
- Figure 21: All banks median leverage, seasonal effect every year?
- Leverage lowest in 2007
- Overall Leverage did fall over time: Introduction of Basel 1 in 1988 might have lead to continuously decrease in leverage
- Top 0.1% have much higher volatility, which could just be caused by the low sample size.
- Top 0.1% and 1% actually become less risky than all banks together from 2010 onwards
- Figure 25 shows slightly negative correlation between the top 0.1% banks and all banks.
- Crisis 2008/9: Top 0.1% banks have a average leverage spike in 2008, while top 10%, 50% and all spike around a year later.

Figure 31: Boxplots (1976-2013)



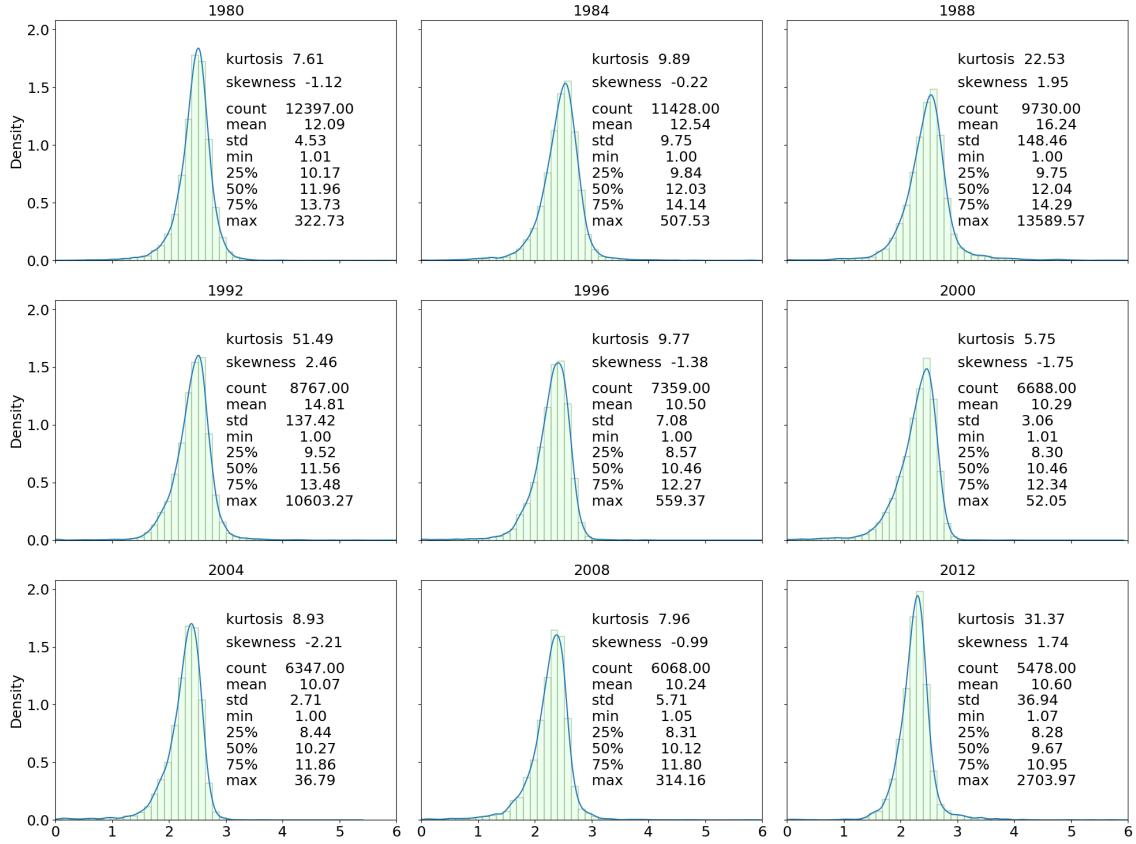
Graph description: Boxplots of all leverage ratios by banks by year.

Key Observations:

- 75% of all banks have a leverage ratio between 10-15.

A look into the distribution of leverage

Figure 32: Distribution 1980-2013

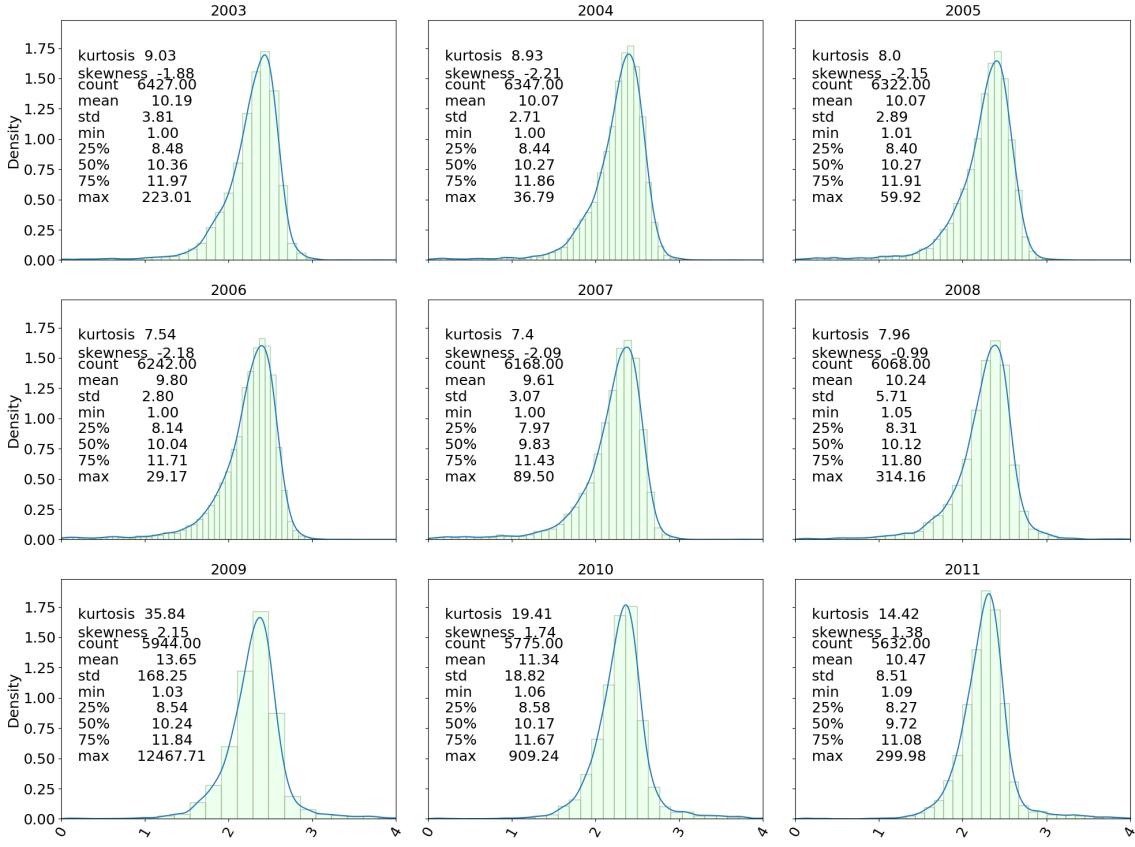


Graph description: Counts are normed to 1. Leverage is transformed with log10. Leverage ratios are always from quarter 4.

Key Observations:

- Log-normal distribution
- Large standard deviation in year 2010 with 18.82
- Less and higher bars in 2012 indicate higher homogeneity in 2013 compared to the years before.

Figure 33: Distribution in crisis 2003-2011



Graph description: Leverage ratios are always from quarter 4 and logarithmised.

Key Observations:

- Increasing homogeneity over time.

3 Evaluation/Outlook

shadow banking/investment banks not considered

off balance sheet

valuations not realistic, book values...

Applying more time-series models

Applying of models such as Regression...

Other structural events considered

significant part of trading assets still owned by non commercial banks

4 Conclusion

crisis data: <https://www.nber.org/cycles.html>