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Bachelor Thesis in Macroeconomics

„U.S. Commercial Banks: Trends and Cycles“

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1 Introduction

This article is an explorative journey through the historical balance sheet filings of U.S. commercial banks. Its objective is to shed light on the financial development of arguably the most important backbone of the U.S. economy - commercial banking. Not least, the severe financial crisis in 2008, which originated from the banking industry, proves the importance of regulating commercial banking. However, only with a deep empirical understanding of the behaviour of commercial banks, one can design regulations that are ultimately effective. We use different perspectives and a variety of approaches to unveil interesting stylized facts about balance sheet trends (long-term) and cycles (short-term) among banks. Banks are studied in both dimensions - time and cross-section. Within the analysis we also careful consider contextual information such as crises and regulatory efforts that occur in our time-frame, the years 1976-2013. Some areas of interest we will elaborate on are the growth and distribution of assets, the relationship between different balance sheet accounts and leverage. We gather interesting insights such as that small banks business cycles are independent to that of large banks.
This article should be seen as a complement and a way of clarification to the wide variety of existing literature exploring similar themes. Adrian and Shin 2011, for instance, investigate the pro-cyclicality of leverage. We use their approaches as a basis to apply them on our data and compared the results. We find that indeed commercial banks do have pro-cyclical leverage, but it differs between bank sizes. Similar to DeYoung and Yom 2008, we also do correlation analysis between different balance sheet accounts, but we do not go in such great depths.
We start by outlining the data and methods used. Then, we give a more general overview of commercial banks and elaborate on each balance sheet position. A section about the development of distribution of assets follows. We then continue by analysing banks by different asset sizes. Lastly, we examine the important economic indicator leverage for commercial banks.

2 Main part

2.1 Data

The analysis in this thesis is build upon a dataset of balance sheets originally provided by the FFIEC. Also named call reports, the FFIEC collects this balance sheet information quarterly from every FDIC insured institution. Drechsler et al., 2017 used these reports and formed a consistent time-series from year 1976Q1 to 2013Q4, accounting for variable and other changes over the years. They only included commercial banks (Charter Type 200). To graph these time-series we create a horizontal axis with a tick for every quarter.

We also add a year label for every first quarter. This axis is consistently used throughout the analysis. Bank filings with negative equity are removed from the dataset, since they indicate a bankrupt bank. To prevent skewing the data, the two big investment banks Goldman Sachs and Morgan Stanley becoming commercial banks in the proceedings of the financial crisis 2008 are removed. When looking at leverage, we aggregate all commercial banks to their belonging bank holding companies. For our use case it is not necessary deflate the data. Along the way of our analysis it were often the outliers that drive the measurements. This aligns with the interdependent banks system of today, where just one bankrupt banks can lead to significant spillover effects. Hence, we took those outliers into careful consideration and did not consistently filter them out. In the proceedings of our analysis, we took into account recession definitions provided by the National Bureau of Economic Research. They define a recession not in terms of two consecutive quarters of decline in real GDP, but a significant decline in economic activity spread across the economy, lasting more than a few months, normally visible in real GDP, real income, employment, industrial production, and wholesale-retail sales (NBER, 2010). In addition, we differentiated between so called "banking" (originated in the banking sector) vs "market" (originated from outside banking sector) crisis as in Berger and Bouwman, 2012. The assumption here is that banking crisis are stronger reflected in bank data.
Crises (Marked in our graph as gray zones):

- 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)

For further context awareness, it is important to mention following other structural events that affected the U.S. commercial banks landscape considerably:

- Gramm-Leach-Bliley Act in 1999 - This act repealed part of the Glass-Steagal Act of 1933, removing barriers that prevented banks from offering traditional commercial banks services and investment bank services or insurance company services at the same time.
- Reigle-Neil in 1994 - This law removed several obstacles to banks opening branches in other states and provided a uniform set of rules regarding banking in each state.
- FDIC Improvement Act (FDICIA) passed in 1991, gave the FIDC the responsibility to rescue banks with least-costly method. Aimed to relativize the evolving moral hazard.

- Basel 1 in 1988, Basel 2 in 2004, Basel 3 in 2010 - Capital and liquidity regulations to improve banking sectors' stability.
- Over our data time-frame the banking sector experienced a wide-spread adoption of financial innovations. The main ones being interest rate derivatives, asset securitization and adjustable rate mortgages.

2.2 Methods

We use a number of methods to aid analysis of banking data over time and in the cross-section. For most methods we transform the data with the natural logarithm to focus on relative changes. In graphs we will indicate this transformation with proper labels. Furthermore, we apply the recognized Hodrick-Prescott Filter with the recommended parameter of 1600 for quarterly time-series to de-trend out data. Seasonal effects will not be removed. The resulting cyclical graphs show the relative cyclical variations of the underlying variable. For correlations and autocorrelations, we use the linear Pearsons' correlation coefficient. To determine significance we compute the 2-tailed p-value. Significance is then determined according to following levels:

1. ***: <0.01
2. **: <0.05
3. *: <0.1

2.3 U.S. commercial banks - Overview

This section will guide us through the distribution of financial components held by the U.S. commercial banking sector as a whole. We will see what types and amounts of financial instruments banks are holding and how these positions evolved over time.

2.3.1 Stylized balance sheet

Table 1 shows a common perspective of a us commercial banks' balance sheet.

Figure 1: Stylized balance sheet of us commercial bank [a]

Assets	**Liabilities**
Cash	Equity
Fed funds sold and securities purchased under agreements to resell (fedfundsrepoassets)	Fed funds bought and securities sold under agreements to repurchase
Securities: - Treasury - Mortgage-backed Security (MBS) - Other	Deposits: - short - other
Loans net[b]	
Trading assets:	Trading liabilities
- net interest rate derivatives - net other fixed income - net other trading	
Other assets[c]	Other liabilities

[a]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.

[b]Loans and leases net of unearned income and allowance for loan and lease losses

[c]composed of derivatives "not for trading" and other items

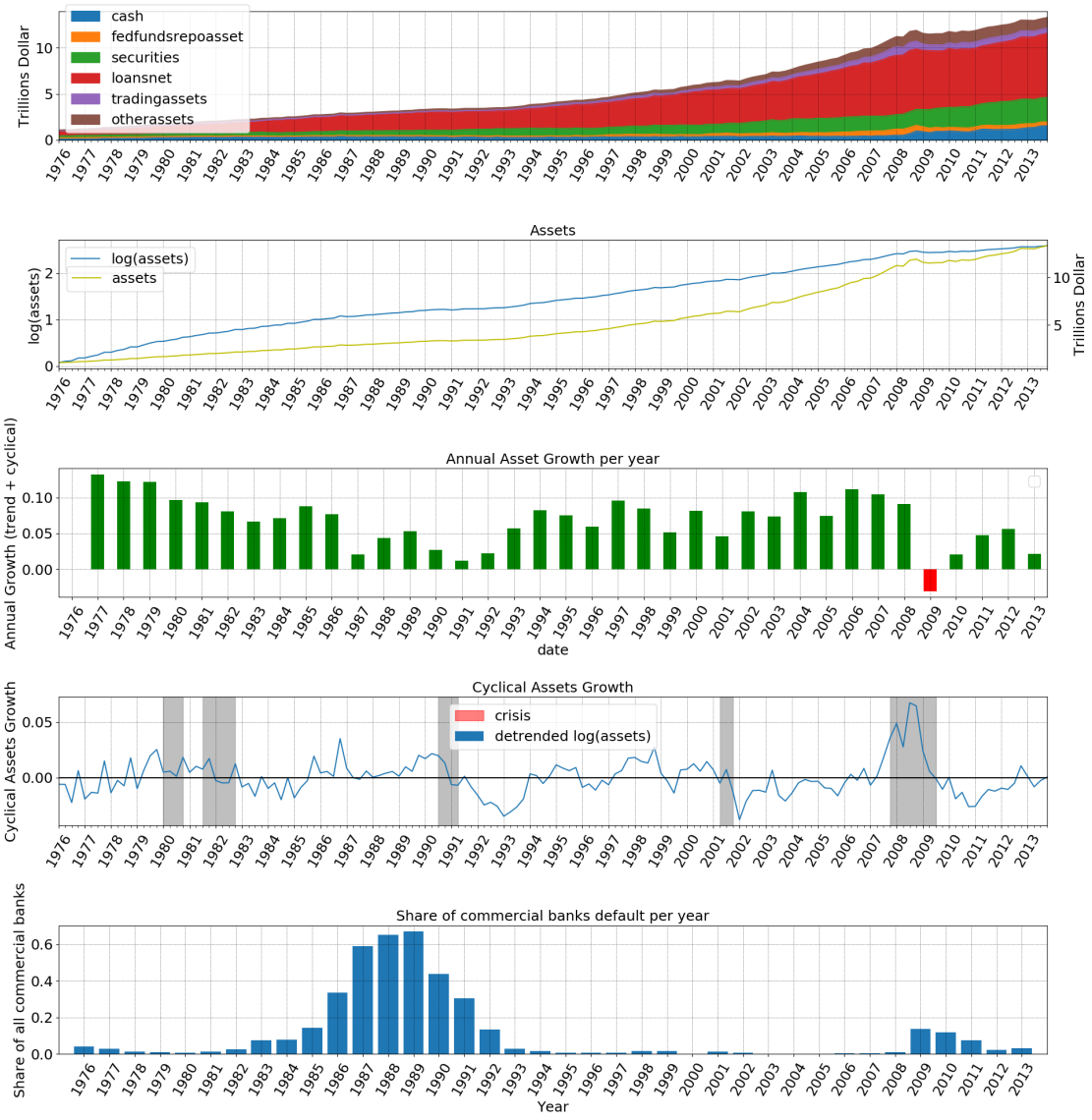
We have simplified the balance sheet of a typical U.S. commercial bank similar to Drechsler et al., 2017. Cash consist out of noninterest-bearing balances, with currency and coin included, and of interest-bearing balances. Federal funds sold and securities purchased under agreements to resell are both ways of lending excess cash to fellow commercial banks in return for interest. Fed funds bought and securities sold under agreements to repurchase in turn are ways of borrowing cash short-term. Securities can be divided into Held-to-maturity and Available-for-sale. These categories then include a large amount of different types of securities, with Treasury and MBS being the largest. Loans are netted by unearned income and allowance for loan and lease losses to gather their existent value. Trading assets are securities hold with the intention to sell them as profit. They are intended to hold only for short-term. Trading asset can be in any type of form such as a derivative, MBS or loan. Trading liabilities tend to be in the form of short positions or derivatives. Deposits can be divided into transaction and non-transaction deposits. Time and savings deposits make up non-transaction deposits, while the major part of transaction deposits are demand deposits.

2.3.2 Total assets

Figure 2 gives a general overview how the aggregated 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. In comparison, the GDP of U.S. in 2013 was 16.78 trillions. The first graph already indicates a period of flatness in years 1990-1993 and an asset spike in 2008/Q2. The fourth graph within our Figure also emphasizes these two periods

with significantly low growth. To get a better insight into what is occurring in specific periods, we will perform time-series analysis by decomposing the logged data into a trend and cyclical component. The second graph within figure 2 compares the logged with the absolute total assets. Both are drawn within their own vertical axis. While the growth of absolute assets is more exponential over time, the linear trend of the logged assets, suggests a constant relative growth rate. The third graph of Figure 2 shows the de-trended total assets, which can also be interpreted as its cyclical movements. The gray areas within this graph indicate crises, as defined in section 2.1. The alignment of crises with our commercial banks total assets cyclical are 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 U.S. 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. However, we need to consider the fact that there might be differences in cyclical behaviour between different banks sizes. Section 2.5 addresses this point. Finally, the last graph of Figure 2 shows the banks default rate per year. The graph aligns with the growth graph just above. In periods with a lot defaults we have a low growth rate. Periods that mark high default rates are the loans and saving crisis in 1990 and the financial crisis in 2008. It is interesting to mention that the loans and savings crisis caused significant higher default rates than the crisis in 2008. This might be related to the fact that in 1990 the number of small banks was considerably higher and small banks were more affected in this crisis. In 1990, 74% of the banks that defaulted were small, while in 2010 the share of small banks defaults was only at 35%. We elaborate on the change in banking landscape in section 2.4.

Figure 2: Asset side [a]



[a]Graph 5 shows an estimation of how many banks have defaulted every year. For instance in year 1989 over 0.6% have defaulted. 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.

2.3.3 Cyclical analysis of balance sheet accounts

Diving into more detailed analysis of the individual balance sheet accounts, Figure 3 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. As a complement, Figure 32 shows the share of each position in relation to the total assets.

The cash position shows a clear spike in 2008, but beside then, the movements show no clear sign of irregularity. With the 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 32 further supports our thesis that securities are

sold to raise cash. Here we can see that while the share of securities fell until 2008, the share of cash rose. The liability "other borrowed money" also gets to its highest point in 2008, indicating anomalies in a bank financing 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 32 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. We will see more of equities behaviour in the leverage section, when we analyse it in regards to total assets.

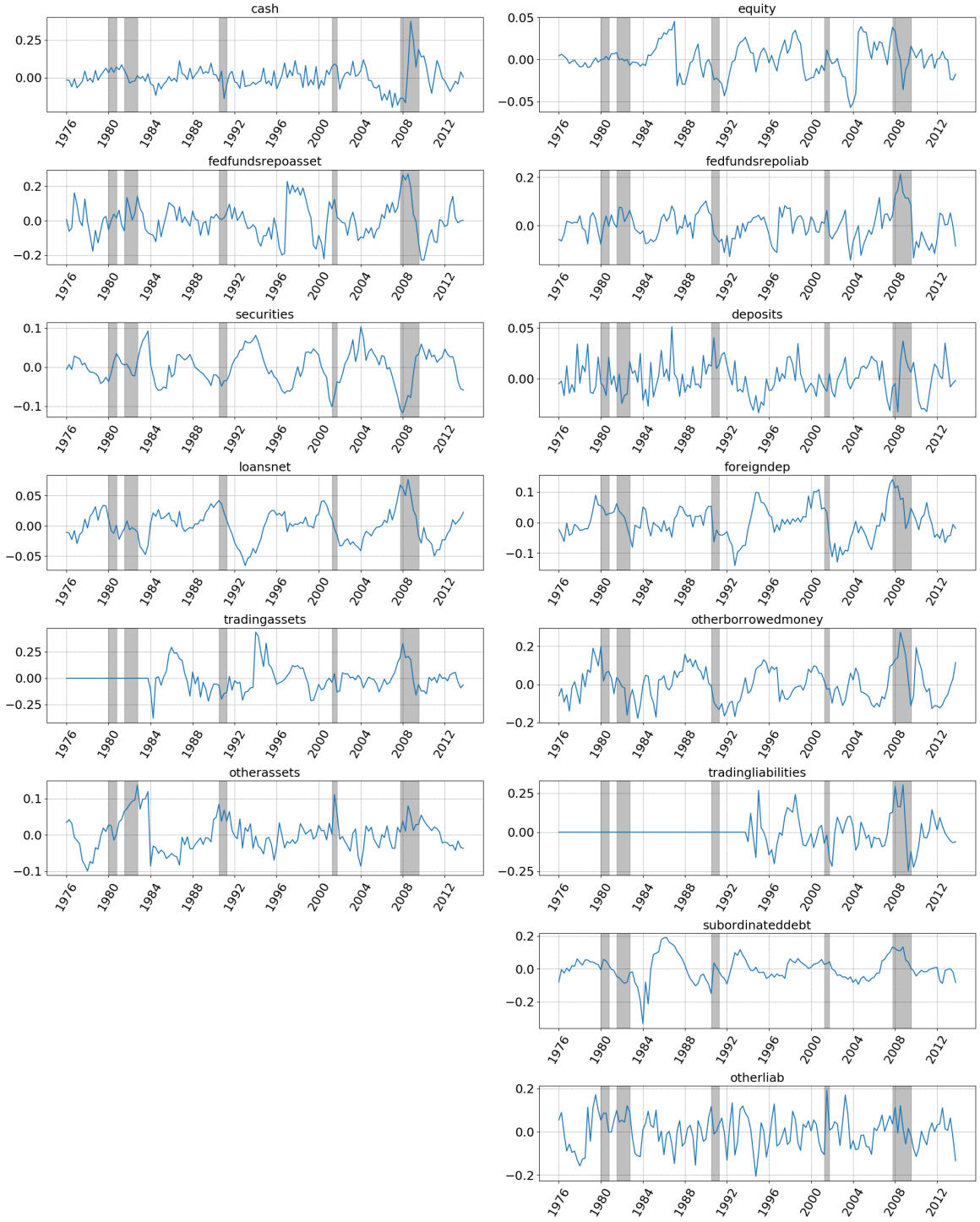
Another interesting observation is that some positions show larger fluctuations in more recent times. The volatility of fedfundsrepoasset increased from 1996 onwards and of foreign deposits from 1992 onwards. We also see a contradictory relationship between loans and securities. When securities fall, loans rise and vice versa. Figure 4 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 7 illustrates this negative relationship. The two asset categories could be seen as substitutes to each other. With a substantial part of securities being mortage backed securities, this relationship does not come as a surprise.

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 7 confirms a possible positive linear relationship. A similar positive relationship can be seen between fedfundsrepoassets and loans. However, the scatterplot in Figure 7 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 increases in equity leads to increases in trading.[1] Another observation is the strong positive relationship between loans and foreign deposits of $r = 0.59$. Foreign deposits are deposits made in foreign offices. It is not clear why there is such strong relationship here.

[1]It is important to note that the mere assumption of a correlation between the two sides of a balance sheet contradicts the Modigliani-Miller-Theorem. The Theorem states the independence of assets by the financing capital structure. In addition, a key part of asset liability management for banks is maturity transformation. For correlation analysis, we should have differed between the different maturities of assets and liabilities. Correlations between positions of different maturity would have a more causal relationship. Furthermore, canonical correlation analysis could have been used to consider that balance sheet positions are jointly determined by the other positions.

Figure 3: Detrended asset positions(left column) Detrended liability positions(right column) [a]



[a]Data 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.

Figure 4: 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***

[a]Pearsons correlation coefficient based on the detrended data used in Figure 3.

Figure 5: Correlation liabilities[a]

	equity	fedfundsrepoliab	deposits	foreigndep	otherborrowedmoney	tradingliabilities	subordinateddebt	otherliab
equity	1.0***	0.17**	-0.02	0.04	-0.06	0.12	0.27***	0.07
fedfundsrepoliab	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***

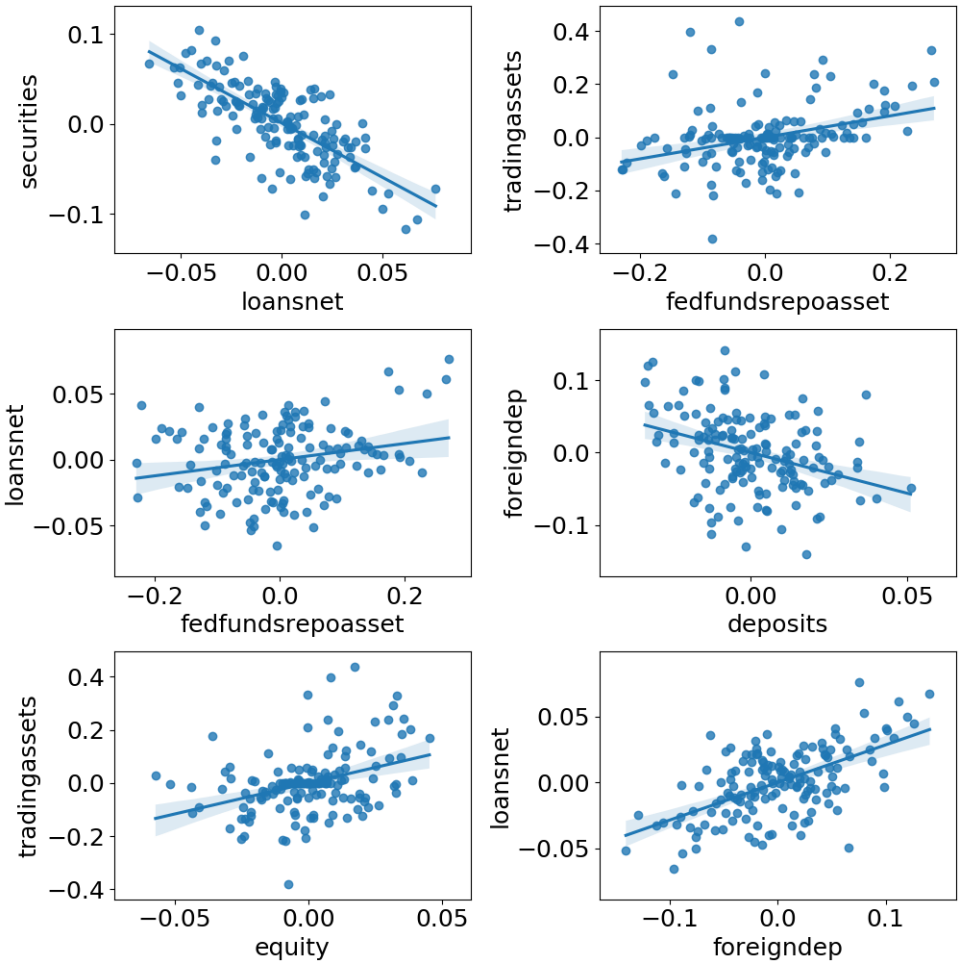
[a]Pearsons correlation coefficient based on the detrended data used in Figure 3.

Figure 6: Correlation assets with liabilities[a]

	equity	fedfundsrepoliab	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***

[a]Pearsons correlation coefficient based on the detrended data used in Figure 3.

Figure 7: Scatterplot for selected positions[a]



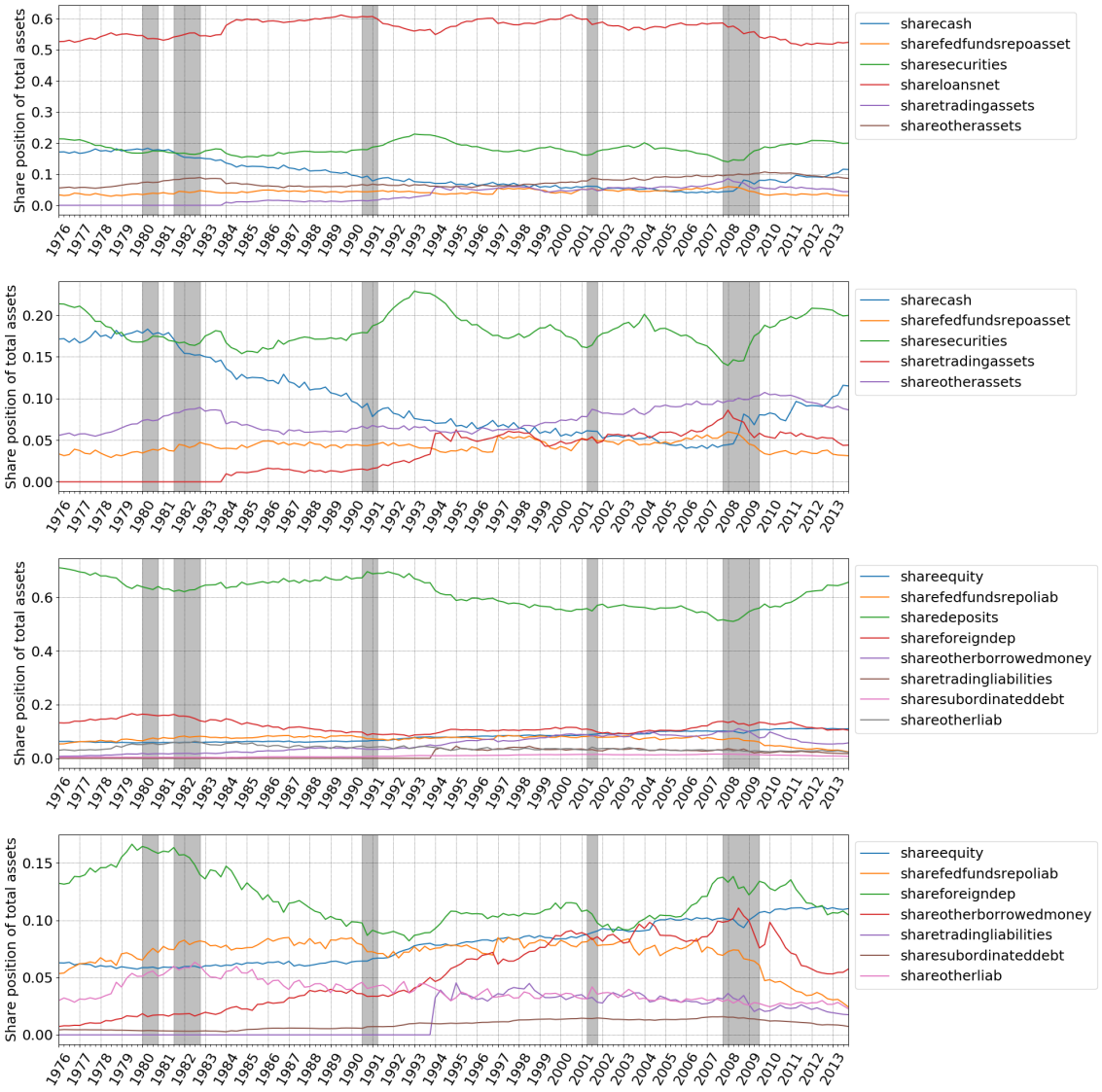
[a]Linear regression based on the detrended data used in Figure 3.

2.3.4 Balance sheet composition of aggregate U.S. commercial banks

Further elaborating on Figure 32, we can see that on the asset side, loans are the main target of investment for commercial banks. Throughout the 37-year time-frame the share of loans always stayed between $50 - 60\%$. The banks started with a share at 55% until it rose to just above 60% from 1985 onwards. The credit crunch crisis in 1991 caused a fall of the share back to 55%. This fall continued until 1995. From then on, the share of loans rose back to 60% until 2008, where it started to fell again. It fell to an all-time low in 2013 with a share of just above 50%. With the confirmed negative correlation between securities and loans, this came along with a rise in securities. The development of the cash share is also interesting. Cash continuously fell from a share of just below 20% to a share of below 5%. Here, the crisis 2008 also marked a turning point with share rising back to above 10% again. On the liability side, as one would expect, we have deposits as a dominating source of funding for commercial banks. The share started in 1976 with 70% and fell until 2008 to an all time low of just above 50%. From there it went back to roughly 65%. This decrease in deposits, especially until 2008, must obviously come

along with the increases of other types of finance. There is a significant increase of other borrowed money, peaking in 2008. Other borrowed money consists of Federal Home Loan Bank advances (FHLB) and other borrowings not clearly defined. After the crisis in 2008 there was a rapid decreases of other borrowings. FHLB advances are mainly used in funding low mortgages for low income households, which explains the alignment with the housing crisis in 2008. Lastly, Figure 32 shows a general increase in the share of equity commercial banks hold from just above 5% to above 10%.

Figure 8: Share of balance sheet positions [a]



[a]The second/fourth graph is a focus of the first/third, just without loans/deposits position.

2.4 Too Big to Fail - Distribution of total assets among banks

This section tries to empirically illustrate a problematic commonly referred to as *"Too Big to Fail"*. Banks are considered as "*too big to fail*", when their size and interconnections with other banks are so high that its individual risk impacts the systemic risk of a whole economy. The term first came into play with the failure and bailout of Continental Illinois National Bank and Trust Company in 1984. From that point onwards, it developed into a world-wide phenomenon with its severe consequences unveiled in the financial crisis of 2008.

Indeed, over the last few centuries the number of banks on the US landscape fell significantly from 14419 banks in 1976 to 6035 banks in year 2013. While the mere reduction would not impose such a problem, the distribution of total assets developed more and more unequal. In 1976, the top 0.1% a total of 14 banks held 32.4% of all assets. In comparison, in 2013 the top 0.1% - a total of 6 banks - held 50% of all assets. Table 9 and Figure 10 show these numbers by looking at the assets distribution by banks percentiles. In addition, the unequal distribution of assets can also been seen in Figure 11, the curved lines show the Lorenz curve per year. The more curved the lines become, the more unequal is the distribution. The horizontal line represents perfect equality. Although in 1980 unequal distribution was high already, it increased even more. In year 2013, the top 5% held almost 90% of all assets. Figure 12 shows us the Gini coefficient over time. Its range is from zero to one. A value of one means one bank owns everything, while a value of zero indicates perfect equality (10% of banks own 10% of assets, 50% of banks own 50% of assets and so on...). The higher the value, the higher the inequality in asset distribution. The trend of the coefficient supports our observation of rising inequality. An interesting observation here is the impact of crises on the asset distribution. Crisis tend to reduce the inequality and act as way of redistributing assets. Assuming that assets values fall in times of crisis, the impact of crises must be higher on larger banks. We will look into how different banks size categories are impacted differently by crises in section 2.5. Reasons for the trends we have just documented are not absolute clear. However, geographic deregulation and other regulation reforms such as the repeal of the Glass-Steagall act in 1999 did support the increasing inequality. In addition, larger banks are more likely to be bailed out. This puts them in an easier position to finance themselves and creates the perverse consequence of a moral hazard. A bank with high likelihood to be bailed out takes on too much risk (**FarhiTirole2012**). The severe consequences of this problematic are clear since the financial crisis in 2008. Authorities responded to this issue by setting additional capital requirements on larger banks with frameworks such as Basel 1,2,3.

Figure 9: 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 10: Aggregate assets by percentiles

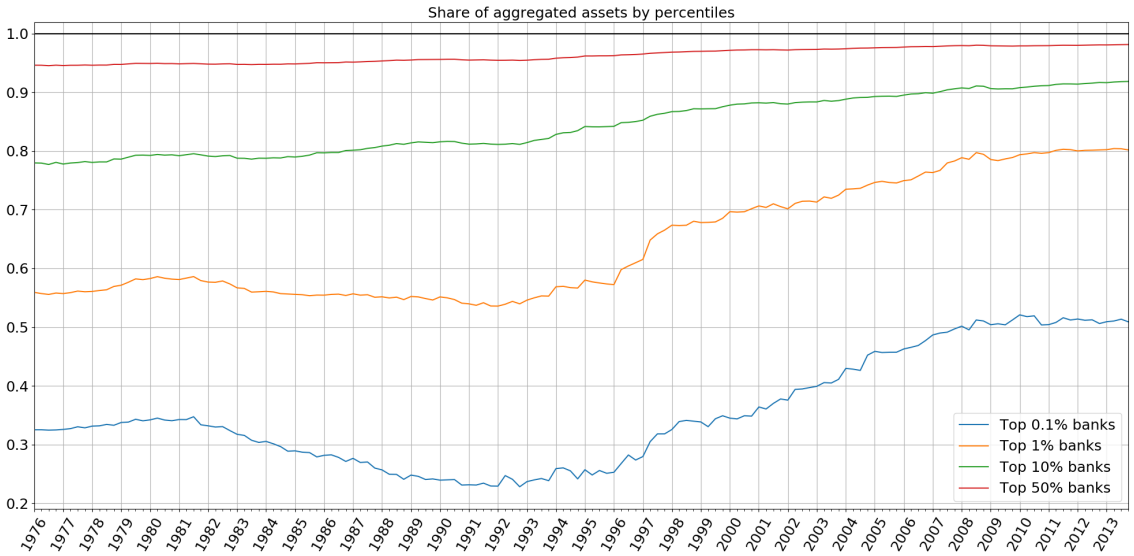
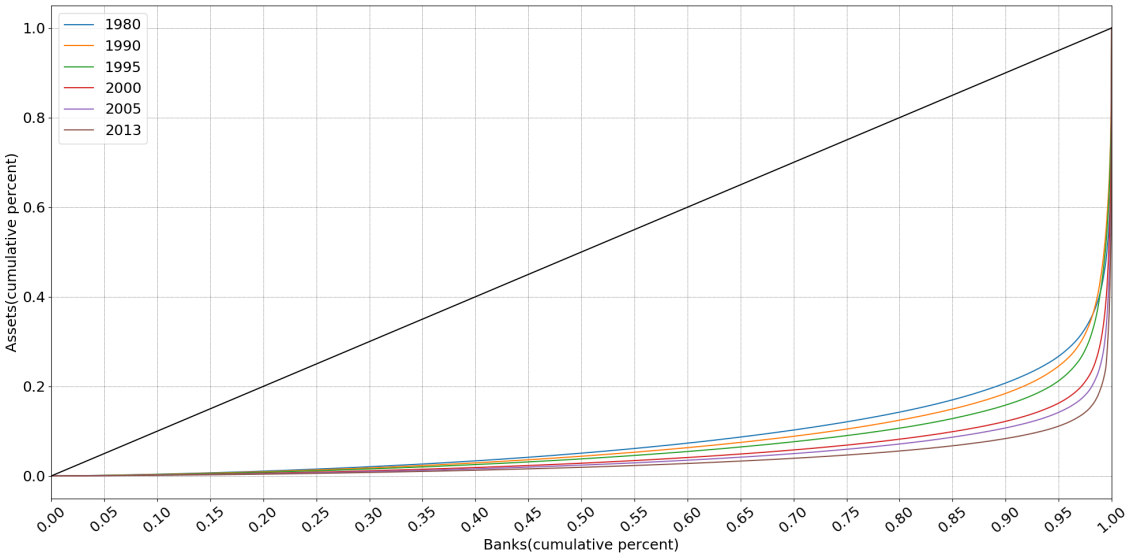
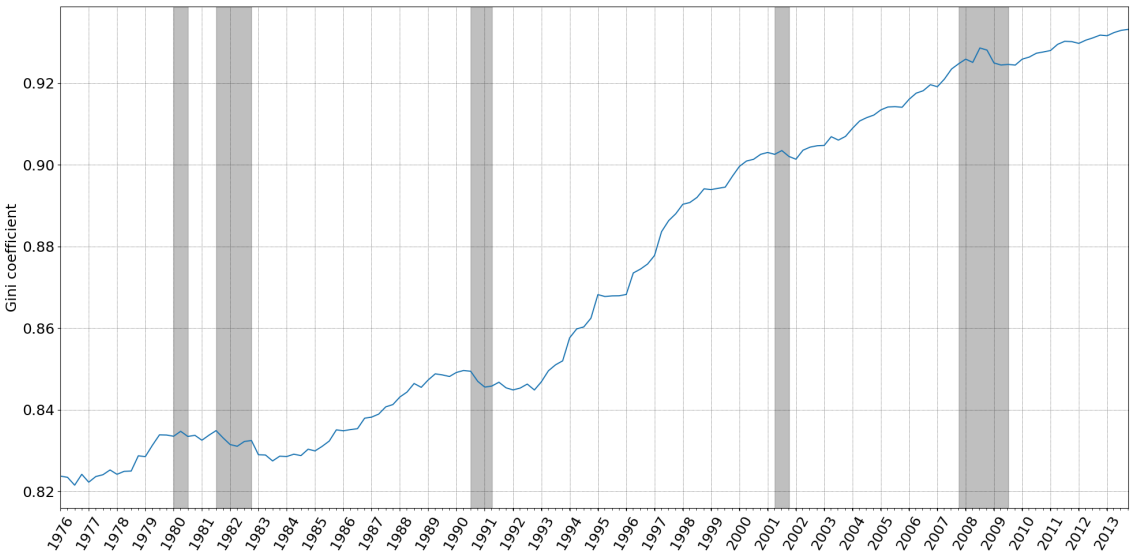


Figure 11: Lorenz Curve[a]



[a]Always Quarter 1

Figure 12: Gini coefficient[a]



[a]

2.5 Banks by total assets

2.5.1 General

This section allocates banks into different categories ranked by asset size to find differences in trends and cycles. In general, it is common way by regulators and academics to categorize banks by their total assets. It measures the gross nominal volume of a bank's activities, but suffers from significant valuation problems, not only for derivatives, and it does not account for differences in individual bank business models. Alternative ways such as categorizing by capital or employees could have been used.
Following the convention of the Federal Reserve Bulletin we divided the commercial banks into these four categories:[2]

- 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)

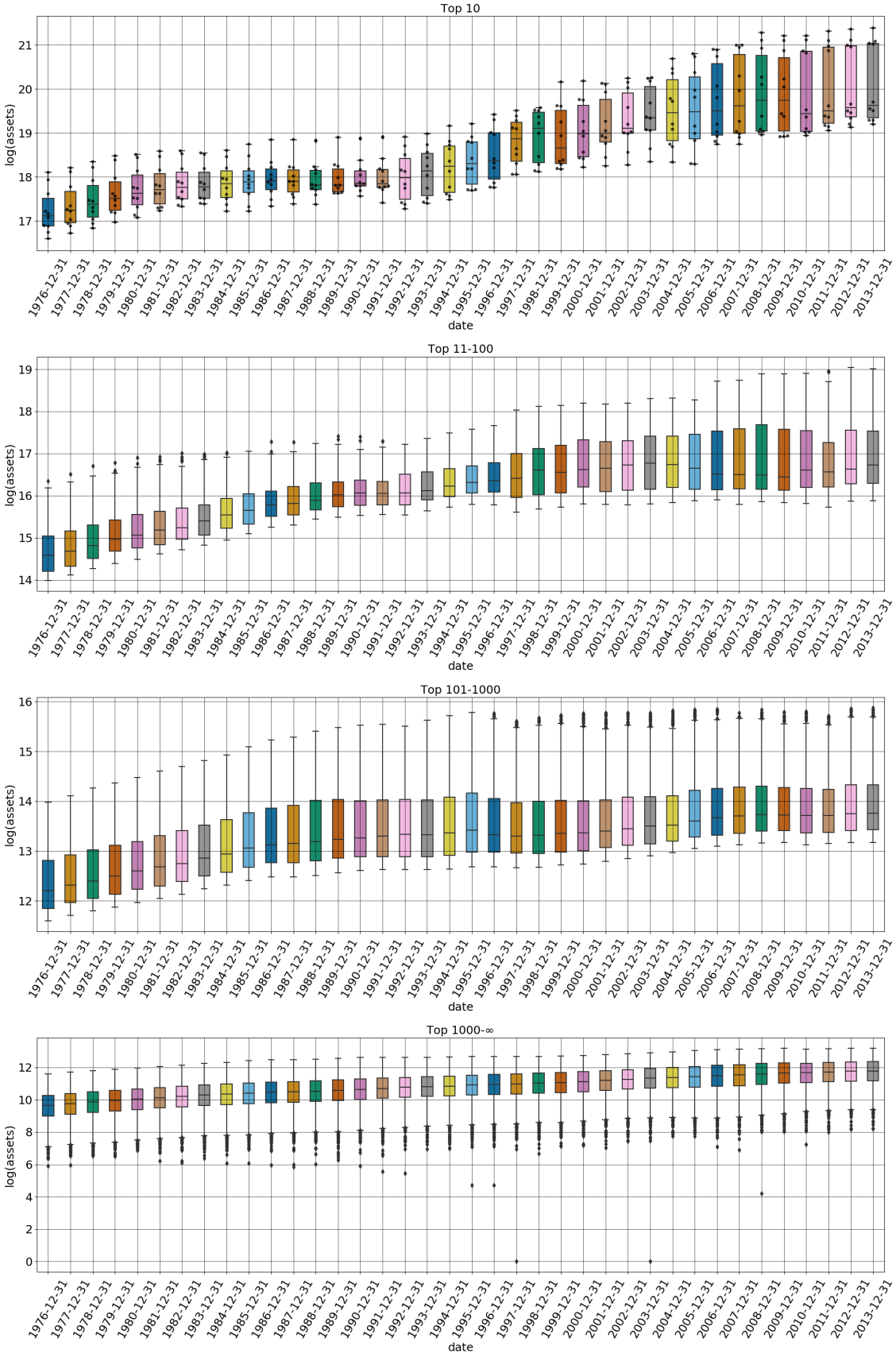
To get an overview of what asset sizes each category covers Figure 13 contains boxplots for each category and year. Within all categories we can see a consistent rise of overall asset sizes.
In 1976, every top 10 bank has a asset size lower than a quarter of a trillion asset. In 2013, the median asset size of the top 10 banks was 0.32 trillion (10^{12}) with banks going up to an asset size of just under two trillion.[3] We can also see a clear rise in heterogeneity over time regarding the asset sizes of the top 10 banks. The Interquartile Range (IQR) get to its largest size until the end of the time-frame.
Large banks began with an asset size way below $0.25 * 10^{11}$ in year 1976 and worked their way up to asset sizes up to $1.75 * 10^{11}$ dollar in year 2013. The heterogeneity of large banks regarding asset size also increased over time.
Medium banks ranges between $0.25 - 8$ billion (10^9) dollar assets per bank and small banks between $0.25 - 5$ hundred million dollars assets over our time-frame. Similar to what we will see later, the top two categories benefit more from the asset size increases. Compared to the asset increases within the top 10, the typical small bank did not show any significant gains over time. Overall, the fact that the chosen categories do not have

[2]Our choice of categorization could have been different. The asset size ranges they cover, differ over the years. This can be seen as an advantage or disadvantage. On the one side they evolve over the years and possibly match changing asset size levels. On the other side, there is a risk of distributional changes among the asset sizes of banks, making our chosen categorization unsuitable.

[3]Note, we have not combined commercial banks with their matching bank holding company. Bank Holding Companies have asset sizes beyond two trillion.

many outliers strengthens our choice of categories. Only the small banks category has a decent amount of outliers with an asset sizes way lower than the median small bank.

Figure 13: Boxplots for each category [a]

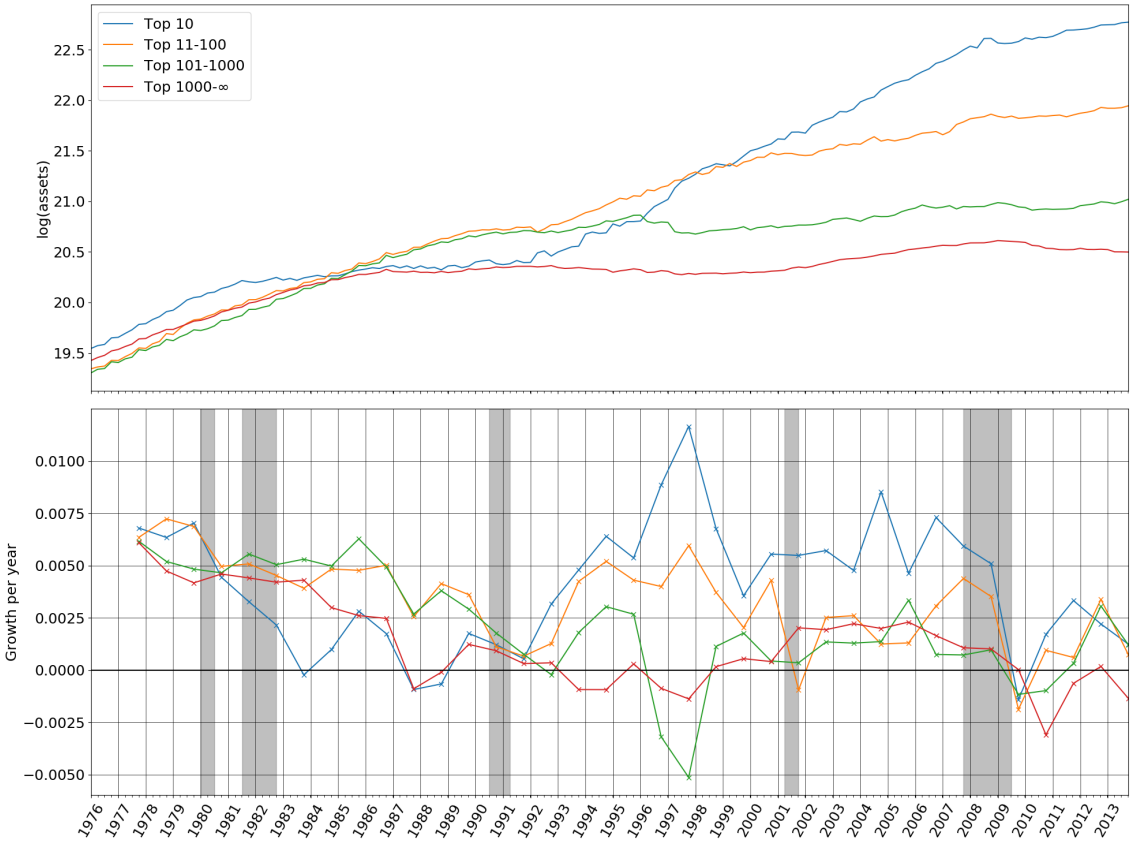


[a]Asset data is logged. Coloured boxes cover the mid 50% of asset sizes - IQR:25th Percentile to 75th Percentile. For the top 10, all individual data-points are marked as dots. For the rest, only outliers are marked as dots. Outliers are data-points above 1.5 times IQR.

2.5.2 Trend and Cycles of total assets by category

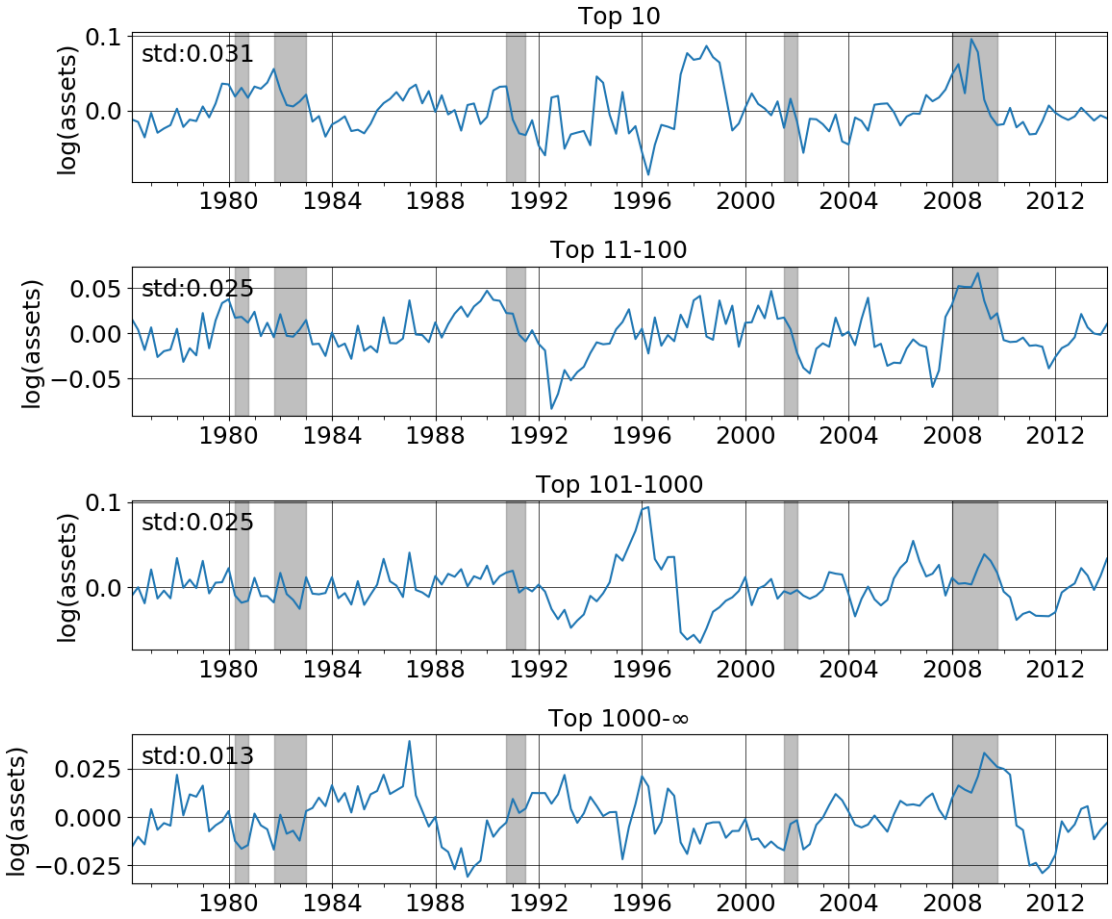
Figure 14 shows us the development of aggregate assets by the defined banks categories over time. There a key points in time for each category that marked changes in their asset growth. From the start of our chosen timeframe 1976 until 1985 all the categories showed similar growth behaviour. Then, in year 1984, growth of the top 10 assets started to slow. Shortly after that, year 1985 marked a starting point of flat, low growth for the small banks. The small banks did not recover from this low growth until the end of our chosen timeframe. An obvious reason for this could be the fact that the total number of banks also fell. Table 9 shows the year 1984 marked a starting point for a continuous fall in the number of banks. Category two and three asset growth, covering the banks ranked from $11-1000$, are alike each other until 1992. From this point in time, the banks ranked $101-1000$ entered a period of low and negative growth, while the banks ranked from $11-100$ went on a period of high growth, together with the top 10 banks. In the 1990s, a lot of regulation reforms occurred, aiding the growth of larger banks. These reforms are mentioned in section 2.1 and could have been key drivers for the growth of larger banks in the 1990s. In 2001, the growth rate of banks ranked from $11-100$ also declined. The top 10 banks assets, however, kept growing until the financial crisis in year 2008.
In Figure 15 we can see assets cycles by each category over time. All bank categories were more or less affected by the crisis in 2008. For each category we see a spike, followed by a fall in assets. The top 10 banks were affected the most. However, they also have higher volatility overall. The figure also shows the standard deviation of aggregate assets by category. The larger the category the larger the standard deviation of the business cycles. Similar to behaviour of all aggregated banks in 2.3 the spikes in 2008 occur after the begin of the crisis defined by the NBER. This might be related to the fact that it was the shadow banking sector not the commercial banking which was first impacted by the crisis. Medium and small banks experience significant downturns after their spike, with their cycles falling below the trend. Only the top 10 do not follow this behaviour. Their cycle does not significantly fall below the trend after their spike.

Figure 14: Total assets by bank category [a]



[a]

Figure 15: Asset cycles by bank size category [a]



[a]

2.5.3 Correlation between asset categories

This section will look at the similarity between the categories asset cycles. It might convey different balance sheet behaviours by bank size.

Table 16 shows the linear correlation between assets cycles over time for each category. As one might expect, all categories are positive correlated with the category just below themselves. However, there are significant differences when going beyond that. Category 1 (Top 10 banks) has a negative correlation with category 3 (Top $101 - 1000$) of -0.27 and no correlation with category 4 (Top 1000-Rest). Although a negative correlation of $r = -0.27$ is not strong, this difference in business cycle timings would probably not be expected. It means that while the top 10 banks might go through a period of decreasing assets, the Top $101 - 1000$ might go through a period of increasing assets. However, a closer look at the graph indicates that the main driver for this negative correlation could be the period from 1996 to 1999. Indeed, excluding this time-period from the correlation computation reveals an $r = 0.05$. Similar to the relationship between top 10 and small banks (cat4), this complete lack of cyclical relationship between large banks and small

banks underlines their independence of balance sheet decisions in regards to the other category.

We also computed the autocorrelations to take into account different timings. Significant asset changes of the top 10 might not have an immediate effect on the other categories in the same period, but perhaps one quarter later. We go up to ten quarters back to see possible impacts. The associated tables can be found in the Appendix (Figure 33). An interesting observation can be found for the correlation between category 1 and category 2 (lag 1) one period later. The correlation did rise from 0.4 to 0.43 with an one quarter lag. Indicating that large banks (cat 2) react slightly delayed to the decisions of the top 10 banks. The rest autocorrelations show no sign of anomalies.

Figure 16: Correlation between assets of each category [a]

	cat1_assets	cat2_assets	cat3_assets	cat4_assets
cat1_assets	1.0***	0.41***	-0.27***	-0.07
cat2_assets	0.41***	1.0***	0.24***	-0.05
cat3_assets	-0.27***	0.24***	1.0***	0.41***
cat4_assets	-0.07	-0.05	0.41***	1.0***

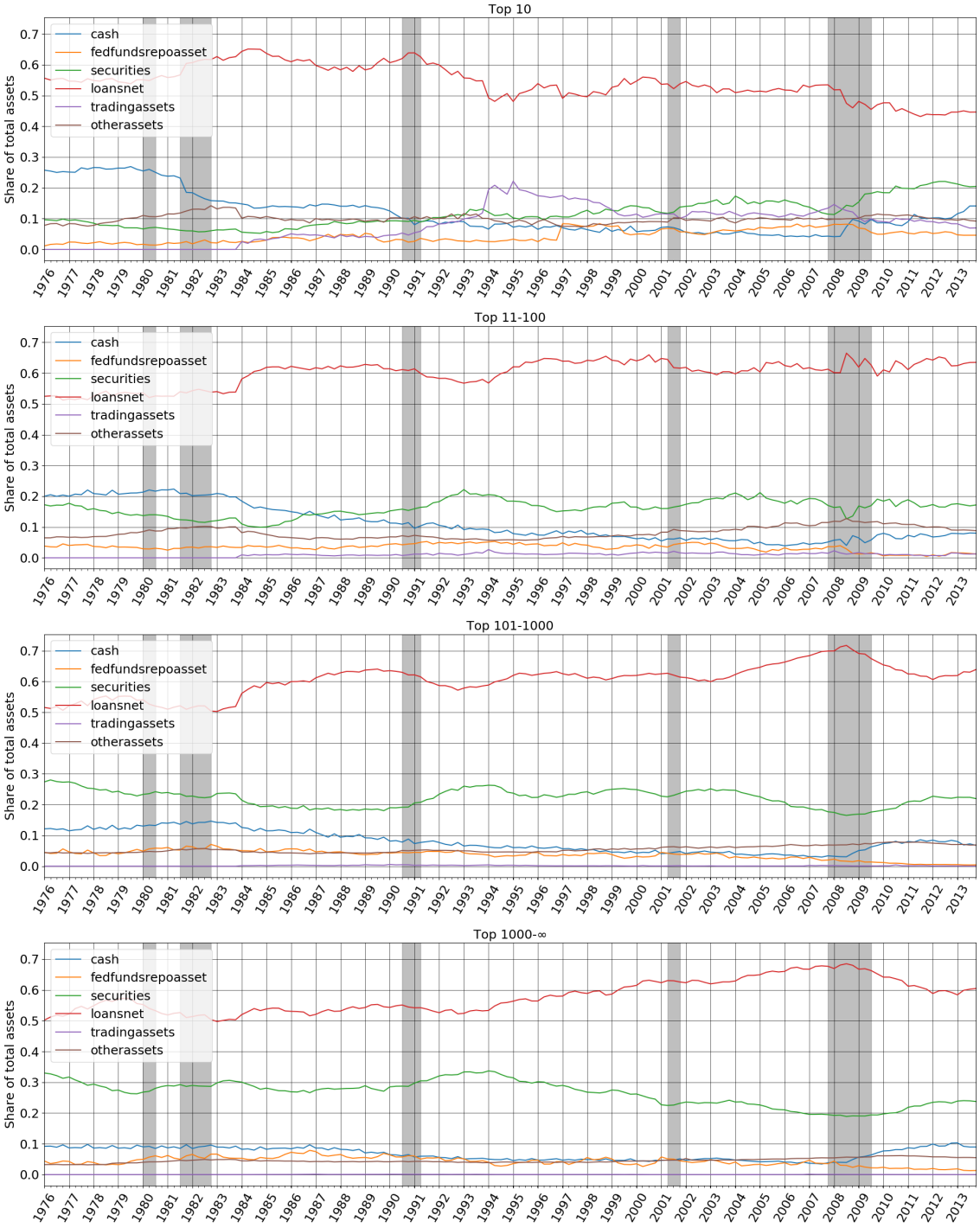
s

[a]Pearsons Correlation Coefficient

2.5.4 Balance sheet composition by category

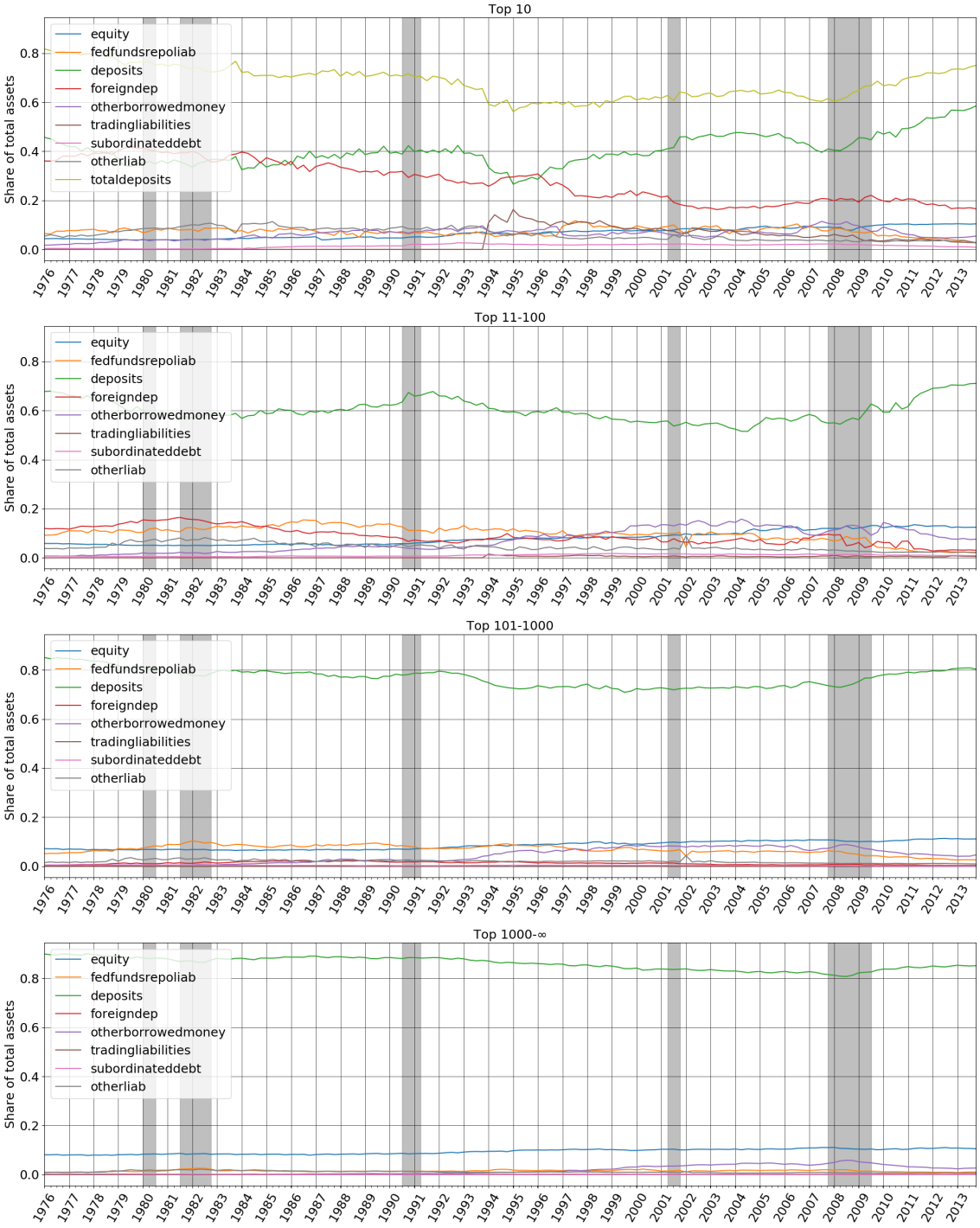
To get an understanding on the balance sheet composition by category and how they differ, Figure 17 and 18 show the share of each account for both sides of the balance sheet. Loans continue to be the highest share on the asset side for all categories. Interestingly, all other categories beside the top 10 banks, show an increasing trend for share of loans. But the top 10 banks share of loans fell over our time-frame. Furthermore, only the top 10 are engaging in proper trading with a share of trading assets beginning to rise significantly in year 1994. For the liabilities, deposits are a main source of funding for all categories. However, the share of deposits varies between the categories. Larger banks tend to have a lower deposit share than medium and small banks. The share for the top 10 is between $60\% - 80\%$ and for the top 11-100 at 60% most of the time. Medium banks have a share that is consistently at 80% and small banks a share of almost 90%. Hence, other forms of finance are relatively low for smaller banks. Our findings confirm the pattern: The larger the bank is, the more alternative ways of financing beside deposits are facilitated.

Figure 17: Share of total assets for each balance sheet account [a]



[a]

Figure 18: Share of total liabilities for each balance sheet account [a]



[a]

2.6 Leverage

2.6.1 General

In this section we are going to take a look at the leverage of commercial banks. Leverage is a well known and often used concept for monitoring risk and health of financial institutions. While there are a few definitions of leverage, given the dataset we are working with, focus will be on accounting leverage: Total assets divided by total equity capital[4]. Banks use leverage to improve their return on equity. As long as the interest on external capital does not exceed the total capital ratio, raising external capital, thus increasing leverage, is beneficial for a bank. With this incentive in mind, it might not come as a surprise that when shareholder ask for a high return, increases in leverage follow. As a result the buffer to cover losses in case investments turn bad is reduced. As a result, increases in leverage can be seen as increases in risk.
We took into account that policy makers set capital requirements on banks on their highest organizational level and aggregated all commercial banks to their belonging bank holding company. We are also removing all banks with negative equity from the dataset as they can be considered bankrupt.[5] We only want to assess leverage behaviour of still operating banks. For more information about bankrupted banks in the dataset see section 2.3.

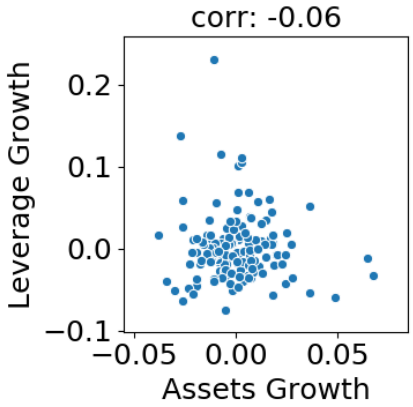
When looking at balance sheet leverage, it is important to realize its dynamics in regards to business cycle movements. Lets assume, we have a negative business cycle and asset values are falling together with the bank experiencing losses. This reduces banks equity. As balance sheet leverage can be written as $(equity + liabilities)/equity$, this would result in increased leverage, assuming liabilities do not change. Hence, when banks do not actively adjust their balance sheet towards business cycle changes, leverage behaves countercyclical. However, Adrian and Shin, 2010 showed that commercial banks tend to actively manage their balance sheet by trying to keep their leverage constant. Figure 19, showing the growth of average leverage for all commercial banks in regards to aggregate assets growth, supports this theory. Many observations show no changes in leverage, when assets change. However, Adrian and Shin, 2011 use different data and come to the conclusion that leverage is pro-cyclical. Instead of computing the average leverage, they computed leverage by aggregating assets and equity of all commercial banks first. Essentially computing leverage of the commercial banking market as a whole. Instead of following this approach, we also consider the relationship of average leverage with the growth of total assets of different bank sizes. We know from previous 2.5, that different bank sizes do differ in their behaviour. Figure 20 gives us scatterplots between asset growth and leverage growth by category. Indeed, positive relationships (pro-cyclicality) can be identified within all bank size categories.

[4]Tier 1 capital, as defined in Basel III.

[5]Banks with negative equity, do not report financial information in the following periods. Only in the rare case of bailouts, they survive.

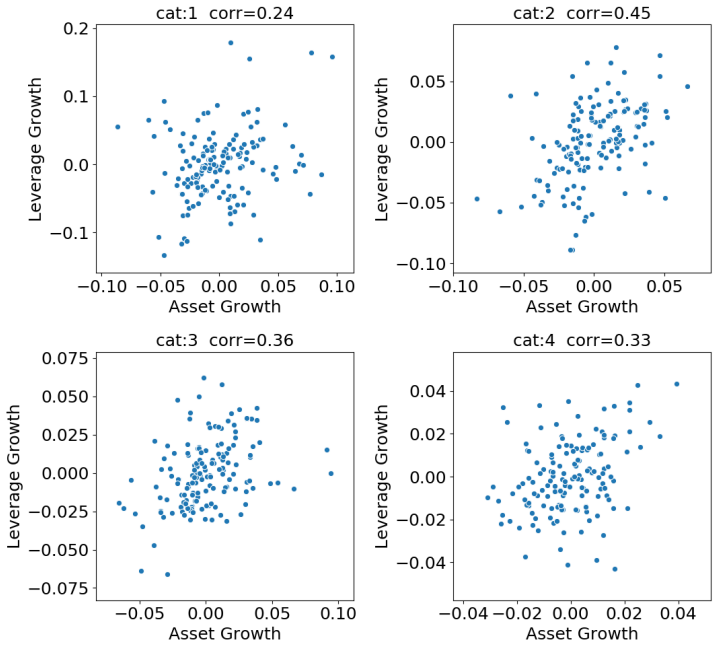
Now that we have established this positive relationship, it is important to recall what it tells us. We know that with passive behaviour by banks, leverage should be counter-cyclical. The identified pro-cyclicality now, not only indicates that banks actively adjust their balance sheet, but they are increasing leverage in good times and decreasing leverage in bad times. Banks are taking on additional debt to not just balance the usual negative relationship, but to lever their assets even further.

Figure 19: Scatterplot: Cylical Assets vs Cyclical Leverage (All commercial banks) [a]



[a]We compute the leverage for each bank individually and then take the average. With that average, we then compute cyclical growth by applying the HP-Filter. We aggregate all assets per year and quarter and then compute cyclical growth.

Figure 20: Scatterplot: Cylical Assets vs Cyclical Leverage by Category [a]

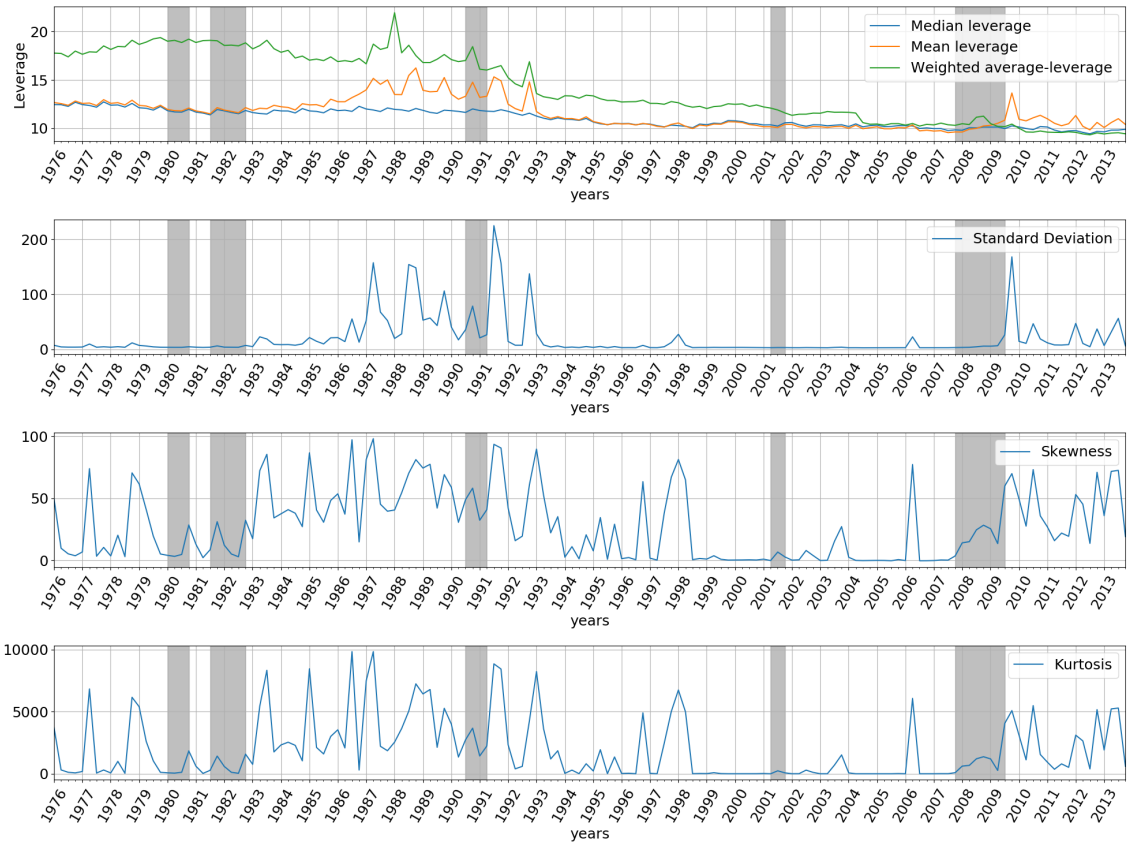


[a]We compute the leverage for each bank individually and then take the average. With that average, we then compute cyclical growth by applying the HP-Filter.

2.6.2 Leverage development

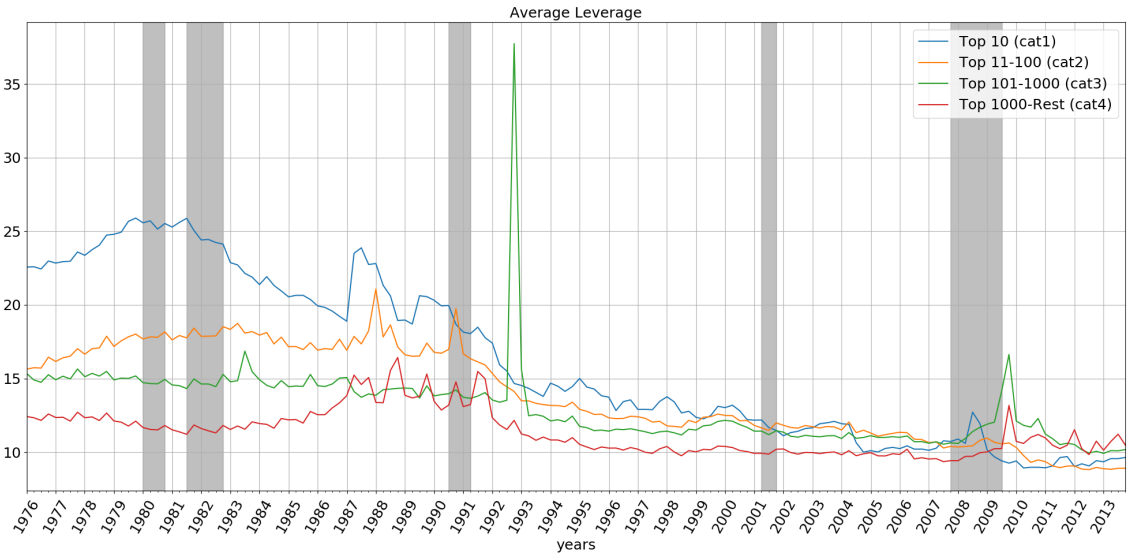
Long-term discussion Figure 21 shows the mean, median and weighted-average leverage for each point in time. We can see the clear impact of high leverage banks on the average. Especially, in the periods around 1990 and 2008 where bankruptcy levels are high, there are major leverage increases in Figure 21 on the mean leverage. Looking at the median gives us a clearer indication how leverage among healthy banks look. Hence, depending of what type of measure we choose (average, median...), we arrive at different observations. The only consistent information conveyed by all measures is a falling trend in leverage from year 1976 to 2013. The median, representing the typical bank, started with a leverage of 12.5 in 1976 and fell continuously over the years to 10 in 2013. The mean also fell from 12.5 to 10. It had some short-term fluctuations around the crisis in 1990 and 2008, which we will elaborate on later. The weighted-average leverage, which takes into account the asset size, started of with a significant higher leverage level of 18, but then also fell to a leverage of 10 in 2013. The idea behind the weighted leverage is that larger banks with more assets have a stronger impact on the overall systemic risk than smaller banks. The significant measurement differences between the common average and weighted leverage, marks the importance of differentiating between asset sizes in leverage analysis. Also, as seen in Figure 10 the small banks (banks ranked from 1000-Rest) dominate the bank landscape in quantity. As a result, the overall leverage average and small banks leverage average (cat 4) are almost identical. The first graph in Figure 22 shows the average leverage for each defined bank size category. Here we can also see an overall falling trend in leverage along all categories. This can be attributed to regulatory efforts such as Basel $1, 2$ and 3. In addition, the graph shows an interesting pattern until year 1993 - the larger the bank is the more leverage it takes. However, after year 1993, the pattern seems to disappear. In 2013, the pattern even reversed - the larger the bank the lower the leverage. These observations are closely linked to information gathered in section 2.4. If the top 10 banks would have kept their higher leverage, their significant rise in total asset share from year 1993 and onwards would have resulted in major leverage increases for the whole bank sector. Hence, regulators adjusted their regulations to target systemically important banks with even stronger capital requirements (G-SIB Framework). The top 10 banks, our category 1, are affected by these additional capital requirements.

Figure 21: Median and Average leverage for all banks [a]



[a]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.

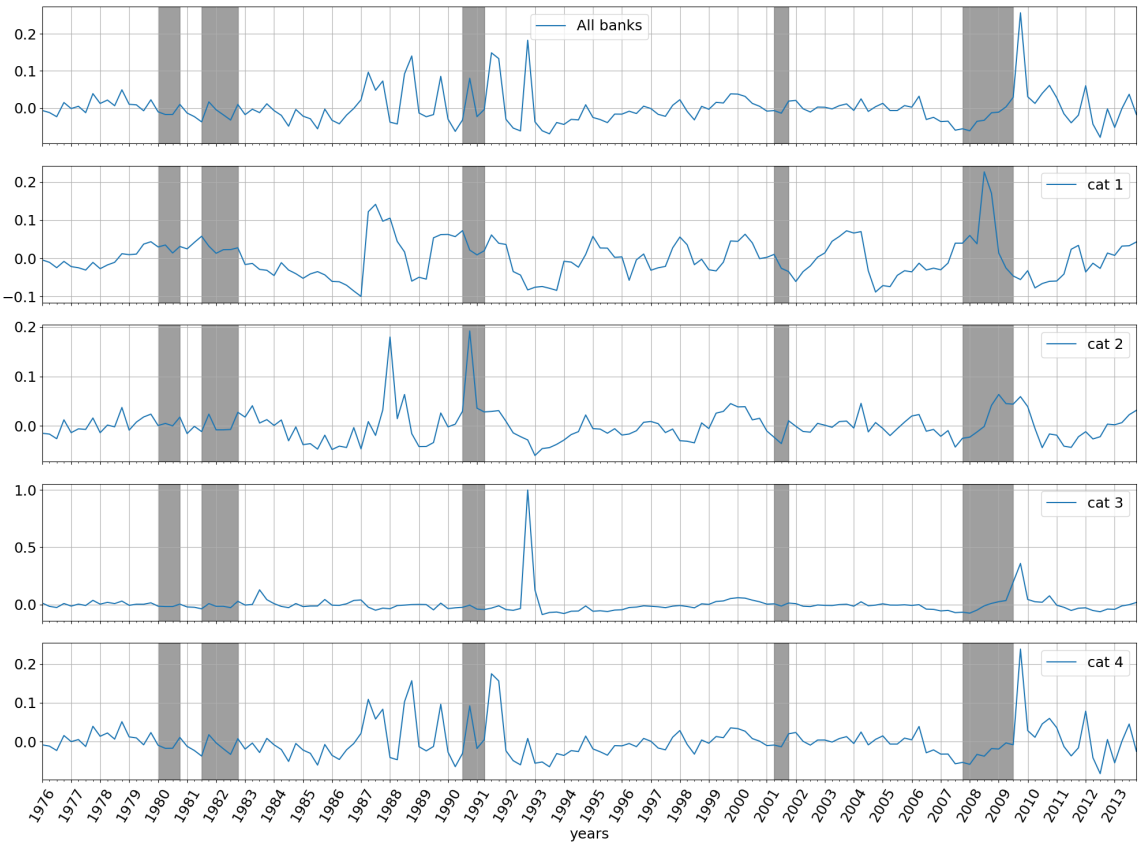
Figure 22: Average leverage by category [a]



[a]

Short-term discussion For short term analysis, we are considering the cyclical component and standard deviation of leverage. The standard deviation already indicates the already mentioned two critical periods - the crisis in 1990 and 2008. Looking at the first graph in Figure 23, the cyclical graph marks those same periods. However, similar to the standard deviation, the spike in average leverage for all banks occured right after the NBER crisis definition. We know that small banks drive the average leverage with their quantity. Hence, their cyclical components - graph 1 and graph 5 - in figure 23 are almost identical. In comparison to the small banks, the cyclical leverage of the top 10 banks actually spikes in the crisis in 2007-8, indicating top 10 banks counter-cyclical behaviour. The mid-categories two and three show behaviour right between the two extreme behaviours of categories one and four. Category two has small peaks during and after the crisis. Category three only has a peak up to 2 after the crisis, closer resembling category four. Note, the graph of category three cyclical leverage contains some extreme outliers in year 1992Q4, which increased the limits of the vertical axis up to 20. To ease analysis, table 24 gives us the actual cyclical values of the average leverage for the crisis periods. We marked changes > 0.04 with red color. Similar to the graph, we can see a spill-over effect of high leverage from large to small banks. Figure 29 gives us a visual insight into the structural changes that occurred regarding asset size and leverage. Each data-point represents one bank. We can see a clear increase in dispersion of leverage in year 2009 among the small and medium banks. This aligns with the standard deviation shown in Figure 26, where the standard deviation also has a spike in 2009. An interesting pattern within the standard deviation is the increasing volatility the smaller the asset size category becomes. Hence, within smaller banks we see much higher differences in leverage.

Figure 23: Cyclical average leverage by category [a]



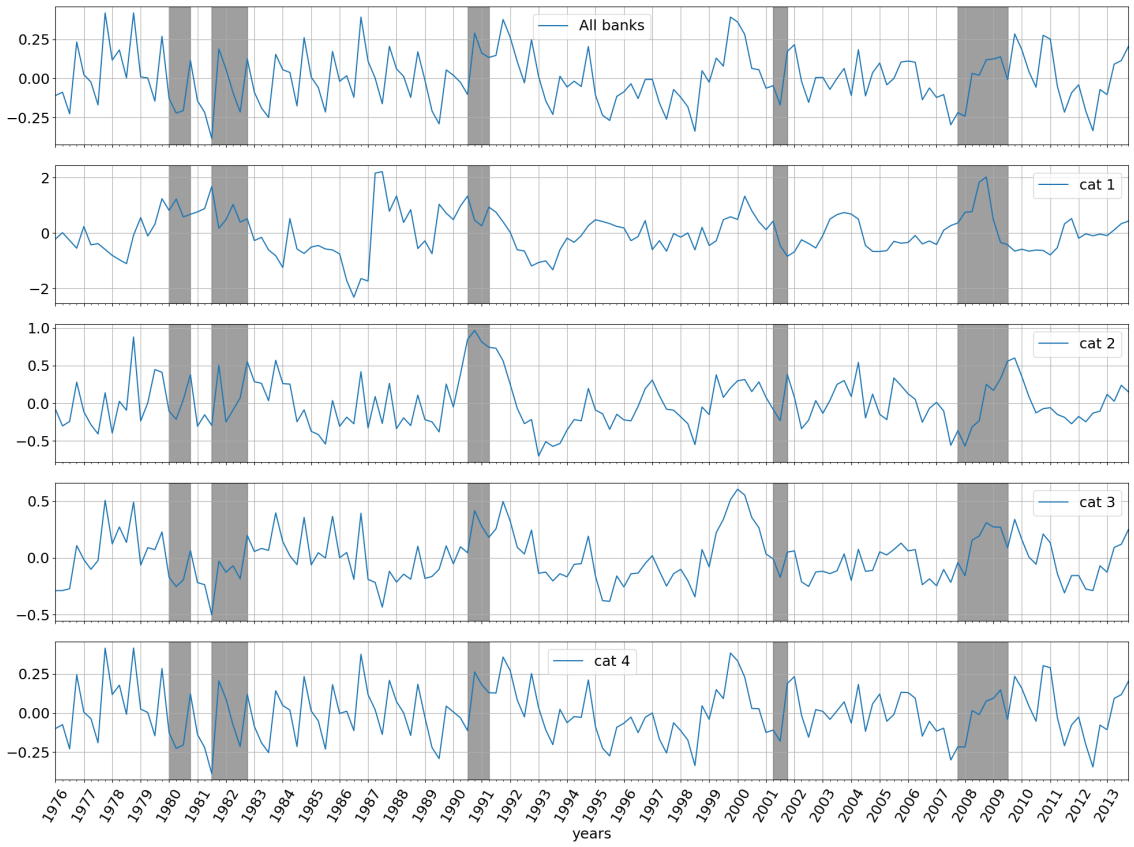
[a]Category 3 contains a banks with leverage over 10000 in year 1992Q4, which results in this exorbitant high spike.

Figure 24: Cyclical Average Leverage [a]

year	quarter	cyclical_leverage_cat1	cyclical_leverage_cat2	cyclical_leverage_cat3	cyclical_leverage_cat4
2007.0	1.0	-0.029887	-0.021031	-0.056249	-0.032116
	2.0	-0.012429	-0.009437	-0.051671	-0.031969
	3.0	0.039798	-0.042668	-0.071142	-0.057048
	4.0	0.039783	-0.024953	-0.067480	-0.053403
2008.0	1.0	0.060017	-0.022654	-0.075584	-0.058472
	2.0	0.038200	-0.012307	-0.048921	-0.032843
	3.0	0.226450	-0.001022	-0.011661	-0.037448
	4.0	0.170388	0.041481	0.009405	-0.017864
2009.0	1.0	0.014133	0.063467	0.024552	-0.018963
	2.0	-0.025306	0.045066	0.034259	-0.003208
	3.0	-0.046115	0.044002	0.195956	-0.008145
	4.0	-0.055506	0.059162	0.358070	0.238390
2010.0	1.0	-0.032219	0.038947	0.043614	0.028410
	2.0	-0.077345	-0.005151	0.023953	0.011182
	3.0	-0.065939	-0.043899	0.019594	0.045642
	4.0	-0.060088	-0.016217	0.075700	0.059942

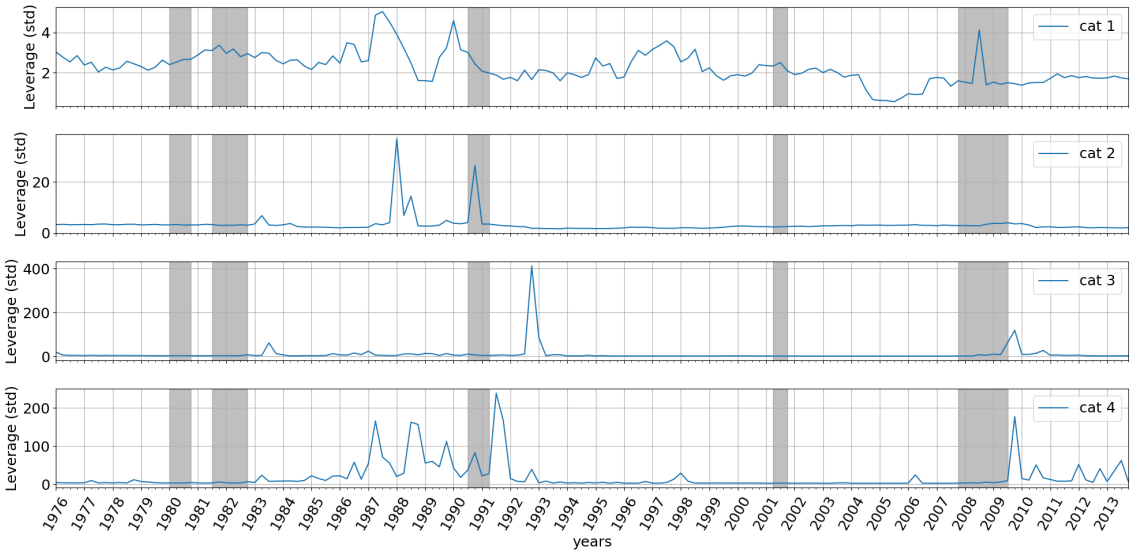
[a]

Figure 25: Cyclical median leverage by category [a]



[a]

Figure 26: Standard deviation of average leverage by category [a]



[a]Category 3 contains a banks with leverage over 10000 in year 1992Q4, which results in this exorbitant high spike.

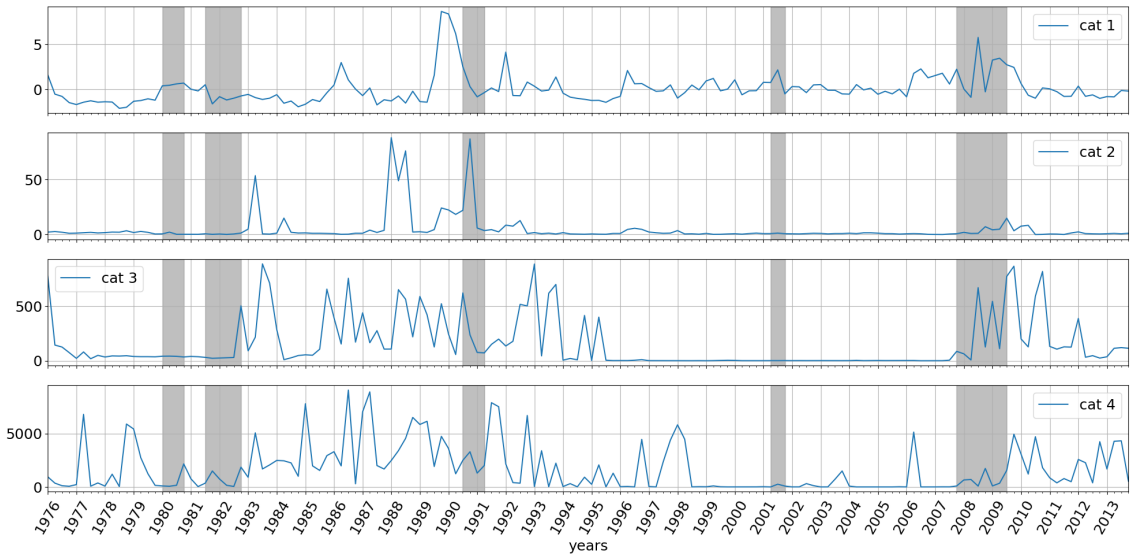
2.6.3 Leverage distribution

Long-term discussion In regards to the distribution of leverage, we have plotted the skewness as well as the kurtosis for all banks together in figure 21. Both variables behave similar. There are periods of strong as well as low variation. Notable periods of high variation are the S& L crisis around 1990 and the crisis in 2008. Since high positive skewness means the graph is right-skewed with the mean being higher than the median and high kurtosis indicates heavy tails, together they prove the existence of high positive outliers. The periods with low variation in turn indicate periods of normal distribution leverage. Furthermore, the two variables only move in the positive direction (values of zero and above). For the skewness, this can be explained by the fact that banks are kind of stiff to the lower boundaries of leverage, with not much variation happening within banks of the left tail of the distribution. But there is much more variation happening between banks located at the right tail of the distribution - banks with leverage above the mode. The consistent positive kurtosis in turn tells us that we have never less outlier than a normal distribution. Figure 28 and 27 give us the distribution information by asset category over time. It is important to note that the overall distribution was mainly driven by smalls banks because of their sheer quantity. Thus, the division by categories gives us a clearer view. Again, skewness and kurtosis are behaving very similar. For the top 10 and top 10-100 (cat2) banks, we have short periods where the skewness moves below zero. We take a look at those periods in the short-term discussion. The rest of the time, both measures are either zero or above for all categories, suggesting that once you have a certain amount of banks, the distribution tends to be right skewed. In general, we can deduce that most of the distributional changes in our graphs are driven by two factors:

1. Already high levered banks increasing their leverage even more (high skewness)
2. Increases of outliers (high kurtosis)

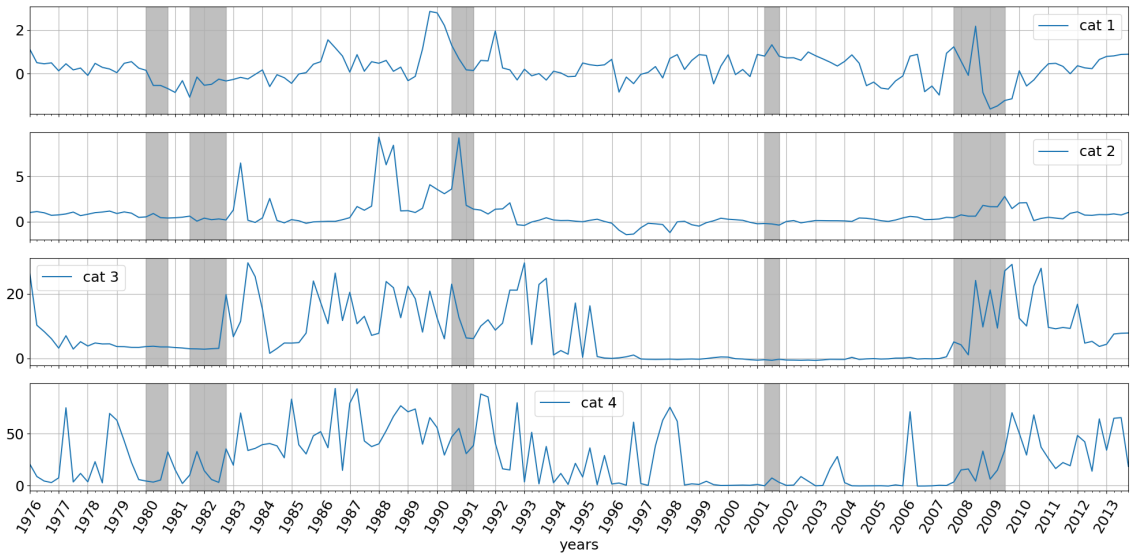
These factors seem to be most present during the S& L crisis around 1990 and the crisis in 2008. Hence, the significant graph movements around that time-periods. The top 10 banks have negative kurtosis in some periods, which just means that their leverage ratios became really similar in these periods. They also show much less distributional volatility around the S& L crisis, compared to the rest categories. Actually, when moving along our categories, the distributional changes are higher the smaller the banks become. This aligns with the arguments made about the standard deviation in the sections before.

Figure 27: Kurtosis of leverage by category [a]



[a]

Figure 28: Skewness of leverage by category [a]

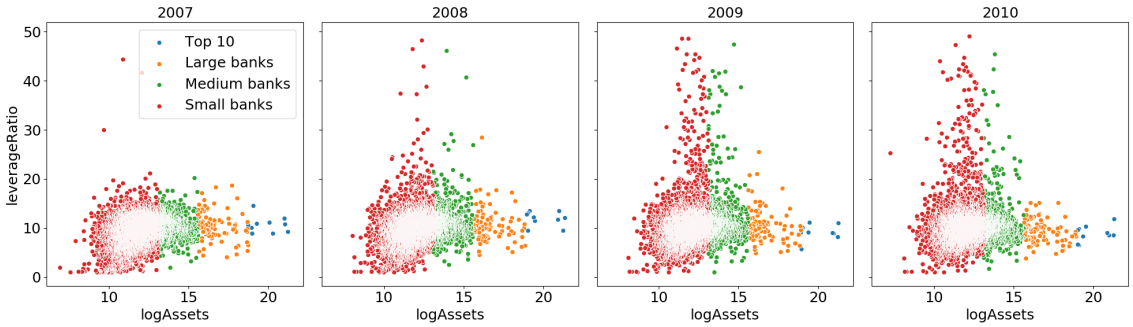


[a]

Short-term discussion As mentioned, in our short-term analysis we investigate the reason skewness turns negative in some periods. The negative measurements of the top 10 in the crisis 2008 are particular interesting, since we associate crises with already high levered banks increasing leverage even more. However, this could indicate some low levered banks within the top 10, became high leveraged as well. The skewness rises from 2008Q1-2008Q3 and then it takes a dive in 2008Q4 and 2009Q1. As a result, the distribution of leverage is left skewed in 2008Q4 and 2009Q1. This left skewness also means that the mean is to the left of the peak. To have a better overview, Figure 30

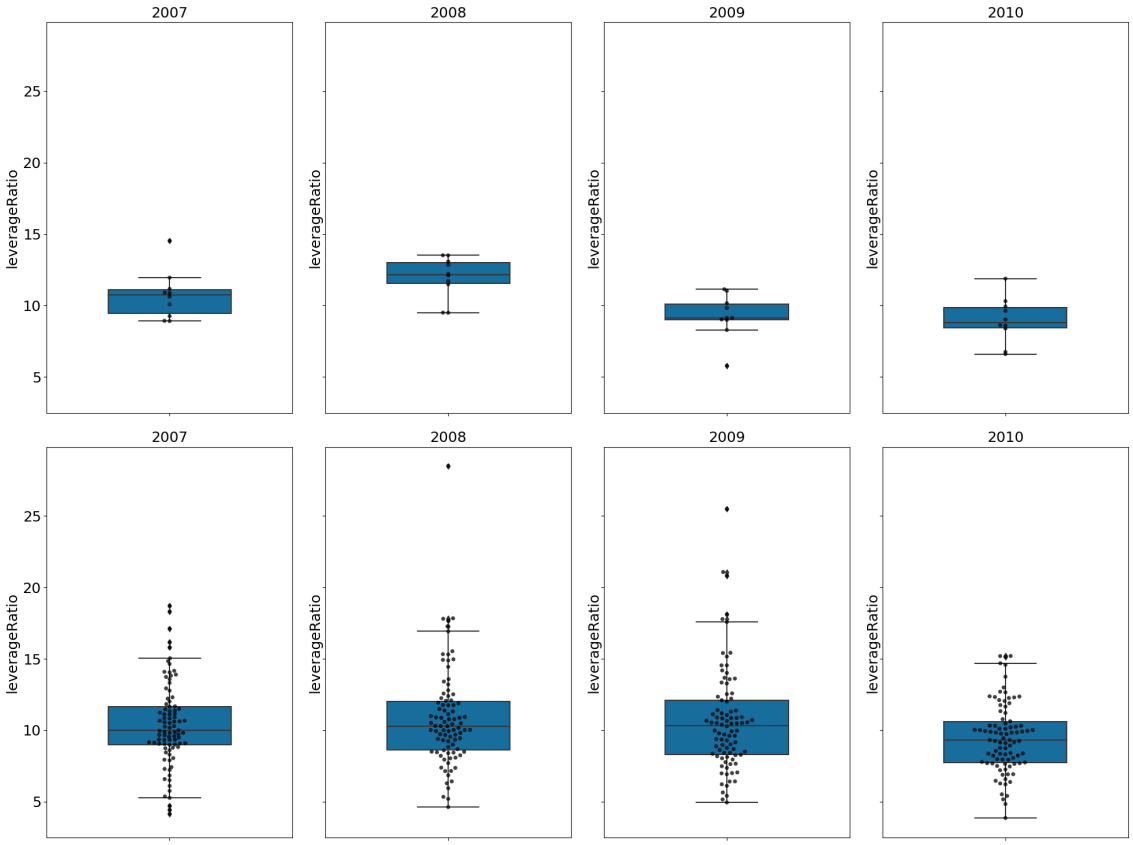
combines a boxplot with the top 10 banks leverage marked as a dots for the year and quarter in question. The boxplot moved significantly up from 2007 to 2008. In addition, the lower whisker increased as well. Both of these observations are characteristics of left skewness. We see here an overall increase in leverage among top 10 banks, which are not only driven by outliers. This has a significant impact on the bank industry as despite being small in numbers, the asset share of the top 10 was 60% in year 2013.

Figure 29: Scatterplot: Assets/Leverage [a]



[a]Banks with leverage ratios beyond 50 are considered as outlier and not included. Each data-point represents one bank.

Figure 30: Boxplot: Leverage data points [a]



[a]The first row of plots represents top 10 (cat1) and the second row top 10-100

3 Evaluation and Outlook

In general, this article gives a broad overview over the U.S. commercial bank landscape and key important factors that should be considered. We find interesting trends and cycles on an aggregate level as well as for different bank sizes. Many points discussed are open for interpretation and future work should go into more detail about the approached topics. For instance, it would be interesting to find an optimal way to categorize us commercial banks. The literature seems to have found no coherent way of categorization. These categories would obviously be of key importance to regulators. Furthermore, as seen from the large amount of literature about leverage there is wide variety of possibilities to explore it in greater depths. One might consider the relationship of leverage not just with assets, but GDP and other variables.

Moreover, commercial banks are just a part of the financial intermediaries an existing economies have. The so called shadow banking sector does play a major role in today's financial industry and hold a significant share of total assets. It also were investment banks which had to bear the major impacts of the financial crisis in 2007, not commercial banks.

Lastly, another factor we have not considered is that according to **Kalemli-OzcanBentSorensenSevca** a big fraction of assets, especially for large commercial banks, are off balance sheet items.

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A Appendix

Figure 31: Autocorrelation - Asset side [a]

	lag	assets	cash	fedfundsrepoasset	securities	loansnet	tradingassets	otherassets
0	0	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
1	1	0.668482	0.543616	0.678344	0.857966	0.874169	0.670577	0.686616
2	2	0.549088	0.385644	0.441868	0.663799	0.750934	0.462435	0.564927
3	3	0.383607	0.185667	0.262141	0.481113	0.582572	0.290667	0.429074
4	4	0.364207	0.276731	0.141942	0.259817	0.426244	0.183740	0.414830
5	5	0.094690	0.003499	-0.063425	0.026585	0.225113	-0.058170	0.243093
6	6	0.023946	0.023056	-0.208787	-0.153482	0.071170	-0.161202	0.167211
7	7	-0.114478	-0.179763	-0.294161	-0.288772	-0.092589	-0.247924	0.069033
8	8	-0.103289	-0.096091	-0.311070	-0.350237	-0.192288	-0.221654	-0.017683

[a]

Figure 32: Autocorrelation - Liabilities side [a]

lag	equity	fedfundsrepoliab	deposits	foreigndep	otherborrowedmoney	tradingliabilities	subordinateddebt	otherliab
0	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
1	0.723293	0.628063	0.328080	0.798504	0.731746	0.529164	0.805696	0.368007
2	0.449616	0.404419	0.292106	0.661453	0.541543	0.243973	0.689890	0.012917
3	0.179874	0.211710	0.055729	0.463610	0.361965	0.147006	0.509253	0.078217
4	0.009426	0.183654	0.348144	0.329830	0.283648	-0.132563	0.336406	0.145914
5	-0.103217	0.005744	-0.196956	0.117763	0.173004	-0.291591	0.190992	-0.091779
6	-0.109206	-0.058821	-0.179869	0.001884	0.064673	-0.387505	0.081116	-0.295527
7	-0.155159	-0.182500	-0.321517	-0.124807	-0.095045	-0.427252	-0.068200	-0.089373
8	-0.143907	-0.143367	0.106174	-0.155675	-0.215672	-0.382195	-0.173296	0.008344

[a]

Figure 33: Correlations: Category 1-4 [a]

lag	cat1_assets+cat1_assets	cat1_assets+cat2_assets	cat1_assets+cat3_assets	cat1_assets+cat4_assets
0	1.0	0.41	-0.27	-0.069
1	0.66	0.34	-0.26	-0.088
2	0.44	0.27	-0.18	-0.032
3	0.36	0.18	-0.11	-0.007
4	0.26	0.079	-0.084	-0.029
5	0.055	-0.057	0.044	0.0053
6	-0.029	-0.14	0.2	0.12
7	-0.11	-0.19	0.32	0.18
8	-0.18	-0.17	0.36	0.14
9	-0.21	-0.11	0.36	0.12

lag	cat2_assets+cat1_assets	cat2_assets+cat2_assets	cat2_assets+cat3_assets	cat2_assets+cat4_assets
0	0.41	1.0	0.24	-0.046
1	0.43	0.63	0.11	-0.19
2	0.4	0.53	0.12	-0.14
3	0.33	0.32	0.075	-0.16
4	0.31	0.3	0.21	-0.016
5	0.25	0.071	0.084	-0.15
6	0.18	-0.00094	0.12	-0.089
7	0.074	-0.13	0.11	-0.063
8	0.019	-0.12	0.2	0.068
9	0.019	-0.3	0.04	-0.033

lag	cat3_assets+cat1_assets	cat3_assets+cat2_assets	cat3_assets+cat3_assets	cat3_assets+cat4_assets
0	-0.27	0.24	1.0	0.41
1	-0.14	0.12	0.68	0.14
2	-0.04	0.14	0.53	0.025
3	-0.026	0.047	0.35	-0.09
4	0.048	0.1	0.34	-0.0024
5	0.095	-0.076	-0.0006	-0.17
6	0.13	-0.11	-0.14	-0.19
7	0.061	-0.19	-0.31	-0.23
8	0.048	-0.22	-0.29	-0.083
9	-0.089	-0.43	-0.45	-0.11

lag	cat4_assets+cat1_assets	cat4_assets+cat2_assets	cat4_assets+cat3_assets	cat4_assets+cat4_assets
0	-0.069	-0.046	0.41	1.0
1	0.0062	-0.12	0.22	0.71
2	0.036	-0.054	0.2	0.55
3	-0.033	-0.083	0.16	0.39
4	-0.0073	0.019	0.25	0.42
5	0.035	-0.1	0.051	0.15
6	0.055	-0.067	0.0012	0.016
7	-0.043	-0.12	-0.057	-0.13
8	-0.11	-0.08	0.054	-0.063
9	-0.2	-0.22	-0.058	-0.22

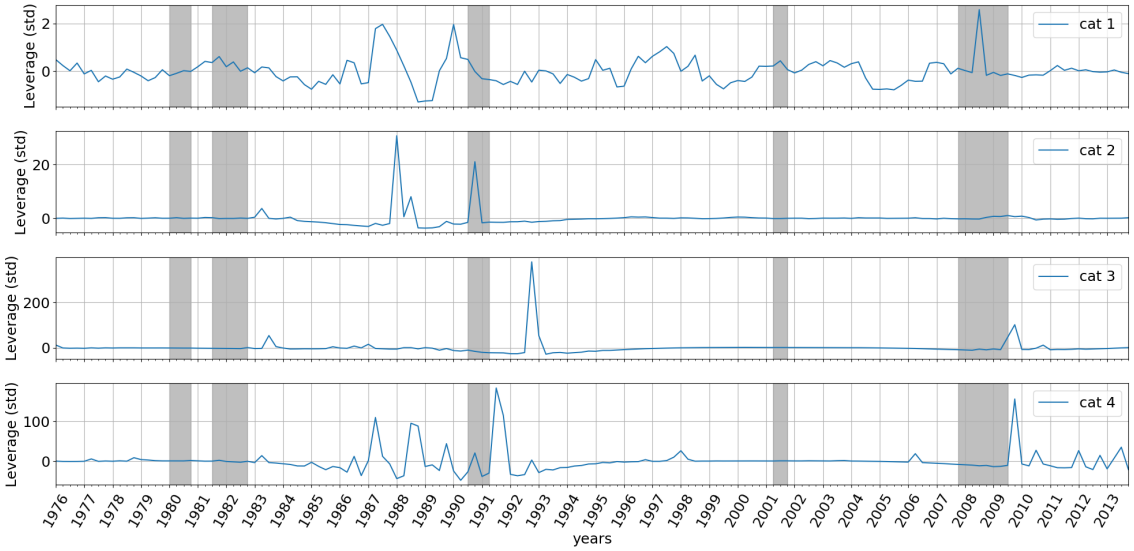
[a]This graph shows the correlation of a banks size category assets with the lagged assets of another banks size category. The category after the "+" is the lagged category. Hence, the first graph shows the correlation between categories 1 aggregate assets and all the different other categories lagged aggregate assets.

Figure 34: Banks count by asset size [a]

	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, 10000000000.0]	18.0	27.0	49.0	75.0	80.0	80.0	83.0

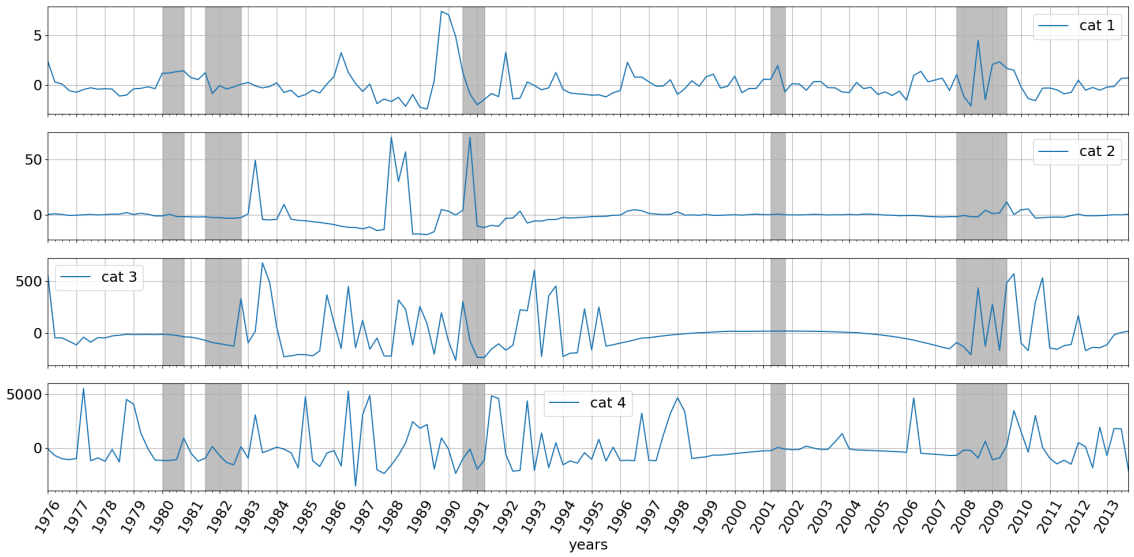
[a]The left column is the asset interval size and the corresponding row the number of banks per year.

Figure 35: Cyclical standard deviation of average leverage by category [a]



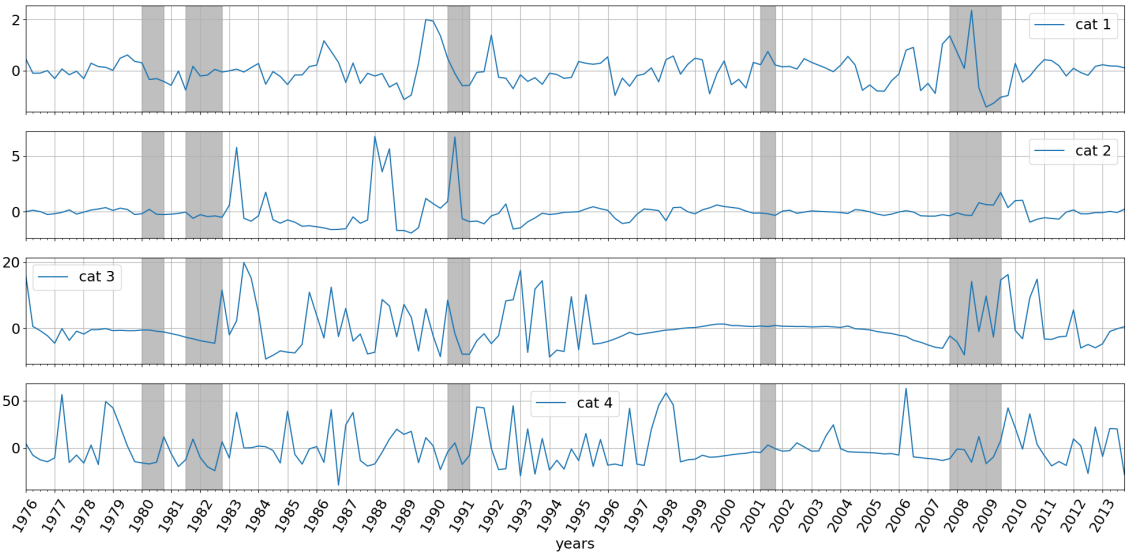
[a]Category 3 contains a banks with leverage over 10000 in year 1992Q4, which results in this exorbitant high spike.

Figure 36: Cyclical skewness of leverage by category [a]



[a]

Figure 37: Cyclical kurtosis of leverage by category [a]



[a]