Online Appendix

This document, not intended for publication, provides supplementary material to the paper "Measuring the Capital Shortfall of Large U.S. Banks."

OA.1 Measuring SEL for BHCs

Our main results are based on data at commercial bank level. As discussed in Section 3.1, we need to address two important issues to apply our methodology to BHCs. First, BHCs are not requested to provide as much information as commercial banks on the composition of their assets, in particular regarding the issuers of the securities held by the bank. Currently the data provided by BHCs on the composition of their assets is sufficient to construct the SEL measure. However, the historical data for some BHCs are not available or sufficiently detailed, and thus we did some data adjustment. Overall, there are 10 BHCs in our sample with missing data for a few years at the beginning of the sample. In 7 cases (mostly subsidiaries of foreign financial institutions), we used the data from the commercial bank subsidiary to represent the parent BHC. In 3 cases (Goldman Sachs Group, Morgan Stanley, and American Express Company), which were operating as an entity other than a BHC before the financial crisis and were not involved in any significant commercial banking activity, we could not compute their SEL before 2009, which is assumed to be equal to 0 until the end of 2008. As a result, before 2009 the estimated SEL for BHCs is only a proxy for the measure we would have constructed if we had full sample data for all BHCs.

Second, if we consider BHCs instead of commercial banks, we need to take into account the implicit guarantee of the BHC long-term debt by the government.[1] Arslanalp and Liao (2015) assumes that the government implicitly guarantees a fraction $(1 - \alpha)$ of all BHC liabilities, where α denotes the percent loss per insured liability. We follow a similar approach and proceed as follows: First, we compute the total capital shortfall of a defaulting BHC in an extreme downturn assuming that all liabilities (including long-term debt) are guaranteed

[1] Whereas long-term debt only represents 1.9% of commercial bank liabilities on average, it corresponds to 7.9% of BHC liabilities.

by the government:

$$SEL_{t:t+1}^{(BHC_i)} = (1+R_{Dep,t}^{(i)})Dep_t^{(i)} + (1+R_{SD,t}^{(i)})SD_t^{(i)} + (1+R_{LD,t}^{(i)})LD_t^{(i)} - E_t[A_{t+1}^{(i)MV} \mid A_{t+1}^{(i)MV} \leq L_{t+1}^{(i)BV} \text{ in a Market downturn}_{t:t+1}]. \quad (A.1)$$

This measure can be viewed as an upper bound for the cost to the government because it assumes that the government would bail out all debt issued by a defaulting BHC.

Second, we measure the implicit cost of the guarantee by the government of all the deposits and short-term debt and a fraction $(1-\alpha)$ of the long-term debt:

$$SEL_{t:t+1}^{(i)} = (1+R_{Dep,t}^{(i)})Dep_t^{(i)} + (1+R_{SD,t}^{(i)})SD_t^{(i)} + (1-\alpha)(1+R_{LD,t}^{(i)})LD_t^{(i)} - E_t[A_{t+1}^{(i)MV} \mid A_{t+1}^{(i)MV} \leq L_{t+1}^{(i)BV} \text{ in a Market downturn}_{t:t+1}]. \quad (A.2)$$

Following the calibration proposed by Arslanalp and Liao (2015), we assume $\alpha = 20\%$. As before, a default occurs when the mark-to-market value of the assets falls below the book value of the liabilities.

In Figure OA.1, we display the average probability of default and the aggregate SEL for the 34 BHCs covered by the 2017 stress test performed by the Federal Reserve Board. This list includes the two large investment banks, Goldman Sachs Group, Morgan Stanley, and American Express Company. We do not report the evolution of the probability of crash as it is the same as the one reported in Figure 4.

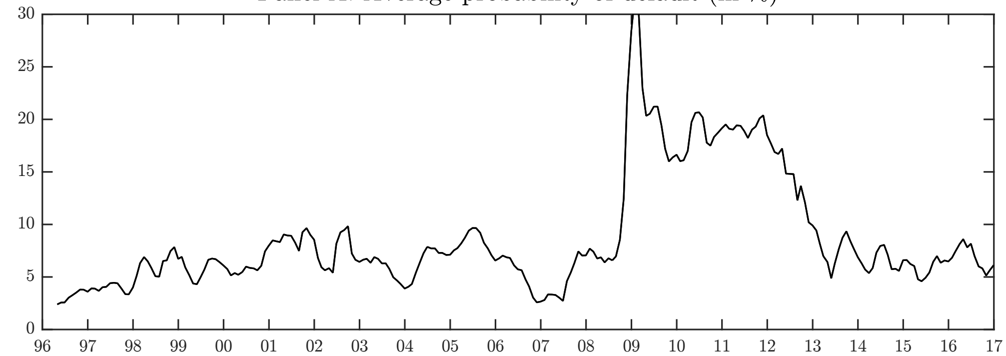
The average probability of default of BHCs is lower than the probability of default estimated for commercial banks. In January 2009, the average probability of default is equal to 40% for commercial banks and 30% for BHCs. Similarly, in December 2016, it is equal to 9% for commercial banks and 5.5% for BHCs. The main reason for this lower probability of default is that BHCs rely more on equity financing and therefore suffer slightly less in a market downturn.

For $\alpha = 0$, the aggregate SEL would be higher than our previous estimate for commercial banks for two reasons. First, we now use all BHCs of the list of the 2017 stress test (including Goldman Sachs Group and Morgan Stanley). Second, we assume that all long-term debt is guaranteed by the government. Numbers before 2009 are probably underestimated because we do not have sufficient details on the assets of Goldman Sachs Group and Morgan Stanley. During the financial crisis, SEL increases to approximately \$500 billion and remains at that level until 2013. After 2013, SEL varies between 300 and 400 billion. In percentage of total assets, the order of magnitude is close to our estimate for commercial banks.

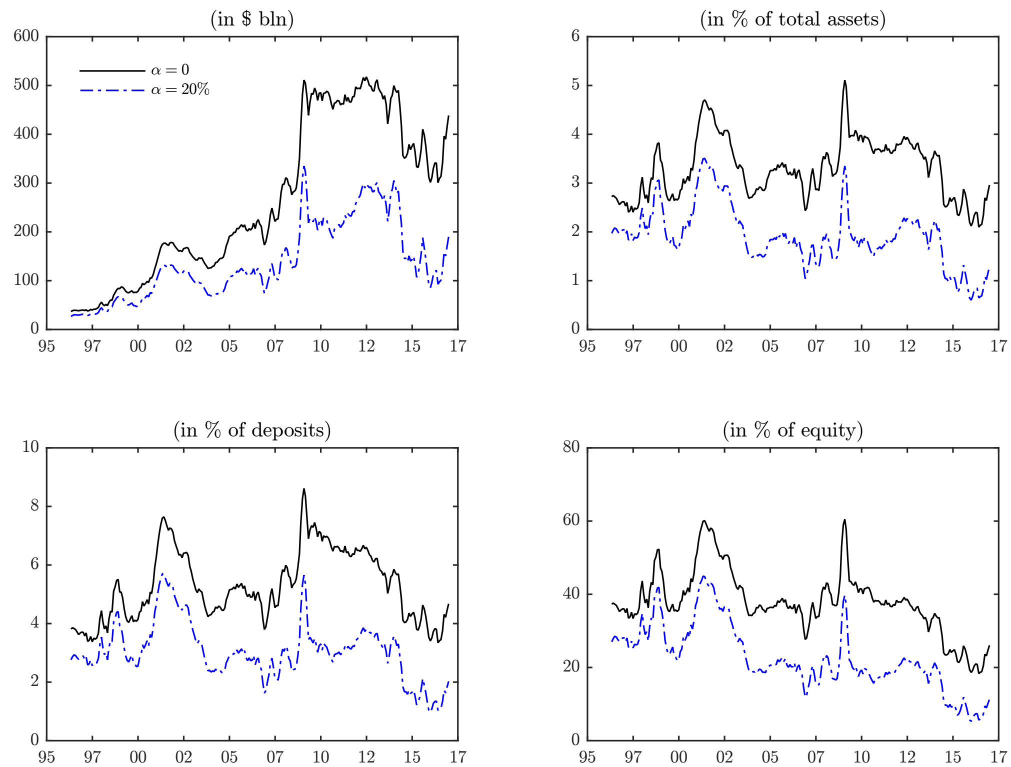
If we now assume that 80% of the long-term debt is guaranteed by the government, SEL decreases to approximately 300 billion between 2009 and 2013 and below 200 billion afterwards. This estimate is close to the SEL obtained for commercial banks. Interestingly at the end of the sample, BHC SEL is close to 1% of total assets, 2% of deposits, and 10% of equity.

Figure OA.1: Probability of Default and Aggregate SEL for BHCs

Panel A: Average probability of default (in %)



Panel B: Aggregate SEL



Note: Panel A displays the probability of default, measured in percentage. Panel B displays the aggregate SEL, measured in $ billion, in % of total assets, in % of deposits, and in % of equity. BHCs correspond to the sample of the 34 largest and most complex BHCs subject to the 2017 stress test performed by the Federal Reserve Board.

In Table OA.1, we consider the same exercise but now we estimate SEL at the BHC level for all 34 institutions listed in the 2017 stress test. We define SRISK accordingly, which consists in adding Goldman Sachs Group, Morgan Stanley, and American Express Company to the list. As expected, the results improve for SEL because we define the capital shortfall for the same entities as in the stress tests. The parameter estimates are close to 1 and highly significant for all four regressions. The adjusted R^2 increases to values close to 70%. In contrast, for SRISK, parameter estimates and adjusted R^2 are substantially lower. Adjusted R^2 values are in a range between 30% and 47%. The reason for this disappointing result is that some banks (such as Wells Fargo, U.S. Bancorp, or PNC Financial Services Group) have SRISK values equal to 0 since 2014, whereas the projected loss of capital is relatively high.

OA.2 Construction of Market Risk Factors

Bank of America Merrill Lynch (BofA) provides extensive coverage of global fixed income markets through 4,500 standard indexes tracking more than $66 trillion in fixed income securities. These indexes are available across different market segmentations such as sector, rating, maturity, and combinations of them. Information about criteria for selecting constituent securities and weighting and rebalancing strategies are available on Bank of America Merrill Lynch website and from third party data vendors. Information about the indexes is summarized in Table OA.2.

OA.2.1 Government Related Indexes

As explained in Section OA.6 of this Online Appendix, government related assets are the sum of Treasuries, agency, state, and politically related assets. Thus, among the universe of indexes, we select those whose performance best explains the performance of such assets. The selected indexes are the U.S. Treasury Master total return index, the U.S. Agencies Composite Master total return index, and the National Select Municipal Securities total return index. Treasury Master index contains 259 sovereign bonds across all maturities, with effective duration of about 6 years. Bonds with effective duration of up to 5 years represent around 60% of the total value of the index and bonds with effective duration of 10 years and more represent approximately 17%. Except few government guaranteed bonds in

Table OA.1: Predicting BHC Loss of Capital Projected in the Severely Adverse Scenario

	I	II	III	IV	V	VI
	Panel A: 2014 Stress test			**Panel B: 2015 Stress test**		
Constant	-0.6460	0.9594	-0.2996	-0.6141	0.8312	-0.4375
	(0.061)	(0.000)	(0.378)	(0.018)	(0.000)	(0.111)
$\log(1 + SEL_i)$	0.9658	–	0.8494	1.0232	–	0.8548
	(0.000)		(0.000)	(0.000)		(0.000)
$\log(1 + SRISK_i)$	–	0.6070	0.3028	–	0.6813	0.1949
		(0.000)	(0.000)		(0.000)	(0.132)
Adjusted R^2 (in %)	57.619	45.551	63.945	71.067	46.827	72.278
	Panel C: 2016 Stress test			**Panel D: 2017 Stress test**		
Constant	0.0132	1.0421	0.0703	-0.6163	1.1897	-0.4749
	(0.952)	(0.000)	(0.752)	(0.027)	(0.000)	(0.093)
$\log(1 + SEL_i)$	0.9281	–	0.8107	0.9546	–	0.8461
	(0.000)		(0.000)	(0.000)		(0.000)
$\log(1 + SRISK_i)$	–	0.5126	0.1348	–	0.5625	0.1756
		(0.000)	(0.207)		(0.000)	(0.108)
Adjusted R^2 (in %)	67.481	37.122	68.139	69.160	30.778	70.614

Note: This table presents predictive regressions for the loss of capital projected by large financial institutions in the severely adverse scenario of the Dodd-Frank Act supervisory stress test. The model is estimated in the cross section. The endogenous variable is the projected loss of capital estimated by banks in the Dodd-Frank Act supervisory stress test under the severe adverse scenario ($\log(CS_i)$). Regressors are as of end of December of the previous year. The table reports the parameter estimates, the p-values in parentheses, and the adjusted R^2.

the Agencies Composite Master index, the other 95.5% of 447 bonds are agency securities. The effective duration is approximately 4 years. The third index contains U.S. Tax-Exempt Municipals, which contains 7,897 bonds including Revenue bonds (54%), General Obligation bonds (45%), and Refunded bonds (1%). The effective duration is approximately 8 years.

The first index is available as early as 1990, the other two exist on a daily basis since 1996 and 2001, respectively, making them absent in our construction of the government index for the period before. To construct the final index, we use the weights of each of the three categories, that is, Treasuries, agency, and municipal securities over time using aggregate data (Flow of Funds) of the banking sector. On average, close to half of the government related assets are Treasuries and the other half is split between agency (20%) and municipal (30%) bonds.

OA.2.2 Real-Estate Related Indexes

For real-estate securities, we choose three types of indexes. First, Government National Mortgage Association (GNMA) represents the agency guaranteed mortgage-backed securities. It consists of 116 bonds and has an effective duration of 5.4 years.[2] Second, two indexes based on commercial mortgage-backed securities and composed of $2,518$ bonds together are used to represent investment grade rating, with an average duration of 4.7 years. Finally, there are two indexes based on six home equity loan asset backed securities, with a duration equal to from 1.6 and 6.2 years, respectively.

Similar to the government risk factor, to construct the real-estate risk factor, we approximate the contribution of various real-estate securities in the banking sector using the Flow of Funds data. On average, 60% of the real-estate assets are residential loans and securities and the rest are 32% commercial mortgage-backed securities and finally 8% of home equity loans. We use these weights to construct the final real-estate risk factor. The selected indexes contribute to the final index only when they are available. For instance, the CMBS with BBB rating is only available since 2006, so we use the same index with bonds maturing in 0–10 years only, which is available since 1998.

OA.2.3 Corporate Related Indexes

The factor representing corporate assets (commercial and industrial loans issued by the bank) is based on three indexes. The first index tracks the performance of $5,619$ non-financial investment grade corporate bonds, with an average duration of 7.8 years. The other two indexes represent $1,888$ high yield corporate bonds. The majority of the bonds in these indexes belong to the industrial sector, so that the financial sector only represents 6% of the total number of bonds. The duration of the high yield indexes is half the duration of the high grade index.

As information about the weights of the various categories of corporate loans and securities in banks' balance sheet is not available in Flow of Funds data, we use an equal weighting for the three sub-indexes.

[2] This index is very close to the Federal National Mortgage Association (FNMA) and Federal Home Loan Mortgage Corporation (FHLMC) indexes, with correlations equal to 98.1% and 97.9%, respectively, over the sample.

Table OA.2: Selected Market Risk Factor Indexes

Selected Index	I Ticker	II Number of bonds	III Rating	IV Effective duration
Government				
US Treasury Master	G0Q0	259	AAA	6.0
US Agencies Composite Master	UAGY	447	AA-AAA	3.9
National Select Municipal Securities	UAMA	7897	AA-AAA	7.9
Real Estate				
US GNMA MBS	MGNM	116	AAA	5.4
US Fixed Rate Commercial MBS	CMA0	2146	A-AAA	4.7
US Fixed Rate Commercial MBS	CB45	372	BBB	4.7
US Fixed Rate Home Equity Loan ABS	R0H1	1	AAA	1.6
US Fixed Rate Home Equity Loan ABS	R0H2	5	BBB-AA	6.2
Corporate				
US Non-Financial Corporate	CF0X	5619	BBB-AAA	7.8
US High Yield Corporate	H0A4	1576	B-BB	4.1
US High Yield Corporate	H0A3	312	D-CCC	3.1
Household				
US Fixed Rate Automobile ABS	R0U1	616	AAA	1.2
US Fixed Rate Automobile ABS	R0U2	481	BBB-AA	1.8
US Fixed Rate Credit Card ABS	R0C1	90	AAA	1.9
US Fixed Rate Credit Card ABS	R0C2	19	BBB-AA	1.5

Note: This table presents details on the market risk factor indexes selected for our empirical analysis. The first column shows the selected total return indexes separated by the asset classes defined earlier. The second column shows their ticker identified by Bank of America Merrill Lynch. The third column shows the number of constituent bonds in each index. Rating is the average of Moody's, S&P, and Fitch ratings. The last column presents the effective duration of each index provided by Bank of America Merrill Lynch as of end of 2016.

OA.2.4 Household Related Indexes

We construct a factor that represents the non-residential household assets of the banks. Most of the household assets of banks are consumer loans, which are non-securitized. However, since the credit quality of the underlying affects the claims on the asset, we assume that the performance of the securitized assets is a good proxy for the performance of the underlying. Consumer loans are mostly composed of credit card and automobile loans. Thus we select four indexes that track the performance of credit card and automobile asset-backed securities. These indexes together include $1,206$ securities with duration ranging from 1.2 to 1.9 years and correspond to different ratings of the ABS.

We construct the final risk factor using the weighted average of individual indexes where we infer the weights from the Flow of Funds data. On average consumer loans consist of 45% automobile loans and 55% credit card loans.

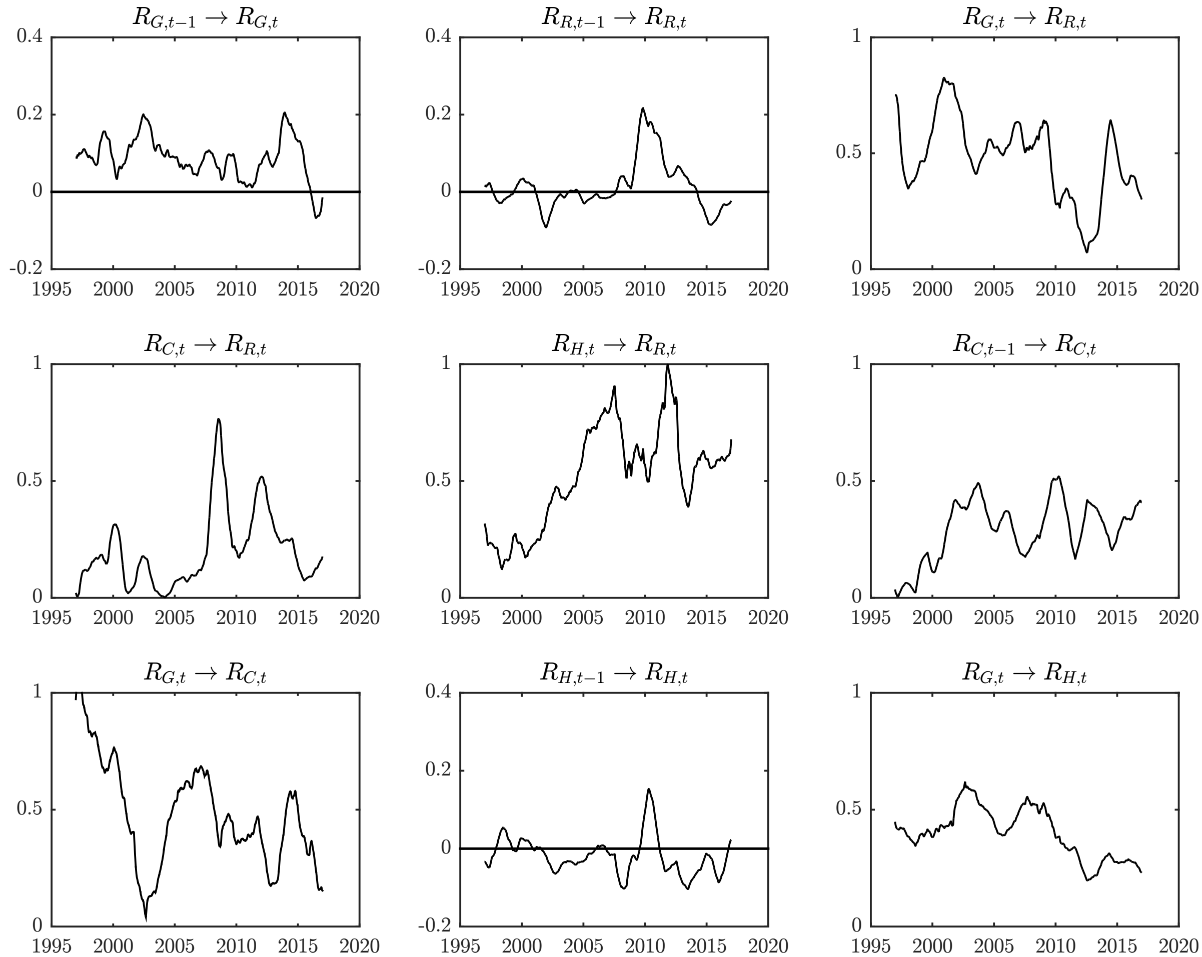
OA.3 Parameter Estimates

Figure OA.2 displays the dynamics of the conditional betas implied by the model (estimated over the complete sample), which reflect the time dependence between factor returns. Some interesting patterns emerge. First, own lagged factor return usually has a limited impact. The only exception is the lagged corporate risk factor return, which has a large positive impact on the current corporate risk factor return. Second, the contemporaneous sensitivity to the government risk factor return is always positive, typically between 0.2 and 0.7, reflecting the sensitivity of credit markets to interest-rate risk shocks. We note that the sensitivity to the government factor tends to decrease in the recent period. Third, the real-estate risk factor return is, in general, more sensitive to the household risk factor than to the corporate factor, reflecting the fact that most real-estate loans and securities held by banks are issued by households. However, there was a temporary switch during the subprime crisis, with a stronger sensitivity to the corporate risk factor and a weaker sensitivity to the household factor.

Figure OA.3 displays the evolution of the copula parameters over time. In Panel A, we observe that the degree of freedom $\bar{\nu}$ increases substantially between 2001 and 2007, from 5.5 to 9.5, indicating that market factors are relatively less affected by joint extreme events. Estimates of $\bar{\nu}$ severely decrease during the subprime crisis to levels close 6, suggesting a stronger dependence between market risk factors.

We also find that the dependence between market risk factor returns implied by the copula model slightly varies over time. The dynamics of the correlation matrix Γ are presented in Panels B and C. On the one hand, the dependence between the government risk factor and the other factors is low and varies between -10% and 10% over time. The correlation between the government and real-estate risk factors is the only correlation to be affected by a large change, as it temporarily decreased to -25% in 2009. On the other hand, most of other dependence parameters vary in a similar range between -10% and 10%. The only correlation that varies more substantially is between corporate and household risk factors. Even if it is close to 0 over most of the sample and equal to 6% on average, it experiences some episodes at a relatively high level.

Figure OA.2: Estimates of Dynamic Conditional Betas



Note: This figure displays the temporal evolution of the conditional beta estimates. The model is estimated using the full sample from January 1996 to December 2016.

OA.4 Alternative Thresholds

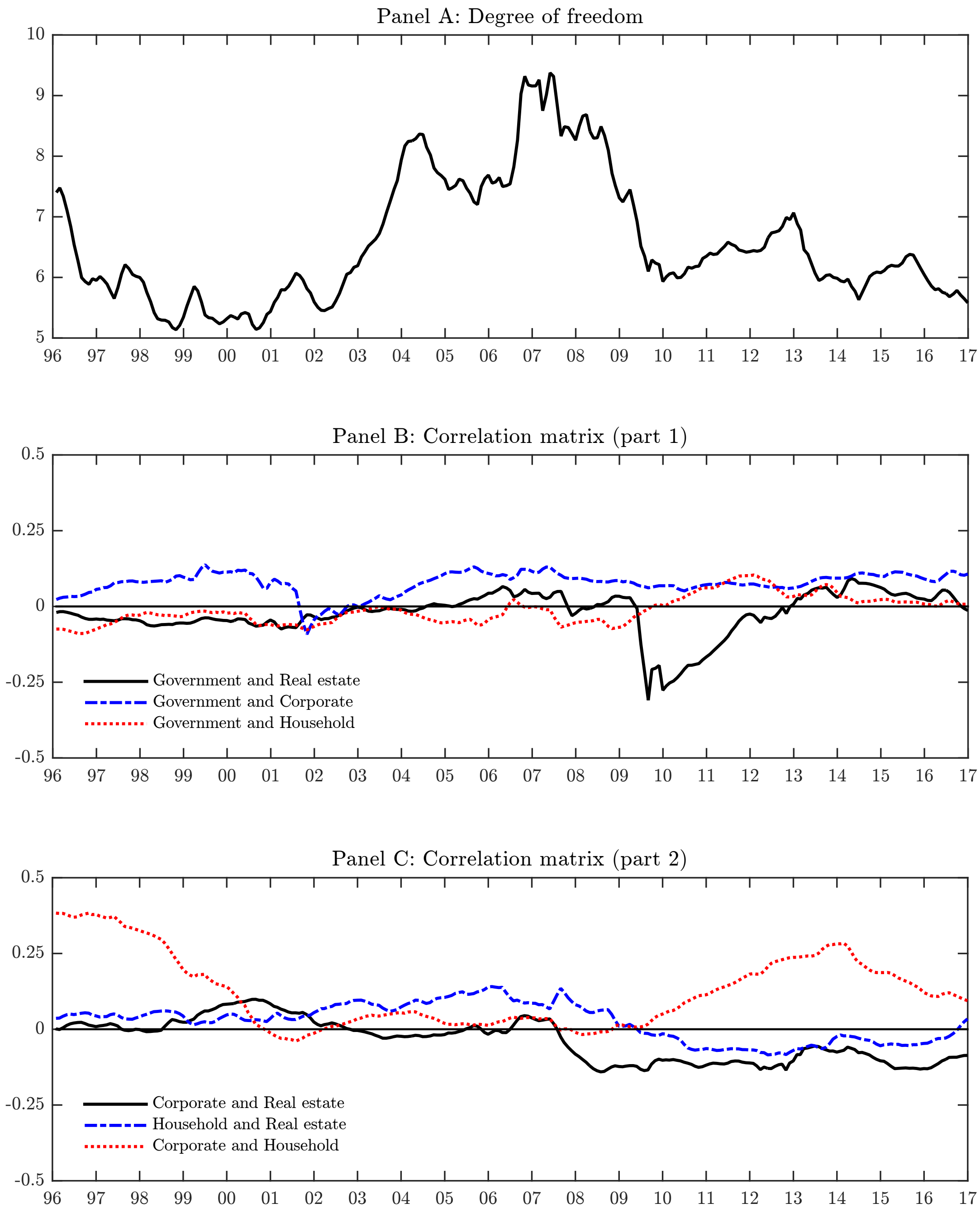
An important aspect of the stress scenario is the way the thresholds are determined. In the main results, the thresholds are based on the EWMA estimation of the standard deviation of the market factor returns. As alternative approaches, we examine two other cases: (1) the standard deviation is estimated with a five-year rolling window, or (2) the standard deviation is estimated with an expanding window.

Figure OA.4 displays the alternative thresholds obtained from these approaches. The levels are relatively similar before the subprime crisis. However, the impact of the crisis is much stronger (almost twice as large) with the five-year window than with the expanding window. After the crisis, the thresholds implied by the five-year window go back to pre-crisis levels, while those implied by the expanding window remain at relatively low levels. Our baseline case based on EWMA standard deviations can be viewed as an intermediate case.

Figures OA.5 and OA.6 show that these approaches have an opposite impact on the probability of a credit market downturn and the average probability of default during and after the subprime crisis. With the five-year rolling window, the probability of downturn is reduced compared to the baseline case in the five years following the subprime crisis. The reason is that observations in the crisis matter more in computing the thresholds, such that the thresholds are lower and a downturn is less likely. However, if a market downturn occurs, a default of a bank is more likely. In the case of an expanding window, the probability of a downturn is increased compared to the baseline case after the subprime crisis. In contrast, the probability of default is significantly reduced. These results clearly indicate that the probabilities of a downturn and a bank's default depend on the magnitude of the shocks that we consider.

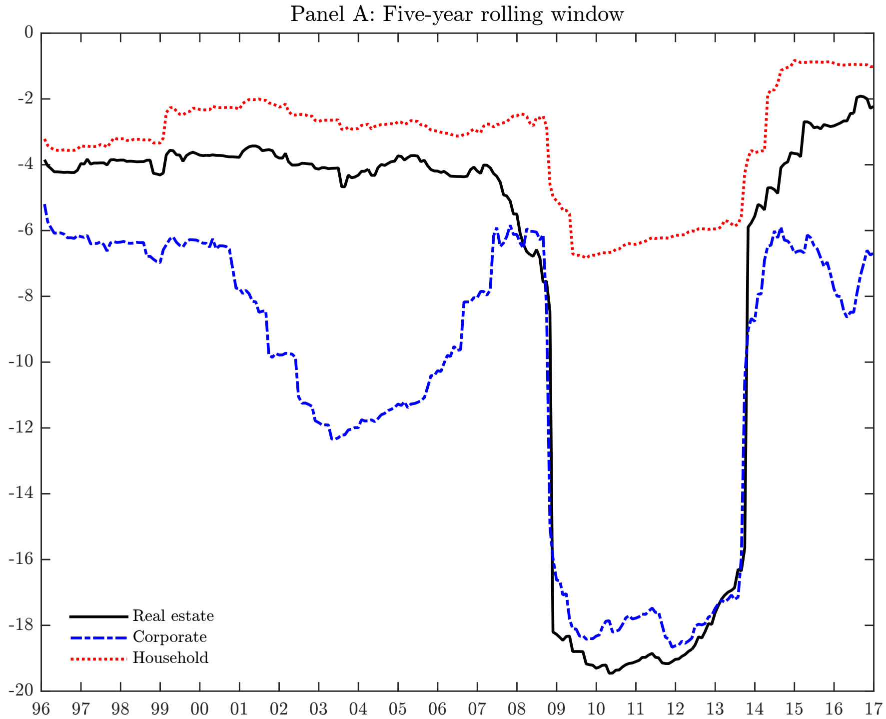
Importantly, the figures also indicate that the estimate of SEL is essentially the same in the three cases that we consider. The reason is that it is computed conditional on both a market downturn and a bank's default. This result is important because it demonstrates that the precise way the thresholds are defined has limited impact on the SEL value.

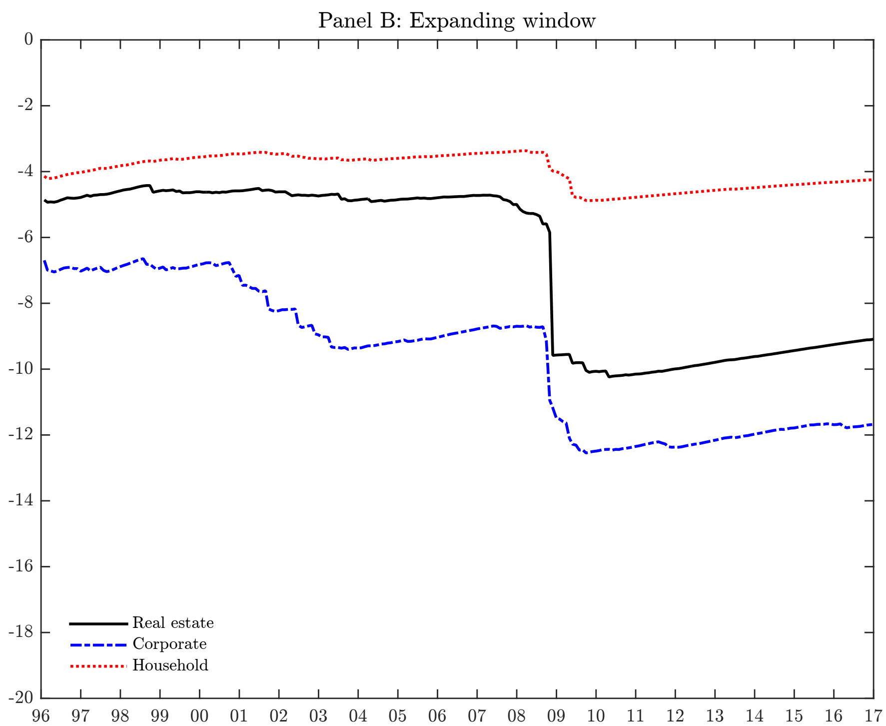
Figure OA.3: Temporal Evolution of Copula Parameter Estimates



Note: This figure displays the temporal evolution of the estimates of the copula degree of freedom $\bar{\nu}$ and correlation matrix Γ. The parameters are estimated using rolling windows of five years.

Figure OA.4: Alternative Threshold Estimates

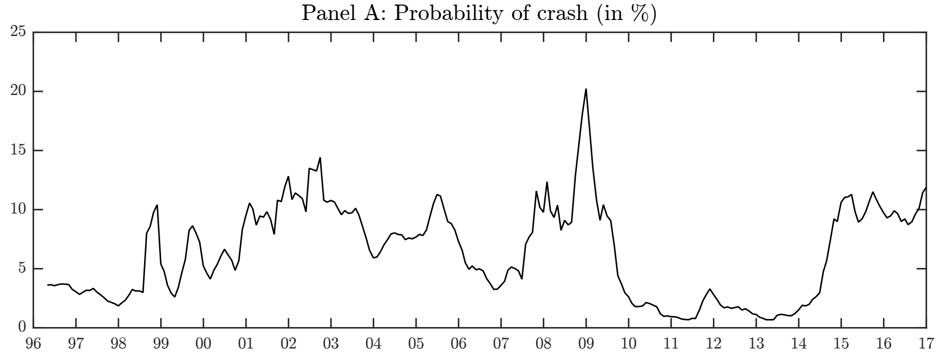




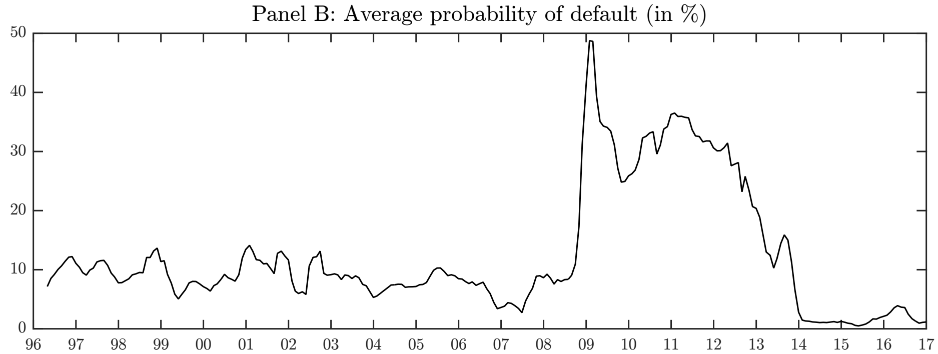
Note: This figure displays the three-month thresholds implied by two alternative approaches: In Panel A, standard deviation are estimated over five-year rolling windows. In Panel B, standard deviations are estimated over an expanding window.

Figure OA.5: SEL with Five-Year Rolling Window Thresholds

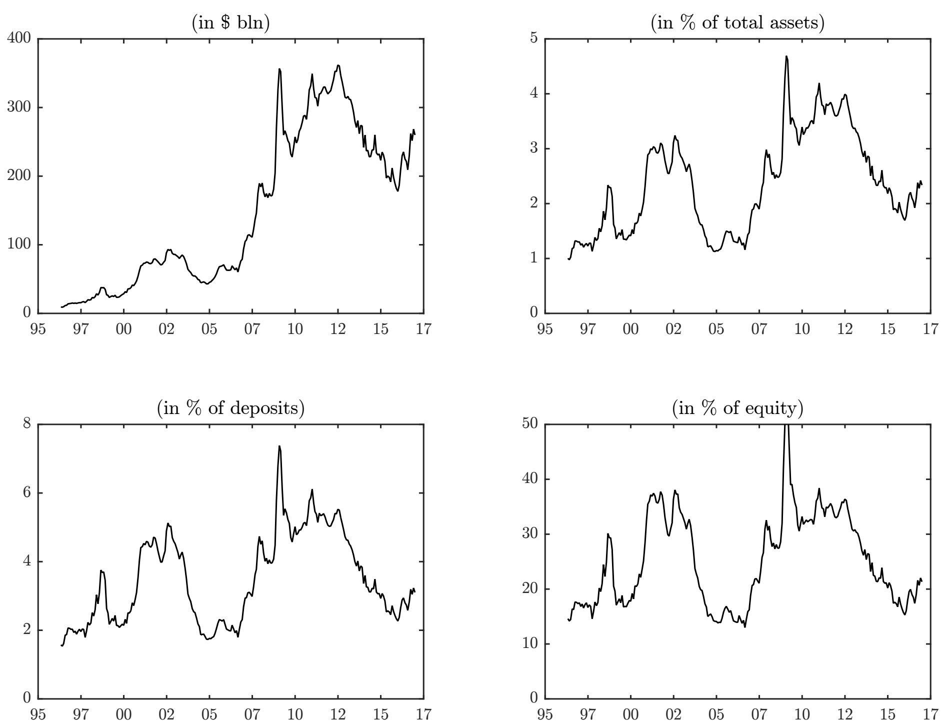
Panel A: Probability of crash (in %)



Panel B: Average probability of default (in %)

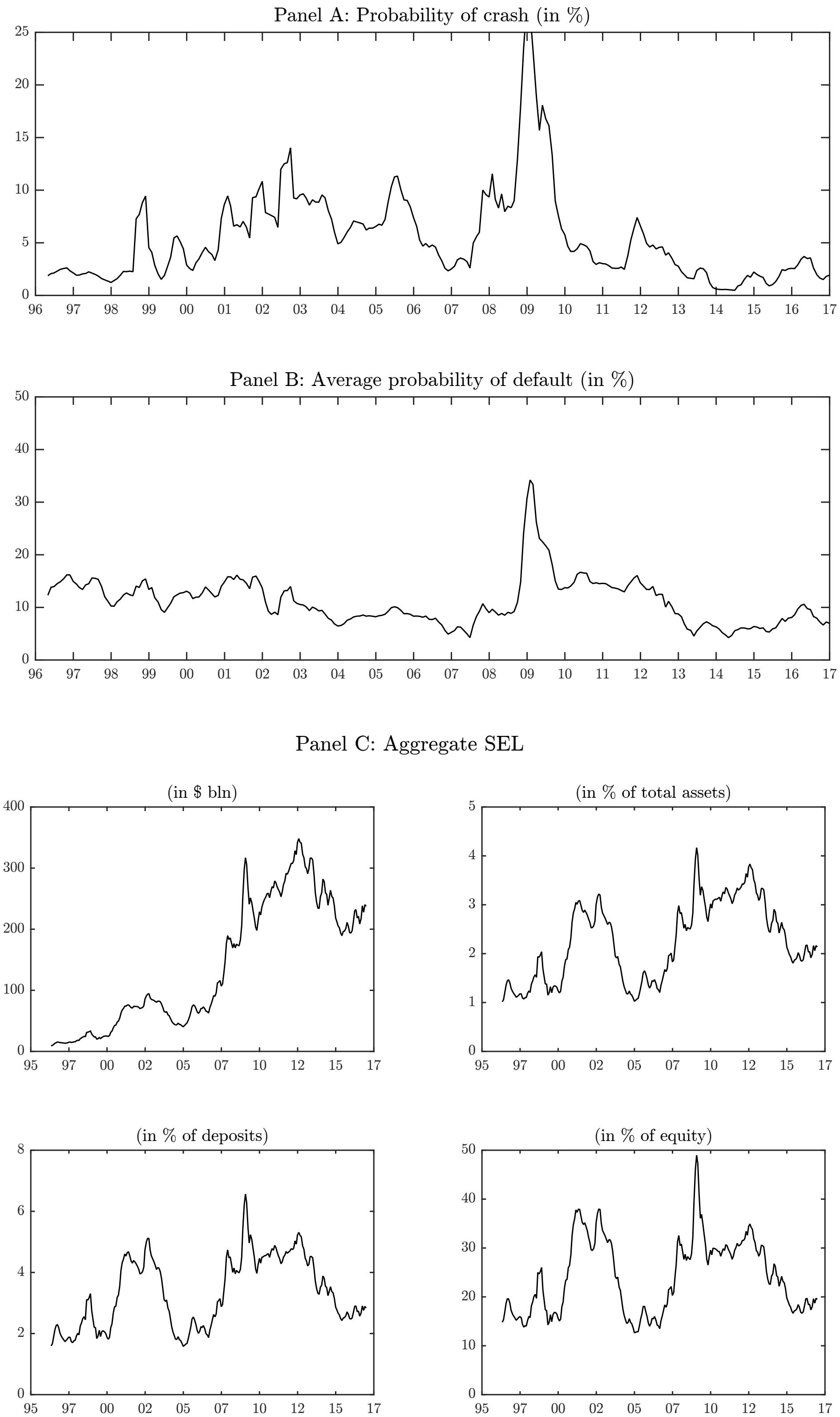


Panel C: Aggregate SEL



Note: Panel A displays the probability of crash, measured in percentage. Panel B displays the average probability of default, measured in percentage. Panel C displays the aggregate SEL, measured in $ billion, in % of total assets, in % of deposits, and in % of equity.

Figure OA.6: SEL with Expanding Window Thresholds



Note: Panel A displays the probability of crash, measured in percentage. Panel B displays the average probability of default, measured in percentage. Panel C displays the aggregate SEL, measured in $ billion, in % of total assets, in % of deposits, and in % of equity.

OA.5 Price Impact

In this section, we evaluate the sensitivity of our results to the calibration of the price impact. In the main, we assume that, in the event of a default, the liquidation of the market-sensitive assets has no price impact on the value of these assets. Several papers discuss the importance of the price impact in a fire sale process, which results in a further decrease in market prices (Coval and Stafford, 2007, Shleifer and Vishny, 2011, Duarte and Eisenbach, 2013, and Caballero and Simsek, 2013, among others). We denote by φ the average price impact on the mark-to-market value of market-sensitive assets ($\varphi \in [0, 1]$). In the case when the fire sale has a price impact, the estimate of SEL is obtained as follows:

$$SEL_{t:t+1}^{(i)} = [(1 + R_{Dep,t}^{(i)})Dep_t^{(i)} + (1 + R_{SD,t}^{(i)})SD_t^{(i)}] - \frac{1}{S_{C,t+1}} \sum_{\tilde{s}=1}^{S_{C,t+1}} A_{t+1}^{(i)\tilde{s}} \, 1_{\{A_{t+1}^{(i)\tilde{s}} \leq L_{t+1}^{(i)}\}},$$

where $A_{t+1}^{(i)\tilde{s}} = (1 + R_{F,t}^{(i)})Cash_t^{(i)} + (1 - \varphi)(1 + R_{M,t+1}^{(i)\tilde{s}})MA_t^{(i)\tilde{s}} + (1 + R_{O,t}^{(i)})OA_t^{(i)}$.

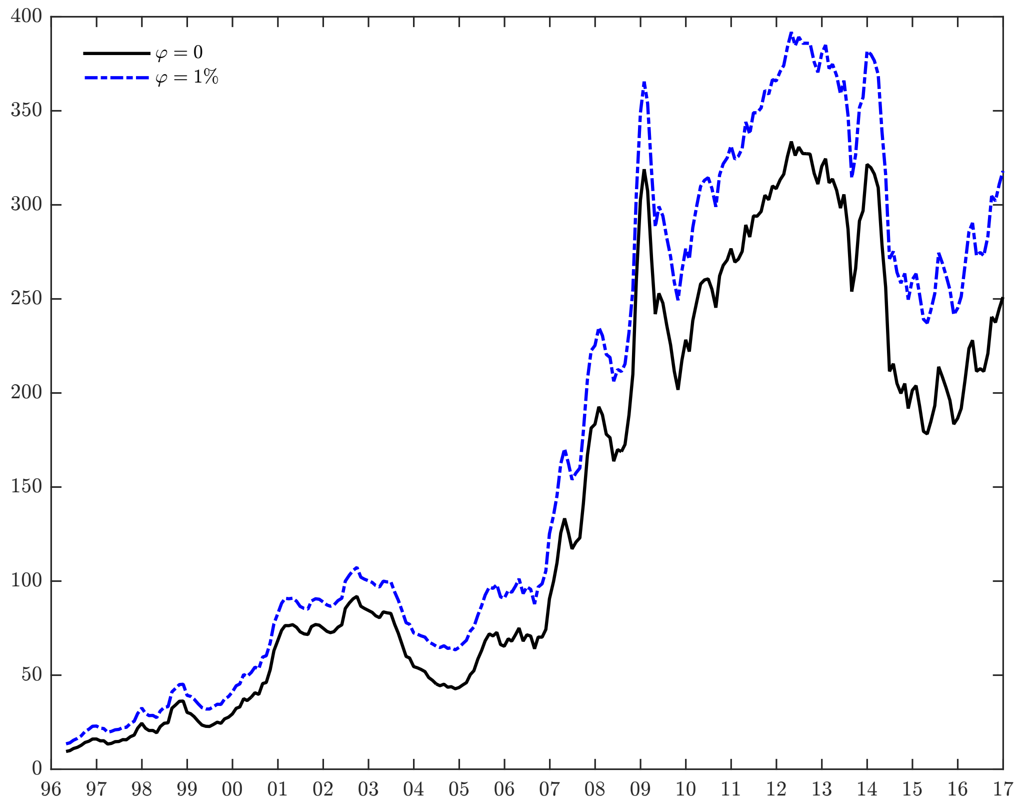
We assume a relatively modest value of the price impact, equal to $\varphi = 1\%$. As Figure OA.7 reveals, even in this conservative case, the effect of the price impact on SEL is substantial. After the subprime crisis, the increase in SEL that would result from a 1% price impact ranges between \$40 and \$70 billion. At the end of the sample, SEL would be close to \$310 billion instead of \$250 billion when $\varphi = 0$, which means that SEL would be almost 25% larger than in the case with no price impact.

OA.6 Banks' Balance Sheet

In this appendix, we provide details on the main categories of assets held by commercial banks. Banks in general hold loans and securities. Loans are issued and usually held until they mature, whereas securities might be sold before they mature.[3] Banks classify loans that they issue based on the borrower's purposes or the collateral for secured loans. For instance, they separate loans to borrowers who wish to buy a residential real-estate property with the property being as the collateral from loans to corporate firms for commercial and industrial purposes. On the other hand, securities can be standard securities, such as Treasury bills, or structured securities, such as mortgage-backed securities (MBSs).

[3] Banks also hold a small fraction of loans in their trading portfolio.

Figure OA.7: SEL with Price Impact



Note: This figure displays SEL when a price impact of $\varphi = 1\%$ is assumed on the value of the market-sensitive assets. The aggregate SEL is measured in $ billion.

OA.6.1 Loans

In this section, we briefly explain different types of loans that banks hold in their balance sheet. We use terms similar to the ones used in the balance sheet and focus only on the three main types of loans, i.e., real-estate loans, commercial and industrial loans, and consumer loans, which differentiate the business of the commercial banks from that of other financial institutions. Finally, we use the term "other loans" to describe loans other than these three types.

Real-Estate Loans. Banks report a loan as real-estate loan when it is secured by a real property. Formally, a loan secured by real estate is a loan that, at origination, is secured wholly or substantially by a lien or liens on real property. To be considered wholly or substantially secured by a lien on real property, the estimated value of the real-estate collateral at origination (after deducting any more senior liens) must be greater than 50% of the principal amount of the loan at origination. For our purpose of categorization as well as reporting by the bank, the purpose of the borrower does not matter.

Commercial and Industrial Loans. These are loans originated by the banks to borrowers as long as it is for commercial and industrial purposes. Examples of borrowers are individuals, partnerships, corporations, and other business enterprises. The loan can be secured or unsecured, single-payment, or installment. Example of collateral can be production payments of a company. These loans may take the form of direct or purchased loans. Banker's acceptances are also reported as commercial and industrial loans only when the counterparty is a commercial or industrial enterprise. What matters for the bank to report a loan as commercial and industrial loan is the purpose of the borrower and not the borrower itself. For instance, a loan to a commercial entity for investment or personal expenditure would not be reported as such a loan, whereas a loan to an individual for the purpose of financing capital expenditures and current operations would be reported in this category. We note that this is unlike the previous category, real-estate loans, where the collateral (the real estate) matters for the bank. So in the previous example, a loan to an individual for the purpose of financing capital expenditures and current operations would be reported as real-estate loan if it is secured by real-estate property.

Consumer Loans. Banks report loans to individuals for household, family, and other personal expenditures as consumer loans. Such loans can vary from extension of credit to credit cards to auto-loans. The purpose of the loan also can vary from purchases of household appliances or a boat, educational or medical expenses to personal taxes or vacations. All such loans must not meet the definition of a loan secured by real estate, and exclude loans to individuals for the purpose of purchasing or carrying securities. So in the case of consumer loans, borrower's type, purpose of the borrower and collateral, if any, all matter for the bank when they report the loan in their balance sheet. For instance, credits extended to individuals through credit cards or loans to an individual for buying an automobile would not be counted as consumer loans if they are substantially secured by a real-estate property.

The three types of loans described above are mainly reported in the loan portfolio of the bank. However, such loans can also exist in the trading portfolio of the bank.

Other Loans. Banks also owe loans other than those described above. They include loans to finance agricultural production and other loans to farmers. Examples are loans for purpose of financing agricultural production, for purchases of farm machinery, equipment, and implements, or purposes associated with the maintenance or operations of the farm. They also include loans to depository institutions and acceptances of other banks, and loans to non-depository financial institutions. Examples of the latter are loans to real-estate investment trusts and to mortgage companies that specialize in mortgage loan originations and warehousing or in mortgage loan servicing, or to insurance companies and investment banks, or even to federally-sponsored lending agencies. Finally, they include loans to foreign governments and official institutions, and lease financing receivables. All these other loans are classified as corporate loans.

OA.6.2 Standard Debt Securities

Treasury, Agency, State, and Politically Related Securities. Treasuries are all types of fixed income instruments issued by the U.S. government. In government agency securities, debt obligations are fully and explicitly guaranteed by the U.S. government. The difference between government agencies and government-sponsored agencies is that in the latter case the debt obligations are not explicitly guaranteed by the full faith and credit of the U.S. government. Last, states and political subdivisions also issue debt obligations. We merge these three groups into one class of assets, i.e., Government securities.

Corporate Bonds. This category includes all bonds, notes, and debentures issued by corporations and held as investments by commercial banks.

OA.6.3 Structured Debt Securities

Structured assets are those backed by a pool of other assets originated by the bank itself or other financial institutions. Another type of structured assets are collateralized debt obligations, which are pools of risky tranches from other structured assets further tranched and formed into a new security. In all cases of such assets, what matters for the purpose of our classification is the final holding institution of the asset (the bank) and the underlying assets.

Mortgage-Backed Securities. Bank holding of MBS consists of Residential MBS and Commercial MBS.[4] In either case, the mortgages are in the form of pass-through and non-pass-through mortgages.[5] Both pass-through and non-pass-through mortgages (RMBS and CMBS) can be issued and/or guaranteed by GSEs and non-GSEs.[6] So, in total one can think of eight different possible combinations. For instance, a bank holds a pass-through RMBS, which is issued by a GSE, or a pass-through CMBS, which is issued by a non-GSE. It can also happen that the issuers are different for a CMO. For instance, a CMO is issued by a non-GSE but the collateral is an MBS, which is issued by a GSE.

We note that the underlying securities in this class are residential or commercial real-estate properties. Information on the weights of RMBS and CMBS categories are not available in Call Reports prior to 2009. Since then, the majority of pass-through RMBSs are issued and guaranteed by GSEs. Other RMBSs, such as CMO and REMIC, are mainly due to GSEs. However, it is likely that the order has been reverse prior to 2009, that is, banks tended to hold private labeled RMBSs.

Asset-Backed Securities. Although both MBSs and ABSs are structured products in a broad sense, banks report them as different items. As a rule of thumb, banks report assets either directly or indirectly related to a real property as a separate item. For instance, a commercial paper backed by loans secured by 1-4 family residential properties is reported under the MBS category, whereas asset-backed commercial papers are reported as ABS and other debt securities. ABSs exist in both trading and non-trading accounts of the banks.

Structured Financial Products. Structured financial products generally convert a pool of assets (such as whole loans, securitized assets, and bonds) and other exposures (such as derivatives) into products that are tradable capital market debt instruments. Some of the more complex financial product structures mix asset classes in order to create investment products that diversify risks. One of the more common structured financial products is

[4] In the case of an RMBS, the underlying property is a 1-4 family residential property, whereas for CMBS, the securitization is done on commercial properties. As opposed to an RMBS, commercial mortgages are often set for a fixed term and therefore are less exposed to prepayment risk.

[5] Non-pass-through mortgages include all classes of collateralized mortgage obligations (CMO), real-estate mortgage investment conduit (REMIC) and stripped MBS.

[6] Main GSEs are the Federal National Mortgage Association (FNMA, Fannie Mae), and the Federal Home Loan Mortgage Corporation (FHLMC, Freddie Mac). The Government National Mortgage Association (GNMA, Ginnie Mae) is a government agency. Other non-GSEs are non-U.S. government issuers such as depository institutions, insurance companies, state and local housing authorities.

referred to as a collateralized debt obligation (CDO). Other products include synthetic structured financial products (such as synthetic CDOs) that use credit derivatives and a reference pool of assets, hybrid structured products that mix cash and synthetic instruments, collateralized bond obligations (CBOs), resecuritizations such as CDOs squared or cubed (which are CDOs backed primarily by the tranches of other CDOs), and other similar structured financial products. These strands of assets exist in both trading and non-trading accounts of the banks.

OA.6.4 Interest Rates

The cost of deposits ($R^{(i)}_{Dep,t}$) is obtained for each bank by dividing *Interest Expenses on Deposits* to *Average Interest Bearing Deposits*, where the latter is the average of interest bearing deposits of current and previous calendar quarters. The cost of borrowing ($R^{(i)}_{D,t}$) is computed as *Interest Expenses on Borrowing* divided by *Average Borrowing*. Average Borrowing is defined as *Average Interest Bearing Liabilities* minus *Average Interest Bearing Deposits*. For the interest rate on cash ($R^{(i)}_{F,t}$), we use the Federal Fund rate for all banks. Last, for other (unclassified) assets, which are mostly fixed assets, we assume that the return is $R^{(i)}_{O,t} = 0$. Comparing these rates obtained from the information in the balance sheet and the Federal Fund rate, we find that $R_{F,t} < R^{(i)}_{Dep,t} < R^{(i)}_{D,t}$ (with average values: 1.8% < 1.9% < 3.5%).[7]

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[7] These rates required some cleaning. Missing values were replaced by the value from previous quarter. For the cases where the first quarter was missing, we used the rate of the same quarter from next firms in the size ranking. Rates higher than 20% were replaced by the median of the sample for the same quarter.

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