Government Guarantees and the Valuation of American Banks

Andrew G. Atkeson, *University of California, Los Angeles, and NBER*
Adrien d’Avernas, *Stockholm School of Economics*
Andrea L. Eisfeldt, *University of California, Los Angeles, and NBER*
Pierre-Olivier Weill, *University of California, Los Angeles, and NBER*

I. Introduction

Are banks safer today than they were in 2007? Book measures of leverage indicate that regulations postcrisis have shored up the US banking system (see Yellen 2017); however, market measures of leverage and bank credit risk are actually higher than precrisis levels (Sarin and Summers 2016). Do book or market measures more accurately depict the safety of the US banking system? The answer depends on the quantitative drivers of the difference between the market and book values of bank assets. In this paper, we provide a decomposition of banks’ market-to-book values into a component driven by bank profitability, or “franchise value,” and a component driven by the value of explicit and implicit government guarantees. We find that, quantitatively, about half of the elevated market values of banks from the mid-1990s to 2007 arose from the ability of bank equity holders to capitalize the value of the government safety net. Under current regulatory limitations on leverage, the ability of banks to capture the value of government guarantees is constrained, and, as a result, market-to-book ratios are lower.

The key to understanding the difference between book and market measures of bank leverage is a decomposition of the drivers of banks’ market value of equity versus book value of equity into two components, franchise value and the value of government guarantees. Building on this idea, we provide and apply a measurement framework to quantitatively assess the drivers of bank valuation and bank safety using market and accounting data. Our decomposition can be written simply as

\[
\frac{\text{MVE}}{\text{BVE}} = 1 + \frac{\text{FVE} - \text{BVE}}{\text{BVE}} + \frac{\text{MVE} - \text{FVE}}{\text{BVE}}.
\]

© 2019 by the National Bureau of Economic Research. All rights reserved.
where MVE indicates market value of bank equity, BVE indicates book value of bank equity, and FVE indicates fair value of bank equity. The first component of banks’ market-to-book equity ratios is the ratio of the gap between the fair value of bank equity and the book value of bank equity divided by the book value of bank equity. We define the fair value of bank equity as the difference between the fair value of all of the bank’s assets and the fair value of all of the bank’s liabilities. Fair values are measured as the discounted present value of all of the cash flows associated with bank assets and liabilities, not considering the contribution to bank value from government guarantees. The difference between the fair value and book value of bank equity, then, is the gap between the market value and book value of the bank’s business arms, which we refer to as the franchise value of the bank.

The second component is the ratio of the gap between the market value of bank equity and the fair value of bank equity to the book value of bank equity. The market value of bank equity includes the discounted present value of cash flows associated with taxpayer bailouts of banks’ liability holders in times of distress. By definition, this second component reflects the contribution to bank equity valuation from bank risk taking with the support of government guarantees for bank liabilities.

The implications of observations on the market-to-book values of equity for bank financial soundness depend critically on which of these two components, franchise value or government guarantees, accounts for most of the movement in bank equity valuation. As emphasized by Keeley (1990), Sarin and Summers (2016), and Chousakos and Gorton (2017), to the extent that the market-to-book value of equity is high because banks have high franchise value, a high market-to-book value of equity is a manifestation of economic capital not recorded on banks’ balance sheets, and indicates that banks have less risk of default in a crisis.

In contrast, to the extent that high market-to-book values of equity are due to the value of government guarantees, then high valuations of bank equity are a signal of risk in banks and of a large taxpayer contingent liability for bank bailouts in a crisis. As we show in our model below, in this case, increases in book or regulatory capital should be expected to reduce bank market-to-book ratios and accounting profitability. The reduction in bank’s market-to-book ratios has an upside, namely, a lower liability forcing taxpayers to bail out bank debt and deposits in a crisis.¹

Our paper is closely related in its objective to that of Haldane, Brennan, and Madouros (2010). These authors ask whether the evolution
of bank profitability and valuation prior to the financial crisis reflected an increase in the economic profitability of bank loan making and deposit taking (what we term “franchise value”) or, instead, a return by bank owners to risk taking backed by government guarantees. They examine how increases in bank leverage and risk taking might account for the rise in bank accounting profitability from the mid-1990s until the financial crisis. We extend their analysis to provide a quantitative accounting of the evolution of US bank valuations and the relative contributions from franchise values and value from risk taking backed by government guarantees. Our accounting indicates that there has been a reduction in bank franchise values from before the 2008 crisis to now, mostly stemming from a lower fair value of core deposits. However, our main finding is that there has been an equally large decline in banks’ capitalized values from government guarantees.

Our framework allows us to assess which channel for capturing the value of government guarantees, namely, risk taking, leverage, or prospects for growth of banks’ balance sheets, has declined in importance since the crisis.

It does not appear that regulation has succeeded in reducing risk taking by banks. In particular, our accounting indicates that bank equity would still be wiped out in a crisis of the magnitude observed in 2008. This finding is driven by two observations. First, bank accounting profitability is still quite high relative to available riskless rates of return even after adjustment for the fair value of bank assets and liabilities. This observation implies that banks’ assets are still quite exposed to aggregate risk. Second, the market signals from bank equity and debt reviewed by Sarin and Summers (2016) still signal considerable risk to subordinated claims on US banks, suggesting that the market perceives that bank equity and subordinated debt would still be wiped out in a crisis.

Instead, we find that the reduction of the value of government guarantees to bank equity is due primarily to the increase in bank regulatory capital and a reduction in the growth rate of banks’ balance sheets. With greater regulatory or book capital, equity suffers more of the loss to bank assets in a crisis. Holding fixed the drop in bank asset values in a crisis, the taxpayer contribution required to honor deposit guarantees is smaller. Moreover, with lower expected growth, equity is not able to grow implicit guarantees in advance of the next crisis.

Our accounting model suggests that moves to lighten the regulatory burden on banks going forward may lead to substantially greater bank
risk exposure. The value of government guarantees to bank equity is highly sensitive to small changes in the risk exposure of bank assets. If regulators allow even a moderate increase in risk taking by banks, we should see a significant jump in bank valuations and accounting profitability. The temptation will be to interpret this increase in bank valuations and accounting profitability as a restoration of bank franchise value previously damaged by regulation. Instead, we argue that it would properly be interpreted as a return to the days in which taxpayers had a large contingent liability to bail out banks in a crisis.

The remainder of our paper is organized as follows. In Section II, we document the facts on bank valuation and profitability that we focus on in our accounting exercise. In Section III we present the model we use for measurement. We define the book and fair values of items on banks’ balance sheets. We show that to construct a fair value balance sheet for banks, one must measure the fair values of bank loans and deposits, as well as banks’ growth opportunities to earn future profits from originating new loans and acquiring new deposits. We establish the result that in the absence of government guarantees, the market value of bank equity is equal to the fair value of bank equity, regardless of the risk in the banks’ assets and regardless of bank equity’s decisions to default on bank subordinated liabilities in a crisis. In the presence of government guarantees, we show that equity holders obtain a market value in excess of fair value by taking on risk, boosting dividends in normal times and defaulting during crises.

The concept of the fair value of bank equity for banks is very similar to the concept of the value of equity absent violations of the Miller and Modigliani (1958) theorem from the familiar adjusted present value formula in corporate finance. The difference between the fair value of bank equity and the market value of equity stems from a nonzero net present value of banks’ financing decisions. In particular, implicit and explicit guarantees lead to a positive net present value of debt financing for US banks because of the injection of taxpayer funds into the bank in the event of a crisis. We use the terminology “fair value of bank equity” for two reasons. First, our concept of fair value is related to that used in financial institution accounting. Second, we include the franchise value of a bank’s deposit business in the fair value of equity, despite the fact that the value of the deposit business depends on the bank’s capital structure.

The quantitative value of government guarantees depends critically on the risk-neutral probability of a crisis state. In Section IV, we use data
on the realized returns on broad portfolios of corporate bonds from Asvanunt and Richardson (2016) as well as estimates of the credit risk premium from Berndt et al. (2017) to measure exposure to aggregate credit risk and to calibrate the risk-neutral probability of a crisis. Based on these data, we calibrate the risk-neutral probability of the crisis state to 5% on an annual basis. Under the assumption that marginal utility is high in the crisis state, 5% is an upper bound on the objective probability of a crisis, and thus crises are rare events.

In Section V we use a stylized, two-state model of a bank to demonstrate that, under reasonable parameters describing bank leverage and aggregate credit risk, the observed drop in bank valuations since 2007 can easily be generated by a decline in the value of government guarantees to bank equity. The stylized bank issues liabilities insured with a government guarantee and holds only marketable securities exposed to aggregate credit risk. By definition, this bank has no franchise value. However, with guaranteed liabilities and assets with the same distribution of excess returns as those on BBB-rated corporate bonds, the bank trades at a market-to-book ratio of equity of 2 given book leverage of 90%. Leverage is key to this valuation. If book leverage is constrained to 85%, the market-to-book ratio of this bank falls from 2 to close to 1. The entire decline is due to the reduction in the size of taxpayers’ exposure to bailouts in the crisis state.

With confirmation of the quantitative plausibility of guarantees as main drivers of bank equity values in hand, we turn in Section VI to a complete accounting exercise. We construct estimates of the book value, the fair value, and the market value of banks in the 1970–85, 1996–2007, and 2011–17 time periods. We model each time period as one in which only the “normal” state is realized. We collect data on the book value of items on banks’ balance sheets from bank regulatory reports. To construct a fair value version of banks’ balance sheets, we use banks’ reports of the fair value of their loans found in the footnotes of banks’ annual reports since the mid-1990s as well as two measures of the fair value of bank deposits. The first is a measure of the fair value of bank deposits from the Portfolio Value Model developed by the Office of Thrift Supervision (OTS). The second is a measure of the fair value of deposits derived from the measure of core deposit intangibles recorded on bank books when one bank acquires another. We then use a Gordon (1962) dividend growth model to value bank equity using observed accounting returns for banks, our calibration of the risk-neutral probabilities of the normal and crisis states, and measures of the riskless interest rate
and the growth rate of bank balance sheets in normal times from each of these three time periods.

Using our model for measurement, we find the following results for banks’ market-to-book equity values, and the contribution from franchise values and government guarantees.

In the early period from 1970 to 1985, according to our model, banks did not have large franchise values and did not derive value from risk taking with government guarantees. Our model yields a market-to-book equity value of 1, which matches the observed ratio for financial firms for that time period.

In contrast to this early period, in the precrisis, postderegulation period from 1996 to 2007, our model predicts that banks’ market-to-book equity ratio was 2.24, which closely matches the observed average ratio of 2.12 over this time period. We find that the excess in market over book values was driven mainly by the value of government guarantees. In particular, we find that banks’ franchise values contributed \((FVE - BVE) / BVE = 0.34\) and the value of government guarantees contributed \((MVE - FVE) / BVE = 0.91\) to the total gap between market and book values of \((MVE - BVE) / BVE = 1.24\) implied by our model. Hence, we find that government guarantees contribute roughly three times more than franchise value to the market-to-book ratio of equity over this precrisis window. Our model suggests that the value of government guarantees was so high in this time period because, starting in the late 1990s, banks took on significantly more risk, as evidenced by significantly higher realized accounting returns in banking relative to riskless benchmarks.

This accounting evidence of risk taking by banks continues past the 2008 crisis. However, due to changes in book leverage and the growth rate of bank assets over time, this risk taking by banks has had a smaller effect on the market value of bank equity since the crisis. For the 2011 to 2017 time period, our model implies that banks’ market-to-book equity ratios should have averaged a much lower value of 1.19. In the data, the market-to-book ratio in banking averaged 0.98 over this time period. In the postcrisis data, about half of the excess of market over book values of equity stem from franchise value and half from government guarantees.

Finally, in Section VII, we conclude. Our valuation estimates indicate that regulation-induced reductions in book leverage have succeeded in reducing the market value of the funds that taxpayers will need to contribute in a bailout, consistent with the views of Yellen (2017) and the important contribution by Admati and Hellwig (2013), which provides
strong arguments for lower bank leverage. In contrast, we also show that the risk of equity and subordinated debt being wiped out has not gone down substantially, which explains the observations of high market leverage as well as market measures of bank credit riskiness in Sarin and Summers (2016).

In appendix A, we present proofs of several propositions regarding the impact of changes in leverage, risk taking, and economic profitability on banks’ accounting profitability and market-to-book ratios. In appendix B, we discuss in greater detail several of our modeling assumptions and compare our results on the value of government guarantees to other measures of the value of government guarantees in the literature.

II. Historical Data on the Valuation

In this section we develop the main stylized facts describing changes in bank valuation, leverage, profitability, and market credit risk measures. These facts motivate our study and support the calibration of our model.\(^5\)

A. Bank Valuation

We measure the valuation of the banking sector in each time period as the ratio of market-to-book value of equity for the entire sector in each quarter from 1991 to 2017.\(^6\) We display this market-to-book value of equity for the US banks over the time period 1991–2017 in figure 1.

This figure shows a substantial increase in the ratio of the market-to-book value of equity for US banks in the mid-1990s and a sharp reduction in this ratio after the financial crisis. In particular, we find that the market-to-book ratio in banking averaged 2.12 over the 1996–2007 time period and 0.97 over the 2011–17 time period. This pattern of bank valuations over time is consistent with the findings in Chousakos and Gorton (2017) and Minton, Stulz, and Taboada (2017) regarding the valuation of bank equity relative to balance sheet benchmarks.

Keeley (1990) provides evidence on the valuation of banks in the 1970s. He finds that market-to-book values of bank equity were closer to 1 during that time period. To confirm that finding, in figure 2, we examine the ratio of the market-to-book value of equity for the US financial sector from 1975 to the present together with our series for bank holding companies over the 1986–2017 time period.\(^7\) Note that the market-
The market-to-book value of equity for the US financial sector corresponds closely to that for bank holding companies over the time period for which we have data for both series. Figure 2 shows that the ratio of the market-to-book value of equity for the financial sector from 1975 into the early 1990s was close to 1.

Consistent with the findings of Minton et al. (2017), we find similar patterns of bank valuations over time for large and small bank holding companies. In figure 3, we show the ratios of the market-to-book value of equity for bank holding companies with assets of more than $250 billion and those with assets from $10 to $250 billion. These data on the valuation of large and smaller banks suggest that fluctuations in bank market valuations are not driven by valuations of the investment banking activities of the largest bank holding companies.

B. Bank Financial Soundness

In what follows, we consider the implications of the data on bank valuations presented above as an indicator of bank financial soundness. The
connection to bank financial soundness is through bank leverage. It is common to evaluate bank leverage on both a book and a market basis. Bank capital regulation is applied to banks’ book leverage, that is, the ratio of the book value of debt to the book value of assets (we abstract here from risk weighting of assets). Figure 4 shows book leverage for bank holding companies over the period 1991–2017. Book leverage has declined steadily over this time period.

We plot market leverage for bank holding companies, defined as the ratio of the book value of debt to the market value of assets, over this time period in figure 5. Bank market leverage shows a pattern over time that is different from that of book leverage. Specifically, bank market leverage was relatively low in the period before the 2008 crisis and it is high in the period since that crisis.

C. Bank Profitability

Accounting measures of bank profitability are a key input into our accounting for the market valuation of banks. As we will show in our

Fig. 2. Market-to-book value of equity for bank holding companies and financial firms. The ratio is computed as the sum of the market value of equity across bank holding companies divided by the sum of the book value of equity across bank holding companies. The book value of equity comes from the holding company data of the Federal Reserve Bank of Chicago (2019) and corresponds to item 28 of Schedule HC from FR Y-9C reports. The market value of equity comes from the Center for Research in Security Prices database. We use financial firms with a standard industry classification code between 6000 and 6199 to go back to 1975.
model, bank profits in normal times are driven both by banks' exposure to crisis risk (consistent with the findings of Meiselman, Nagel, and Purnanandam [2018]) and by sources of franchise value. Here we document the accounting data that we target.

Figure 6 displays the accounting return on equity (ROE) for US bank holding companies over the period 1991–2017. ROE is measured as the ratio of bank net income to the book value of bank equity. Figure 6 shows that the ROE for bank holding companies was high at just under 15% from the mid-1990s into 2007, and it has been substantially lower since the 2008 crisis.

Figure 7 shows the corresponding accounting profitability of bank holding companies over this time period measured in terms of bank return on assets (ROA; the ratio of net income to total book assets). Here we find that the ROA for bank holding companies was consistently above 1% from the mid-1990s into 2007 and has been below 1% since the 2008 crisis.

The high accounting profitability of banks in the period from the mid-1990s into 2007 was unusual in a longer historical perspective. In figure 8,
we show the ROA for commercial bank subsidiaries reported in the Federal Deposit Insurance Corporation (FDIC) historical statistics on banking from 1934 to 2017 (FDIC 2019b). This figure shows that the ROA for banks was consistently under 1% until the mid-1990s. Then, as in the bank holding company data in figure 7, banks had an ROA consistently above 1% from the mid-1990s into 2007, and then a lower ROA since the 2008 crisis.

D. Spreads on Subordinated Debt

As we apply our accounting model, we need to confirm that it is consistent with the evolution of market signals of the risk exposure of bank equity and subordinated debt to a crisis. Sarin and Summers (2016) provide a convincing review of those equity and debt market signals and conclude that these signals have not improved from levels observed before the 2008 crisis. In our accounting model, we focus on matching data on spreads on banks’ subordinated debt. In figure 9 we present data on these corporate bond spreads from 1991 to 2017. For a sample of firms covered by Standard & Poor’s Compustat database and the Center for
Research in Security Prices, we matched month-end secondary market option-adjusted credit spreads of their outstanding senior unsecured bonds from the Lehman/Warga and Bank of America Merrill Lynch (BAML) databases.\textsuperscript{10}

In figure 9, the thick solid line corresponds to averages of the natural log of option-adjusted spreads on bank holding company bonds calculated by BAML.\textsuperscript{11} The other lines correspond to averages of option-adjusted spreads on bonds of nonfinancial firms within a certain credit rating.\textsuperscript{12} Starting from the bottom and going up, these lines correspond to AAA- and AA-rated bonds together in one line, A-rated bonds, BBB-rated bonds, BB-rated bonds, and B-rated bonds. Thus, in this figure, we see how the level of bank bond spreads has evolved over time and how these spreads have moved relative to those of nonfinancial firms. We see that the level of bank bond spreads has risen both in absolute terms since before 2008 and in relative terms compared with nonbank bonds. Before the crisis, bank bond spreads were in line with those of A-rated firms. After the crisis, bank bond spreads are in line with those of BBB-rated
firms. The average level of bank holding companies’ corporate bond option-adjusted spreads was 93 basis points (bp) over the period 1996–2007 and 151 bp over the period 2011–17.

III. An Accounting Model

We now present the model we use to define the concepts of book, fair, and market values of equity and to establish the results that $FVE - BVE$ is a measure of the franchise value of the bank and $MVE - FVE$ is a measure of the market value of the taxpayer injections of resources needed to honor government guarantees of bank liabilities.

A representative bank operates a loan-making arm and a government-guaranteed deposit-taking arm.\textsuperscript{13} Deposits are fully guaranteed by the government. Every period, the loan-making arm makes new loans and the deposit arm takes in new government-guaranteed deposits. The bank also issues subordinated debt. Both the loan-making and the deposit-taking arms are subject to shocks: shocks to the prepayment rate and default rate of loans, to the withdrawal rate of deposits, and to the growth rate of the balance sheet achieved through origination of new loans and

Fig. 6. Return on equity for bank holding companies. This figure reports the quarterly annualized return on equity from the Federal Reserve Bank of New York (2017). The ratio is computed as the sum of net income across bank holding companies divided by the sum of total equity across bank holding companies. Net income corresponds to item 14 of Schedule HII from FR Y9-C reports. The book value of equity corresponds to item 28 of Schedule HCl from FR Y-9C reports.
deposits. We assume that the vector of shocks is independently and identically distributed over time under the risk-neutral probability measure but that the shocks can be contemporaneously correlated. After observing the realized shocks, equity holders have the option to default. In that case, the subordinated debt holders take over the bank and auction it off immediately to new owners. The government makes a contribution of taxpayer funds to the sale sufficient to ensure that the new owners of the bank are willing to assume the bank’s deposit liabilities and pay a nonnegative price for the bank to the holders of the subordinated debt.

A. The Loan-Making Arm

Let $L$ denote the total face value, or book value, of the loans on the bank’s balance sheet. Every period, every dollar of loan pays a coupon $c_i$, net of servicing cost. Then the face value of the loan is prepaid with probability $\mu'_i$, and default on the face value of the loan occurs with probability $\delta'_i$. We use the prime notation, $\mu'_i$ and $\delta'_i$, to indicate that the probability of prepayment and default are themselves random var-

![Fig. 7. Return on assets for bank holding companies. This figure reports the quarterly annualized return on assets from the Federal Reserve Bank of New York (2017). The ratio is computed as the sum of net income across bank holding companies divided by the sum of total assets across bank holding companies. Net income corresponds to item 14 of Schedule Hf from FR Y9-C reports. The book value of assets corresponds to item 12 of Schedule HC from FR Y-9C reports.](image)
variables, representing aggregate risk of prepayment and default. The fair value of the loans on the bank’s balance sheet is $v_L \times L$, where the ratio of fair-to-book value for the stock of loans on the balance sheet solves the asset pricing equation

$$v_L = \frac{1}{1+i} \mathbb{E}[c_L + \mu_L + (1 - \mu_L - \delta_L) \mathbb{E}L],$$

(1)

where $i$ is the risk-free rate and $\mathbb{E}[\cdot]$ denotes expectations under the risk-neutral probability measure. Solving for $v_L$ we obtain:

$$v_L = \frac{c_L + \bar{\mu}_L}{i + \bar{\mu}_L + \bar{\delta}_L},$$

where the “bar” notation denotes the expectation given risk-neutral probabilities, for example $\bar{\mu}_L = \mathbb{E}_L[\mu_L]$. That is, $v_L$ is the present value of receiving the coupon $c_L$ and the average prepayment $\bar{\mu}_L$, until the loan is either prepaid or defaulted on.

Next, let us calculate the fair value of the loan-making arm of the bank. We assume that the bank grows at rate $g'$ and impose the standard growth condition $\bar{g} < i$. To achieve that growth, the bank must make new
loans at a rate $\mu' + \delta' + g'$ so as to replace the principal prepaid, $\mu'_L$, written down, $\delta'_L$, and achieve net growth rate $g'$ in the book value of its loans. We assume that the bank incurs origination costs at rate $\phi_L > 0$ per dollar of new loans. Therefore, the contribution to the bank dividend, or free cash flow, generated by the loan-making arm is $\text{DIV}'_L \times L$, where the dividend rate is

$$\text{DIV}'_L = c_L + \mu'_L - (1 + \phi_L)(\mu'_L + \delta'_L + g').$$

The first term is the coupon, the second term is the prepayment rate, and the third term is the sum of the principal and origination cost for new loans. The fair value of the loan-making arm is the risk-neutral expected present value of these free cash flows. Therefore, the fair value of the loan-making arm is $FVL \times L$, where the fair value ratio solves

$$FVL = \frac{1}{1 + i} \hat{E}[\text{DIV}'_L + (1 + g')FVL].$$

(2)

Taking the difference between the pricing equation for $FVL$, (2), and $v_L$, (1), we obtain

$$FVL - v_L = \frac{1}{1 + i} \hat{E}[((\mu'_L + \delta'_L + g')(v_L - (1 + \phi_L)) + (1 + g')(FVL - v_L)].$$
Solving for FVL, we obtain

$$FVL = v_L + \frac{\bar{\delta}_L + \bar{g}}{i - \bar{g}} (v_L - (1 + \phi_L)).$$

Assuming that banks only make investments with positive net present value, we have that $v_L \geq 1 + \phi_L$. Thus, the fair value of the loan-making arm exceeds the book value for two reasons: value from assets in place and value from growth opportunities. First, the present value of all the payments to be received from each outstanding loan, $v_L$, exceeds its book value of 1. Second, each time the bank will issue a new loan, it will make a profit equal to the net present value, $v_L - (1 + \phi_L)$.

**B. The Deposit-Taking Arm**

Let $D$ denote the total face value, or book value, of the deposits on the bank’s balance sheet. Every period, every dollar of deposits costs the bank $c_D$, equal to the sum of the interest rate paid on deposits and the servicing cost. The deposit is withdrawn with probability of repayment, $\mu_D$. As before, we use the prime notation, $\mu_D$, to indicate that the probability is random, representing aggregate run or funding risk. Hence, the fair value of the deposits on the bank’s balance sheet is $-v_D \times D$, where the ratio of the fair-to-book value of deposits solves

$$v_D = \frac{1}{1 + i} \hat{E}[c_D + \mu_D (1 - \mu_D)v_D] \Rightarrow v_D = \frac{c_D + \bar{\mu_D}}{1 + \bar{\mu_D}}.$$

Next, let us calculate the fair value of the deposit-taking arm of the bank. We again assume that the bank grows at rate $g'$. Hence, to achieve that growth, the bank must take new deposits at a rate $\mu_D' + g'$ so as to replace the deposits withdrawn, $\mu_D'$, and achieve net growth of the book value of deposits of $g'$. We assume that, when it originates new deposits, the bank incurs costs at rate $\phi_D$. Therefore, the contribution to bank dividends, or free cash flow, generated by the deposit-taking arm is $-\text{DIV}'_D \times D$, where the dividend rate solves

$$\text{DIV}'_D = c_D + \mu_D' - (1 - \phi_D)(\mu_D' + g').$$

The fair value of the deposit-taking arm is $-\text{FVD} \times D$, where

$$\text{FVD} = \frac{1}{1 + i} \hat{E}[\text{DIV}'_D + (1 + g')\text{FVD}].$$
Taking the difference between the equations for \(FVD\) and \(v_D\), we obtain that

\[
FVD - v_D = \frac{1}{1+i} \bar{E}[(\mu_D + g')(v_D - (1 - \phi_D)) + (1 + g')(FVD - v_D)].
\]

Solving for \(FVD - v_D\), we obtain:

\[
FVD = v_D - \frac{\bar{\mu}_D + \bar{g}}{1 - \bar{g}} (1 - \phi_D - v_D).
\]

Assuming as before that the bank invests only in projects with positive net present value, we have that \(v_D + \phi_D \leq 1\). This implies that the fair value of the deposit-taking arm exceeds the book value for two reasons. First, the present value of the payment to be made on outstanding deposits is less than the face value of \(1\). Second, each time the bank takes a new deposit, it makes a profit equal to the net present value, \(1 - v_D - \phi_D\).

C. Subordinated Debt

In addition to deposits, we assume that the bank also issues subordinated debt. We assume that subordinated debt takes the form of one-period defaultable debt with face value \(1 + i\). We denote the price of a unit of subordinated debt by \(v_B\). To determine \(v_B\), we need to study the default decision of equity.

The Default Decision of Equity

Suppose that equity enters the period with \(L\) loans, \(D\) deposits, and \(B\) subordinated debt. If equity does not default, subordinated debt is paid principal and interest \((1 + i)B\) out of the bank’s free cash flows \(DIV_L - DIV_D\). In these states, equity issues new subordinated debt in quantity \((1 + g')B\) at price \(v_B\). Thus, the dividend to equity in the event that equity does not default is \(DIV'_E = DIV'_L - DIV'_D \Theta_D - (1 + i)\Theta_B + v_B(1 + g')\Theta_B\), where

\[
DIV'_E = DIV'_L - DIV'_D \Theta_D - (1 + i)\Theta_B + v_B(1 + g')\Theta_B,
\]

with \(\Theta_D = D / L\) and \(\Theta_B = B / L\). If, on the other hand, equity chooses to default, then it receives zero dividend and gives up all future claims on the bank. Hence, the default decision is obtained as the solution of the following Bellman equation:
\[ \text{MVE} = \max \frac{1}{1+i} \hat{E} \{ I'(\text{DIV}_E + (1+g')\text{MVE}) \} \] (6)

with respect to repayment decisions \( I' \in \{0, 1\} \), where the prime notation indicates that the repayment decision will depend on the vector of shocks realizations, \((\mu', \delta', \mu'_D, g')\). Clearly, this implies that equity defaults if

\[ \text{DIV}_E + (1+g')\text{MVE} < 0. \] (7)

The Valuation of Subordinated Debt

Now let us turn to the valuation of subordinated debt. If there is default, \( I' = 0 \), then subordinated debt is not paid its principal and interest \( 1+i \). Instead, subordinated debt holders immediately resell the bank to new owners at price \( R' \). The bank is sold inclusive of some government support \( T_0 \geq 0 \) per unit of assets. After purchasing the bank, new owners receive the current free cash flow from loans and deposits, and issue new subordinated debt at price \((1+g')v_B\). New owners do not have to repay current subordinated debt owners. All in all, this implies that the price at which new owners purchase the bank from subordinated debt holders is, per unit of asset,

\[ R' \Theta_B = T'_0 + \text{DIV}'_E + (1+i)\Theta_B + (1+g')\text{MVE}. \] (8)

The first term, \( T'_0 \), is the government support received by subordinated debt holders and immediately resold, bundled with the rest of the bank, to new owners. The second term, \( \text{DIV}'_E \), is the dividend received by the new owners. The third term adjusts the payout to the new owners for the fact that new owners do not have to repay principal and interest, \((1+i)\Theta_B\), to current subordinated debt owners. The last term is the continuation value of new owners. We assume that the government support, \( T' \), is chosen so that

\[ 0 \leq R' \leq 1+i. \] (9)

The left-hand inequality reflects limited liability for subordinated debt holders. The right-hand inequality imposes that the government does not pay more than principal and interest on outstanding subordinated debt.

Given that, in case of default, subordinated debt holders resell the bank at price \( R' \Theta_B \), the selling price of subordinated debt is
Finally, we can compute the fair value of the subordinated debt arm of the bank as before:

\[ F_{V_{\text{B}}} = \frac{1}{1 + \hat{\theta}} \hat{\beta}(1 + i)\hat{I}' + (1 - \hat{I}')\hat{R}' \]  

(10)

and one sees by direct comparison that \( F_{V_{\text{B}}} = v_B \).

D. Book, Fair, and Market Value of Equity

Book Value

Banks hold loans and deposits on their books at face values. Banks hold subordinated debt on their books at market value. The book value of bank equity is the difference between the book value of bank assets and the book value of bank liabilities. Hence, the ratio of the book value of bank equity to the book value of bank assets is given by

\[ BVE = 1 - \Theta_D - \Theta_B v_B. \]

Define \( \Theta = \Theta_D + \Theta_B v_B \). Then \( \Theta \) is the book leverage of the bank. We thus have \( BVE = 1 - \Theta \).

Fair Value

The fair value of bank equity, on the other hand, is the difference between the fair value of bank assets and the fair value of bank liabilities not including the value of government guarantees. The ratio of the fair value of bank equity to the book value of bank assets is given by

\[ FVE = FVL - \Theta_D FVD - \Theta_B v_B. \]  

(11)

Because \( FVL \geq 1 \) and \( FVD \leq 1 \), it follows that the fair value of bank equity exceeds the book value.

Note that the difference between the fair value and book value of bank equity is given by

\[ FVE - BVE = (FVL - 1) - \Theta_D (1 - FVD), \]

which is the gap between the fair value and book value of the bank’s loans and deposits. Accordingly, we define the franchise value of the bank (relative to total book assets) to be the difference between the fair
value and book value of bank equity because this gap corresponds to the gap between the fair value and book value of the bank’s business arms.

Market versus Fair Value

To compare the fair value of equity to the market value of equity, we use a budget identity in the tradition of Miller and Modigliani (1958). We start from the observation that shareholders and subordinated debt holders do not make all payments on deposits: in a severe default, some of the payments are made by the government. Hence, we have the standard result that the sum of the market values of equity and subordinated debt are equal to the fair value of the bank’s two business arms, plus the market value of all the payments made by the government (shown as MVG)

\[ \text{MVE} + \Theta_B + \text{MVG} = \text{FVL} - \Theta_D FVD + \text{MVG}, \]

where MVG is defined recursively from

\[ \text{MVG} = \frac{1}{1 + i} \hat{E}[(1 - I)T + (1 + g')\text{MVG}]. \]  

(12)

Subtracting the value of the bank’s subordinated debt from both sides gives us

\[ \text{MVE} = \text{FVE} + \text{MVG}. \]  

(13)

This identity is straightforward to formally verify using equations (2)–(6), (8), and (10)–(12).

Equation (13) implies that, in the absence of government guarantees, the market value of bank equity is equal to the fair value of bank equity regardless of the risk in bank assets and bank equity’s strategy for default. It follows from this decomposition that, as long as the bank defaults with positive probability and the government contributes resources to bail out bank liabilities, then the market value of bank equity exceeds the fair value of bank equity.

Notice as well that, in our model, equity does not directly receive payments due to government guarantees upon default. Only debt receives these payments. Yet, equity indirectly profits from these payments. This is because equity reaps the benefit of issuing risk-free liabilities without bearing the full cost of making these liabilities risk free: equity only repays liabilities in good times, and the government repays in bad times. Equation (13) shows that the market value of equity capitalizes the present value of all future government contributions.
Finally, using our definition of the market value of government guarantees, we obtain the following decomposition of the market-to-book ratio of equity:

\[
\frac{MVE}{BVE} = 1 + \frac{FVE - BVE}{BVE} + \frac{MVG}{BVE} = 1 + \frac{FVE - BVE}{BVE} + \frac{MVG}{BVE}.
\]

Both the second and the third terms are positive. The second term reflects the franchise value of the bank relative to the book value of bank equity. The third term reflects the market value of government guarantees relative to the fair value of bank equity.

E. Comparative Statics for the Market-to-Book Ratio

As we argued earlier, the market-to-book equity ratio dropped dramatically after the financial crisis of 2008. This drop has been interpreted by Sarin and Summers (2016) as a signal that banks have become riskier. In what follows, we provide comparative statics to demonstrate that, in fact, whether a drop in the market-to-book ratio signals an improvement or a deterioration in bank safety depends on the forces driving the decline. For instance, if the drop is the consequence of a decrease in bank franchise value, it indicates that banks are riskier. But if the drop is the consequence of a decrease in risk taking (perhaps due to more stringent regulation), it indicates that banks are safer, not riskier.

We focus on the case in which the bank does not issue subordinated debt \((B = 0)\). This case is appropriate because, in the data, banks issue very little subordinated debt. In this case, the cash injections from the government in the case of default by bank equity are whatever is needed to pay off depositors. In terms of the equations above, the cash transfer from the government in the event of default is

\[
T' = -[DIV_L' - DIV_D'\Theta_D + (1 + g')MVE]
\]

per unit of asset.

Franchise Value

The first comparative static is with respect to a decrease in bank franchise value. Formally, consider any change in parameter, besides growth and leverage, that decreases the equity dividend rate in all states. This includes, for example, a decrease in loan coupon, \(c_L\), an increase in average
prepayment, \( \hat{\mu}_L \), an increase in average default, \( \hat{d}_L \), or an increase in deposit coupon, \( c_D \).

**Lemma 1 (rents and quasi-rents).** Consider a decrease in rents or quasi-rents. Then:

- The franchise value, \( \frac{FVE - BVE}{BVE} \), decreases.
- The market-to-book ratio, \( \frac{MVE}{BVE} \), decreases.
- The value of the government guarantee, \( \frac{MVG}{BVE} \), increases. QED.

It is intuitive that a decrease in the bank’s economic profitability reduces both the market value and the fair value of bank equity. The key point is that it reduces the franchise value by more. Indeed, for the franchise value, the decrease in profitability matters in all states, both those in which the bank defaults \( l' = 0 \) and those in which it does not \( (l' = 1) \). For the market value, it only matters in nondefault states, \( l' = 1 \). On net, this implies that \( MVE - FVE = MVG \) must increase.

This comparative statics exercise illustrates that a decrease in the market-to-book equity ratio, if driven by a decrease in bank franchise value, can be interpreted, following Sarin and Summers (2016), as a decrease in bank safety.

**Risk Taking**

Second, we consider the impact of an increase in risk taking, defined as follows. Assume that the shocks \( x' = (\delta_i, \mu_i, \mu_D, g') \) have a factor structure, that is \( x' = \bar{x} + A\Sigma \epsilon' \) for some vector of mean zero, unit variance, and contemporaneously independent shocks, \( \epsilon' = (\epsilon_1', \epsilon_2', ..., \epsilon_N') \), some \( 4 \times N \) matrix \( A \), and some \( N \times N \) positive diagonal matrix \( \Sigma = \text{diag}(\sigma_1, ..., \sigma_N) \). We define a decrease in risk taking as a decrease in \( \sigma_n \) for some \( n \in \{1, ..., N\} \).

**Lemma 2 (risk taking).** Consider a decrease in risk taking. Then:

- The market-to-book ratio, \( \frac{MVE}{BVE} \), decreases.
- The franchise value, \( \frac{FVE - BVE}{BVE} \), stays the same.
- The government guarantee, \( \frac{MVG}{BVE} \), decreases.

The decrease in risk leaves the franchise value constant because bank franchise value only depends on the mean of shocks under the risk-neutral probabilities. The decrease in risk decreases the market-to-book ratio value because of a usual option valuation effect: the payoff of eq-
uity is convex, so a decrease in risk reduces the upside by more than the downside.

This comparative statics exercise illustrates that a decrease in the market-to-book equity ratio for a bank, if driven by a decrease in risk of the bank, can be interpreted as signal of an increase in bank safety.

Leverage

The last comparative statics exercise is with respect to leverage, $\Theta$.

**Lemma 3** (leverage). Consider a decrease in leverage. Then:

- The market-to-book ratio, $\frac{MVE}{BVE}$, decreases.
- The franchise-value, $(FVE - BVE) / BVE$, decreases.
- The government guarantee, $\frac{MVG}{BVE}$, decreases.

To understand this comparative statics result, notice that a decrease in leverage has two effects on bank safety going in opposite directions. On the one hand, it makes it less profitable to operate a bank, so it increases incentives to default. Correspondingly, we find that the franchise value decreases. On the other hand, it also increases the bank’s equity cushion, so it reduces incentives to default. Correspondingly, we find that the government guarantee decreases.16

This comparative statics exercise illustrates that a decrease in the market-to-book equity ratio for a bank, if driven by a decrease in book leverage, can be interpreted, following Yellen (2017), as a signal of an increase in bank safety.

**F. What Triggers Default**

The Default Region

In this paragraph, we investigate the multiple dimensions of banks’ default risk: we ask which types of shocks bring the bank closer to default, in the sense of decreasing the sum of current dividends and continuation payoffs, $DIV + (1 + g')MVE$.

**Lemma 4.** Holding every other shock realization the same, the bank is strictly closer to default if:

- Loan delinquency, $\delta_i$, increases.
- Loan prepayment, $\mu_i$, increases and $\phi_i > 0$. 

• Deposit withdrawal, $\mu_D$, increases and $\phi_D > 0$.
• Balance sheet growth, $g'$, decreases and either $\text{MVG} > 0$, $\nu_L > 1 + \phi_L$, or $\nu_D < 1 - \phi_D$.

Loan delinquencies create losses and so bring the bank closer to default. Loan prepayment also brings the bank closer to default because the cost of replacing a loan on the balance sheet exceeds its face value, $1 + \phi_L > 1$. When loan making has zero net present value, $\nu_L = 1 + \phi_L$, this observation becomes equivalent to the standard intuition that prepayment must create a loss for the bank, which is long premium bonds (loans). Conversely, deposit withdrawal also brings the bank closer to default. Indeed, the cost of honoring a withdrawal is greater than the benefit of replacing the deposit on the balance sheet $1 > 1 - \phi_D$. When deposit taking has zero net present value, $\nu_D = 1 - \phi_D$, this is equivalent to the standard intuition that prepayment creates a loss for the bank, which is short discount bonds (deposits). Finally, negative shocks to the growth rate of the bank’s balance sheet also bring the bank closer to default as long as growth opportunities have strictly positive value.

Growth opportunities can arise in our model if the value of government guarantees is positive, loan making has positive net present value, or deposit taking has positive net present value. Lemma 4 illustrates the commonly held view that a bank’s default risk has multiple dimensions, such as credit risk ($\delta_0$), prepayment risk ($\mu'_L$), run risk ($\mu'_D$), or growth opportunity risk ($g'$).

**Default and Accounting Profitability**

Although risk has multiple dimensions, the bank’s default decision ultimately depends on the overall performance of its portfolio, as measured by the sum of current dividends and continuation payoff, $\text{DIV} + (1 + g')\text{MVE}$. In this paragraph, we relate the bank’s overall performance to standard measures of accounting profitability. First, we note that

$$\text{DIV}' = \text{ROA}' - g'\text{BVE} - (1 - \nu_B)\Theta_B,$$

where $\text{ROA}'$ is the bank’s return on assets. That is, the dividend of equity, per unit of assets, is equal to the $\text{ROA}'$ adjusted for the cost of growing assets in excess of liabilities, $g'\text{BVE}$, and the cost of issuing subordinated debt at a discount. Dividing both sides by BVE, and keeping in mind that $\text{ROE}' = \text{ROA}' / BVE$, we obtain that
\[
\frac{DIV_i}{BVE} = \text{ROE}' - g' - (1 - v_B) \frac{\Theta_B}{BVE}. \tag{14}
\]

Hence, the bank defaults whenever
\[
\text{ROE}' + g' \left( \frac{MVE}{BVE} - 1 \right) - (1 - v_B) \frac{\Theta_B}{BVE} < - \frac{MVE}{BVE}. \tag{15}
\]

That is, the bank defaults whenever the ROE, properly adjusted for the benefit of current growth opportunities, falls below the negative of the market-to-book ratio.\(^{17}\)

**G. Two-State Valuation**

In this subsection, we develop the valuation formulas that we implement in the remainder of the paper. Because default is a binary decision, a bank’s valuation ultimately depends on probabilities and payoffs for two events: repayment \((I' = 1)\) and default \((I' = 0)\). Hence, we can value the bank as if there were only two states. Of course, these two events are determined by the optimal default decision for equity, but given that decision, we can use the following valuation formulas.

Formally, let \(q(n) = \mathbb{E}[I']\) denote the risk-neutral probability for the event of repayment, which we will refer to as “normal times.” Vice versa, let \(q(c) = 1 - q(n)\) denote the total risk-neutral probability for the event of default, or “crisis time.” For any random variable \(x'\), we let \(x(n) = \mathbb{E}[x' | I' = 1]\) denote the risk-neutral expectation conditional on a normal time and \(x(c) = \mathbb{E}[x' | I' = 0]\) denote the expectation conditional on a crisis. Again, let \(\bar{x} = \mathbb{E}[x']\) denote the unconditional expectation of that variable under the risk-neutral probabilities.

With this notation, we obtain using equations (6) and (14)
\[
\frac{MVE}{BVE} = \frac{q(n)}{1 + i - q(n)(1 + g(n))} \left[ \text{ROE}(n) - g(n) - (1 - v_B) \frac{\Theta_B}{BVE} \right], \tag{16}
\]
a formula that will prove to be convenient for our quantitative exercises.

Likewise we can obtain a formula for the market value of government guarantees, assuming for simplicity either that there is no subordinated debt \((\Theta_B = 0)\) or that this debt is fully bailed out in default \((so \ that \ v_B = 1)\):
\[
\frac{MVG}{BVE} = - \frac{q(c)T(c)}{i - \bar{g}}, \tag{17}
\]
where \(T(c)\) is the expectation of the cash injection from the government required to sell the failed bank, conditional on bank failure. That is,
In what follows, it is useful for us to compute the value of government guarantees in terms of banks’ realized accounting returns and balance sheet growth rates conditional on not defaulting relative to the unconditional expectation of these accounting returns. Now take unconditional expectations in (14) and recall that $FVE = \frac{DIV_E}{(i - \bar{g})}$. Under the assumption that either $\Theta_B = 0$ or $v_B = 1$, we obtain after rearranging that the unconditional expectation of the accounting ROE for a bank is given by

$$ROE = \frac{i}{C18} FVE \frac{BVE}{C19} - \frac{g}{C22} FVE \frac{BVE}{C19}.$$

(18)

We can then write the market value of government guarantees by taking the difference between the market value and fair value of bank equity as

$$MVG = \frac{q(n)}{1 + i - q(n)(1 + g(n))} \left[ (ROE(n) - g(n)) - (ROE - \bar{g}) \right]$$

$$- \left[ 1 - \frac{q(n)(i - \bar{g})}{1 + i - q(n)(1 + g(n))} \right] FVE \frac{BVE}{C20/C21}.$$

(19)

This formula for the value of government guarantees is useful for understanding the source of the value of these guarantees. The value of these guarantees is broken into two components. The first component is represented by the term

$$\frac{q(n)}{1 + i - q(n)(1 + g(n))} \left[ (ROE(n) - g(n)) - (ROE - \bar{g}) \right].$$

This term represents the expected discounted present value of the realized excess return (dividend) that the owners of the bank earn from risk taking until the first time that a crisis occurs. The second component is represented by the term

$$- \left[ 1 - \frac{q(n)(i - \bar{g})}{1 + i - q(n)(1 + g(n))} \right] FVE \frac{BVE}{C20/C21}.$$

This term represents the expected discounted value of the loss that the owners of the bank will suffer when they default because they must give up their equity in the bank.
IV. Calibrating Aggregate Credit Risk

Our findings regarding the value of government guarantees to bank equity require that banks be exposed to a risk that involves a small probability of a very negative outcome. We document that aggregate credit risk has this feature. Broad portfolios of corporate bonds experienced large negative realized excess returns in 2008. These portfolios earn relatively small realized excess returns from their exposure to this risk in normal times.\(^{18}\)

We build on existing studies of bank risk exposure. Begenau, Piazzesi, and Schneider (2015) is an important study of banks’ exposure to interest rate risk and credit risk. They estimate the size of banks’ exposure to these risks in terms of factor portfolios. They find that banks increased their exposure to both interest rate risk and credit risk in advance of the financial crisis. Building on their study, we model bank exposure to credit risk directly in terms of the excess returns on portfolios of corporate bonds with different credit ratings financed with risk-free debt.\(^{19}\)

In our model, we abstract from the impact of interest rate risk on banks’ profitability and valuation.\(^{20}\) We discuss this assumption further in appendix B.

In this section, we rely on the insight from Subsection III.G that a bank’s valuation ultimately depends on the bank’s expected risk-neutral performance in two states: a crisis state in which the bank finds it optimal to default and a normal state in which the bank finds it optimal to repay. We use data on the total returns on portfolios of corporate bonds in excess of returns on similar maturity bonds without credit risk to calibrate the risk-neutral probabilities \(q(c)\) of a crisis. Our calibration of the risk-neutral probability of the normal state \(q(n)\) determines the trade-off investors face between exposure to negative realized excess returns in the crisis state \(c\) and reward in terms of positive realized excess returns in the normal state \(n\).

Our calibration of the risk-neutral probabilities \(q(s)\) is based on the asset pricing equation for excess returns on any two fairly priced assets:

\[
q(n)(R(n) - R'(n)) + (1 - q(n))(R(c) - R'(c)) = 0. \tag{20}
\]

To focus on credit risk, we let \(R(s)\) denote the realized returns on a portfolio of corporate bonds with a given credit rating below AAA, and we let \(R'(n)\) denote the realized returns on a portfolio of AAA-rated bonds.

We also use information from recent studies of the expected credit risk premium on investment-grade corporate bonds relative to similar dura-
tion Treasury bonds by Asvanunt and Richardson (2016) and Berndt et al. (2017). The expected risk premium on any asset relative to another asset is the expected value of the excess return under the physical probabilities $p(s)$. As long as realized excess returns on corporate bonds in the normal state are positive, estimates of expected risk premia on corporate bonds are a lower bound on the realized excess return on these bonds in the normal state. That is, under these assumptions we have the inequality

$$R(n) - R^f(n) \geq p(n)(R(n) - R^f(n)) + (1 - p(n))(R(c) - R^f(c)).$$

(21)

Corporate bonds are useful for studying the nature of aggregate credit risk as these bonds are traded, and hence their returns can easily be measured for different credit ratings. We measure the credit risk in corporate bonds using BAML Total Return Indices for portfolios of bonds of different credit ratings. To measure credit risk, we examine the total returns on bonds rated AA, A, BBB, BB, B, and the BAML High Yield Total Return Index in excess of the total returns on bonds with a rating of AAA. See table 1 for a presentation of these data.

The realized excess returns on the BAML portfolios for 2008 were increasingly negative as the rating of the bond portfolio declines, consistent with the hypothesis that bonds with a lower credit rating are more exposed to aggregate credit risk. For the most part, the realized excess returns on these bond portfolios in the noncrisis years of 1997–2007 and 2011–17 are increasing as the credit rating of the bond portfolio declines, consistent with the hypothesis that investors were compensated in normal times for exposure to this risk.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Realized Annualized Excess Returns and Credit Risk Premium on Corporate Bonds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AA</td>
</tr>
<tr>
<td>Returns BAML 2008, %</td>
<td>–5.00</td>
</tr>
<tr>
<td>Premium AV 1988–2014, bp</td>
<td>. . .</td>
</tr>
<tr>
<td>$R(n) - R^f(n)$ if $q(n) = .95$, bp</td>
<td>26</td>
</tr>
</tbody>
</table>

Note: BAML = Bank of America Merrill Lynch; bp = basis points; HY = high yield; AV = Asvanunt and Richardson (2016); BDDF = Berndt et al. (2017). The last line is calculated as $R(n) - R^f(n) = -(1 - q(n))/q(n) [R(c) - R^f(c)]$, where $R(c) - R^f(c)$ is the realized BAML excess return in 2008.

* bp for investment grade.
Next, consider the evidence on the expected credit risk premium, which, through equation (21), puts a lower bound on the realized excess returns on corporate bonds in normal times. In table 1, we present the expected credit risk premia estimated by Asvanunt and Richardson (2016) over the 1988–2014 time period and by Berndt et al. (2017) over the 2002–15 time period.\(^\text{23}\)

To map these data to our model, we use the realized excess returns on these various portfolios as a measure of the realized excess return on a portfolio of assets with the credit risk in corporate bonds in the crisis state \(c\), which we denote by \(R(c) – i\).\(^\text{24}\) Thus, given a choice of \(q(n)\), our model implies a predicted realized excess return for each of these bond portfolios in normal times \(R(n) – i\). In the last line of table 1, we present the model’s predictions for these realized excess returns in the normal state under the hypothesis that the risk-neutral probability of the normal state is \(q(n) = 0.95\).

Based on these observations, in what follows, we use a calibration of the risk-neutral probability of the normal state of \(q(n) = 0.95\).

V. Applying the Model to a Stylized Bank

We now use our model to study the implications of government guarantees for the market valuation of a stylized bank that has no franchise value because all of its assets and liabilities are simply marketable securities. We do so to make a simple quantitative illustration of the two comparative statics results that we considered in lemmas 2 and 3.

In particular, we first show that, in the presence of government guarantees, it is quantitatively plausible that observed variations in bank accounting profitability and market valuations in normal times can be accounted for by small changes in bank exposure to the aggregate credit risk in investment-grade corporate bonds. We demonstrate that a bank with government guarantees, plausible amounts of book equity, and assets with exposure to aggregate credit risk of BBB-rated corporate bonds can capture enough value from government guarantees to boost the ratio of the market-to-book value of its equity to 2.

We then use this stylized model to demonstrate the result in lemma 3: a reduction in book leverage can result in a substantial decline in the accounting profitability and market valuation of the bank, even if it implies that the bank is becoming safer in the sense that the market value of the government guarantees is getting smaller. Specifically, this exercise demonstrates that higher regulatory capital standards should be ex-
expected to significantly reduce the accounting profitability and valuation of a risk-taking bank.

Our stylized bank holds on its asset side a portfolio of marketable securities with exposure to the credit risk observed in corporate bonds with different credit ratings and finances its portfolio with wholesale deposits backed by a full government guarantee. Accordingly, because all of the bank’s assets and liabilities are obtained through transactions in capital markets, we assume that the fair value of this bank’s assets and liabilities is equal to the book value. That is, we assume that \( v_L = v_D = 1 \) and that there are no costs of originating new loans or deposits \( \phi_L = \phi_D = 0 \). The book leverage of the bank is \( \Theta \). Thus, the book value and the fair value of the bank’s equity are given by \( 1 - \Theta \).

The assets of this stylized bank earn gross returns \( 1 + R(s) \) realized in state \( s \). We assume that the bank reinvests to have its portfolio of assets and liabilities grow at rates \( g(s) \). With these assumptions, the free cash flow of the bank is given by

\[
\text{DIV}_L(s) = (R(s) - i) + (1 - \Theta)(1 + i) - (1 + g(s))(1 - \Theta).
\]

The accounting ROE for this stylized bank is given by

\[
\text{ROE}(s) = \frac{R(s) - \Theta i}{1 - \Theta}.
\]

The market value of this bank is given by equation (6). The decision of bank equity to default \( I(s) \) is governed by equation (7). With only two states, the ratio of the market value of equity to its book value is given by the maximum of the value given from equation (16) and the ratio of the fair-to-book value of equity (corresponding to no default). Hence, it is optimal for the bank to default in the crisis state if

\[
q(n) \frac{1 + i - q(n)(1 + g(n))}{1 + i - q(n)(1 + g(n))} [\text{ROE}(n) - g(n)] > \frac{\text{FVE}}{\text{BVE}}.
\]  

(22)

For our stylized bank, the ratio \( \text{FVE} / \text{BVE} = 1 \).

A. Risk and Bank Valuation

We now examine the implications of our stylized model for the market valuation and accounting profitability of stylized banks that have different exposures to aggregate credit risk as indexed by their realized excess returns in the crisis state \( R(c) - i \) and different levels of leverage \( \Theta \). We calibrate our stylized model to a risk-neutral probability of the nor-
nal state of $q(n) = 0.95$ and hence a risk-neutral probability of a crisis of $q(c) = 0.05$. We set the risk-free interest rate to $i = 5\%$ and the growth rate of the book balance sheet in normal times of $g(n) = 7.5\%$. 25

To model banks with different exposures to aggregate credit risk, we consider four banks that differ in their realized excess returns in the crisis state. We calibrate these crisis excess returns to those observed for the different BAML bond portfolios in 2008 discussed above in table 1. We refer to these four banks with different risk profiles as the AA, A, BBB, and BB banks.

We now examine how the market valuation and accounting profitability of our four stylized banks vary with these banks’ exposure to credit risk. We consider first a value for leverage in these banks of $\Theta = 0.90$.

With the parameters we have set, we show that the realized accounting ROEs for these banks in the normal state (ROE($n$)) are rising sharply in bank exposure to credit risk (see the first row of table 2). Thus, we see that it is quite plausible that large differences in banks’ observed accounting ROEs in normal times can be accounted for by differences in their exposure to the aggregate credit risk in investment-grade corporate bonds.

Which of these banks chooses to default in the crisis state? From equation (22), we have that the banks with A-, BBB-, and BB-rated assets would all choose to default in the crisis state. Only the safest bank, the bank with AA-rated assets, would choose not to default.

Now consider the implications of our model for the market valuation of these banks. The safest bank, the bank with AA-rated assets, does not default in the crisis state. Hence, the market value of its equity is equal to the fair value of its equity, which, in turn, is equal to the book value of its equity. Hence, it trades at a market-to-book value of 1.

To value the three riskier banks that choose to default in the crisis state, we use equation (16). From this equation, we have that the bank

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Profitability and Valuation of Stylized Banks by Rating of Bank Assets</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AA</td>
</tr>
<tr>
<td>$\Theta = .90$:</td>
<td></td>
</tr>
<tr>
<td>ROE($n$), %</td>
<td>7.63</td>
</tr>
<tr>
<td>MVE / BVE</td>
<td>1</td>
</tr>
<tr>
<td>$\Theta = .85$:</td>
<td></td>
</tr>
<tr>
<td>ROE($n$), %</td>
<td>6.75</td>
</tr>
<tr>
<td>MVE / BVE</td>
<td>1</td>
</tr>
</tbody>
</table>
with A-rated assets trades at a market-to-book ratio of 1.31, the bank with BBB-rated assets at a ratio of 1.95, and the bank with BB-rated assets at a ratio of 3.33 (see the second row of table 2.) Thus, we see that the market valuation of these banks rises sharply with their exposure to aggregate credit risk. Moreover, our stylized bank can attain a market-to-book ratio close to 2 simply from exposure to the aggregate credit risk in BBB bonds.

The results in table 2 from this simple numerical exercise make clear the quantitative implications of lemma 2. Specifically, we see that, in the presence of government guarantees, it is entirely plausible that large changes in banks’ accounting profitability and market valuations can be accounted for by small changes in banks’ exposure to the aggregate credit risk in investment-grade corporate bonds.

B. Equity Capital, Bank Accounting Profits, and Valuation

We now illustrate the comparative statics exercise in lemma 3. Specifically, we now consider the accounting profitability and valuation of our stylized banks with a value for leverage in these banks of $\Theta = 0.85$. Results are reported in the lower half of table 2.

The realized accounting ROEs for these banks in the normal state ($\text{ROE}(n)$) are substantially reduced relative to the example above with lower equity capital (cf. first and third rows of table 2.)

Which of these banks chooses to default in the crisis state? From equation (22), we have that now only the two riskiest banks, the banks with BBB and BB assets, would choose to default in the crisis state. The banks with AA and A assets would not choose to default in the crisis state.

This reduction in banks’ book leverage has a striking impact on their market valuations (cf. second and fourth rows of table 2.) Now, the banks with AA- and A-rated assets both trade at a market-to-book ratio of 1. The BBB bank now trades at a market-to-book ratio of only 1.02 instead of 1.95. Although this bank continues to default in the crisis state (and hence with the same probability), with lower leverage, the equity of this bank derives much less value from the government guarantees.

The results in table 2 from this second simple numerical exercise highlight the quantitative implications of lemma 3, that is, the prediction of our model that an increase in bank capital following a crisis should be expected to substantially reduce bank market valuations and accounting profitability relative to what was observed prior to that crisis.
C. Risk Taking and Accounting Profitability

As shown in table 2, the accounting profitability of our stylized bank rises in the risk exposure of its assets. We can use the benchmark for accounting profitability in equation (18) to decompose the accounting profitability of banks observed in normal times into a component that is due to exposure to aggregate risk $\text{ROE}(n) - \text{ROE}$ and a component that is due to the fair value of bank equity $\text{ROE}$.

For our stylized banks in which $\text{FVE} = \text{BVE}$, we have $\text{ROE} = i$, which we calibrate to $i = 5\%$. For each of our stylized banks, we see that they show accounting profitability in normal times in excess of this benchmark, with this gap increasing as the credit quality of the bank’s assets is reduced. Note that this excess accounting profitability for the BBB bank with book leverage of $\Theta = 0.9$ is 840 bp. When book leverage is reduced to $\Theta = 0.85$, this excess profitability is reduced to 560 bp. The risk-neutral expectation of the bank’s accounting profitability, however, is unchanged at $\text{ROE}$ regardless of risk taking. A bank that takes risks succeeds at raising its accounting profitability in normal times at the expense of reducing its profitability in the crisis state. From equation (19) and our quantitative results, we see how this impact of risk taking on accounting profitability translates into higher valuations of government guarantees.

VI. Accounting for the Valuation of US Banks

In this section, we use our model to provide a full accounting of the evolution of the market valuation of banks for three time periods: 1970–85, 1996–2007, and 2011–17. We choose these time periods to correspond to “normal” states as opposed to crisis states. We omit the time period between 1986 and 1995 because this was a period of rapid change in the regulatory environment and business models for banking and of substantial volatility in bank earnings and valuations. We omit the years 2008–10 as these correspond to a crisis period in banking. Table 3 summarizes all the parameters and results of this section. Our accounting proceeds in two steps.

In the first step, we construct a measure of the fair value of bank equity, using data on the book value of items on banks’ balance sheets together with data reported in the footnotes of banks’ annual reports and results from the Portfolio Value Model created by the OTS. We do so using equations (3), (4), and (11). The inputs required here are the values of
the ratio of the fair-to-book value of loans $v_L$, the ratio of the fair-to-book value of deposits $v_D$, and an assumption regarding the value of growth opportunities in loan making, $FVL - v_L$, and deposit taking, $FVD - v_D$. This first step gives us a measure of the ratio of the franchise value of banks relative to the book value of bank equity implied by $(FVE - BVE) / BVE$.

In the second step, we construct a measure of the model’s implications for the market value of bank equity. This measure is the maximum of the fair value of bank equity and the market value of bank equity conditional on equity defaulting in the crisis state from equation (16). The inputs required here are measures of the risk-free interest rate $i$, a measure of the growth rate of the bank balance sheet in normal times $g(n)$, a measure of the bank’s free cash flow to equity in the normal state $DIV_e(n)$ given observed accounting profitability, and our calibration of the risk-neutral

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Calibration and Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Theta$, %</td>
<td></td>
</tr>
<tr>
<td>$\Theta_B$, %</td>
<td></td>
</tr>
<tr>
<td>$i$, %</td>
<td></td>
</tr>
<tr>
<td>$g(n)$, %</td>
<td></td>
</tr>
<tr>
<td>$v_L$</td>
<td></td>
</tr>
<tr>
<td>$v_D$</td>
<td></td>
</tr>
<tr>
<td>ROA($n$), %</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>MVE / BVE</td>
<td>1</td>
<td>2.24</td>
<td>1.19</td>
<td>Market-to-book value of equity</td>
<td>Accounting model</td>
</tr>
<tr>
<td>$(FVE - BVE)$ / BVE</td>
<td>0</td>
<td>.33</td>
<td>.10</td>
<td>Franchise value/book equity</td>
<td>Accounting model</td>
</tr>
<tr>
<td>$(MVE - FVE)$ / BVE</td>
<td>0</td>
<td>.91</td>
<td>.09</td>
<td>Value of government guarantees/book equity</td>
<td>Accounting model</td>
</tr>
<tr>
<td>ROE, %</td>
<td>10.79</td>
<td>5.80</td>
<td>1.64</td>
<td>Return on equity with no asset risk</td>
<td>Accounting model</td>
</tr>
<tr>
<td>ROE($n$) – ROE, bp</td>
<td>89</td>
<td>908</td>
<td>577</td>
<td>Excess returns in normal times</td>
<td>Accounting model</td>
</tr>
</tbody>
</table>
probability of the normal state \( q(n) = 0.95 \). Hence, this second step gives us a measure of the ratio of the market value of government guarantees to the fair value of bank equity implied by \((MVE - FVE) / BVE\).

A. First Step: Fair Value of Equity

Measurement of Franchise Value in Banking

From equation (11), the fair value of bank equity, and hence the franchise value of the bank, is determined by the fair value of the current stock of bank loans relative to its book value \( v_L \), the fair value of the current stock of deposits relative to its book value \( v_D \), the leverage of the bank \( \Theta_D \), and the value of the bank’s opportunities to originate new loans and deposits. Note that the subordinated debt of the bank is recorded on the balance sheet at its market price, so we are able to read \( \Theta_B v_B \) off bank balance sheets.

To measure \( v_L \), our paper relies on banks’ estimates of the fair value of their loans presented in the footnotes to the financial statements in their annual reports. To measure \( v_D \), we rely on estimates of the fair value of bank deposits from a model developed by the OTS. We assume that banking is competitive in the sense that loan and deposit origination is a zero net present value activity, that is, \( \phi_L = (v_L - 1) \) and \( \phi_D = (1 - v_D) \). This implies that the gap between the fair value and the book value of bank equity relative to the book value of bank assets is given by \( (v_L - 1) - \Theta_D(1 - v_D) \).

The methods that banks and the OTS use to estimate the fair value of loans and deposits are related to the internal cost-accounting models banks develop to evaluate the risk versus the profitability of their lending and deposit-taking units. This methodology is commonly referred to as “funds transfer pricing.” This methodology is also related to the methodology that the Bureau of Economic Analysis uses when it measures value added in banking. In particular, the Bureau of Economic Analysis methodology attributes a portion of banks’ net interest income to implicit charges for service provision, which they refer to as “financial intermediation services implicitly measured.”

Loan Fair Values

First consider our data on the fair value of bank loans. Banks have been required since the mid-1990s to report an estimate of the fair value of
their loans in the footnotes to their annual reports. We collected data from the footnotes in bank annual reports on the fair and book values of bank loan portfolios for the period 1995–2016 for 19 large bank holding companies.\footnote{We compute a ratio of the fair-to-book value of loans for the banking sector by taking the sum of loan fair values across these banks divided by the sum of loan book values. The resulting ratios from these data are shown in figure 10. In normal times, these ratios range between 1.00 and 1.02. Thus, consistent with the finding of Begenau and Stafford (2018) that bank assets have not substantially outperformed passive portfolios of securities, we find that according to bank models of loan fair values, the gap between loan fair values and book values is small.}

The coefficient $v_L$ in our model refers to the ratio of the fair value to book value of all bank assets. To obtain an estimate of $v_L$ to be used in our model, we must convert the figure for the ratio of the fair-to-book value of bank loans to a fair-to-book value of all bank assets. We do

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{fig10}
\caption{Fair-to-book value of loans. The ratio is computed as the sum of the fair value of loans across bank holding companies divided by the sum of the book value of loans across bank holding companies. Observations of fair value of loans come from notes in the annual reports of bank holding companies. See, for example, note 22, “Fair Value of Financial Instruments,” on page 208 of the Bank of America (2017) 2016 annual report. We collected observations for Bank of America, Citigroup, JPMorgan Chase, Wells Fargo, American International Group, MetLife, American Express, Huntington Bancshares, Fifth Third Bank, Washington Mutual, SunTrust Banks, Regions Financial Corporation, PNC Financial Services, National City Corporation, Zions Bancorporation, Countrywide Financial, Comerica, KeyCorp, and US Bancorp.}
\end{figure}
so as follows. We treat all earning bank assets that are not loans as having fair values equal to book values.\textsuperscript{32} We also treat all nonearning bank assets as having fair values equal to book values.\textsuperscript{33} If we denote the ratio of fair-to-book value of bank loans taken from bank annual reports by \( \tilde{v}_L \) and the ratio of bank loans in the data to total assets in the data by \( \bar{L} \), these assumptions give us that \( v_L \) in our model is given by

\[
v_L = 1 + (\tilde{v}_L - 1)\bar{L}.
\]

We report the implied values of \( v_L \) in table 3. We do not have data for the 1970–85 time period. We set \( v_L = 1 \) for this time period.

Deposit Fair Values

Now consider our data for the fair value of bank deposits. Banks do not report on the fair value of their deposits. Instead, we rely on estimates of the fair value of deposits constructed by the OTS in its Portfolio Value Model.\textsuperscript{34} Their estimate of the ratio of the fair-to-book value of deposits (which they refer to as the intangible value of deposits) is an estimate of the interest savings to the bank that arise if current depositors leave their funds in their demand accounts or roll over their funds in time deposits at rates below prevailing wholesale interest rates (or a combination of both).

The OTS published estimates of the fair value of selected assets and liabilities on a quarterly basis from 1997 to 2011.\textsuperscript{35} We use the OTS estimates of the intangible value of retail certificates of deposit, transaction accounts, money market accounts, passbook savings accounts, and non-interest-bearing accounts to construct an estimate of the fair value of deposits in banks in the data, which we denote by \( \tilde{v}_D \).\textsuperscript{36}

We check the results from the OTS Portfolio Value Model for the intangible value of deposits against accounting data on the core deposit intangibles that banks record when one bank purchases another bank. Davis (2017) charts three reports on average core deposit intangibles recorded from whole bank transactions from 2000 to 2017. Core deposit intangibles range from 2.5% to 3% in the early 2000s and have fallen to roughly 1% since the crisis. These estimates imply a large drop in the gap between the book value and fair value of deposit liabilities across these two time periods. This finding is consistent with the discussion in Fine and Rohde (2013).

As with loans, the concept of \( v_D \) in our model corresponds to the ratio of the fair value to book value of all bank liabilities. In addition to depos-
its, bank liabilities include fed funds purchased, repo, and trading liabilities.\(^\text{37}\) We assume that these liabilities are all carried on the books at fair value. Hence, if \(\bar{D}\) denotes the ratio of deposits to total assets in the data, our model concept of \(v_D\) is given by

\[
v_D = 1 - (1 - \bar{v}_D) \frac{\bar{D}}{\Theta},
\]

where \(\bar{D}/\Theta\) is the ratio of deposits to total liabilities in the data.

We report the implied values of \(v_D\) in table 3. Again, we do not have data for the 1970–85 time period. We set \(v_D = 1\) for this time period. We find significant gaps between the fair and book values of bank deposits, particularly during the 1996–2007 time period.\(^\text{38}\)

Bank Leverage

The sources we use to measure bank leverage \(\Theta\) (and accounting profitability and growth of assets) are as follows. For the 1970–85 time period, we use data from the FDIC’s (2019b) historical statistics on banking. This source provides data on bank income statements and balance sheets on an annual basis from 1934 through 2017. For the 1996–2007 and 2011–17 time periods, we use data on bank holding companies from the Federal Reserve Bank of New York’s (2019) report “Quarterly Trends for Consolidated US Banking Organizations.” This source provides quarterly data on bank holding company income statements and balance sheets on a quarterly basis from 1991 through 2017Q3. The values of the ratio of the fair value of bank subordinated debt to total assets (\(\Theta_B v_B\)) for these three time periods are from line 19 from Schedule HC on the bank holding company FR Y-9C reports. These data are presented in the top panel of table 3.

Results on Bank Franchise Values

Bank franchise parameters give us the following results for the ratio of the fair value of bank equity to the book value of bank equity presented in the bottom panel of table 3. We estimate that the ratio of the fair value of bank equity relative to the book value of bank equity was 1.33 for bank holding companies in the 1996–2007 time period and 1.10 for bank holding companies in the 2011–17 time period. Thus, our estimates imply that bank franchise values have fallen considerably relative to bank book equity—from 33% in 1996–2007 to 10% in 2011–17.
B. Second Step: Market Value of Equity

We now turn to the second step of our accounting, that of measuring the model’s implications for the market value of bank equity. For this step, from equation (16) we require measures of the following parameters: \(q(n)\), \(i\), \(g(n)\), and ROE\((n)\). These parameters are presented in the top panel of table 3, where we compute ROE\((n) = \text{ROA}(n) / (1 - \Theta)\).

We use our calibration of the risk-neutral probability of the normal state of \(q(n) = 0.95\) for all time periods that we consider.

To calibrate the level of the riskless interest rate \(i\) for each of our three normal time periods, we consider the constant maturity yield on 5-year Treasury securities as reported in the top panel of table 3. To calibrate the growth rate of assets in the normal state \(g(n)\), we examine the average of the growth rate of bank total assets in the time periods under consideration. We use values of the growth rate of banks in normal times \(g(n)\) of 10.0% for 1970–85, 7.5% for 1996–2007, and 2.4% for 2011–17.

To compute equity dividends in normal times \(\text{DIV}_E(n)\), we use

\[
\text{DIV}_E(n) = \text{ROA}(n) - (1 - v_B)\Theta_B - g(n)\text{BVE}.
\]

To estimate the market price of subordinated debt \(v_B\), we use data on banks’ bond spreads as described in Section II. We have that \(v_B = (1 + i) / (1 + y)\) where \(y\) is the yield on subordinated debt. We calibrate the spreads on bank-subordinated debt \(y_B - i\) to 93 bp for 1996–2007 and 147 bp for 2011–17. We do not have data for the 1970–85 time period. We use a spread of 100 bp for this time period. This calibration implies values of \(v_B\) equal to 0.991 for 1970–85 and 1996–2007 and 0.986 for 2011–17. Using these data, we have implied values of \(\Theta_B\).

C. Results

Our results are presented in the bottom panel of table 3.

Our model predicts that during the 1970–85 time period, banks would not choose to default in the crisis state, and hence they derived no value from government guarantees. This implies that the market-to-book ratio of banks during this time period should equal the ratio of the fair value to book value of equity and that government guarantees did not add to the market value of bank equity.

Our model predicts that during the 1996–2007 time period, banks would choose to default in the crisis state and that the model-implied ratio of market-to-book value of equity was 2.24. This value is quite close...
to the observed average value in the data of 2.12. As a result, we argue that our model can account for observed bank valuations during the 1996–2007 time period. Because the predicted ratio of the fair-to-book value of equity during this time period was only 1.33, our model implies that banks derived a substantial portion of their market value of equity from government guarantees (roughly 91% of their book value of equity).

Our model predicts that during the 2011–17 time period, banks would choose to default in the crisis state and that the model-implied ratio of market-to-book value of equity was 1.19. This figure is close to the model’s predictions for the ratios of the fair-to-book value of bank equity of 1.10 discussed above. Hence, our model predicts that banks currently do not derive much of their market value from government guarantees. Our model actually overpredicts the ratio of the market-to-book value of bank equity relative to the data. In the data, this figure averages 0.98 over this time period.

What forces drive our finding that the market value of government guarantees was large relative to the book value of bank equity in the period 1996–2007 but not in the other two time periods? The forces that we focus on here are changes in the book value of bank leverage and the risk in bank assets.

We have seen that the book value of bank leverage has declined steadily across the three time periods that we study. This finding raises the question of why the market value of government guarantees was not high in the 1970–85 time period.

The answer lies in the amount of aggregate risk in bank assets. To derive this answer, we use equation (18) to measure the excess accounting ROE of banks in normal times for these three time periods.39 We find a value of ROE(\(n\)) – ROE of only 89 bp in the 1970–85 time period. This excess accounting return to equity contrasts sharply with the value of 908 bp in the 1996–2007 time period and the value of 577 bp for the 2011–17 time period. Based on this evidence, we argue that risk taking by banks in terms of the exposure in bank assets rose sharply from the 1970–85 time period to the 1990s and beyond. This evidence suggests that the risk in bank assets has declined only modestly since the crisis of 2008.40

VII. Conclusion

In this paper, we have shown that a large part of the evolution of bank valuations from 1970 to the present can be explained by changes in the
value of government guarantees. By increasing leverage and exposure to losses in credit crisis states, bankers increase the capitalized value of government guarantees. We show that changes in the capitalized value of these guarantees, driven mainly by changes in bank leverage, risk taking, and the growth rate of banks’ balance sheets, have been at least as important as banks’ true franchise values in determining the value of US banks over time.

Our paper has important implications for bank regulation. Indeed, we show that very small changes in banks’ exposure to aggregate credit risk, as well as small changes in bank leverage, have very large effects on taxpayers’ liability to bail out banks in a crisis. Currently, bank book leverage is lower than precrisis levels. The larger bank equity cushion has reduced the value of taxpayers’ liability to bail out banks in a crisis. However, data on bank profitability and market measures of bank credit risk indicate that banks have not substantially reduced their exposure to aggregate risk. As a result, current data suggest that bank equity and subordinated debt would again be wiped out in a credit crisis of the magnitude of 2008.

To conclude, our accounting model suggests that moves to lighten the regulatory burden on banks going forward may lead to substantially greater bank risk exposure. The value of government guarantees to bank equity is highly sensitive to small changes in the risk exposure of bank assets. If regulators allow even a moderate increase in risk taking by banks, we should see a significant jump in bank valuations and accounting profitability. The temptation will be to interpret this increase in bank valuations and accounting profitability as a restoration of bank franchise value previously damaged by regulation. Instead, we argue that it would properly be interpreted as a return to the days in which taxpayers had a large contingent liability to bail out banks in a crisis.

Appendix A

Omitted Proofs

A.1. Proof of Lemma 1

It is clear from the Bellman equations that a decrease in profitability decreases both market and fair value of bank equity. Because $BVE = 1 - \Theta$ is not affected by profitability, it follows that both $MVE / BVE$ and $FVE / BVE$ decrease. To sign the net impact on market value of all the pay-
ments made by the government, recall the Bellman equation for fair value of bank equity:
\[
FVE = \frac{1}{1 + i} \mathbb{E}[\text{DIV}_t' + (1 + g')FVE].
\]
Subtract this Bellman equation for fair value of bank equity from the Bellman equation for market value of bank equity, (24).

\[
\text{MVE} - FVE = \frac{1}{1 + i} \mathbb{E}[\max\{-\text{DIV}_t' - (1 + g')FVE, (1 + g')(\text{MVE} - FVE)\}]
= \frac{1 + \bar{g}}{1 + i} (\text{MVE} - FVE)
+ \frac{1}{1 + i} \mathbb{E}[\max\{-\text{DIV}_t' - (1 + g')FVE - (1 + g')(\text{MVE} - FVE), 0\}],
\]

Let \( \rho = (\text{MVE} - FVE) / \text{BVE} \) and recall that \( \text{BVE} = 1 - \Theta \) and that \( FVE = \text{DIV}_t'/i - \bar{g} \). Dividing through both sides by \( 1 - \Theta \) and rearranging, we obtain
\[
\rho(i - \bar{g}) = \mathbb{E}\left[\max\left\{-\frac{\text{DIV}_t' + (1 + g')\text{DIV}_t}{1 - \Theta} - (1 + g')\rho, 0\right\}\right]. \quad (23)
\]

The left-hand side is strictly increasing in \( \rho \) and the right-hand side is weakly decreasing. It is clear that any parameter that decreases dividends in all states, besides growth and leverage, increases the right-hand side. This implies that following any change in parameter that decreases dividends in all states, besides growth and leverage, \( \rho \) must increase.

A.2. Proof of Lemma 2

Recall the equation for MVE:
\[
\text{MVE} = \frac{1}{1 + i} \mathbb{E}[\max\{0, \text{DIV}_t' + (1 + g')\text{MVE}\}] . \quad (24)
\]
Subtract \((1 + \bar{g})/(1 + i)/\text{MVE}/\text{BVE}\) from both sides to obtain
\[
(i - \bar{g})\text{MVE} = \mathbb{E}[\max\{-\text{MVE}, \text{DIV}_t\}] .
\]

Government Guarantees and Valuation 123
The left-hand side is strictly increasing in MVE, is equal to zero when MVE = 0, and goes to infinity as MVE → ∞. The right-hand side is decreasing and positive. Hence, there exists a unique solution.

By definition, an increase in risk taking keeps $g$ the same, so it leaves the left-hand side the same. It is easy to see that it increases the right-hand side. Indeed, rewrite the right-hand side as

$$-(1 + \bar{g})MVE + \hat{E}[\max\{0, DIV' + (1 + \bar{g}')MVE\}]$$

$$= -(1 + \bar{g})MVE + \hat{E}\left[\max\left\{0, a + \sum_{i=1}^{N} k_i \sigma_i \epsilon_i \right\}\right]$$

for some coefficients $a$ and $k_i$ because the dividend is an affine function of shocks and the shocks are affine functions of the $\epsilon_s$. Now it is easy to see that, for any mean 0 random variable, the function $\sigma \mapsto \hat{E}[\max\{0, a + b \sigma \}]$ is increasing in $\sigma$, so the result follows.

A.3. Proof of Lemma 3

Start from the right-hand side of (23). Let

$$N(\Theta) = DIV' + (1 + \bar{g}') \frac{DIV}{i - \bar{g}}.$$

It is clear from the expression of $DIV'$ that $N(\Theta)$ is decreasing in $\Theta$ and that $N(\Theta) < 0$ whenever the right-hand side of the Bellman equation (23) is positive. Therefore:

$$-\frac{\partial}{\partial \Theta} \left( \frac{N(\Theta)}{1 - \Theta} \right) = -\frac{\partial N(\Theta) / \partial \Theta}{1 - \Theta} - \frac{N(\Theta)}{(1 - \Theta)^2} > 0$$

whenever the right-hand side of the Bellman equation (23) is positive. This implies that a decrease in $\Theta$ decreases $r$.

A.4. Proof of Lemma 4

We have

$$DIV' + (1 + \bar{g}')MVE = DIV' - \Theta_D DIV - (1 + i) \Theta_B + v_B (1 + \bar{g}') \Theta_B$$

$$= c_L + \mu' - (1 + \phi_L) (\mu' + \delta_l + \bar{g}')$$

$$- \delta_D c_D + \mu' - (1 - \phi_D) (\mu' + \bar{g}')$$

$$= (1 + i) \Theta_B + v_B (1 + \bar{g}') \Theta_B + (1 + \bar{g}')MVE.$$
Clearly, the partial derivative with respect to $\delta_L$ is strictly negative, the partial derivative with respect to $\mu_L$ is strictly negative if $\phi_L > 0$, and the partial derivative with respect to $\mu_D$ is strictly negative if $\phi_D > 0$.

The partial derivative with respect to $g'$ is equal to

$$-(1 + \phi_L) + \Theta_D (1 - \phi_D) + v_b \Theta_B + \text{MVE.}$$

Now use that $\text{MVE} \geq \text{FVE} = \text{FVL} - \Theta_D \text{FVD} - \Theta_B v_B$ to obtain that the partial derivative with respect to $g'$ is greater than

$$\text{FVL} - (1 + \phi_L) + \Theta_D (1 - \phi_D - \text{FVD}) \geq 0,$$

because $\text{FVL} \geq v_L \geq 1 + \phi_L$, and $\text{FVD} \leq v_D \leq 1 - \phi_D$. Hence, the partial derivative is positive. Clearly, the partial derivative is strictly positive if $\text{MVE} > \text{FVE}$, $v_L > 1 + \phi_L$, or $v_D < 1 - \phi_D$.

**Appendix B**

**Frequently Asked Questions**

Here we address several questions that have been asked about our modeling and measurement of the fair value of banks and of the value of government guarantees for banks. These questions are as follows.

1. In our measurement of the franchise value of banks, we have focused on measuring the gap between the fair value and book value of banks’ loans and deposits. Would consideration of the gap between the fair value and book value of the other assets and liabilities on banks’ balance sheets have a substantial impact on our measurement of banks’ franchise value?

2. In our measurement of the franchise value of banks, we have assumed that bank equity does not derive value from banks’ noninterest income other than service charges on deposits. Noninterest income has grown considerably as a portion of banks’ operating income over the past several decades. Would consideration of the contribution of noninterest income to dividends to bank equity substantially affect our measurement of bank franchise value?

3. In our model of the value of government guarantees for stylized banks, we have focused on aggregate credit risk and abstracted from the role of interest rate risk. How would consideration of interest rate risk affect our measurement of the value of government guarantees?

4. In our model of the value of government guarantees for banks, we have assumed that banks’ opportunity to grow their balance sheets con-
tributes to the value of these guarantees. What justification do we have for this assumption? Why is it that competition between banks does not eliminate the value of this growth opportunity?

5. In our valuation model for banks, we use a discrete time model and consider each time period to be 1 year. Hence, we have implicitly assumed that banks are required to meet capital standards only once per year (at the beginning of each time period) and that the risks to bank assets and liabilities over a 1-year horizon is the relevant horizon for measuring bank risks. How should one interpret this assumption? And what impact would it have to use a longer or shorter time period in our analysis?

6. How do results from our model of the value of government guarantees compare to other estimates in the literature?

We address each of these questions in the subsections below.

**Question 1: A Full Accounting for Fair Value of the Balance Sheet**

In our measurement of the franchise value of banks, we have focused on measuring the gap between the fair value and book value of banks’ loans and deposits. Would consideration of the gap between the fair value and book value of the other assets and liabilities on banks’ balance sheets have a substantial impact on our measurement of banks’ franchise value?

Based on work by Nissim and Penman (2007) and Calomiris and Nissim (2014), we argue that the answer to this question is no.

As described by Calomiris and Nissim (2014), banks have been required to report their own estimates of the fair value of their financial assets and liabilities in the footnotes to their annual reports for several decades now. Specifically, these authors report that “the measurement of the disclosed fair value of equity is made possible by an accounting change in 1992. Since 1992 on an annual basis, and since Q2:2009 on a quarterly basis, companies are required to disclose the estimated fair value of their financial assets and liabilities as of the balance sheet date. These disclosures are quite comprehensive. They include essentially all loans, securities, debts payable, time deposits, derivatives, and most other financial instruments” (406). In figure 2 of their paper, they plot the mean and median of the ratio of the disclosed fair value to disclosed book value of equity for the bank holding companies in their sample from the end of 2000 through mid-2013. As is evident in this figure, the ratio of disclosed fair value to disclosed book value of equity is very stable over time and very close to 1. These results indicate that banks’
estimates of the fair value of items on their balance sheets are very close to the book value of these items.

Note that these disclosed estimates of the fair value of bank assets and liabilities do not include estimates of the fair value of deposits with no defined maturity (demand deposits). This is why we have focused on estimating the ratio of the fair value to book value of these deposits using alternative data from the Office of Thrift Supervision Portfolio Value Model and from estimates of core deposit intangibles from bank transactions.

Nissim and Penman (2007) provide a comprehensive discussion of the gap between the fair and book values of all of the items on banks’ balance sheets. Using data from before the crisis, they report,

On average, 36% of banks’ reported assets (cash and balances due, federal funds sold, securities purchased under resell agreements, available-for-sale securities, and trading assets) and 16% of their liabilities (federal funds purchased, securities sold under repurchase agreements, and trading liabilities) were reported on the balance sheet at or close to fair value. Another 52% of assets (loans, held-to-maturity securities, and other financial assets) and 34% of liabilities (time deposits and debt) were subject to Statement of Financial Accounting Standard (SFAS) 107 and SFAS 115 fair value disclosure requirements. Thus, for approximately 88% of BHCs’ [bank holding companies’] reported assets and 50% of their liabilities, fair value estimates were generally available during the sample period. (6)

They further conclude that the difference between the fair and book values of existing assets is likely of “secondary importance.”

**Question 2: Noninterest Income and Bank Value**

In our measurement of the franchise value of banks, we have assumed that bank equity does not derive significant value from banks’ noninterest income other than service charges on deposits. Noninterest income has grown considerably as a portion of banks’ operating income over the past several decades. This has been especially true for the largest banks. Here we consider the question of whether the contribution of noninterest income to dividends to bank equity substantially affect our measurement of bank franchise value.

On the basis of cross-sectional data on overall bank accounting profitability and bank equity valuations, we argue that it is unlikely that bank equity derives significant value from activities that generate noninterest income other than service charges on deposits. This is because, although noninterest income has become relatively more important for larger banks, there does not appear to be significant systematic variation
across banks of different size in accounting profitability and equity valuation.

The main categories of bank holding company noninterest income are as follows: service charges on deposits; income from fiduciary activities; fees and commissions from securities brokerage; investment banking, advisory, and underwriting fees and commissions; fees and commissions from annuity sales; underwriting income from insurance and reinsurance activities; income from other insurance activities; venture capital revenue; net servicing fees; net securitization income; and trading revenue. The main sources of noninterest expense are expenses for salaries and employee benefits, premises, and intermediate inputs.

Copeland (2012) analyzes the evolution of noninterest income for bank holding companies of different sizes over the period 1994–2010. He finds that the most dramatic growth of nontraditional sources of noninterest income has occurred for the largest bank holding companies, whereas smaller bank holding companies have not seen much of a change in the size and sources of their noninterest income. In figure B1 we show the change in importance of noninterest income in bank net operating revenue by bank size over the period 1991 to the present as reported in the Federal Reserve Bank of New York’s (2019) “Quarterly Trends for Consolidated US Banking Organizations.” These data clearly

![Graph showing noninterest income share by bank size.](image)

Fig. B1. Noninterest income share by bank size. Noninterest income as a percentage of net operating revenue. Net operating revenue is defined as the sum of net interest income and noninterest income (Federal Reserve Bank of New York 2017).
show that noninterest income is more important for larger bank holding companies and that this has been increasingly true over time. We argue that bank equity does not derive significant value from banks’ noninterest income other than service charges on deposits based on two cross-sectional observations regarding bank accounting overall profitability and equity valuations. Each of these observations in cross-sectional data indicates that larger banks are neither more profitable nor more highly valued than medium-sized banks. Thus, it appears that the advantage large banks have in generating noninterest income does not translate into an advantage in terms of overall profitability or valuation.

First, we consider data from the Federal Reserve Bank of New York’s (2019) “Quarterly Trends for Consolidated US Banking Organizations” report on bank holding companies’ accounting ROE by bank size over the time period 1991 to the present. As shown in figure B2, over the time period 1991 to the present, banks’ accounting ROE does not show significant variation across bank size categories. In particular, the time series variation in this measure of accounting profitability is substantially larger than the cross-sectional variation at a point in time.42

Next we consider data on the valuation of banks by bank size. Figure 3 shows measures of the ratio of the market-to-book value of equity by bank size for the period 1991 to the present. Here again, we see that the variation in the ratio of the market-to-book value of equity over time is substantially larger than the variation of this ratio in the cross-section.

![Figure B2](https://example.com/figureB2.png)

**Fig. B2.** Return on equity by BHC size (Federal Reserve Bank of New York 2017)
at a point in time. Minton et al. (2017) conduct a more thorough study of the relationship between bank size and bank valuation and arrive at the conclusion that there is strong cross-sectional evidence that the valuation of large banks falls with size (as is evident in our fig. 3). Moreover, they find that banks with more trading assets are worth less than banks with fewer trading assets.

Question 3: Interest Rate Risk

In our model of the value of government guarantees, we have assumed that the risks that banks face are independent and identically distributed (i.i.d.) over time. With this stark modeling assumption, we can derive very simple formulas for the value of government guarantees based on a few parameters. We see this simplicity as the main advantage of our modeling framework.

One cost of this assumption is that we are unable to account explicitly for interest rate risk. This is because our assumption forces us to keep the risk-free interest rate $i$ constant over time. Hence, the term structure of interest rates in our model is always constant at all maturities. Clearly, the interest rate risk associated with banks’ maturity transformation and interest rate derivatives is an important risk to bank asset values. What is the impact of this omission of interest rate risk on our valuation exercise?

We conjecture that one could capture the impact of interest rate risk and other risks on the value of government guarantees in our model in a reduced-form manner as follows. As shown in equation (16), in our model, the market value of bank equity is determined by a handful of parameters. These are the risk free rate $i$, the expected growth rate of the bank conditional on not defaulting $g(n)$, the risk-neutral probability of bank failure $1 - q(n)$, and the bank’s ROE conditional on not defaulting $\text{ROE}(n)$. To derive these parameters from an underlying model, one must choose a state space $S$ and associated risk-neutral probabilities $q(s)$ and then directly specify the excess returns on the bank’s portfolio of assets $R(s) - i$ together with the growth rates of the bank’s portfolio $g(s)$. These choices imply bank dividends to equity $\text{DIV}_E(s)$ as a function of the state. One would then solve equation (6) for the default decision. As shown in equations (16) and (17), the valuation of bank equity and government guarantees then reduces to the same two-state version of our model studied in Sections V and VI.
To summarize, the reduced-form risks that determine bank default and valuation in our model are the risks to bank dividends $\text{DIV}_t(s)$ and to the growth of the bank $g(s)$. As discussed in lemma 2, the model can accommodate a wide array of underlying fundamental risks. As discussed in Section V, we can also model these fundamental risks directly in terms of realized excess returns on the banks’ portfolio of assets.

Begenau et al. (2015) is an important study of the joint distribution of interest rate and credit risk faced by banks. Future work should incorporate results from their model of the returns banks obtain from exposure to these risks to improve the computation of the implied value of government guarantees.

**Question 4: Government Guarantees and the Value of Growing a Bank**

In our model of the value of government guarantees for banks, we have assumed that banks’ opportunity to grow their balance sheets contributes to the value of these guarantees. That is, we assume that (i) the government guarantee is a regulatory rent, (ii) the value of which accrues to the owners of bank liabilities (insured debt and equity), and that (iii) bankers can expand the value of this rent by growing their bank. What justification can we provide for these assumptions?

It is widely observed that the federal safety net for banking is a regulatory rent for this sector. The Federal Reserve System, in its role as primary regulator of bank holding companies, recognizes the nature of the apparent profit opportunity of setting up or expanding a bank holding company to take advantage of government guarantees and imposes restrictions on bank holding companies as a result (see also Kane 2014).

Our second assumption is perhaps more controversial. Why do the owners of incumbent banks capture the value of these rents? Why doesn’t competition for these rents dissipate these rents?

We conjecture that the answer to this question is based on the observation that entry into banking and growth of incumbent banks are constrained through a somewhat opaque exercise of regulatory discretion by bank supervisors. This discretion is based on both the Bank Holding Company Act and its subsequent modifications and through the direct supervision of bank subsidiaries. Thus, it is reasonable to expect that the owners of an incumbent bank with permission to issue government-backed liabilities would enjoy a quasi-rent from government guarantees earned as compensation for past expenditures on rent seeking to gain
permission to establish an incumbent bank under the federal safety net. This is one classic definition of the charter value of a bank.

Our third assumption is the most controversial. Why would owners of incumbent banks in the early 1990s capture value from the opportunity to grow their bank rapidly over the next two decades under a vastly expanded federal safety net? Why did increased competition following deregulation fail to dissipate the rents associated with this growth opportunity? We conjecture that a full answer to this question would be based on the observation that most of these rents from this growth opportunity were offered to and captured by incumbents who grew dramatically larger to take advantage of the specific benefits offered to banks that could achieve the scale needed to be labeled “too big to fail.” Thus, we conjecture that the resolution of the Tullock paradox in this case would be based on the argument that in the transition from a fragmented, highly constrained banking sector in the 1970s to the large sector now dominated by a few very large banks, owners of larger incumbent banks did indeed capture most of the value of the growth opportunity to expand the scope of the federal safety net for finance due to increasing returns to scale in rent seeking in finance.

Based on these observations, we interpret the assumption that the growth of banking \( g(s) \) is an exogenous parameter in our model as a constraint imposed by regulation. Our assumption that owners of incumbent banks do not need to incur noninterest lobbying expenses to gain permission to expand their bank is based on a conjecture that these rent-seeking expenses were quite small relative to the value of the expanded government guarantee obtained. This is a conjecture that should be evaluated more closely in future work.

**Question 5: The Impact of the Length of the Time Period on Valuation**

In our valuation model for banks, we use a discrete time model and consider each time period to be 1 year. Hence, we have implicitly assumed that banks are required to meet capital standards only once per year (at the beginning of each time period) and that the risks to bank assets and liabilities over a 1-year horizon is the relevant horizon for measuring bank risks. We choose this time period based on the observation that larger banks are required to undergo a full examination annually. This convention of an annual review of bank balance sheets has continued post crisis with the implementation of annual stress tests and approval of capital plans for larger banks.
What is the impact of this choice of time period on our valuation exercise? The answer to this question depends on the nature of the risks that banks face.

For example, if one assumes that the value of bank assets follows a diffusion, as is typically assumed in a Merton- or Leland-style structural credit risk model, then it is essentially impossible for a bank with a positive equity position to fail over a short time horizon. This implies that, in this case, if regulators were to examine banks frequently enough and force them to meet capital standards based on a mark-to-market accounting of their balance sheet often enough, then the failure of a bank would occur with vanishing probability.

In contrast, if one assumes that the value of bank assets is subject to the risk of a discrete jump downward large enough to trigger default that occurs with some Poisson rate over time (often called “jump to default” risk), then more frequent examination of the bank, in and of itself, does not significantly reduce the probability of bank failure over a given time horizon. The only option for reducing the risk of bank failure in this case is to raise the capital standard for the bank so that a downward jump in its asset value, should it occur, no longer triggers failure of the bank. In interpreting our model, we opt for this second approach to modeling the risk within banks.

There is a large literature in finance, both in option pricing and structural credit risk modeling, that indicates that the risk of discrete jumps in asset values is significant and important in understanding the pricing of options and credit risk (see, e.g., Broadie, Chernov, and Johannes 2007). Certainly, during the crisis of 2007—9, the transition of the financial system from a mildly distressed state in the late summer of 2008 to a severely distressed state by late September of 2008 was extremely rapid. Likewise, the large negative realized excess return on corporate credit portfolios in 2008 that we use in our measurement exercise was concentrated in the last few months of 2008.

Based on these observations that the risk of jump to default is likely to be an important driver of the risk of bank failure, we conjecture that the choice of the length of a time period in our model does not have a substantial impact on our results.

Question 6: Comparison to Other Estimates in the Literature

Our finding of large capitalized values of government guarantees in the period before 2008 follows a large literature on the impact of government
guarantees on the value of bank debt and equity. Li, Qu, and Zhang (2011); the Government Accountability Office (2014); and Acharya, Anginer, and Warburton (2016) have published recent studies of the impact of government guarantees on the pricing of bank bonds. Schweikhard and Tsesmelidakis (2012) study the impact of government guarantees on bank credit default swap spreads relative to equity-based estimates of banks’ probability of default. Gandhi and Lustig (2015) and Gandhi, Lustig, and Plazzi (2017) study the impact of government guarantees on the pricing of bank equity. Kelly, Lustig, and Van Nieuwerburgh (2016) study the impact of government guarantees on the pricing of options on bank equity. This paper highlights the impact of guarantees on option pricing due to guarantees against an aggregate or systemic shock to the financial sector as opposed to an idiosyncratic shock to an individual bank. All of this literature finds a significant impact of government guarantees on the pricing of bank debt and equity, particularly for larger banks.

Several studies have focused on quantifying the value of these government guarantees to owners of bank debt and equity. Here we focus on comparing our results to two of these studies in particular. The first of these is presented in Ruud (2007). This paper presents an estimate of the fair value of government guarantees to banks based on methodology used by Lucas and McDonald (2006) to measure the value of government support for Fannie Mae and Freddie Mac. The second of these is presented in Tsesmelidakis and Merton (2013). This paper uses results from Schweikhard and Tsesmelidakis (2012) to derive an estimate of the ex ante and ex post values of government support during the recent financial crisis.

Ruud (2007) applies a Merton-style structural credit risk model to assess the value of deposit insurance for 231 publicly traded banks, using data from 2004 to estimate the inputs of equity volatility and leverage needed for the model. She extrapolates results from these calculations to find a fair value of expected payouts from the FDIC (net of the recovery value from selling what remains of the failed bank) over a 5-year horizon of only $4 billion.

Tsesmelidakis and Merton (2013) is a detailed study of the pricing of bank bonds for 74 large financial firms. They use the Merton-type model of bond spreads in Schweikhard and Tsesmelidakis (2012) calibrated to match the pricing of bonds of nonfinancial firms to measure the impact of government guarantees on the pricing of bank bonds over the period 2007–10. They calculate that these guarantees amounted to a wealth transfer of $365 billion over this time period. They refer to this number
as a valuation of implicit guarantees as it does not include the value of explicit deposit insurance. They divide this number into two components. The first is the benefit obtained by shareholders from being able to issue bonds at a higher price. They value this component at $129 billion. The remainder is the amount gained by incumbent bondholders ex post when the negative shock of the financial crisis occurs. The ex ante figure of $129 billion is conceptually closer to the value of government guarantees that we compute.

We find a larger value of government guarantees for the period 1996–2008 than is found in these other two papers. There are two significant methodological differences between our model for estimating the value of government guarantees and the models presented in these other papers that account for the differences in the estimates obtained in our paper and in these other papers.

First, from equation (12), we value government guarantees as a growing perpetuity. That is, we take into account that when a regulator sells what remains of a failed bank to new owners, the prospect that these new owners will also benefit from continued government guarantees affects the sale price and thus the recovery value of a failed bank (as noted in equation [8] in our model). In contrast, the papers by Ruud (2007) and Tsesmelidakis and Merton (2013) measure the value of guarantees over a fixed time horizon and consider the recovery value of a failed bank to be a fixed parameter that is not included in the measure of government guarantees. To facilitate a comparison of our measure of the value of government guarantees as a growing perpetuity to measures of the value of these guarantees over a fixed horizon, one can use equation (12) to convert our estimates of the value of government guarantees to any finite time horizon of $T$ years using a standard annuity formula

$$MVG^T = \left[ 1 - \left( \frac{1 + \frac{\bar{g}}{1+i}}{1+i} \right)^T \right] MVG.$$

For example, to convert the ex ante value of government guarantees obtained from our model to a value over a horizon of 5 years as in Ruud (2007) with a risk-free interest rate of $i = 0.05$ and expected growth of the bank balance sheet of $\bar{g} = 0.025$, we have that the value of government guarantees over a 5-year horizon is 11.4% of the estimate obtained in our paper for the value of these guarantees over an infinite horizon.

Note that this adjustment for the time horizon is sufficient to reconcile our estimate of the value of government guarantees with that obtained in Tsesmelidakis and Merton (2013). Specifically, if one converts their es-
timate of the benefit to bank shareholders of $129 billion from issuing bonds at a premium over a 4-year period to an infinite horizon, one would obtain an estimate of the value of government guarantees in the neighborhood of $1 trillion.

The second methodological difference between our study and these other studies is the approach we take to calibrating the parameters of the measurement model. As shown in equation (19), in applying our model in Section V, we measure the value of government guarantees using a measure of the fair value of bank assets and observed bank accounting profitability. Our measure of the risk that banks face is consistent with a small probability of a large negative shock to the bank’s balance sheet. In contrast, the approach followed by Ruud (2007) and Tsesmelidakis and Merton (2013) is based on the structural model of Merton as applied to banks in Merton (1977). In these models, the risk in bank assets is measured using observations on the volatility of bank equity and measures of bank market leverage.

Note that if one assumes a model in which risk to bank dividends and growth is i.i.d. and in which banks reset balance sheets to conform with regulatory limits on leverage once a year, as we have done, then the valuation formulas for bank equity and the value of government guarantees are given as in equations (17) and (19) conditional on a solution for the default decision from equation (15) regardless of the approach used for measuring the risks to the bank’s ROE and to the growth of the bank’s balance sheet. Thus, the other principal difference in methodology that accounts for the difference between our estimate of the value of government guarantees and the estimates presented in Ruud (2007) and Tsesmelidakis and Merton (2013) is that our model assumes a large downside tail risk for banks.

Endnotes

All errors are ours. Author email addresses: Atkeson (andy@atkeson.net), d’Avernas (adrien.davernas@hhs.se), Eisfeldt (andrea.eisfeldt@anderson.ucla.edu), Weill (poweill@econ.ucla.edu). For acknowledgments, sources of research support, and disclosure of the authors’ material financial relationships, if any, please see http://www.nber.org/chapters/c14085.ack.

1. A closely related point is made by Admati and Hellwig (2013) and Admati et al. (2013), who argue that, to the extent that leverage reduces banks’ cost of capital, it is due to distortions from government subsidies to bank debt.

2. Meiselman, Nagel, and Purnanandam (2018) show that high rates of accounting profitability for banks in good times is a signal of bank exposure to tail risk in bad times, and apply this idea successfully to the cross-section of US bank values during the crisis.

3. We note that there are no deadweight costs from bank failure in our model but instead a bankruptcy benefit, which is a transfer from taxpayers to banks.
4. We impose the assumption that banks do not derive value from the opportunity to originate new loans or deposits.

5. We collect financial information on bank holding companies from the “Quarterly Trends for Consolidated US Banking Organizations” report from the Federal Reserve Bank of New York (2019) and from the holding company data of the Federal Reserve Bank of Chicago (2019). To construct market prices, we merge this data set with Standard & Poor’s Compustat and the Center for Research in Security Prices (CRSP) databases using the CRSP-FRB links from the Federal Reserve Bank of New York. Our sample of public bank holding companies consists of 1,128 banks and 40,468 bank-quarter observations from 1986 to 2016 and covers 93% of total assets of all FDIC-insured institutions in the fourth quarter of 2016. To have a longer historical perspective, we also use the consolidated annual financial statements of FDIC-insured institutions from 1935 to 2016 available in the FDIC (2019b) historical statistics on banking. We obtain corporate bond credit spreads from the Lehman/Warga and Bank of America Merrill Lynch (BAML) databases.

6. We construct the market-to-book value of equity for the sector as the sum of the market value of equity across bank holding companies in our sample divided by the sum of the book value of equity across the same bank holding companies. This ratio corresponds to a value-weighted average of the market-to-book value of equity across bank holding companies.

7. The CRSP-FRB linked database starts in 1986. Therefore, we use financial firms with a standard industry classification code in between 6000 and 6999 to go back to 1975.

8. We use the gross domestic product implicit price deflator with base year 2009 as the deflator.

9. The market value of assets is defined as the book value of debt plus the market value of equity.

10. We eliminate all observations with credit spreads below 5 basis points (bp) and greater than 3,000 bp. In addition, we drop very small corporate issues (equity market value of less than $1 million) and all observations with a remaining term to maturity of less than 6 months or more than 20 years. Some firms tend to have many different corporate bond securities outstanding. To avoid overweighting firms that issue a lot of different securities, when different prices were available for the same firm, we keep only the security with time to maturity closest to 8 years (sample average). Financial, utility, and public administration firms are also excluded from the sample. Restricting to unique credit spreads’ monthly observations for each firm eliminates 45% of the data set; other restrictions affect less than 5% of the rest.

11. Option-adjusted spreads roughly follow a log-normal distribution with time-varying mean and standard deviation.

12. We define “nonfinancial firms” as firms with a standard industry classification code not between 6000 and 6999.

13. In the data, banks also manage a portfolio of marketable securities on both the asset and liability side of their balance sheet including federal funds and repo (a securities arm) and conduct a wide range of fee-for-service business (a fee-for-service arm). Here we assume that the securities arm of the bank has no franchise value, but that it can contribute to the risk exposure of the bank and hence to the value of government guarantees. This assumption is in line with the assumptions used by the Bureau of Economic Analysis to construct its measure of value added in banking (see Hood 2013). We assume that the fee-for-service arm of the bank does not generate franchise value for the bank because the costs of labor and physical premises required to conduct these activities soak up all of the revenue associated with these activities (in discounted present value). We discuss this assumption in greater detail in app. B. We discuss how we map the accounting items in bank holding company regulatory reports on their income statements and balance sheets (form FR Y-9C) into our accounting model when we do our full accounting in Section VI.

14. In our model, we assume that the bank issues deposits that are default free, as they are guaranteed by the government. We include subordinated debt in the model to allow some of the liabilities of the bank to suffer losses in default. Subordinated debt is distinct from repo and derivatives exposures that are collateralized and hence protected in the event of bank failure by specific assets within the bank. A normal firm without government guarantees would have no deposits, and all of its liabilities would be subordinated
debt. In the data, banks issue very little subordinated debt; however, the credit spreads on these bonds are informative about banks’ default risk.

15. For a bank with positive deposits (with no risk of default) to operate without government guarantees, we must allow for unlimited liability for subordinated debt in the event of default. Before deposit insurance, it was standard for bank investors to be liable to inject resources in the event of failure of the bank, either as partners or through double liability of bank shares (see, e.g., Macey and Miller 1992).


17. Note that the presence of government guarantees affects the default decision in our model through the effect on MVE. Lucas and McDonald (2010) emphasize the importance of this effect in explaining the difference in implied values of government guarantees recovered from credit spread versus option data.

18. Giesecke et al. (2011) present data on default rates for corporate bonds over the period from 1866 to 2008. They find evidence of repeated events of clustered defaults much worse than those experienced during the Great Depression. Moody’s (2018) provides an update of these data. These data suggest that, for bonds, 2008 was not a unique event in history.

19. See also Begenau, Bigio, and Majerovitz (2018), which documents the magnitude of losses on the market value of bank equity in the 2008 crisis.

20. A rapidly growing new literature on the interest rate risk inherent in banks’ portfolios argues that maturity transformation does not expose banks to significant interest rate risk. See, e.g., English, Van den Heuvel, and Zakrajsek (2012); Landier, Sraer, and Thesmar (2013); Drechsler, Savov, and Schnabl (2017a, 2017b); see also Di Tella and Kurlat (2017).

21. These indices are available on the website for the FRED database at the Federal Reserve Bank of St. Louis (https://fred.stlouisfed.org).

22. Bonds with ratings of AAA, AA, A, and BBB are considered investment grade. Bonds with ratings of BB and below are considered high yield.

23. See table 3 of Berndt et al. (2017) for the median credit risk premia by credit rating.

24. In our model, we abstract from interest rate risk. Clearly, the BAML portfolio of AAA bonds is not completely riskless because it is subject to interest rate risk, so its return does not correspond to the riskless rate \( i \). Thus, we take the gap between the returns of these bond portfolios and the portfolio of AAA bonds to control for interest rate risk and use this measure of realized aggregate credit risk in the crisis state to calibrate \( R(c) - i \) in our model.

25. These values are representative of those observed in the data for the 1996–2007 time period. With this calibration, if our stylized bank chooses to default in the crisis state, then its price-dividend ratio in the normal state as given in eq. (16) is equal to 33 regardless of the riskiness of the bank.

26. Meiselman et al. (2018) use a closely related model to study the accounting profitability of a bank as a measure of the risk to which its assets are exposed using cross-sectional data.

27. The default decision is given in eq. (22).

28. For background information on these reports on loan fair values, see Calomiris and Nissim (2014); Knott et al. (2014); Nissim (2003); Nissim and Penman (2007); Tschirhart et al. (2007).

29. Hutchison and Pennacchi (1996); Janosi, Jarrow, and Zullo (1999); Jarrow and van Deventer (1998); O’Brien (2000); and Sheehan (2013) develop fair value models for loans and deposits. For a discussion of banks’ models for funds transfer pricing, see Dermine (2012); Grant (2011); Wyle and Tsaig (2011).

30. Wang, Basu, and Fernald (2008) and Basu, Inklaar, and Wang (2011) study the measurement of financial intermediation services implicitly measured (FISIM), and Hood (2013) and Akritidis (2017) discuss the methods used in the United States and elsewhere to conduct this measurement. Haldane, Brennan, and Madouros (2010) focus on the impact of risk taking on measurement of FISIM in banking.

31. Bank of America, Citigroup, JPMorgan Chase, Wells Fargo, AIG, MetLife, American Express, Huntington Bancshares, Fifth Third Bank, Washington Mutual, SunTrust
Banks, Regions Financial, PNC Financial Services, National City Bank, Zions Bank, Countrywide, Comerica, KeyCorp, and US Bancorp.

32. These assets include cash and deposits due, securities, trading assets, fed funds sold, and reverse repo. We discuss banks’ estimates of the fair values of these assets in app. B.

33. Bank nonearning assets such as premises, other real estate owned, intangible assets such as goodwill, and tax-related assets are all recorded at book values. We treat the fair value of these assets as equal to their book value. This is likely an overstatement of the fair value of these assets.

34. See OTS (2000) for a description of that model. See also Sheehan (2013).

35. These estimates are available on the website of the Office of the Comptroller of the Currency (US Treasury 2019).

36. The aggregation of these OTS fair value estimates requires considerable judgment on our part. With more time, perhaps a more precise estimate could be constructed.

37. Recall that we handle subordinated debt separately. We discuss banks’ estimates of the fair value of these other bank liabilities in app. B.

38. This finding is consistent with the findings of Egan, Lewellen, and Sunderam (2017) regarding the importance of variation in the productivity of deposits in explaining the cross section of bank valuation. Similarly, Furlong and Kwan (2006) study the determinants of bank valuation in the cross section.

39. To implement this formula, we set \( \frac{g}{C22} = i - 0.025 \).

40. We do not directly address changes in the regulatory and economic environment that would account for the changes in bank risk taking and value derived from government guarantees that we document here. There is a large literature on the changes in the regulatory environment that increased the incentives for banks to take risks and become too big to fail. See, e.g., Boyd and Gertler (1994); Rolnick and Feldman (1998); Wilmarth (2002); Stern and Feldman (2004); Mishkin (2006). There is also a literature that examines the impact of equity-based incentives for CEOs on bank risk taking. See, e.g., Chesney, Stromberg, and Wagner (2012); Larcker et al. (2014); Boyallian and Ruiz-Verdú (2018).

41. Egan et al. (2017) is a recent study of the determinants of bank value that focuses on valuing the loan-making and deposit-taking arms of the bank.

42. The large decline in bank ROE in the final quarter of 2017 is largely due to the impact of the recent corporate tax cut on the valuation of banks’ tax assets.

43. Note that our assumption that growth of the bank contributes to the value of government guarantees only applies to growth achieved through organic growth via new injections of bank equity. The opportunity to grow an individual bank through a strategy of acquisitions would not contribute to the value of the acquiring bank in our model because the acquiring bank would have to pay the shareholders of the acquired bank for the value of expanded government guarantees.

44. In a policy statement regarding the obligations of bank holding companies to insured bank subsidiaries, the Federal Reserve states that “the important public policy interest in the support provided by a bank holding company to its subsidiary banks is based upon the fact that, in acquiring a commercial bank, a bank holding company derives certain benefits at the corporate level that result, in part, from the ownership of an institution that can issue federally insured deposits and has access to Federal Reserve credit. The existence of the federal safety net reflects important governmental concerns regarding the critical fiduciary responsibilities of depository institutions as custodians of depositors’ funds and their strategic role within our economy as operators of the payments system and impartial providers of credit. Thus, in seeking the advantages flowing from the ownership of a commercial bank, bank holding companies have an obligation to serve as sources of strength and support to their subsidiary banks.” See FDIC (2019a).

45. This is the classic question raised in Tullock (1980) regarding the value of regulatory rents.

46. See Wilmarth (2002) and Omarova and Tahyar (2012) for a discussion of the evolution of this act and its impact on the growth of banking. A bank that is given a low CAMEL rating (supervisory rating system to classify a bank’s overall condition) in an examination
by the FDIC or other bank regulator will face direct restrictions on its further growth under the regulatory framework of the FDICIA’s policies for prompt corrective action.

47. There is a large literature on the changes in the regulatory environment that increased the incentives for banks to take risks and to grow to become too big to fail. See, e.g., Boyd and Gertler (1994); Berger, Kashyap, and Scalise (1995); Rolnick and Feldman (1998); Wilmuth (2002); Stern and Feldman (2004); Mishkin (2006); Avraham, Selvaggi, and Vickery (2012).

48. This is the apparent paradox pointed to in Tullock (1980) of the low costs of rent seeking relative to the gains from rent seeking.

49. Such expenses could be modeled in a manner parallel to the noninterest expenses \( \phi \), and \( \phi \), we assumed that banks incur to grow deposits and loans.

50. This is because asset value follows a diffusion. Thus, the probability of the event that bank asset values fall below a default threshold in a short period of time converges to zero as the time horizon shrinks to zero.

51. See the calculations illustrating this point in Hanson, Kashyap, and Stein (2011) and Flannery and Giacomini (2015).

52. Lucas et al. (2001) and Nagel and Purnanandam (2017) provide theoretical arguments that returns on bank portfolios should be expected to have a thick tail of extreme negative returns. Recall that our measure of the value of government guarantees for stylized banks in Section V is a proof of concept based on direct observation of the downside risk in portfolios of corporate bonds.

53. As discussed in Atkeson, Eisfeldt, and Weill (2017), the distribution of equity volatility across firms appears to experience regime shifts that have a dramatic impact on estimates of the risk in firm or bank assets derived from a Merton-type structural credit risk model. See, for example, estimates of the probabilities of default of European banks based on this method in Flannery and Giacomini (2015). These regime shifts suggest that it may be fruitful to move beyond an i.i.d. model of the risks facing banks to include shifts in regimes. See d’Avernas (2018) for a regime-switching model of equity volatility and bond spreads for nonfinancial firms in the United States.

References


Are U.S. Banks Safer?
Reading The Fed’s New Dashboard*

Andrew G. Atkeson† and Adrien d’Avernas‡

September 12, 2019

Abstract

Are U.S. banks safer now than before the financial crisis of 2007-08? As part of its new Supervision and Regulation Report, the Federal Reserve Board of Governors has put together a new dashboard of accounting and market signals of the condition of the U.S. banking system to answer this question. This dashboard is displaying seemingly contradictory information. Based on accounting signals, banks now hold more capital, and the Board’s annual CCAR stress tests show little or no risk of widespread bank failures even in the face of an extremely severe macroeconomic shock. In contrast, based on market signals, banks’ market leverage and credit risk have both increased. In this paper, we present a unified bank valuation model to account for these accounting and market signals pre- and post-crisis. We use this model to assess the risks to the U.S. taxpayer and to holders of bank equity and subordinated debt and to interpret results from two recent papers studying risk-taking by banks and the risk to taxpayers from future bank bailouts.

*All errors are ours.
†Department of Economics, University of California, Los Angeles, NBER, and Federal Reserve Bank of Minneapolis, e-mail: andy@atkeson.net
‡Department of Finance, Stockholm School of Economics, e-mail: adrien.davernas@hhs.se
1 Introduction

A little more than a decade has passed since the financial crisis of 2007-08. In that crisis, the market value of bank equity plummeted, bank bond spreads soared, and U.S. taxpayers were called on to bailout bank bondholders and backstop losses for a large portion of the banking system. Bank regulators, U.S. taxpayers, and holders of bank equity and bonds are all wondering: is the U.S. banking safer now than it was before the financial crisis? Are holders of bank equity and bank subordinated debt at risk of having their investment wiped out in another crisis? And are U.S. taxpayers still at risk of being called on to bail out the banking system again in the face of a severe macroeconomic shock?

The U.S. Treasury Department argues in Mnuchin and Phillips (2017) that the risks to U.S. taxpayers from a severe macroeconomic shock to the banking system are now much reduced. Their argument is based on accounting indicators and the Federal Reserve Board’s annual CCAR stress tests. On an accounting basis, banks now hold significantly more equity capital than they did before the crisis. Banks’ accounting profitability and the quality of bank loan portfolios are both steadily recovering towards pre-crisis levels. According to the annual stress tests of large banks carried out by the Federal Reserve under the authority of the Dodd-Frank Act, U.S. banks would still have substantial book equity capital relative to risk-weighted assets even after a macroeconomic shock substantially more severe than that suffered in 2008. These observations lead the U.S. Treasury (and many other regulators\textsuperscript{1}) to conclude that, at least for U.S. taxpayers, and perhaps for holders of banks’ subordinated debt and equity, the risks from widespread bank failures in a crisis are now much lower relative to the risks revealed in the crisis of 2007-08.

But these observations do not appear to be consistent with the signals sent by market data on the valuation of bank equities and bonds. Stern (1999) and many others have argued that market signals regarding banks’ financial soundness should

\textsuperscript{1}See, for example, Janet Yellen’s opening remarks at the 2017 Jackson Hole Symposium “Financial Stability a Decade After the Onset of the Crisis”.
play an important role in guiding regulators’ assessments of the risks to the banking system. This call for the use of market signals in banking regulation is an important part of the legacy of research at the Federal Reserve Bank of Minneapolis. In perhaps a small step toward including the use of market signals in monitoring the soundness of the banking system, the Federal Reserve Board has released a dashboard of accounting and market signals of the health of the U.S. banking system as part of the new *Supervision and Regulation Report* made to Congress every six months.

The question of how one should interpret these accounting and market signals has taken on a new urgency because, as pointed out by Sarin and Summers (2016) and others, the market signals seem to contradict the signals from accounting data and the Board’s bank stress tests. While bank’s capital cushions as measured by the ratio of book capital to risk-weighted assets have increased substantially, they have not improved on a market value basis. The ratio of the market value of bank equity relative to risk-weighted assets is only now returning to the levels seen before the financial crisis. Banks’ credit default swap rates and the yield spreads on banks’ subordinated debt have deteriorated since before the crisis.

Equally concerning is the observation that the magnitude of the shock to banks’ market values in the 2007-08 crisis, as documented by Begenau, Bigio, Majerovitz, and Vieyra (2019), was substantially larger than the shock to book capital in 2007-08 and substantially larger than the drop in book capital envisioned under the severe macroeconomic scenario in the CCAR stress tests conducted since 2013. The market observations suggest that the accounting data and the results of the Fed’s stress tests are not painting a complete picture of the risks to U.S. taxpayers and holders of bank equity and bonds.

How should we interpret these accounting and market signals from the Fed Board’s new dashboard? Our goal in this paper is to provide at least a preliminary answer to this question. We proceed in two steps.

First, we look at historical market data on the total returns on various bond portfolios to calibrate the magnitude of possible severe shocks to bank value in a
crisis. In doing so, we follow Begenau, Piazzesi, and Schneider (2015) who argue that the dynamics of bank value can be well approximated by sensitivities to a few factors that account for the returns on bond portfolios. We calibrate the extent of possible losses in bank value based on the magnitude of large losses observed on portfolios of investment grade bonds not only in 2008, but also in the late 1970’s to early 1980’s and in the early 2000’s.

Second, we build a model of banks’ accounting returns and the valuation of bank equity and subordinated debt that prices the risk of a severe shock to bank value as calibrated in our first step. This model is an extension of that in Atkeson, d’Avernas, Eisfeldt, and Weill (2019). Following the discussion in Stern (1999), we include consideration of the impact of government support in event of a crisis on the valuation of bank equity and subordinated debt. We also include consideration of the possibility that banks have intangible capital or monopoly power that gives them some franchise value. In these respects, our model is similar to that in Berndt, Duffie, and Zhu (2018b).

In using data on returns on bond portfolios to calibrate the possible losses to bank value in the event of a crisis, we differ from the large literature that uses bank equity volatility or Merton’s distance to default as a market measure of the risks to banks’ asset values. Our choice is motivated by the observed negative skew in returns to bond portfolios and the research of Nagel and Purnanandam (2020) suggesting that measures of risks to banks’ asset values drawn from simple structural credit risk models may dramatically underestimate the risks of a large negative shock to bank asset values.

As in Atkeson et al. (2019), we use the model to discipline our analysis of the relative importance of changes in banks’ franchise value and risk-taking with government guarantees in accounting for the evolution of the accounting and market signals

\[\text{\textsuperscript{2}}\text{See for example Dreschler, Savov, and Schnabl (2018), Calomiris and Nissim (2014), Egan, Lewellen, and Sunderam (2017), and Begenau and Stafford (2019).}\]

\[\text{\textsuperscript{3}}\text{See, for example Atkeson, Eisfeldt, and Weill (2017) or Berndt, Douglas, Duffie, and Ferguson (2018a).}\]
shown on the Fed Board’s dashboard. We then also use the model to interpret results from two recent papers on the role of risk-taking and government guarantees in determining banks’ accounting profitability and bond spreads in the cross-section.

Meiselman, Nagel, and Purnanandam (2018) is a provocative paper that documents that higher accounting profitability of banks pre-crisis predicts worse bank performance in the crisis. These authors interpret this finding as indicative that banks’ accounting profitability in normal times is a useful indicator of their exposure to a severe shock to bank value. We use our model to show that if bank assets are more exposed to a crisis shock and if banks enjoy the support of government guarantees, then they should have both higher accounting profitability and a higher market-to-book ratio of equity. We also use the model to show that, absent government guarantees, while risk taking by banks does increase accounting earnings in normal times, it does not alter banks’ market valuations of equity. This result is a direct consequence of the Modigliani-Miller Theorem.

We then document in the data used by Meiselman et al. (2018) that banks that had higher accounting profitability pre-crisis did indeed have higher market-to-book ratios. Moreover, we show that banks with higher market-to-book ratios pre-crisis experienced worse performance in the crisis. We view these results as supportive of the hypothesis that risk taking with the support of government guarantees played an important role in determining bank valuations pre-crisis.

Berndt, Duffie, and Zhu (2018b) use a model closely related to ours to estimate the extent to which the expectations of government bailouts for bank subordinated bondholders have been reduced following the crisis of 2007-08. Under the new bank resolution regimes imposed under the Dodd-Frank Act, holders of the subordinated debt of bank holding companies are now supposed to be exempt from future bailouts in the event of default by the bank holding company. This layer of subordinated debt exempt from bailouts on top of bank equity is intended to add to what is called banks’ Total Loss Absorbing Capacity (TLAC). Debt instruments that count as TLAC need to be able to be written down or converted into equity to recapitalise the bank as
it goes through resolution. The work of Berndt et al. (2018b) is directly relevant to the question of whether the market is pricing bank debt in a manner consistent with this debt being written down in a crisis.

We use our model and the logic of the identification scheme in Berndt et al. (2018b) to argue that bank bondholders are still expecting large recovery rates on their bonds conditional on bank default. In our calibrated model, we find that the conditional expectation of bank bondholder losses in default rose from 12% pre-crisis to 30% post-crisis. While this increase is sizable, it is not consistent with no government protection for subordinated debt. In our calibrated model, absent government protection, subordinated debt spreads should be on the order of 521bp instead of the 150bp seen in the post-crisis data.

The remainder of our paper is organized as follows. We review the data on the new Fed Board’s dashboard in section 2. We review market data on the magnitude of potential shocks to the value of bank assets in a crisis in section 4. We present our model in section 5. We calibrate the model in section 6 and report on comparative statics exercises in section 7. We then conclude in section 8.

2 The Board’s Dashboard For Evaluating Conditions for the Banking Industry

In November of 2018, The Board of Governors of the Federal Reserve System presented its inaugural Supervision and Regulation Report. This report summarizes banking conditions and the Federal Reserve’s supervisory and regulatory activities, and is presented in conjunction with semiannual testimony before Congress by the Vice Chairman for Supervision. Our main focus in this paper is the section of

---


5The most recent report was released in May of 2019 and is available https://www.federalreserve.gov/publications/2019-may-supervision-and-regulation-report.htm.
this report titled “Banking System Conditions.” This section provides an overview of trends in the banking sector based on data collected by the Federal Reserve and other federal financial regulatory agencies as well as market indicators of banks’ condition. These data are intended to serve as a dashboard for evaluating the safety of the banking system. The question we are interested in is how we should interpret these data as indicators of the safety of the banking system?

The data presented in the Banking System Conditions section of the Board’s Supervision and Regulation report is organized into two categories: accounting information and market signals of banks’ financial soundness. In this section, we review these accounting and market signals in a broader historical perspective using data provided by the Federal Reserve Bank of New York in its report *Quarterly Trends for Consolidated U.S. Banking Organizations.*\(^6\) We begin with a discussion of the accounting information presented and then discuss the market signals presented as well as additional market signals considered elsewhere in the literature.

The accounting measures of banks’ financial soundness presented in the Fed Board’s report are as follows

- Accounting Measures
  - Capital Adequacy measured as the ratio of Tier 1 Common Equity to Risk Weighted Assets
  - Book Leverage measured as the ratio of the book value of Equity to Total Assets
  - Bank Profitability measured by accounting return on equity (ROE) and return on assets (ROA)
  - Various Income Statement Ratios
  - Various Indicators of Loan Quality

\(^6\)This report is available at https://www.newyorkfed.org/research/banking_research/quarterly_trends.html.
Asset and Loan Growth

• Market Measures in the Fed Report
  – Market Leverage measured as the market value of bank equity over the sum of the market value of bank equity and the book value of bank liabilities
  – CDS spreads

• Additional Market Measures used in the literature
  – Bank Bond Spreads
  – Bank Equity Volatility

Review of Accounting Data: We first review the historical values of the accounting measures considered in the Board’s report in the following figures.

In Figures 3 and 4, we present the ratio of Tier 1 Common Equity to risk weighted assets and to total assets for banks in various size categories and for the banking industry as a whole. In these figures, we see that large banks now hold significantly more accounting, or book, capital relative to assets than they did before the 2007-2008 banking crisis.7 We also see that the drop in book capital relative to assets in the crisis of 2007-08 itself was relatively small—on the order of two percentage points of assets or less. These data indicate that banks now hold substantially more capital relative to assets on an accounting or book basis and that this capital cushion is large relative to the decline in capital observed in the crisis of 2007-08 is central to the claim that the U.S. banking system is now substantially safer than it was before the 2007-08 crisis.

In Figures 5 and 6, we present data on the accounting profitability of bank holding companies as measured by their return on equity and return on assets (the ratio of

7The increase in book capital relative to assets for banks with less than $50 billion in assets is not as pronounced as it is for larger banks.
their after-tax net income after provisions for loan and lease losses to book equity and book assets respectively). In these figures we see that banks were substantially more profitable before the 2007-08 crisis than they have been since. We also see that banks sustained a sharp but short decline in accounting profitability during the crisis. As we discuss below, these data on bank profitability are a key input into the models used in bank stress tests that rely on simulations of the response of bank accounting data to macroeconomic shocks to evaluate the financial soundness of banks.

Figures 7 and 8 are examples of some of the accounting indicators of the quality of banks’ loan portfolios presented in the Board’s report. Here we focus on data on non-performing loans in figure 7 as a measure of the condition of banks’ loan portfolios and on bank’s allowances for loan and lease losses relative to this stock of non-performing loan. These data are often used to forecast future provisions for loan and lease losses that would then negatively impact banks’ future accounting profitability. In figure 7, we see that the stock of non-performing loans grew substantially during the crisis and took quite few years to return to the low levels seen before the crisis. In figure 8, we see that bank’s stock of loan loss reserves fell substantially during the crisis and that it has taken quite a few years to build that stock up to levels seen before the crisis.

In Figures 9 and 10 we review data on the growth rate of bank assets and loan portfolios. In these figures, we see that the growth of the stock of bank assets and loans was quite high before the crisis and has been substantially smaller since then. Data on the growth of bank balance sheets are important for bank stress tests because rapidly growing banks must either retain earnings or raise new equity to grow their book capital in line with the overall size of their balance sheets. As we discuss below, data on the growth of bank balance sheets is also important for valuing banks and the protection provided to them by government guarantees.

**Review of Market Data:** We now review market data considered in the Board’s dashboard of indicators of the condition of the US Banking system and in the broader

---

8Note that these data are quarterly at annual rates so that the decline in earnings relative to equity or assets in each quarter is only one quarter as large as that shown in the figure.
literature.

In Figure 11, we show the Fed Board’s data on banks’ market leverage as measured by the ratio of the market value of bank equity to the sum of the market value of bank equity and the book value of bank liabilities. These data are analogous to the data in Figure 4 on bank leverage, except here the capitalization of banks is measured using the market value of bank equity rather than the book value of bank equity. In Figure 12, we report on the capital adequacy of banks on a market value basis by showing the percentiles of the cross section distribution of the ratio of the market value of bank equity to risk weighted assets across publicly traded bank holding companies. These data are analogous to the data in Figure 3 on bank capital adequacy, except here the market value of bank equity is substituted for the book value of bank equity.\footnote{This indicator is not included in the Fed Board’s report. We have constructed this ourselves using data from CRSP and regulatory FR9YC reports.}

As emphasized by Sarin and Summers (2016), Atkeson et al. (2019) and Begenau et al. (2019), these data on the capital adequacy of banks on a market value basis stand in sharp contrast to the data on the capital in banks on an accounting basis. First, we see that the capital in banks on a market basis has not regained the levels attained before the crisis. Second, we see that the drop in the ratio of the market value of equity relative to risk weighted assets in the crisis as shown in Figure 12 was much larger than was the case for the ratio of the book value of equity relative to risk weighted assets shown in Figure 3—the market value of equity for the median bank fell by 15 percentage points or more relative to risk weighted assets as opposed to a drop of only 1 to 2 percentage points of risk weighted assets for the book value of bank equity.

In Figures 13 and 14, taken from Begenau et al. (2019), we show the dollar value of the loss of market capitalization of U.S. Banks in the aggregate and the losses experienced by four large banks during the 2007-08 crisis. These data show a striking drop in market valuations of banks in absolute terms during the crisis—on the order of $1 Trillion for the sector as a whole. We also see that for Citigroup and Bank of America in particular, the market value of their equity dropped to very low levels.
during the crisis. It appears that on a market value basis, the capital in these two banks was almost completely wiped out.

We next consider market data on the risk in bank bonds. First consider data on bank credit default swap (CDS) spreads. In Figure 15 we show the Fed Board’s data on the average spread on CDS for large banks. In this figure, we see that large banks’ CDS spreads are higher now than they were before the crisis. In Figure 16 we show the logarithm of the median CDS spread for banks in red together with the logarithm of the 10th, 30th, 50th, 70th, and 90th percentiles of the cross section distribution of CDS spreads for all firms at each data in five gray lines. This figure shows that bank CDS spreads are not just higher than they were before the crisis, but they are also higher relative to CDS spreads for all firms than they were before the crisis. Bank CDS are now priced as being riskier than before the 2007-08 crisis on both an absolute and relative basis.

The data on spreads on bank borrowing are similar. Figure 17, taken from Duffie (2019), shows the average of the spread between one year LIBOR rates (for large banks) and the safe OIS rate. As was the case in Figure 15, we see that spreads on borrowing by large banks are higher than before the crisis. In Figure 18 we show a figure analogous to Figure 16 using data on the yield spreads on bank debt relative to those for all other firms and we reach a similar conclusion: bank bond spreads are not just higher than they were before the crisis, but they are also higher relative to bond spreads for all firms than they were before the crisis.

Sarin and Summers (2016) also consider data on the volatility of bank equity. Data on equity volatility are an important input, together with data on market leverage, into standard models of corporate credit risk based on the notion of distance-to-default.\footnote{See, for example Atkeson et al. (2017) and Berndt et al. (2018a).} In Figure 19, we plot the logarithm of realized equity volatility for the median bank holding company in red together with the 10th, 30th, 50th, 70th, and 90th percentiles of the cross section distribution of realized equity volatility for all firms in gray. In this figure, we see that equity volatility is at the same level now as...
it was before the crisis. As noted in Sarin and Summers (2016), the accumulation of book equity by banks has not led to a decrease in bank equity volatility either in absolute terms or relative to that for other firms.

**Summary of Accounting and Market Dashboard Data** The accounting and market signals considered in the Fed Board’s Dashboard paint seemingly contradictory pictures of both the severity of the impact of the 2007-08 crisis on the condition of US Banks and of the recovery of the banking system since that time. The crisis, as seen in accounting data, resulted in a sharp but short drop in bank net income and a relatively small decline in bank capital. This view of the crisis from the accounting data stands in contrast to the severe drop in the market value of equity of banks during the crisis and Ben Bernanke’s testimony that “As a scholar of the Great Depression, I honestly believe that September and October of 2008 was the worst financial crisis in global history, including the Great Depression,” and that of the “13 most important financial institutions in the United States, 12 were at risk of failure within a period of a week or two.”

These accounting and market signals also paint contradictory pictures of the recovery of the U.S. Banking System since the crisis. The accounting data show a significant increase in the book equity in banks relative to assets and an almost complete recovery of bank profitability and the condition of bank loan portfolios. As discussed in Sarin and Summers (2016), market signals of the financial soundness of U.S. banks have not improved in line with accounting data on bank capitalization. Specifically, bank leverage, as measured on a market basis has not improved. Bank CDS and bond spreads, and equity volatility all are at the same level or higher than they were before the crisis on both an absolute and relative basis.

How should we interpret this apparent contradiction between the accounting and market signals we see for US Banks?

One approach is to study the accounting data in greater detail. This is the approach followed by the Federal Reserve in its implementation of the Comprehensive Capital Analysis and Review (CCAR) stress tests. A second approach is to find ways
to use market data to evaluate the risk to banks. This is the approach favored by Begenau et al. (2015), Atkeson et al. (2019), and Berndt et al. (2018b). We review these two approaches in the next two sections.

3 Stress Tests as a Measure of the Condition of U.S. Banks

Bank stress tests, based on historical responses of the evolution of bank capital on an accounting basis in response to macroeconomic shocks, have become one of the main tools for evaluating the risks that bank equity would fall to a dangerously low level in response to a large macroeconomic shock. The Federal Reserve implements these stress tests annually for larger banks under the Dodd-Frank Act as one component of its analysis during its annual Comprehensive Capital Analysis and Review (CCAR), which assesses the capital planning processes and capital adequacy of large bank holding companies.

These stress tests are based broadly on the following accounting identity for the evolution of bank capital on a book basis:

$$\frac{CET_{t+1}^1}{RW A_{t+1}} = \frac{1}{(1 + g_{At})^{1/4}} \frac{CET_{t+1}^1}{RW A_t}$$

$$\frac{CET_{t+1}^1}{RW A_t} = \frac{CET_{t}^1}{RW A_t} + \frac{PPNR_t}{RW A_t} - \frac{Provisions_t}{RW A_t} - \frac{Taxes_t}{RW A_t} - \frac{Dividends_t}{RW A_t}$$

where $RW A_t$ denotes Risk Weighted Assets at the end of period $t - 1$, $g_{At}$ denotes that annualized net growth rate of Risk Weighted Assets from end of $t - 1$ to end $t$, $CET_{t}^1$ denotes Tier 1 Common Equity at the end of period $t - 1$, $PPNR_t$ denotes pre-tax pre-provisions Net Revenue in period $t$, $Provisions_t$ denotes bank Provisions for loan and lease losses in period $t$, $Taxes_t$ denotes Taxes paid in period $t$, and $Dividends_t$ denotes banks’ return of capital to investors in the form of Dividends and/or share
buybacks paid in period $t$. Provisions for loan and lease losses are determined by a forecast of future net loan and lease charge-offs relative to the current reserves against (allowances for) loan and lease losses.

It is in this accounting equation and in the modeling of provisions for loan and lease losses that the accounting data presented in the Fed Board’s dashboard is organized to assess the soundness of US Banks. In a stress test, banks are modeled as starting with a certain capital position on a book basis, as well as initial profitability ratios, non-performing loan ratios, and initial allowances for loan and lease losses. The responses of income statement variables and loan quality to a large macroeconomic shock are modeled on a granular basis. The model includes models of the dynamics of loan loss provisions and taxes and of payouts to equity holders through dividends (or share buybacks), as well as of the growth of bank risk weighted assets. The accounting identity above is then used to track the evolution of bank capital relative to assets on a book basis over a model horizon of two years.

We wish to draw attention to two aspects of results from the stress tests that have been conducted since 2013.

First, the stress tests have fed in very large macroeconomic shocks and found losses of book capital relative to risk weighted assets substantially larger than those that occurred in the 2007-08 crisis. In this sense, the stress tests should be considered as a severe test of the resilience of U.S. banks to a large macroeconomic shocks. But even so, given banks’ currently high levels of book capital, these stress tests find that banks can withstand this severe shock and still have adequate capital.

Second, note that the losses of book capital found in the stress test, while larger than the losses of book capital in 2007-08, are nowhere near as large as the losses in the market value of bank equity relative to risk weighted assets observed in that crisis. Without a model to interpret the observed losses in the market value of equity,

---

11 Pre-provision net revenue is the sum of net interest income (interest income minus interest expense) and non-interest income (including trading income) less non-interest expenses. Provisions for loan and lease losses and taxes are subtracted from pre-provision net revenue to obtain after-tax net income.
this observation casts doubt on whether the stress tests should be considered as a reliable guide to the resilience of the U.S. Banking system to another severe shock.

To illustrate these two observations, consider the summary of the most recent stress test results shown in Figure 20. In the first line of the table shown, we see a prediction that the ratio of tier 1 common equity to risk weighted assets would fall by a maximum of nearly six percentage points (from 12.3% to 6.3%) in response to the severely stressed macroeconomic scenario. Clearly, this drop in bank capital on a book basis relative to risk weighted assets is more than three times that shown in Figure 3 as occurring for large banks during the crisis. But note this drop in bank capital shown in Figure 20 is still less than half as large as that shown in Figure 12 as occurring for banks on a market value basis during the crisis. In terms of the absolute magnitude of the decline, the most recent stress tests predict total losses of $410 billion in the most severe scenario for the 18 largest banks. This contrasts with a decline in market value of over $1 Trillion for banks in the crisis shown in Figure 13.

These same two observations characterize all of the stress test results since 2013. In Figure 21, we show the results for the maximum drop in book capital relative to risk weighted assets aggregated for large banks predicted in each of the stress tests since 2013 in response to the severely stressed macroeconomic scenario. We see that this drop is consistently in the neighborhood of 6 percentage points—significantly larger than occurred in the 2007-08 crisis on a book value basis but significantly smaller than occurred in that crisis on a market value basis.

Largely speaking, these two facts are also true at the level stress test results for individual banks. In Figure 22, we show a histogram of the maximum drop in the ratio of common equity to risk weighted assets on a book value basis using results from each individual bank subject to the severely stressed macroeconomic scenario in all of the stress tests since 2013. In that figure, we see that the losses of bank capital have rarely reached 10 or more percentage points of risk weighted assets. In essentially no cases do the losses reach the 15 percentage points seen for bank capital
on a market value basis during the crisis.

Some observers draw the conclusion from these stress test results that U.S. Banks are safer than before the crisis because they now have a significantly higher level of book capital relative to risk weighted assets than they did in 2008 and the condition of their income statements and loan portfolios have recovered enough so that they could withstand a severely adverse macroeconomic shock and still have adequate capital after the shock. This point of view is expressed in the U.S. Treasury report Mnuchin and Phillips (2017) and is summarized in Figure 23 taken from that report. That figure summarizes the results of a recent stress test. The left panel of that figure shows US banks as starting the simulated severely adverse macroeconomic shock with considerably more capital than they held in 2009. The middle of the figure shows banks as starting with reduced net revenues and suffering, in the simulation, a further reduction in net revenues. Toward the right, the figure shows banks suffering loan losses in the simulated severely adverse scenario and then finishing with capital that would still be higher than banks held in 2009. The Federal Reserve Bank of New York makes a similar argument using its CLASS model of the stress tests based on publicly available accounting data.12

But given the data from market signals, one might have reason to question this conclusion. Why is the market value of bank equity relative to risk weighted assets no higher now than it was before the crisis? Why is it that holders of bank bonds still demand a significant spread? Why is it that option prices still reflect a significant risk of a substantial drop in the market value of bank equity? Do these market signals indicate that U.S. banks might suffer a significantly larger shock in market value terms that is indicated by the Stress Tests? Do these market signals reflect a significant risk to US Taxpayers of another bailout?

In the next section, we review market data and academic research on the question of how big a shock to bank value should we expect in a crisis. Is this shock large

---


16
relative to banks’ current levels of capital on a market value basis? Our answer is yes.

4 Market Indicators of the Size of Shocks to Bank Value

In this section, we consider several market indicators of the size of a crisis-type shock to bank value. We first consider the size of the decline in bank market values that occurred in 2007-08 as discussed by Begenau et al. (2019). We next consider measures of the risk of bank default based on the Distance to Default measure discussed by Berndt et al. (2018b) and the criticism of this measure by d’Avernas (2018) and Nagel and Purnanandam (2020). Finally we consider simple measures based on the realized excess returns on bond portfolios that are exposed to interest rate and credit risk as discussed by Atkeson et al. (2019) and much more formally by Begenau et al. (2015). (See also English, Van den Heuvel, and Zakrajsek (2018) and Dreschler et al. (2018).) From these data we conclude that it is plausible that banks are exposed to shocks that might result in losses in market value terms of 20% or more of risk weighted assets. Given the data in on the market capitalization of banks shown in Figure 12, we see that a shock to bank value of this magnitude would put the banking system at risk of insolvency again.

Consider first the data on the drop in bank values discussed by Begenau et al. (2019) and shown in dollar terms in Figure 13. The peak loss in bank value from the middle of 2006 into the depth of the financial crisis was over $1 Trillion. The drop in market value from the third quarter of 2007 through the fourth quarter of 2008 as $705 Billion. The total risk weighted assets in the banking system at the end of 2006 was roughly $9 Trillion. So the drop in banks’ market value of equity was on the order of 10% of risk weighted assets. Given the standard result from structural credit risk models that the value of equity drops less than a dollar for every dollar drop in the value of assets, this drop in the market value of bank equity is a lower
bound on the magnitude of the drop in the value of bank assets in the crisis.\footnote{This result follows from the observation that equity is a call option on the value of bank assets.}

Consider next the measurement of the risk to bank assets using structural credit risk models of the Merton or Leland variety. These models use data on the volatility of bank equity together with data on bank leverage measured using the market value of equity to measure the risk of default by banks. This can be done either using the model directly to conduct this risk measurement or in a more reduced form manner as in Atkeson et al. (2017) and Berndt et al. (2018a). Because bank equity volatility was low before the crisis and is relatively low now (as shown in Figure 19), and because of the market leverage of banks has not changed much (as shown in Figures 11 and 12) these models find a relatively small probability of bank default and limited losses to bank assets conditional on default.

As discussed in d’Avernas (2018) and the papers cited therein, one feature of the data that these models miss is the sudden increase in equity volatility common to all firms that is observed moderately frequently. (See, for example, the spike in equity volatility for the entire distribution of firms in the crisis in Figure 19). These sudden shifts in equity volatility are typically associated with a sudden increase in bond spreads for all firms. (See, for example, the movement in the distribution of bond spreads for all firms in Figure 18). In a framework in which sudden regime changes in volatility are possible, it is likely the risk of a regime change that needs to be measured to assess the risk of bank failure. This risk is not picked up in simple structural models in which the volatility of shocks to firms’ asset values is assumed constant over time and it is unclear whether the risk of a sudden, common, spike in equity volatility is well picked up in more reduced form approaches to measuring default risk.

As discussed in Nagel and Purnanandam (2020) a second feature of the data that standard models based on distance to default miss is the negative skew in return to bond or debt portfolios. This negative skew arises because the upside return to bond portfolios is limited while the downside is not. This observation is
particularly relevant for banks since the main asset of banks is a portfolio of debt of households and other firms. Nagel and Purnanandam (2020) argue that adding this feature the returns to bond portfolios to a structural credit risk model results in a substantially higher prediction for default risk in times when equity volatility is low than is obtained in a more standard Merton type model. (See Figure 24 reproduced from their paper.) These authors estimate five-year risk-neutral default probabilities on the order of 20% for their stylized banks even in recent years. If default is independent over time, this corresponds to an annual risk neutral default probability on the order of 4-5%.

Begenau et al. (2015) argue that the risk to bank assets can be well-modeled through measuring bank exposure to a few factors that account for most of the returns to bond portfolios. Atkeson et al. (2019) use an approach of this kind to calibrate the size of the shock to bank assets in their model of the value of government guarantees. Here we present data on the returns to three bond- portfolios to assess the size of the shocks to simple bond investing strategies that have been seen in past data. We argue that the frequency of large losses in a short period of time to these bond investing strategies is quite large. These data suggest that, going forward, there is a significant probability of a large loss in value to bank assets.

To measure the risk of large shocks to the market value of bond portfolios, we use the ICE Bank of America- Merrill Lynch Total Return Indices available on the Federal Reserve Bank of St. Louis FRED website. We examine the risk in three bond portfolios. In each case, we consider the logarithm of the cumulative total return on one bond portfolio in excess of that on another portfolio. We do so to model the cumulative returns to a strategy of going long in one type of bond and short in another, much as a bank does in conducting maturity and credit risk transformation.

As a measure of the risks inherent in maturity transformation, in Figure 25 we plot the logarithm of the cumulative excess returns on 10-15 year Corporate Bonds relative to 1-3 year Corporate Bonds from 1976 into early 2019.\textsuperscript{14} Over the full

\textsuperscript{14}This figure is constructed using the ICE-BAML Total Return Indices BAMLCC7A01015YTRIV and BAMLCC1A013YTRIV available on the FRED website at

19
time period, the longer term bonds have earned a considerable excess return of 80 log points, or just under 2 percentage points per year. It is clear, however, that at times, these longer term bonds have lost considerable value relative to the shorter term bonds. In particular, from August of 1979 through September of 1981, this portfolio lost 35% (in log points) relative to the shorter duration portfolio. This is the famous interest rate shock of the Volcker disinflation that wiped out the capital of the Savings and Loan industry. Several additional drops over 10% (in log points) are also observed, such as that from October of 1993 through November of 1994, from January of 1999 through May of 2000, and October of 2007 though October of 2008.

As a measure of the potential for large shocks to the market value of bond portfolios due to exposure to credit risk, in Figure 26 we show the logarithm of the cumulative excess returns on BBB-rated Corporate Bonds relative to AAA-rated Corporate Bonds over the period from 1989 to the present.\textsuperscript{15} BBB rated bonds are the lowest rated category of investment grade bonds. This portfolio is also subject to large losses from time to time: it loses 10\% from the beginning of 2000 through September of 2002 and 19\% from May of 2007 through December of 2012.\textsuperscript{15}

The risk of losses through exposure to aggregate credit risk grows much larger if one bets on high-yield rather than investment grade credit. In Figure 27 we show the logarithm of the cumulative excess returns on high yield Corporate Bonds relative to AAA-rated Corporate Bonds from 1989 to the present.\textsuperscript{16} The timing of losses through exposure to this strategy is similar to that for investment grade bonds shown in Figure 26, but now the magnitude of the losses is much larger — over 20\% from March of 1989 though December of 1990, 40\% from the end of 1999 through October of 2002, and over 40\% again from May of 2007 through December of 2008.

\textsuperscript{15}This figure is constructed using the ICE-BAML Total Return Indices BAMLCC0A4BBBTRIV and BAMLCC0A1AAATRIV available on the FRED website at the Federal Reserve Bank of St Louis.

\textsuperscript{16}This figure is constructed using the ICE-BAML Total Return Indices BAML-HYH0A0HYM2TRIV and BAMLCC0A1AAATRIV available on the FRED website at the Federal Reserve Bank of St Louis.
These simple calculations using market return data on bond portfolios suggest that bank assets may be exposed to considerable risk of drops in value of over 10% in a period of less than two years and even 20-40% for more volatile portfolios. To the extent that the market perceives banks as being exposed to such risks, it makes sense that the spreads on bank bonds would still be elevated since existing levels of bank capital, even measured on a market value basis, would not be large enough to withstand such shocks to bank value.

We next present our stylized model of bank value. We use this model together with these data on the risk in bond portfolio to interpret accounting and market data on the condition of the U.S. banking system.

5 A Model of Bank Value

We now present our model of bank accounting profitability and market valuation. The model is an extension of Atkeson et al. (2019) and closely related to Berndt et al. (2018b). We use the model to develop formulas relating accounting and market data on banks to the risks being borne by the taxpayer and the holders of bank equity and subordinated debt. Specifically, the model provides a unified framework for discussing the work of Sarin and Summers (2016), Atkeson et al. (2019), Berndt et al. (2018b), and Meiselman et al. (2018) to measure these risks using accounting and market data. In subsequent sections, we use the model to highlight what is known and not known about the safety of the U.S. Banking System.

In our model, a representative bank invests in a portfolio of loans and issues subordinated debt and deposits fully guaranteed by the government. The bank also may have intangible assets off balance sheet associated with the ability of the bank to issue loans with risk-adjusted yields above yields available in capital markets and to issue deposits with interest rates below borrowing rates available in capital markets. As we show below, the government guarantees of bank liabilities also contributes to its market value. The book value of the bank equity is an accounting-based measure
of the bank’s net worth while the market value of bank equity is a market measure of the bank’s net worth.

Both the loan making and deposit taking arms of the bank are subject to shocks. These include shocks to the pre-payment rate and default rate of loans, to the withdrawal rate of deposits, and to the growth rate of the bank’s balance sheet. The bank grows its balance sheet through the origination of new loans, the raising of new deposits, and additions to book equity. Book equity grows through either retained earnings or new capital injections. We assume that the bank enters each period with a balance sheet of \( L \) loans, \( D \) deposits, and \( B \) units of subordinated debt. We assume that the composition of the bank’s balance sheet as given by the ratio of deposits to total assets \( \Theta_D \equiv D/L \) and of subordinated debt to total assets \( \Theta_B \equiv B/L \) remains constant every period due to regulatory constraints.

We assume that this vector of shocks is independently and identically distributed over time under a risk-neutral measure. While this assumption forces us to abstract from several important sources of risk to banks, it is central to the simplicity of our pricing formulas.\(^{17}\) Our goal here is to use the model to illustrate concepts rather than provide a full quantitative accounting.

Each period, after shocks are realized, the holders of bank equity make a decision either to retain enough earnings (or inject enough new equity) into the bank to keep its ratio of book capital to assets at a level determined by regulation or, alternatively, to put the bank through an administrative resolution procedure. In this administrative resolution procedure, the equity of the bank is wiped out and the assets of the bank together with its deposits are auctioned off to new owners. If the proceeds from this auction absent taxpayer assistance to the sale would be negative, then the government makes a contribution from taxpayer funds to facilitate the sale of the bank at a price of zero. In this case, the government may also make an additional contribution of taxpayer funds to bail out the holders of the bank’s subordinated debt.

\(^{17}\)The assumptions of the model are such that bank valuation can be done using simple Gordon growth formulas with risk adjustments done under a risk-neutral measure.
In our model, the risks to bank equity are determined by the shocks to the value of the loan-making and deposit-taking arms of the bank. Holders of bank subordinated debt and the taxpayer are at risk of loss only to the extent that, in response to these shocks, holders of bank equity choose to put that bank through resolution rather than retain earnings or inject equity to preserve their ownership of the bank. This decision is impacted by the book value of the capital in the bank, the franchise value of the bank as measured by the excess of the fair value of bank equity over its book value, and by the value to the bank of future government bailouts in the event of default.

Note that in the treatment of the bank’s capital structure, our model is fundamentally different from a standard Leland model of credit risk (see, for example, Leland and Toft, 1996) in that the equity holders are required by regulation to return the balance sheet to a fixed level of book leverage at regular time intervals. Thus, in our model, equity holders choose to default only if the shocks realized within that time period are large enough. As discussed below, in comparing our model to data, it is then important to match the length of a time period in the model and the associated magnitude of the shocks to the time it takes bank regulators to force bank owners to recapitalize. Atkeson et al. (2019) set the length of a time period to one year. As discussed below, one might argue that implicit in the Comprehensive Capital Analysis and Review (CCAR) stress tests is an assumption that the time it would take regulators to force banks to replenish their capital is on the order of two years. Certainly, regulators did not take strong steps to force banks to recapitalize as their capital positions began to deteriorate from the summer of 2007 through the summer of 2008. This evidence suggests that, at a minimum, the time period in the model should be set to a year.

We now describe the components of the bank in greater detail.
5.1 The Loan-Making Arm

The loan-making arm of the bank originates loans and holds them on the bank’s balance sheet. Let $L$ denote the total face value, or book value, of the loans on the bank’s balance sheet. Every period, every dollar of loans pays a coupon $c_L$ net of servicing costs. The pre-payment and default shocks to the loan portfolio are denoted by $\mu'_L$ and $\delta'_L$ respectively. That is, $\mu'_L$ is the fraction of loans $L$ that mature in the current period and $\delta'_L$ is the fraction of loans that default.\footnote{Note that we assume that loans that default do pay the coupon due in the current period.} The prime notation indicates that these pre-payment and default rates are random variables.

For any random variable $x'$, we use the notation $\bar{x} \equiv \tilde{E}x'$ to denote the expectation of that random variable next period under the risk neutral measure. Because we have assumed that shocks are independent and identically distributed over time, we have that this conditional expectation does not depend on events that have occurred up through the current period.

The \textit{fair value} of the bank’s loan portfolio is the risk-adjusted expected discounted value of the future cash flows from that loan portfolio. This fair value can exceed the book value of the loan portfolio to the extent that the bank has market power or intangible capital that allows it to originate loans to customers at interest rates higher than market rates on securities with similar risk characteristics. The fair value of the loan portfolio can fall below its book value if interest, default, and/or pre-payment rates rise relative to the coupon rates set on the loan portfolio.

We compute the fair value of the loan portfolio using risk-neutral probabilities. We denote this fair value by $v_L \times L$. The fair value of the loans on the bank’s balance sheets solves the asset pricing equation

$$v_L = \frac{1}{1 + \tilde{i}} \tilde{E} \left[ c_L + \mu'_L + (1 - \mu'_L - \delta'_L)v_L \right]$$

where $i$ is the risk-free interest rate.
Because all shocks are independently and identically distributed over time, the ratio of the fair-to-book value of loans, denoted by $v_L$ is constant over time and is given by

$$v_L = \frac{c_L + \mu_L}{i + \mu_L + \delta_L}$$

where $\mu_L$ and $\delta_L$ denote the expected pre-payment and default rates under a risk neutral measure.

Note that $v_L$ corresponds to the price relative to face value at which the loan portfolio of the bank could be sold. Since data for such loan sales are available for some categories of loans, direct measurement of the fair value of certain loan portfolios can be done with market data.\(^{19}\) As discussed in Atkeson et al. (2019), modern accounting standards also require banks to report model-based estimates of the fair value of their loan portfolios in the footnotes to their annual reports. Calomiris and Nissim (2014), Atkeson et al. (2019), and Begenau and Stafford (2019) all argue that the premium of the fair value of bank loan portfolios over their book value is not large.

We now consider the fair value of the loan-making arm of the bank. This fair value may exceed the fair value of the existing loan portfolio $v_L L$ to the extent that the bank has intangible capital or market power that allows it to originate new loans at a cost below the premium $v_L - 1$ of the fair over the face value of these new loans.

We assume that all items on the balance sheet of the bank grow at a common, random, net growth rate $g'$. We make the standard assumption that the expected growth rate under a risk neutral measure satisfies

$$\bar{g} < i$$

\(^{19}\)In particular, there is an active secondary market in conforming mortgages and in credit card loans. These loan portfolios typically sell at a premium ($v_L > 1$) due to the fact that the coupon rate on these loans net of servicing costs $c_L$ exceeds the risk free interest rate adjusted for default risk $i + \delta_L$. To the extend that these loans are subject to pre-payment risk ($\mu_L > 0$), holding other parameters fixed, the premium paid for these loans is reduced.
to ensure that the value of the bank is finite. To achieve net growth rate \( g' \), the bank must originate \( (\mu' + \delta'_L + g')L \) new loans to replace the existing loans that pre-pay or default and to grow the book value of loans at net growth rate \( g' \). We assume that the bank incurs origination costs net of origination fees \( \phi_L \) per dollar of new loans. Therefore, the contribution of the loan-making arm of the bank to the bank’s dividends to equity is given by \( div'_L \times L \) where

\[
div'_L = c_L + \mu'_L - (1 + \phi_L) (\mu'_L + \delta'_L + g').
\]  

The fair value of the loan-making arm of the bank (ex-dividend), denoted by \( FL \times L \), is given by the asset pricing equation

\[
FL = \frac{1}{1 + \tilde{\theta}} \mathbb{E} \left[ div'_L + (1 + g')FL \right]
\]

where again we have used the fact that shocks are independently and identically distributed over time to get that the ratio of the fair value of the loan-making arm of the bank to the book value of loans is given by a constant \( FL \).

In Atkeson et al. (2019), we assumed that the business of originating loans is competitive, so that the cost of origination of a dollar of new loans equals the fair value of those new loans \( (\phi_L = v_L - 1) \). This assumption implies that the fair value of the loan making arm is equal to the fair value of the outstanding loans \( (FL = v_L) \). This assumption is consistent with the view that the bank does not have any intangible capital or monopoly rents in terms of an ability to originate loans at a cost below the value of the new loans. Instead, in this case, the premium of the fair value of the bank’s loan portfolio to its book value \( v_L - 1 \) is a quasi-rent that compensates the bank for its costs of loan origination. Begenau and Stafford (2019) also argue that large banks do not have the ability to originate loan portfolios with fair values above origination costs. Here we do not make this assumption directly.
5.2 The Deposit-Taking Arm

The deposit-taking arm of the bank raises deposits and holds these to help fund the bank’s assets. Let $D$ denote the face, or book, value of the bank’s deposits. Every period, each dollar of deposits costs the bank $c_D$ dollars in terms of servicing costs and interest paid. A random fraction $\mu_D'$ of the bank’s deposits are withdrawn. The fair value of the bank’s deposits is given by $-v_D \times D$, where the ratio of the fair-to-book value of bank deposits is given by

$$v_D = \frac{1}{1 + \tilde{E}} \left[ c_D + \mu_D' + (1 - \mu_D')v_D \right]$$

which implies that

$$v_D = \frac{c_D + \tilde{\mu}_D}{i + \tilde{\mu}_D}.$$

This formula illustrates that the fair value of the bank’s deposit liability is less than the book value of that liability if the interest and servicing costs of deposits $c_D$ is less than the risk-free interest rate $i$. As discussed in Atkeson et al. (2019), Begenau and Stafford (2019), Dreschler et al. (2018), Calomiris and Nissim (2014), and Egan et al. (2017), the fair value of bank deposits, particularly their transaction and savings deposits, is likely considerably below the book value of these deposits.

We now consider the fair value of the deposit-taking arm of the bank. We assume that the bank grows its deposits at net rate $g'$ in line with loans and that the bank has deposit origination cost net of initial fees $\phi_D$. Thus, the contribution of the deposit-taking arm of the bank to bank dividends or free cash flow is given by $-div_D' \times D$, where

$$div_D' = c_D + \mu_D' - (1 - \phi_D)(\mu_D' + g'). \quad (3)$$

The fair value of the deposit taking arm of the bank is given by $-FD \times D$ where

$$FD = \frac{1}{1 + \tilde{E}} \left[ div_D' + (1 + g')FD \right]. \quad (4)$$

27
Atkeson et al. (2019) shows that this fair value of the deposit taking arm can be written as
\[ F_D = v_D - \frac{\bar{\mu}_D + \bar{g}}{i - \bar{g}} (1 - \phi_D - v_D). \]
That is, the bank has intangible value in deposit taking over and above the value of its existing deposits if the costs of originating these deposits \( \phi_D \) is less than the contribution of new bank deposits to bank fair value \( 1 - v_D \). Atkeson et al. (2019) assume that this is not the case. Begenau and Stafford (2019) argue as well that this is not the case.

### 5.3 Subordinated Debt

In addition to deposits, we assume that the bank also finances itself with subordinated debt. We assume that this debt takes the form of defaultable debt with coupon \( c_B \) and face value at maturity of 1. After paying the coupon, a fraction \( \mu_B \) of this debt matures. Let \( B \) denote the amount of such debt issued by the bank. We have that the market value of the bank’s subordinated debt, denoted by \( v_B \times B \) is given by
\[ v_B = \frac{1}{1 + \hat{\beta} \mathbb{E} [c_B + \mu_B + (1 - \mu_B)v_B - \ell]} \]
where \( \ell \) is a random variable that represents the losses incurred by holders of subordinated debt in the event of default. This variable is equal to zero if there is no default. We then have that
\[ v_B = \frac{c_B + \mu_B - \hat{\beta} \mathbb{E} \ell}{i + \mu_B}. \]
where \( \hat{\beta} \mathbb{E} \ell \) is the expected loss given default under the risk neutral probabilities. In what follows, we normalize the coupon payment on subordinated debt so that this debt sells at par, i.e. at \( v_B = 1 \). We solve the model under this normalization and then, at the end, set \( c_B = i + \hat{\beta} \mathbb{E} \ell \).

In the event that the bank does not default, with the subordinated debt trading
at par, the contribution of the subordinated debt arm to bank dividends is given by $-div_B' \times B$, where

$$div_B' = c_B - g'$$

(6)

To determine the equilibrium expected loss given default and corresponding spread on the bank’s subordinated debt, we must study the decision of equity to put the bank into an administrative resolution procedure and the associated recovery rate of subordinated debt holders inclusive of any government bailouts. We refer to this decision as the default decision.

5.4 The Default Decision

Each period, shocks $\mu_L', \delta_L', \mu_D'$ and $g'$ are realized. Given these realized shocks, equity holders decide whether to retain or inject enough equity into the bank to grow its balance sheet at rate $g'$ or default. If equity chooses not to default, the dividend to equity is given by $div_E' \times L$ where

$$div_E' = div_L' - div_D' \Theta_D - div_B' \Theta_B.$$  

(7)

If equity chooses to default, then we assume that it receives a dividend of zero and gives up all future claims to the dividends from the bank. Thus, the market value of the equity of the bank is obtained from the solution to the following Bellman Equation:

$$ME = \frac{1}{1 + \tilde{\iota}} \max \left\{ 0, \left[ div_E' + (1 + g')ME \right] \right\}$$

where the market value of equity reflects the option for equity to default contingent on the realized shocks.

This equation implies that equity defaults if and only if it would cost more to inject the required equity into the bank that the bank is worth, i.e.

$$div_E' + (1 + g')ME < 0.$$
Let $I'$ be an indicator variable equal to one if equity chooses not to default and equal to zero if it chooses to default. Let

$$q(c) \equiv \tilde{E}[1 - I']$$

denote the risk neutral probability of default, where we use the notation $c$ to indicate a crisis. Let

$$q(n) = 1 - q(c) = \tilde{E}[I']$$

denote the risk neutral probability of no default. We use the notation $n$ to denote normal times.

For any random variable $x'$, let $x(n)$ denote the conditional expectation of the realization of that variable in normal times (no default) and $x(c)$ the conditional expectation of the realization of that variable in crisis times (default).

With this notation, we have that the value of equity can be written as

$$ME = \frac{q(n)}{(1 + i) - q(n)(1 + g(n))}div_E(n). \quad (8)$$

### 5.5 Losses to Subordinated Debt

In this subsection, we develop a formula for the spread between the yield on subordinated debt and the riskless interest rate in terms of the risk neutral probability of default and the expected recovery on subordinated debt. This formula is central to the analysis in Berndt et al. (2018b).

If there is default, the holders of the subordinated debt immediately resell the bank to new owners with government assistance to ensure a recovery rate for subordinated debt holders that is non-negative. Let $\ell(c) \times B$ denote the expected total losses incurred to holders of subordinated debt in the event of default by equity. The
The first term, $-T(c)$ is the expected government bailout conditional on default. Government support is equal to zero if there is no default. The term

$$-div_E(c) - (1 + g(c)) ME$$

is the conditional expectation of the loss that equity holders have avoided by defaulting. This term is determined by bank leverage and the risk to the fair value of the bank (as this represents the losses that equity would incur under unlimited liability in the current period).

The yield to maturity on the subordinated debt is given as the solution $y_B$ to the equation

$$v_B = 1 = \frac{c_B + \mu_B}{y_B + \mu_B}.$$ 

This formula implies that the spread on the subordinated debt is given by

$$y_B - i = q(c)\ell(c).$$ (10)

That is, the spread on subordinated debt is equal to the risk neutral probability of default times the loss given default as a fraction of the original bond price.

Equations (9) and (10) make clear that to interpret the implications of bond spreads for the safety of banks, we need to find a mechanism to decompose changes in observed bond spreads into changes in the risk neutral probability of default, changes in the expected losses bank equity avoid by defaulting, and changes in the conditional expectation of the magnitude of government bailouts.
5.6 The Book, Franchise, and Market Value of Equity

In this subsection, we derive formulas for the book, the franchise, and the market value of bank equity. These formulas are central to the analysis of data on market to book ratios for bank equity as discussed in Atkeson et al. (2019) and the papers cited therein.

We calculate the book value of assets, liabilities, and equity for the bank using face values. The book value of equity is given by the difference between the book value of assets and liabilities, or $BE \times L$, where the ratio of the book value of equity to bank assets $BE$ is given by

$$BE = 1 - \Theta_D - \Theta_B$$

Define $\Theta = \Theta_D + \Theta_B$. Then $\Theta$ is the book leverage of the bank and the ratio of the book equity to assets is given by $BE = 1 - \Theta$.

We define the franchise value of bank equity as the increment to the value of bank equity due to the gap between the fair and book values of the bank’s loan making and deposit taking arms

$$FE = (FL - 1) - \Theta_D(1 - FD)$$

The market value of the bank is the sum of the market value of bank equity $ME \times L$ plus the market value of the bank’s subordinated debt $\Theta_B v_B$. This market value of the bank is equal to the sum of the book value of bank equity plus the franchise value of the bank plus the expected discounted present value of all government contributions to the bank $MG \times L$. That is

$$ME = BE + FE + MG$$
where

\[ MG = \frac{1}{1 + i} \left[ q(c)T(c) + (1 + \bar{g})MG \right] \]

or

\[ MG = \left( \frac{q(c)}{i - \bar{g}} \right) T(c) \]

(14)

Note that in equation 8, we determined the market value of bank equity as the expected discounted present value of dividends to equity up until the first default time. From equation 13 we see that the gap between this value of equity and the sum of the book and franchise value of equity is equal to the market value of government guarantees.

Both Atkeson et al. (2019) and Berndt et al. (2018b) report a substantial contribution of government guarantees to the market value of US Banks pre-crisis. The basis for this finding is as follows. From equation 14 we have a simple formula measuring the value of government guarantees: to the extent that the risk neutral probability of default is roughly equal to the riskless interest rate less the expected growth rate of bank assets, then the value of government guarantees relative to assets \( L \) is equal to the ratio of the size of the expected bailout relative to assets. Or, equivalently, the ratio of the market value of government guarantees to bank book equity \( MG/BE \) is on the order of the expected size of the crisis bailout relative to bank book equity \( T(c)/BE \). At the end of 2007, the book value of equity of banks was about $1 Trillion. At a minimum, the realized value of \( T(c) \) in 2008 and early 2009 was $250 billion of direct capital injections by the US Treasury and was larger if we consider the market value of the easy credit programs supplied by the Fed. Thus, a conservative estimate of \( T(c)/BE \) is 25% and it is easy to get this value up to 40-50% by valuing the credit programs. To the extent that such bailouts were expected in the event of a crisis, they should have contributed a substantial amount to the market capitalization of the bank.
5.7 Accounting Profitability and Bank Valuation

Here we relate accounting data on bank profitability in those states that the bank does not default to measures of the risk in bank dividends. In doing so, we are expanding on the work of Meiselman et al. (2018) relating the accounting profitability of banks to their risk taking.

The ratio of accounting earnings of the bank relative to bank assets is referred to as the bank’s return on assets. We denote this ratio as $ROA'$ and, using $L$, as our measure of bank assets, we have in those states that the bank does not default, the bank’s accounting return on assets is given by

$$ROA' \equiv c_L - \delta'_L - \Theta_D c_D - \Theta_B c_B - \phi_L (\mu'_L + \delta'_L + g') - \Theta_D \phi_D (\mu'_D + g')$$

The first three terms $c_L - \Theta_D c_D - \Theta_B c_B$ are the net interest earnings of the bank, the term $-\delta'_L$ is the reduction in accounting earnings due to loan losses to default, and the last two terms are the net non-interest expenses of the bank due to the origination of loans and deposits.\(^{20}\)

From equations, 2, 3, 7, and 11, we then have that in those states in which the bank does not default,

$$div'_E = ROA' - g'BE + \theta_B \mu_B (1 - v_B)$$

Thus, with the assumption that the subordinated debt trades at par, we have that the conditional expectation of dividends in normal times referenced in equation 8 for the market value of bank equity is related to the conditional expectation of the accounting profitability of the bank in normal times and the conditional expectation of the growth of the bank by

$$div_E(n) = ROA(n) - g(n)BE$$ (15)

\(^{20}\)We have abstracted from the pure fee-for-service activities of the bank.
The Return on Equity of the bank, denoted by $ROE'$ is the ratio of the accounting earnings of the bank to the book value of its equity and is given by

$$ROE' = \frac{ROA'}{BE}$$

Dividing both sides of our previous equation by the ratio of the book value of equity relative to assets gives

$$\frac{div_E(n)}{BE} = ROE(n) - g(n) \quad (16)$$

We can use the result that

$$\overline{div_E} = (i - \bar{g})ME - \theta_B q(c)\ell(c) - q(c)T(c) = (i - \bar{g})(FE + BE) - \theta_B q(c)\ell(c)$$

together with the same relationships between dividends and accounting earnings in the crisis state to derive the following benchmark for expected accounting earnings

$$q(n)ROE(n) + q(c)ROE(c) = i + (i - \bar{g})\left(\frac{FE}{BE}\right) - \frac{\theta_B}{BE}q(c)\ell(c) \quad (17)$$

This equation establishes a benchmark for expected accounting earnings as a function of the risk free rate $i$, the franchise value of the bank, the expected growth of the bank under the risk neutral probabilities, and the expected losses of bank bondholders given default. Note that if the bank has no franchise value and no defaultable debt, then the expectation of its accounting return on equity should be equal to the risk free rate. This equation implies that accounting earnings in normal times can be high either because these fundamentals are high or because the bank is exposed to large negative earnings shock in a crisis $ROE(c)$. This equation is central to our discussion of the connection between bank risk taking and accounting earnings below.
6 Accounting for the Valuation of US Banks

Here we present a calibration of our model and use it to illustrate how changes in bank fundamentals impact accounting and market signals. We use several comparative statics exercises to illustrate how one might use the model to interpret the accounting and market signals presented in the Fed Board’s dashboard. These comparative statics are similar to those considered in Atkeson et al. (2019). 21

To calibrate the model in as simple a manner as possible, we assume that the shocks in the model are perfectly correlated and take on at most two realizations. We refer to one realization as the normal realization and denote it with an $n$ and the other as the crisis realization and denote it with a $c$. When we calibrate the parameters for the crisis realization, we conjecture that equity chooses to default in this state and then verify whether this is indeed the case. The observation that bank CDS and bond spreads are still significant cause us to rule out our parameterizations of our model in which equity does not choose to default in the crisis state.

6.1 Setting Parameters

For the exercises we conduct we parameterize the model using the following procedure.

We set the risk free rate $i$ and the accounting return on equity of the bank in normal times $ROE(n)$ equal to values taken from the data.

As discussed above, we normalize the coupon rate on the bank’s subordinated debt so that this debt trades at par ($v_B = 1$). We solve for the endogenous coupon rate

---

21In our model of banks, we have abstracted from the impact of corporate profits taxes on banks’ accounting earnings and market valuation. This is an important omission that should be fixed in future versions of this model. The recent corporate tax reform has likely had a significant impact on banks’ accounting earnings and bank valuations. See, for example this analysis from the Federal Reserve Bank of New York https://libertystreeteconomics.newyorkfed.org/2018/07/tax-reforms-impact-on-bank-and-corporate-cyclicality.html.
that achieves this price at the end of our procedure.

We take the book equity of the bank relative to asset $BE$ and the subordinated debt relative to assets $\Theta_B$ from the bank’s accounting data.

We next use data on the market valuation of the bank together with accounting data on the profitability of the bank in normal times. We take as given data on the market to book ratio of the bank, its accounting return on equity in normal times, and its payout ratio in normal times (measured as the ratio of dividends to earnings) from data. to obtain a full set of consistent valuation ratios from these data, observe that the market to book ratio for the bank is related to its accounting profitability and its price earnings ratio in normal times by

$$\frac{ME}{BE} = \frac{ME}{ROA(n)}\frac{ROE(n)}{}$$

and the price dividend ratio of the bank in normal times is related to its price earnings ratio and its payout ratio by

$$\frac{ME}{divE(n)} = \left(\frac{ME}{ROA(n)}\right) \left(\frac{ROA(n)}{divE(n)}\right)$$

We solve for the growth rate of the bank in normal times $g(n)$ from the payout ratio of the bank in normal times (measured as the ratio of dividends to earnings)

$$\frac{divE(n)}{ROA(n)} = \frac{ROE(n) - g(n)}{ROE(n)}.$$

We can solve for the risk neutral probability $q(n)$ given data on the implied price dividend ratio for the bank in normal times, which is given from equation (8) by

$$\frac{ME}{divE(n)} = \frac{q(n)}{1 + i - q(n)(1 + g(n))}.$$

We then use data on the yield spread on the bank’s subordinated debt to set the
expected loss on the bank’s bonds given default, \( \ell(c) \) from equation (10).

We choose a value of \( \bar{g} \) so that the constraint \( 1 + g(c) > 0 \) is satisfied.

This procedure for picking parameters exhausts the information on accounting and market signals given in the Fed’s dashboard (and either asset growth or the payout ratio in normal times). We have identified the risk to bank equity holders, as parameterized by the risk neutral probability \( q(c) \) that they are wiped out, as well as the risk to bank subordinate debt investors, as parameterized by the expected loss \( \ell(c) \) conditional on default. But we are unable to use these data to identify the risk to taxpayers as parameterized by the required contribution \( T(c) \) as defined in equation (9). Equivalently, this implies that it is not possible to identify precisely the extent to which the ratio of the market to book value of bank equity is derived from franchise value of the bank or from risk taking with government guarantees from these data.

To identify this risk to taxpayers in the crisis state \( T(c) \) and the value of government guarantees to bank equity \( MG \) (from equation 14), we need to identify the accounting returns on equity that the bank would experience in the crisis state \( ROE(c) \) (and then use equation 16 to compute implied dividends in that state \( div_E(c) \)).

We consider two bounds on the risk to taxpayers: a maximum and a minimum. We consider first the maximum risk to taxpayers which corresponds to the case in which the bank has no franchise value \( (FE = 0) \) and a minimum risk to the taxpayer which corresponds to the case in which the bank has the maximum franchise value and minimum risk consistent with default in the crisis state (so bond spreads are positive).

To compute the maximum risk to the taxpayer, we set franchise value \( FE = 0 \) and use equation (17) to solve for \( ROE(c) \). We take the ratio of subordinated debt to assets \( \Theta_B \) from the data and solve for \( T(c)/BE \) using equations (9) and (16).

To compute the minimum risk to the taxpayer, we set return on equity in the crisis state \( ROE(c) \) so that the contribution from taxpayers \( T(c)/BE \) from equations (9)
and (16) is equal to zero.

In each case, we also report the implied market value of government guarantees relative to book equity $MG/BE$ and the implied franchise value of the bank relative to book equity $FE/BE$. We evaluate the implied risk to bank value in the crisis state by reporting the implied return on assets in that state $ROA(c)$.

We can compare the model implications for the risk to bank value as parameterized by the implied return on assets in the crisis state $ROA(c)$ to the risk in bond portfolios as follows. Consider a bank that holds as assets a bond portfolio of size $L = 1$ with no franchise value and no government guarantees and no option to default. Assume that the bank issues riskless debt $1 - BE$ at interest rate $i$. Assume that this bank marks it assets to market each period, so that the book value of its equity is equal to the market value of its equity $BE = ME$. Under the assumption that the bank marks its assets to market each period, its return on assets in state $s$ would be equal to the total return on the bond portfolio $TR(s)$ less the interest cost on its debt, or, equivalently

$$TR(s) = ROA(s) + (1 - BE) \times i$$

Thus, the realized excess returns on the bond portfolio $TR(s) - i$ are given by $ROA(s) - BE \times i$.

### 6.2 Matching the Model to Accounting and Market Signals

#### Pre- and Post- Crisis

We now follow the procedure described above to choose parameters of our model to match the main features of the accounting and market signals seen for US Banks in the aggregate pre and post crisis.

The parameters and results are shown in Table 1.

In Table 1 we see that the market and accounting signals on the Fed’s dashboard (together with data on the payout ratio) imply little or no change in the risk to bank
Table 1: Model Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Pre-Crisis</th>
<th>Post-Crisis</th>
</tr>
</thead>
<tbody>
<tr>
<td>$i$</td>
<td>5%</td>
<td>2%</td>
</tr>
<tr>
<td>$BE$</td>
<td>9%</td>
<td>13%</td>
</tr>
<tr>
<td>$\Theta_B$</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>$ROE(n)$</td>
<td>15%</td>
<td>8%</td>
</tr>
<tr>
<td>$ME/BE$</td>
<td>2</td>
<td>1.1</td>
</tr>
<tr>
<td>payout ratio</td>
<td>50%</td>
<td>33.3%</td>
</tr>
<tr>
<td>spread</td>
<td>25bp</td>
<td>75bp</td>
</tr>
<tr>
<td>price earnings</td>
<td>13</td>
<td>14</td>
</tr>
<tr>
<td>$ME$</td>
<td>18%</td>
<td>14%</td>
</tr>
<tr>
<td>$q(c)$</td>
<td>5.6%</td>
<td>5.3%</td>
</tr>
<tr>
<td>$g(n)$</td>
<td>7.5%</td>
<td>5.3%</td>
</tr>
<tr>
<td>$\ell(c)$</td>
<td>4.5%</td>
<td>14%</td>
</tr>
<tr>
<td>$\bar{g}$</td>
<td>2%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>max risk</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$TR(c) - i$</td>
<td>-15.3%</td>
<td>-14.5%</td>
</tr>
<tr>
<td>$T(c)/BE$</td>
<td>53%</td>
<td>4%</td>
</tr>
<tr>
<td>$MG/BE$</td>
<td>100%</td>
<td>10%</td>
</tr>
<tr>
<td>$FE/BE$</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>min risk</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$TR(c) - i$</td>
<td>-10.5%</td>
<td>-14.0%</td>
</tr>
<tr>
<td>$T(c)/BE$</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>$MG/BE$</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>$FE/BE$</td>
<td>100%</td>
<td>10%</td>
</tr>
</tbody>
</table>

equity as measured by the risk neutral probability of bank default ($q(c)$ is between 5% and 6% both pre- and post- crisis).

These data imply only a modest increase in the risk to bank bondholders as measured by their expected loss conditional on default ($\ell(c)$ rises from 4.5% to 14%). Hence, viewed through the lens of our model, the data on the Fed’s dashboard do not suggest that regulators have succeeded in convincing bank bondholders that they will suffer substantial losses in event of default.
Now consider our model’s implications for the risk to taxpayers in a crisis pre- and post-crisis. As discussed above, these implications depend on our assumptions about the scale of franchise value in banks. In Table 1, we show results for two scenarios: a maximum risk scenario and a minimum risk scenario. As discussed above, the maximum risk scenario corresponds to the assumption that banks have no franchise value and thus that the market to book ratio of banks is accounted for by risk taking with government guarantees. The minimum risk scenario corresponds to the assumption that risk taking with government guarantees contributes exactly zero to bank value and that, instead, the market to book ratio of banks is accounted for by the franchise value of the bank.

Under our maximum risk scenario, corresponding to the assumption that banks had no franchise value both pre- and post-crisis, we see the following results. The model’s implications for the risk in bank portfolios, as measured by the equivalent crisis realized excess return on a bond portfolio $TR(c)$, is essentially unchanged pre- and post-crisis at $-15\%$. There is, however, a dramatic drop in the implied taxpayer liability in a crisis relative to bank book equity $T(c)/BE$, from 53% to 4%. (Note that that model’s implications for the size of the crisis bailout pre-crisis is not that different from the bailout that occurred in the 2007-08 crisis.) This drop in taxpayer liability is due to the increase in bank book equity and the modest increase in expected losses to be borne by bank subordinated debt holders.

Under our minimum risk scenario, corresponding to the assumption that banks derive no value from government guarantees, we see the following results. Now the model implies a substantial increase in the risk in bank portfolios as measured by the equivalent crisis realized excess return on a bond portfolio $TR(c)$, from the pre-to post-crisis scenario (this risk increases from $-10.5\%$ to $-14\%$). The model also implies a dramatic drop in bank franchise value from $FE/BE = 100\%$ to only 10%.

It is interesting to note that in the post-crisis period, the range of risks in bank portfolios (from maximum to minimum) consistent with data on positive bond spreads and small market to book ratios is very small (from $-14.5\%$ to $14.0\%$) and is con-
sistent with the maximum risk scenario pre-crisis. Thus, the view that the risk in bank portfolios is essentially unchanged from the pre- to post-crisis period and that the change in bank valuations is due to the decrease in taxpayer exposure due to increased bank capital is consistent with the data both pre- and post-crisis.

7 Comparative Statics

We now consider comparative statics exercises motivated by the recent literature on banks and contrast our conclusions with the findings of Berndt et al. (2018b).

Meiselman et al. (2018) is a remarkable empirical study that argues that in the cross-section of banks, high accounting profitability pre-crisis predicts high systematic tail risk of equity market values in the crisis. That is, they interpret high accounting profitability in banks pre-crisis as a signal of higher exposure of the bank to losses in the crisis.

We use our model to show that if bank assets are more exposed to a crisis shock and if banks enjoy the support of government guarantees, then they should have both higher accounting profitability and a higher market-to-book ratio of equity. To illustrate this point, in Table 2, we consider a cross section of accounting returns on equity and market to book ratios for banks with different degrees of risk in their portfolios. We set the risk of a crisis to $q(c) = 0.05$ and $i = 5\%$, set the book equity of these banks as indicated in the table, set the franchise value of all of these banks to zero, and we vary the assumed crisis risk as indexed by $TR(c)$, ranging from $-10\%$ to $-18\%$. Table 2a shows that an increase in risk-taking pre-crisis generates higher accounting returns and market-to-book ratio of equity.

We also use the model to show that, absent government guarantees, while risk-taking by banks does increase accounting earnings in normal times, it does not

\footnote{See Acharya, Pedersen, Philippon, and Richardson (2017) for a discussion of the significance of the systematic tail risk of equity market values in the crisis as a measure of the performance of banks in the crisis.}
alter banks’ market valuations of equity. This result is a direct consequence of the Modigliani-Miller theorem. In Table 2b, while dampened compared to pre-crisis, risk-taking still impact the market-to-book ratio of equity as with 13% book equity equity holders still benefit from government guarantees. In Table 2c, with 20% book equity, a large shock to the loan portfolio does not trigger default anymore and the market value of equity is equal to its fair value.

We then document in the data used by Meiselman et al. (2018) that banks that had higher accounting profitability pre-crisis did indeed have higher market-to-book ratios. The first set of regressions in Table 3 estimates the relationship between a tail risk measure, prior accounting return on equity $ROE(n)$, and the prior market-to-book ratio of equity $(ME/BE)$ for public banks in the U.S. Following Meiselman et al. (2018), the tail risk measure corresponds to the market returns on equity during the 5% worst market days of CRSP market value-weighted index within September 2007 and October 2010. The prior accounting returns on equity and the prior market-to-book ratio of equity are measured in December 2006. As expected from our framework, regression (1) shows that higher accounting profitability was also
Table 3: Tail Risk Indicators

This table presents results from OLS regressions that estimate the relationship between a tail risk measure, prior accounting return on equity $ROE(n)$, and the logarithm of market-to-book ratio of equity $ME/BE$. The tail risk measure corresponds to the market returns on equity during the 5% worst market days of CRSP market value-weighted within September 2007 and October 2010. The prior accounting return on equity and the logarithm of prior market-to-book ratio of equity are measured in December 2006. Both the regressor and regressand are standardized to have mean equal to zero and standard deviation equal to one. T-statistics in parentheses.

\[
\begin{array}{cccc}
(1) & (2) & (3) & (4) \\
\text{log}(ME/BE) & \text{tail risk measure} & \text{tail risk measure} & \text{tail risk measure} \\
\text{ROE}(n) & 0.534^{***} & -0.413^{***} & -0.171^{***} \\
 & (14.25) & (-10.22) & (-3.94) \\
\text{log}(ME/BE) & & -0.544^{***} & -0.452^{***} \\
 & & (-14.59) & (-10.40) \\
\text{Observations} & 510 & 510 & 510 \\
\text{R}^2 & 0.286 & 0.171 & 0.295 \\
\end{array}
\]

Standardized beta coefficients; t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

associated with higher market-to-book ratios of equity pre-crisis. Moreover, in regressions (2) to (4), we show that banks with higher market-to-book ratios pre-crisis experienced worse performance in the crisis. Interestingly, the market-to-book ratio of equity outperforms accounting returns to predict losses during the financial crisis as the R-squared increases from 0.171 to 0.295. We interpret these cross-sectional findings as supportive of the hypothesis that risk-taking by banks with the support of government guarantees played an important role in determining bank valuations pre-crisis.

In Table 4, we empirically investigate the relationship between accounting returns and the market-to-book ratio of equity in the cross-section before and after the financial crisis. We include firm and month fixed effects. This time, we use quarterly observations of all U.S. public firms from 1987 to 2006 for the pre-crisis period and from 2010 to 2018 for the post-crisis period. We include quarter and firm fixed effects. These fixed effects allow for variations over time and across sector in risk premia which affects the relationship between accounting returns and valuations. The
Table 4: Market-to-Book Ratio of Equity and Return on Equity for Bank Holding Companies. This table presents results from a fixed effect regression that estimate the relationship between the market-to-book ratio of equity $ME/BE$ and return on equity $ROE(n)$ for bank holding companies before (1987-2006, POST=0) and after (2010-2018, POST=1) the financial crisis. We use both quarter and firm fixed effects. We also include non-bank holding companies and control for the interaction between $ME/BE$ and $ROE(n)$ for non-bank holding companies pre- and post-crisis (not shown in the table to simplify the exposition). Not including non-bank holding companies yields weaker estimates (from -0.35 to -0.12) but does not alter the conclusion. See Section A for details on the construction of $ME$, $BE$, and $ROE(n)$.

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\log(ME/BE)$</td>
<td></td>
</tr>
<tr>
<td>$\log(ROE(n))$</td>
<td>0.444***</td>
</tr>
<tr>
<td></td>
<td>(54.24)</td>
</tr>
<tr>
<td>$\log(ROE(n)) \times \text{POST}$</td>
<td>-0.353***</td>
</tr>
<tr>
<td></td>
<td>(-21.40)</td>
</tr>
<tr>
<td>quarter fixed effects</td>
<td>YES</td>
</tr>
<tr>
<td>firm fixed effects</td>
<td>YES</td>
</tr>
<tr>
<td>N</td>
<td>335760</td>
</tr>
</tbody>
</table>

$t$ statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Inclusion of non-bank holding companies lets us identify the change post-crisis in the relationship between accounting return and valuation that is specific to bank holding companies. For bank holding companies, the relationship is such that a 1% increase in accounting returns is correlated with a 0.44% increase in the market-to-book ratio of equity pre-crisis. Consistently with the prediction of our model, this relationship is still significant but weakens substantially to 0.09% after the financial crisis. Taking as given the results of Meiselman et al. (2018) that changes in accounting returns reflects variation in risk-taking by banks, we interpret these results as evidence that equity holders of bank holding companies lost an important fraction of the value of government guarantees post-crisis.

Berndt et al. (2018b) is a provocative study of the impact of potential changes in expectations of government support for bank subordinated debt for observed bank bond spreads and market valuation of bank equity. In terms of our model, their study can be interpreted as an examination of the two factors determining bank bond...
spread in equation 10. They use bank’s distance-to-default as a proxy for banks’ risk-neutral probability of default. From these estimated default probabilities and observed bond spreads, they compute the expected loss to bondholders conditional on default. Using credit default swaps, they estimates pairs of pre- and post-crisis bailout probabilities \( \pi \) consistent with their framework (see Table 5). They find that the bailout probability has declined by about 30% after the financial crisis.

In our model, absent government protection, bondholders lose all their investment at insolvency and equation (10) implies that the yield is close to the risk-neutral probability of default \( q(c) \). Thus, with our calibration, corporate bonds spreads should average 521bps post-crisis to be consistent with no bailout at insolvency. In 2018, median credit default swap rates maturing in 1 year average 67bps for bank holding companies. Hence, market expectations are not consistent with an absence of bailout.

In table Table 5, we derive the risk-neutral probabilities of default \( q(c) \) implied by the estimation strategy of Berndt et al. (2018b). While they control for cross-sectional variation in default risk, they do not estimate the risk-neutral probability of default since they use time and industry fixed effects to allow for variation in default risk premia. We use their conceptual formula for credit default swaps rates to derive their implied risk-neutral probability:

\[
cds = q(c) \times (1 - \pi) \times \hat{\ell}(c).
\]
The correspondence between their expected loss at insolvency given no-bailout \( \hat{\ell}(c) \) and our expected loss given default is given by \( \ell(c) = (1 - \pi) \times \hat{\ell}(c) \).

The top rows of table Table 5 report their implied risk-neutral probability of default \( q(c) \) of Berndt et al. (2018b) given their estimates of pairs of pre- and post-crisis bailout probabilities \( \pi \), their measurement of average credit default swap rates \( cds \), and their estimates of the expected loss at insolvency given no-bailout to \( \hat{\ell}(c) \). The bottom row shows our estimates for comparison.

While they do not explicitly provide their average estimate for \( \hat{\ell}(c) \), in Appendix D, they conduct a robustness check where they endogenously fix the expected loss at insolvency given no-bailout to 60%. They also report two recovery rate reported by Moodys Investor Services (2018). The first one is the historical issuer-average ultimate recovery rate for senior unsecured bonds, for 1987-2017, of 47.9%, and the second one is the average recovery rate measured by the market prices of bonds immediately after default, over 1983-2017, of 37.7%. Thus, we use \( \hat{\ell}(c) = 0.60 \).

We argue that their implied post-crisis risk-neutral probabilities of default in the range of 3.5% are too low. Using equity put options, Sarin and Summers (2016) estimate a risk-neutral probability of default of 7.4% on average post-crisis. By adapting a Merton model to the special nature of bank assets, Nagel and Purnanandam (2020) estimate a risk-neutral probability of default of 5% for 1987-2016. With a risk-neutral probability of default of 5%, using the expected loss at insolvency given no-bailout of 60% targeted by Berndt et al. (2018b), the probability of bailout needs to reach 53% to be consistent with post-crisis credit default swap rates of 158bps. Thus, we argue that bank bondholders are still expecting large recovery rates on their bonds conditional on bank default, as with \( \ell(c) = 0.30 \) and a risk-neutral probability of default of 5%, 70% of banks’ subordinated debt is still bailed out by the government in a crisis.
8 Conclusion

We draw several conclusions from our modeling exercise.

First, we conclude that it is feasible and useful to develop a comprehensive model to use in interpreting accounting and market signals of the condition of the U.S. banking system. It is likely not sufficient to rely on signals based on accounting data alone in evaluating the progress that has been made over the past decade in reducing the risks to U.S. taxpayers from another financial crisis. To make a convincing claim that policy has been effective in protecting the taxpayer from future bank bailouts, one must confront the market signals from banks’ market capitalization, credit default swap spreads, and corporate bond spreads and explain why the deterioration those signals from the pre- to post-crisis periods does not reflect continuing exposure of U.S. taxpayers to large bank bailouts. We have attempted to do that in this paper.

Second, and perhaps most important, we conclude that the approach taken in the CCAR stress tests to measuring banks’ capital adequacy based on the historical evolution of bank accounting data in a crisis is likely not a useful guide to the risks to U.S. taxpayers of bank bailouts in future crises. Even the recent stress tests do not appear to be feeding in a big enough shock to bank market values in a crisis. This conclusion is based both on the evolution of banks’ equity market capitalization during the 2007-08 crisis and on the evolution of the total returns to corporate bond portfolios in that and other crises. Both of these types of market data suggest that declines in bank valuations of total assets of 15%-20% or more in a short period of time are quite plausible. If such shocks to bank valuations are possible, then capital buffers of 15% are not large enough to protect the US taxpayer in a banking crisis.

In our modeling exercise, we have taken a very traditional view of the activities of banks, focusing on their loan-making and deposit-taking activities. We have not modeled the capital market operations of the securities broker-dealer subsidiaries of banks. Duffie (2019) argues that the failure of the major securities broker-dealers was central to the severity of the 2007-08 crisis. Working out how to model and value
the operations of securities broker dealers would be a significant challenge.

The Fed Board did not include data on securities broker dealers (SBDs) in their dashboard. Data from the Fed’s Financial Accounts of the United States (Flow of Funds), presented in Figure 28, on the ratio of total assets of SBDs relative to GDP show very interesting patterns regarding the evolution of the size of their balance sheets. From the 1950’s through the 1970’s, SBD’s had very small balance sheets relative to GDP. Starting in the 1980’s through 2007, these balance sheets grew very rapidly relative to GDP. They then shrunk rapidly in the crisis—in particular in the fourth quarter of 2008—and have continued to shrink after the crisis. The total size of these balance sheets relative to GDP are now back to the levels they attained in the late 1990’s.

The Fed Board also did not include data on derivatives held off balance sheet by banks in their dashboard. Data from the Enhanced Flow of Funds presented on the website for the Financial Accounts of the United States Z1 (Flow of Funds) of the fair value of derivatives held by depository institutions also show interesting patterns regarding the scale of derivatives exposures relative to GDP. Figure 29 shows the fair value of interest rate derivatives relative to GDP and Figure 30 shows the fair value of credit derivatives relative to GDP. In both cases, we see a big increase in the fair value of derivatives held by depository institutions going into the crisis and a substantial decline since the crisis.

What were the benefits to banks and to society from the growth of these SBD balance sheets and derivatives exposures before the crisis? What are the costs to banks and society from the shrinkage of these SBD balance sheets and derivatives exposures after the crisis? What are the implications of this evolution of the balance sheets of SBD’s and derivatives exposures for the overall safety of the banking system? These are very difficult questions to answer. But these questions should be high on the research agenda for improving our understanding of the state of the U.S. financial system and its role in society.
Figure 1: Measures of Leverage for Bank Holding Companies. The figure displays two series: the sum of tangible book equity over the sum of risk-weighted assets and the sum of the market capitalization over the sum of risk-weighted assets for U.S. bank holding companies.
Figure 2: Measures of Credit Risk for Bank Holding Companies. The figure displays the value-weighted average of option-adjusted corporate bond spreads with a maturity close to 5 years as well as 5-year credit default swap spreads.
Tier 1 Capital Ratio

![Graph showing Tier 1 Capital Ratio for different segments of the banking industry from 1991 to 2019. The graph indicates fluctuations in capital ratios over time, with notable increases in recent years.](image)

**Figure 3: Tier 1 Capital Ratio for Bank Holding Companies** This figure reports the Tier 1 Capital Ratio from the “Quarterly Trends for Consolidated US Banking Organizations” report of the Federal Reserve Bank of New York. The ratio is computed as the sum of tier 1 capital across bank holding companies divided by the sum of risk-weighted assets across bank holding companies.
Figure 4: Total Capital Ratio for Bank Holding Companies

This figure reports book leverage from the “Quarterly Trends for Consolidated US Banking Organizations” report of the Federal Reserve Bank of New York. The ratio is computed as the sum of total capital across bank holding companies divided by the sum of total assets across bank holding companies.
Figure 5: Return on Equity for Bank Holding Companies

This figure reports the quarterly annualized return on equity from the “Quarterly Trends for Consolidated US Banking Organizations” report of the Federal Reserve Bank of New York.
Figure 6: Return on Assets for Bank Holding Companies This figure reports the quarterly annualized return on assets from the “Quarterly Trends for Consolidated US Banking Organizations” report of the Federal Reserve Bank of New York.
Non-performing Loans

Total non-performing loans as % of total loans

Figure 7: Non-Performing Loan Ratio This figure reports the ratio of non-performing loans to total loans from the “Quarterly Trends for Consolidated US Banking Organizations” report of the Federal Reserve Bank of New York.
Loan Loss Reserves, Percent of Non-performing Loans

Figure 8: Loan Loss Reserves, Percent of Non-Performing Loans. This figure reports the ratio of loan loss reserves to total non-performing loans from the “Quarterly Trends for Consolidated US Banking Organizations” report of the Federal Reserve Bank of New York.
Asset Growth Rate

Figure 9: Annual Growth Rate of Total Assets
This figure reports the annual growth rate of total assets for bank holding companies from the “Quarterly Trends for Consolidated US Banking Organizations” report of the Federal Reserve Bank of New York.
Note: Asset, loan and deposit growth rates presented below are affected by mergers with nonbanking firms and conversions to and from a BHC charter during the sample period. For example, this affects the year-over-year asset growth rate between 2009:Q1 and 2009:Q4 due to the entry of several new firms in 2009:Q1, and between 2016:Q3 and 2017:Q2 due to the introduction of several IHCs in 2016:Q3. See ‘Caveats and Limitations’ for details.

Figure 10: Annual Growth Rate of Total Loans
This figure reports the annual growth rate of total loans for bank holding companies from the “Quarterly Trends for Consolidated US Banking Organizations” report of the Federal Reserve Bank of New York.
Figure 11: Market Leverage for Large Banks  This figure reports the Market Leverage of large banks measured as the ratio of the market value of equity to the sum of the market value of equity and total liabilities from the Supervision and Regulation Report of the Federal Reserve Board of Governors.
Figure 12: Ratio of the Market Value of Bank Equity to Risk-Weighted Assets

This figure reports on the distribution of the ratio of the market value of bank’s equity to their risk-weighted assets. The red line in the figure shows the median of these ratio at each date in the cross section. Each gray line shows the 10th, 30th, 70th, and 90th percentiles of the cross section distribution of this statistic across bank holding companies at each date.
Figure 13: Dollar value of market and book equity for U.S. Banks. This figure shows the market capitalization of publicly traded banks together with their book equity as well as the equity of four large banks (next figure). This figure is taken from Begenau et al. (2019).
Figure 14: Dollar value of market and book equity for U.S. Banks This figure shows the market capitalization of four large publicly traded banks together with their book equity. This figure is taken from ?.
Figure 15: **Average CDS Spread for Large Banks** This figure reports the average CDS spread for large banks from the Supervision and Regulation Report of the Federal Reserve Board of Governors.
Figure 16: Logs of the Median CDS Spread for Banks against the distribution of CDS spreads for all firms This figure reports the logarithm of the median spread for bank holding companies together with the logarithm of the CDS spreads for firms in the 10th, 30th, 50th, 70th, and 90th percentiles at each date.
Average One-Year Credit Spread of Large Banks Borrowing US Dollars: LIBOR versus the OIS Swap Rate

Source: Author using data from Bloomberg.

Note: The figure shows the difference between the one-year US Dollar London Interbank Offered Rate (LIBOR) and the one-year overnight index swap (OIS) rate based on the Fed Funds rate.

Figure 17: Spread between one-year LIBOR and one-year OIS swap rate This figure reports the average one-year credit spread of large banks borrowing US Dollars: LIBOR versus the OIS Swap Rate and is taken from Duffie (2019).
Figure 18: Logs of the Median option-adjusted spread (OAS) for Bank Debt against the distribution of option adjusted spread spreads for all firms. This figure reports the logarithm of the median spread for bank holding companies together with the logarithm of the spreads for firms in the 10th, 30th, 50th, 70th, and 90th percentiles at each date.
Figure 19: Logs of the Median realized volatility for Bank equity against the distribution of realized equity volatility for all firms. This figure reports the logarithm of the median realized equity volatility for bank holding companies together with the logarithm of the realized equity volatility for firms in the 10th, 30th, 50th, 70th, and 90th percentiles at each date.
Table 1. Projected minimum regulatory capital ratios under the severely adverse scenario, 2019:Q1 to 2021:Q1: 18 participating firms

<table>
<thead>
<tr>
<th>Regulatory ratio</th>
<th>Actual 2018:Q4</th>
<th>Projected minimum stressed ratios</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Original planned capital actions</td>
</tr>
<tr>
<td>Common equity tier 1 capital ratio</td>
<td>12.3</td>
<td>6.5</td>
</tr>
<tr>
<td>Tier 1 capital ratio</td>
<td>14.0</td>
<td>8.3</td>
</tr>
<tr>
<td>Total capital ratio</td>
<td>16.4</td>
<td>10.6</td>
</tr>
<tr>
<td>Tier 1 leverage ratio</td>
<td>8.6</td>
<td>5.1</td>
</tr>
<tr>
<td>Supplementary leverage ratio</td>
<td>6.9</td>
<td>4.0</td>
</tr>
</tbody>
</table>

Note: These projections represent hypothetical estimates that involve an economic outcome that is more adverse than expected. These estimates are not forecasts of capital ratios. The tables include the minimum ratios assuming the capital actions originally submitted in April 2019 by the firms in their annual capital plans and the minimum ratios incorporating any adjustments to capital distributions made by a firm after reviewing the Federal Reserve’s stress test. The minimum capital ratios are for the period 2019:Q1 to 2021:Q1. The minimum capital ratios do not necessarily occur in the same quarter. Supplementary leverage ratio projections only include estimates for firms subject to advanced approaches.

Source: Federal Reserve estimates in the severely adverse scenario.

Figure 20: “Stress Test” projections of the loss of BHC capital under a severely adverse stress scenario 2018 This figure reports the predictions of the Federal Reserve’s CCAR “stress tests” for the reduction in bank holding company capital ratios under the severely adverse stress scenario.
Figure 21: “Stress Test” projections of the aggregate loss of BHC capital under a severely adverse stress scenario 2013-2018. This figure reports the predictions of the Federal Reserve’s CCAR “stress tests” from 2013-2018 for the reduction in bank holding company ratios of tier 1 common equity capital to risk weighted assets under the severely adverse stress scenario for the aggregate of those bank holding companies subject to this scenario. Source: https://www.federalreserve.gov/supervisionreg/ccar.htm
Figure 22: Histogram of “Stress Test” projections of the bank-level losses of BHC capital under a severely adverse stress scenario 2013-2018. This figure reports the predictions of the Federal Reserve’s CCAR “stress tests” from 2013-2018 for the reduction in bank holding company ratios of tier 1 common equity capital to risk weighted assets for individual banks under the severely adverse stress scenario. Source: https://www.federalreserve.gov/supervisionreg/ccar.htm
U.S. banks have more than doubled the amount of high quality capital since the crisis.

Banks could face ~$600b in projected losses plus a substantial projected decline in revenues…

…and still have more capital than in 2009.

Figure 23: Schematic Results of the 2016 CCAR Stress Tests This figure presents a graphic summary of the aggregated results of the Federal Reserve’s 2016 CCAR Stress Tests under the assumption of no capital distributions (dividends or share buybacks) used in Mnuchin and Phillips (2017)
Figure 24: Comparison of calibrated risk-neutral default probabilities Merton model and bank risk model. This figure shows the implications of the Nagel and Purnanandam (2020) model as compared to the implications of the Merton model for bank risk-neutral probabilities of default.
Figure 25: Interest Rate Risk as measured by the Log Cumulative Excess Returns on 10-15 year Corporate Bonds relative to 1-3 year Corporate Bonds. This figure is constructed using the ICE-BAML Total Return Indices BAMLCC7A01015YTRIV and BAMLCC1A013YTRIV available on the FRED website at the Federal Reserve Bank of St Louis.
Figure 26: Credit Risk as measured by the Log Cumulative Excess Returns on BBB-rated Corporate Bonds relative to AAA-rated Corporate Bonds. This figure is constructed using the ICE-BAML Total Return Indices BAMLCC0A4BBBTRIV and BAMLCC0A1AAATRIV available on the FRED website at the Federal Reserve Bank of St Louis.
Figure 27: Credit Risk as measured by the Log Cumulative Excess Returns on High Yield Corporate Bonds relative to AAA-rated Corporate Bonds. This figure is constructed using the ICE-BAML Total Return Indices BAMLHYH0A0HYM2TRIV and BAMLCC0A1AAATRIV available on the FRED website at the Federal Reserve Bank of St Louis.
Figure 28: Security Broker Dealer Total Assets (Balance Sheet) to GDP This figure reports the ratio of the total balance sheet measure of the total assets of security brokers dealers (both independent and subsidiaries of bank holding companies) to GDP. The data on total assets (series FL664090663) are from the underlying detail data from the Data Download program for the Federal Reserve’s Financial Accounts of the United States Z1.
Figure 29: Fair Value of Banks’ Interest Rate Derivatives to GDP This figure reports the ratio of the positive and negative fair values of the interest rate derivatives held in depository institutions as reported in the Enhanced Financial Accounts as reported on the website for the Federal Reserve’s Financial Accounts of the United States Z1.
Figure 30: Fair Value of Banks’ Credit Derivatives to GDP This figure reports the ratio of the positive and negative fair values of credit protection bought and sold held in depository institutions as reported in the Enhanced Financial Accounts as reported on the website for the Federal Reserve’s Financial Accounts of the United States Z1.
Appendices

A Data and Methodology

Stock prices and returns are obtained from the CRSP (Center for Research in Securities Prices) database. All accounting information is obtained from the Compustat database. We use bank accounting information from the Holding Company Data of the Federal Reserve Bank of Chicago. Credit default swap prices are obtained from Markit. We collect corporate bond credit spreads from the Lehman/Warga and Merrill Lynch (BAML) databases. All these datasets are merged using the identifiers from WRDS, the CRSP-FRB links from the Federal Reserve Bank of New York, and Committee on Uniform Security Identification Procedures serial numbers.

The book-to-market ratio of a firm is the book value of equity scaled by the market value of equity. These two values of equity are calculated as follows. We measure a firm’s market value of equity as the price of each share times the number of outstanding shares. To calculate the book value of equity, we first obtain the shareholders’ equity. For this measure, we use stockholders equity (Compustat item SEQ) if not missing. Otherwise, we use total common equity (Compustat item CEQ) plus preferred stock par value (Compustat item PSTK), or if that fails, we use total assets (Compustat AT) minus total liabilities (Compustat item LT). If a valid measure of shareholders equity is still not obtained after these procedures, we treat shareholders equity as missing for this firm year. We then subtract the preferred stock value from shareholders equity to obtain the book value of equity. In this process, we use redemption value (Compustat item PSTKRV), liquidating value (Compustat item PSTKL), or carrying value (Compustat item PSTK), in that order as available, as the preferred stock value. If none of the redemption, liquidating, and carrying values is present, we treat book equity as missing for this firm year. Finally, we add to book equity balanced sheet deferred taxes (Compustat item TXDITC) and subtract off FASB106 adjustment (Compustat item PRBA), if both are present.
The return on equity of a firm is calculated as net income (Compustat item NI or FRY-9C item 4340) plus interest expenses (Compustat item XINT or FRY-9C item 4073) plus interest expenses plus tax expenses (Compustat item TXT or FRY-9C item 4302) scaled by the book value of equity.

References


82