On Market-Based Approaches to the Valuation of Capital

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Abstract

Market measures suggest banks are as risky as they were in the pre-crisis period. This appears attributable to a decrease in bank franchise value, rather than a byproduct of the current low interest rate environment, and cautions about the stability of the financial sector. However, stress test results reveal little cause for concern; in 2017, all 34 stressed institutions in the United States passed the tests, suggesting they will remain well-capitalized in the event of a downturn more severe than the Great Recession. Their passage paved the way for capital disbursements and ignited calls for deregulation. In this paper, we demonstrate that a market-based stress test approach produces results that are significantly less encouraging than the regulatory tests. While a pure market-based stress test is undesirable, we believe it is important to incorporate market information into the stress test methodology to facilitate more credible inferences about bank safety.

1 Introduction

By market measures, banks today are much less highly valued than they have been in the past (Sarin and Summers 2017). Price-to-book ratios have fallen to levels in line with the trough of the Great Recession, especially in the Euro Area and Japan (IMF 2016, Bank of England 2016, Vickers 2017). This appears to have to do more with the economic environment of banking rather than simply features of the interest rate environment and raises concerns that the financial sector today remains vulnerable to adverse shocks. Yet the 2017 stress test results report that all 34 stressed banks would remain "well-capitalized" in the event of a severely adverse shock: resulting from a doubling of the unemployment rate, a contraction in real GDP more severe than the Great Recession, and a 50 percent decline in the stock market. If these results are to be believed, there is little reason to be concerned about the ability of the financial sector to survive the next downturn without significant government intervention. Indeed, this is the view of many in the regulatory community: Janet Yellen, Chairwoman of the Federal Reserve, recently stated that the system is much safer and she does not believe there will be another financial crisis in our lifetimes (Yellen 2017).

This paper attempts to reconcile the regulatory and market views of the stability of the banking sector. It proceeds in five parts. First, we document that the economic capital of banks has increased much less than the bold statements of regulators. Second, we examine whether the market's poor perception of bank health

is a byproduct of the current low interest rate environment, finding very little support for this proposition. Third, we look to the most recent stress test results and demonstrate that using a market value approach produces results that are significantly less encouraging than those heralded by the regulatory community. Fourth, we connect our work to other critics of the current stress test framework, notably Acharya et al. (2014) and Bulow and Klemperer (2013), to argue for revising the stress test approach to incorporate market measures. Finally, we conclude.

2 Price-to-book ratios are low, indicating market concern about banks' ability to generate profits

In Table 1, we provide price-to-book ratios for the "Big 6" financial institutions (Bank of America, Citigroup, Goldman Sachs, JP Morgan, Morgan Stanley, and Wells Fargo) in the pre-crisis (2002-2007, and even earlier 1995-2005) and post-crisis (2010-2017) period. We also provide recent annual average price-to-book ratios to assuage concerns that our results are driven by the early post-crisis period. Even though crisis reforms mean that banks are much less levered today than they were previously, there have been substantial declines in the market valuation of the financial sector. This low market valuation suggests that banks' capacity to generate future profits has been depleted substantially in the post-crisis period.

Table 1: Price-to-Book Ratios for Large US Banks Declining Over Time

Bank	1995-2005	2002-2007	2010-2017	2016	2017
Bank of America	1.98	1.93	0.68	0.67	1.03
Citigroup	2.70	2.22	0.70	0.64	0.89
Goldman Sachs	2.41	2.11	1.03	0.94	1.22
JP Morgan	1.84	1.38	1.03	1.07	1.41
Morgan Stanley	2.65	2.17	0.81	0.83	1.16
Wells Fargo	2.85	2.65	1.40	1.39	1.51
Mean	*2.40*	*2.08*	*0.94*	*0.92*	*1.20*
Median	*2.53*	*2.14*	*0.92*	*0.88*	*1.19*

It is important to note, as illustrated by the recent price-to-book ratios highlighted above, that bank equities have gained substantially in the last year. This point is made more clearly in Table 2 below. There are different ways of reading this rise. One possibility is that there has been an upward revision in fundamentals and thus, in the market's perception of banks' future ability to generate profits. Another possibility is that there is an element of "frothiness" in the equity market generally, particularly pronounced in the United States. The Bank of International Settlement's December 2017 Quarterly Review hypothesized that high valuations may be a sign of market complacency, and in presenting its results Claudio Borio

cautioned that that market participants were "basking in the light and warmth of their Goldilocks economy" while vulnerabilities remain (Borio 2017). While it is impossible to predict what the future holds for bank equities, price-to-book ratios in 2017 remained well below their pre-crisis averages, despite asset valuations in the United States reaching their highest level since 1900 (Mueller-Glissman 2017).

Table 2: Substantial Recent Rise for Bank Stock Prices

Bank	2016 Q3	2017 YE	% change
Bank of America	15.43	29.52	91.36
Citigroup	46.26	74.41	60.85
Goldman Sachs	163.18	248.29	52.16
JP Morgan	66.02	106.94	61.98
Morgan Stanley	30.95	51.36	65.95
Wells Fargo	47.68	60.67	27.24
Mean	61.59	95.20	54.58
Median	46.97	67.54	43.79

Outside of the United States, price-to-book ratios have declined even more substantially in the post-crisis period, and have recovered less in the recent period. A recent Bank of England Financial Stability Report notes that price-to-book ratios for major UK institutions are well below pre-crisis levels, which they too attribute to a decline in the markets' perception of banks' ability to generate returns for shareholders. Price-to-book ratios well below 1 in the Euro Area indicate that the market views bank asset values as substantially inflated relative to their true worth (Acharya et al. 2016).

Table 3: Price-to-Book Ratios for Large US Banks Declining Over Time

Date	Barclays	HSBC	Lloyds Banking Group	Royal Bank of Scotland	Average
Pre-crisis (1/1/07)	2.00	1.70	2.66	1.25	1.90
1/1/2016	0.62	0.83	1.12	0.66	0.81
11/1/2016	0.60	0.82	0.91	0.45	0.70
Most recent	0.47	0.87	1.04	0.71	0.77

Chart adapted from 2016 Bank of England Financial Stability Report, 2017 P/B from Telegraph Financials

And the IMF's 2016 financial stability report illustrates the extent to which low price-to-book ratios are a global phenomenon. They point out that weak bank profitability is a looming financial stability challenge, and that the market's assessment of banks' ability to meet this challenge is "not optimistic" with price-to-book ratios for many banks as low as they were during the worst points of the crisis.

Figure 1: Global Price-to-Book Ratios Have Declined

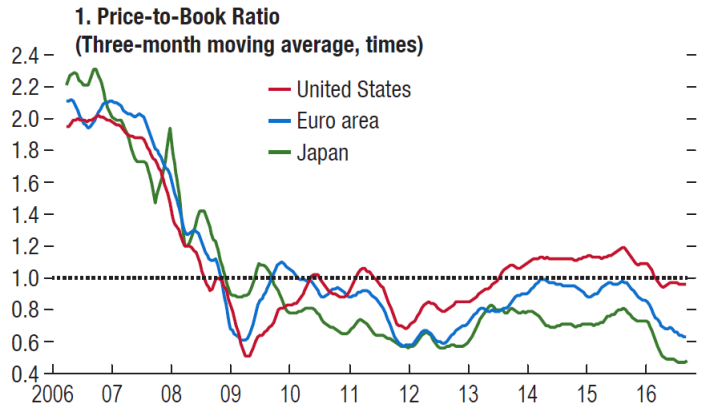

Figure 1: Reproduced from IMF Financial Stability Report, October 2016

These findings run counter to statements by the regulatory community about the improved capital position of the financial sector. For example, in a 2016 speech, Mark Carney, Governor of the Bank of England, noted that "the capital requirements of our largest banks are now ten times higher than before the crisis" (Carney 2016). And yet, the declines in market valuation are so large that, measured on a market basis, banks today have less equity—and thus are in *worse* capital positions and more vulnerable to adverse shocks—than they were in the pre-crisis period

3 Are low rates responsible for declining bank profitability?

Although it is evident to many observers that market valuations of large financial institutions have declined in the post-crisis period, there is no consensus on the cause, and relatively little work on how much of the recent decline in bank franchise value can be attributed to regulatory changes versus current macroeconomic conditions. Calomiris and Nissim (2014) argue that banks' persistent decline in market-to-book ratios reflect both changed economic circumstances (i.e. low interest rates) and changed regulatory policies, but do not comment on which they think is more relevant to banks' franchise value decline. A recent Clearing House note argues that most of the decline can be explained by regulatory changes: "for the largest banks—those above $250 billion in total assets—the most important driver of the decline in ROTCE [return on common tangible equity] is the reduction in fee income....Perhaps surprisingly, net interest margins have narrowed only modestly across all bank groups, [evidence that] the low level of interest rates and the relatively flat yield curve has had less adverse impact on bank profitability than commonly assumed."

It is worth noting that it is not obvious how an increase in rates will impact banks' profitability. Conven-

tional wisdom suggests that since banks borrow short and lend long, they benefit from a steep yield curve. However, a steepening of the yield curve as a result of increases in long-term rates will also precipitate immediate capital losses on banks' longer-term assets (i.e. securities holdings). These capital losses partially offset, or may even totally overwhelm, any gains to banks from higher net interest margins. Additionally, banks' maturity mismatch may diminish gains from higher rates: if banks are funded overnight and pay the short rate, but their assets have longer duration, then an increase in interest rates will reduce their net interest margins (Flannery and James 1984). Many studies find that bank equities react *negatively* to increases in long-term rates. For example, English et al. (2014) find that a 1% level shock to the yield curve causes bank stocks to *fall* by nearly 10%.[1] Recent work by Dreschler et al. (2017) finds a similarly negative response of bank equities to positive interest rate shocks, though smaller in magnitude: a 100-bps shock to interest rates decreases bank equity value by 2.4%.[2]

The idea that bank equities fall in value in response to positive interest rate shocks is slightly at odds with a series of papers that have studied the consequences of a low interest rate environment—and particularly the recent zero-lower bound period-–on bank profitability. Borio et al. (2015) focus on a sample of 108 large international banks and provide empirical evidence that periods of low interest rates reduce bank profitability, which in turn depresses bank lending (see also Borio and Gambacorta 2017). Recently, Claessens et al. (2017) use a large cross-country database of financial institutions and classified them as belonging to a low or high-rate environment (depending on if the interest rate on their three-month sovereign bond was below or above 1.25 percent). They find that a decrease in the short-term interest rate lowers banks' net interest margins in both a low-rate and a high-rate environment, with the effects being larger in a low-rate environment. But importantly they find that effects on profitability are less strong, which they attribute to banks' mitigating the impact of a low-rate environment by cost-cutting or generating more non-interest income. Genay and Podjasek (2014) also estimate the impact of changes in interest rates on banks' profitability. They too find strong evidence that net interest margins are compressed by a low rate environment, but like Classens et al. (2017) find relatively mixed evidence on the overall impact of low rates on banks' return on assets (ROAs). Higher short term rates and a steeper yield curve are associated with marginally higher ROAs for banks above \$10B in total assets, but with *lower* ROAs for banks between \$1B and \$10B in total assets.

In Tables 4 and 5, we build on the approach of Genay and Podjasek (2014) to estimate the impact of

[1] Relatedly, earlier work by Flannery and James (1984) suggests that the co-movement of bank stock returns and interest rate changes in dependent on the maturity mismatch of the bank.

[2] They point out that given the average maturity mismatch of the financial sector (aggregate assets in the last fifteen years have a duration of 4.3 years vs. 0.4 years for bank liabilities), one would expect equity prices to fall even more dramatically in response to a decrease in interest rates (40% to a 100-bps positive interest rate shock); however, banks have relatively low interest rate risk exposure because their interest expenses (the rate they pay on retail deposits) are insensitive to market rates, despite their near-zero maturity. This finding is related to English et al. (2014) who find that banks with more maturity mismatch actually have *less* negative exposure to a rise in interest rates.

rate changes on bank equity returns. In Table 4, we first follow Hanson and Stein (2015) and use changes in the two-year nominal Treasury yield on FOMC announcement dates as an exogenous shock to the interest rate environment. We regress returns returns for the "Big 6" financial institutions[3] as well as returns for four financial sector indices, including the S&P Financial Index, the Dow Jones Financial Index, the S&P Banks Index, and the S&P Select Banks Index[4] on surprise shocks to the two-year nominal Treasury yield.

Specifically, we estimate

$$r_{i,t} = a_i + \beta_i \Delta y_t^{\$(2)} + \gamma_t market_t + \Delta \epsilon_{i,t}$$

where $\Delta y_t^{\$(2)}$ represents changes in two-year nominal yields on FOMC announcement dates during the Hanson and Stein (2015) sample window of 1999-2012, $market_t$ is the return of the S&P 500, and $r_{i,t}$ is bank (or index) i's return on day t. Unsurprisingly, the market return is positively and statistically significantly related to bank equity returns. However, we find no economically or statistically significant relationship between the Federal Reserve's announcement of changes in short-term treasury rates and bank equity returns.

[3]Data for Goldman Sachs is only available post-May 1999, after the company's IPO.

[4]Per the Dow Jones Global Indices methodology, the broad financial index includes banks, asset managers, consumer finance, specialty finance, investment services, and mortgage finance. The banks index includes only banks, and the select index is also only for banks and follows a modified market capitalization weight methodology detailed here: the select sector indices follow a modified market capitalization weight methodology detailed here: https://us.spindices.com/documents/methodologies/methodology-sp-us-indices.pdf. The S&P Financial and S&P Banks Index are available for the entirety of our sample; the Dow Jones Financial Services Index is available from January 1992 onward, and the S&P Select Financials Index becomes available in June 2003.

Table 4: Impact of Monetary Policy Surprise on Bank Equity Returns

Panel A: Bank	Bank of America	Citigroup	Goldman Sachs	JP Morgan	Morgan Stanley	Wells Fargo
Rate change	0.00251	0.0292	0.0126	-0.00670	0.0340	0.0663
	(0.0337)	(0.0299)	(0.0296)	(0.0231)	(0.0477)	(0.0610)
S&P 500 return	1.659***	1.969***	1.929***	1.926***	2.491***	1.563***
	(0.223)	(0.209)	(0.245)	(0.179)	(0.274)	(0.422)
Constant	0.000246	0.000898	0.00297	0.00148	0.000614	0.00168
	(0.00203)	(0.00183)	(0.00191)	(0.00169)	(0.00232)	(0.00271)
Observations	107	107	105	107	107	107
R-squared	0.543	0.674	0.651	0.735	0.645	0.324

Panel B: Index	S&P Financial	Dow Jones	S&P Banks	S&P Select
Rate change	0.0168	0.0239	0.0362	0.00225
	(0.0221)	(0.0205)	(0.0368)	(0.0350)
S&P 500 return	1.564***	1.492***	1.565***	1.647***
	(0.152)	(0.115)	(0.246)	(0.176)
Constant	0.000604	0.00157	0.000848	0.000127
	(0.00108)	(0.00101)	(0.00175)	(0.00171)
Observations	107	107	107	69
R-squared	0.780	0.817	0.560	0.746

To provide for a larger sample, in Table 5 we relate bank equity returns and financial index returns to daily changes in two-year treasury bills during our sample period (1990-September 2017). Specifically, we estimate

$$r_{i,t} = a_i + \beta_i \Delta s_t + \gamma_t market_t + \Delta \epsilon_{i,t}$$

As expected, the market return is positive and a statistically and economically significant predictor of bank equity returns, as in Table 4. However, the coefficients on the impact of the two-year rate on bank equities and financial sector indices in the presence of the market return are in most cases near-zero and not statistically significant. The exception is Goldman Sachs and Morgan Stanley, where a 100 bp increase in the two-year rate increases returns by 1.75 and 1.17 percent respectively. For Wells Fargo, a 100 bp increase in the two-year rate *decreases* equity returns by 1.10 percent, a finding consistent with English et al. (2014). For most financial firms, there appears to be no evidence that increases in short term rates raise bank equity values substantially relative to other non-financial firms.

Our finding is closely related to that of Classens et al. (2017) and Genay and Podjasek (2014). Even when rates are low (and net interest margins thus compressed), banks appear to mitigate the effect on franchise value through other activities (i.e. cost-cutting or raising extra non-interest income). It is thus not surprising that rate increases fail to move equity values more for financial than non-financial firms. It is worth noting again that bank equity values have risen substantially since the election of President Trump, contemporaneously with rate hikes by the Federal Reserve. Viewed through the lens of our results, we believe it likely that the increases in bank equity values are more significantly tied to the market's belief that financial deregulation is on the horizon than to increases in the federal funds rate.

Table 5: Impact of Change in Two-Year Rates on Bank Equity Returns

Panel A: Bank	Bank of America	Citigroup	Goldman Sachs	JP Morgan	Morgan Stanley	Wells Fargo
Rate change	0.00588	0.0048	0.0117**	0.000066	0.0175***	-0.0110**
	-0.0116	-0.0236	-0.00499	-0.00414	-0.00567	-0.00445
S&P 500 return	1.609***	1.766***	1.420***	1.525***	1.895***	1.318***
	-0.0579	-0.118	-0.0219	-0.0207	-0.0284	-0.0222
Constant	-0.00137**	0.000938	0.000263	-0.000025	-0.00014	0.000003
	-0.00064	-0.0013	-0.00025	-0.00023	-0.00031	-0.00024
Observations	6,932	6,932	4,598	6,932	6,932	6,932
R-squared	0.104	0.0325	0.514	0.449	0.405	0.341

Panel B: Index	S&P Financial	Dow Jones	S&P Banks	S&P Select
Rate change	-0.00069	0.00245	-0.00122	0.0157***
	-0.00196	-0.00185	-0.00286	-0.00437
S&P 500 return	1.347***	1.319***	1.340***	1.416***
	-0.0098	-0.00916	-0.0143	-0.0185
Constant	-0.000064	0.000031	-0.000067	-0.000257
	-0.00011	-0.0001	-0.00016	-0.0002
Observations	6,932	6,431	6,932	3,566
R-squared	0.739	0.772	0.567	0.656

4 Market-based stress test approaches caution about bank health

In 2017, for the first time since annual stress tests for large banks began six years prior, all 34 of the nation's largest banks were deemed to have sufficient capital to weather a severely adverse shock.[5] Only one bank (Capital One Financial) was found to have any weakness in its capital position in the event of an adverse stress scenario, and even this did not precipitate a failing grade. Industry champions celebrated these stress test results and used this regulatory stamp of safety as ammunition to call for decreasing the intensity of the stress tests and of the financial regulatory regime more broadly: currently, the Senate is debating a bill with bipartisan support to end stress-testing for over two-thirds of the banks currently subject to the tests by raising the asset cutoff from $50 to $250 billion (Rappeport 2018).

To be sure, the Federal Reserve's "severely adverse stress" is a challenging state. Last year's scenario was characterized by a severe global recession even worse than the Great Recession—with unemployment more than doubling, rising by about 5.25 percentage points, to 10 percent, by the third quarter of 2018; equity prices falling by 50 percent through the end of 2017; house prices falling by 25 percent; and US GDP reaching a trough 6.25 percent below its pre-recession peak (Federal Reserve Board 2017). The stress test results suggest that on average, as a result of the severely adverse stress scenario, common tier 1 capital ratios for large banks would decline from 12.5 percent in Q4 2016 to a minimum of 9.2 percent, and loan losses would be only 5.8 percent. In response to the results, then Governor and soon-to-be Chair of the Federal Reserve Board Jerome Powell noted that "This year's results show that even during a severe recession, our large banks would remain well capitalized. This would allow them to lend throughout the economic cycle, and support households and businesses when times are tough" (Powell 2017).

The stress test methodology relies on regulatory capital ratios. Many have been critical of these ratios as a static and easily arbitraged measure of a bank's true capital position. There are various examples of the deficiency of these measures: Lehman was well-capitalized right before its bankruptcy—despite market indicators revealing distress, its Tier-1 capital ratio was 11.6 percent, higher than the average of the other large banks at the time (8.4 percent). More recently Deutsche Bank had a Tier-1 capital ratio of over 11 percent in February 2016, when its share price dropped by nearly 10 percent in a single day. At the time, CEO John Cryan pointed to the firm's "strong capital and risk position" in attempts to assure bank employees and investors that it was "rock-solid" despite market warnings of its instability (Cryan 2016).

One obvious way to stress the stress test results is to apply a more market-based approach to determine

[5] In this paper, we refer to the stress test as a single exercise. Technically, it comprises of two pieces: the CCAR (Comprehensive Capital Analysis and Review) and the DFAST (Dodd-Frank Act stress testing). They are coordinated jointly by the Federal Reserve (in hopes of reducing duplicative data collection) and aim to assess whether the largest bank holding companies in the United States (above $10B in assets) have sufficient capital to continue operations in event of a financial crisis. https://www.federalreserve.gov/supervisionreg/stress-tests-capital-planning.htm

what the market believes capital losses would look like in the event of the severe adverse stress scenario. In Table 6, we attempt this, providing a very rough market estimate. We compute an average beta for each bank (based on the five years prior to the 2017 stress tests) and use these betas to estimate capital losses if a 50% decline in equity values were to occur. Two important caveats must be raised about these estimates. First, we ignore the other aspects of the Fed's severe adverse stress scenario (i.e. the implications of more than doubling current unemployment and a 25% decline in the housing market, among other elements). Second, we assume that betas are constant throughout the adverse stress scenario, ignoring important issues about the dynamic measurement of capital, for example the fact that banks' assets become more volatile during downturns.

We use these historical bank betas and Q4 2016 tangible common equity reported by the six largest financial institutions in the US to calculate what a 50% decline in the stock market would do to the capital position of these firms.

We compute the tangible common equity that will remain after a 50% decline in the stock market as

$$(1 - \beta_i \times .5) \times TCE = TCE_{adverse}$$

Our market-based stressed TCE ratio is then

$$TCE_{adverse}/(RWA - \Delta TCE)$$

where

$$\Delta TCE = TCE - TCE_{adverse}$$

or how much tangible common equity is lost in the severe adverse stress scenario.

Table 6: Projected Decline in Common Equity Tier 1 Capital Ratio under Adverse Stress Scenario (50% decline in equity prices) vs. imputed decline from bank betas

Bank	Beta	2016 TCE Ratio	2016 RWA	2016 TCE	Adverse TCE	Market TCE Ratio	Stress TCE Ratio
Bank of America	1.63	12.1	1,399,477	169,337	31,016	2.3	8.9
Citigroup	1.65	14.9	1,126,314	167,821	29,157	2.7	9.7
Goldman Sachs	1.29	14.5	549,650	79,699	28,261	5.4	8.4
JP Morgan	1.37	12.5	1,464,981	183,123	57,367	4.1	9.1
Morgan Stanley	1.71	17.8	358,141	63,749	9,204	2.6	9.4
Wells Fargo	1.29	11.1	1,336,198	148,318	52,608	4.1	8.6
Average	*1.49*	*13.8*	*1,039,127*	*135,341*	*34,602*	*3.4*	*9.0*

Despite the fact that our naive market-based estimate is understated (ignoring the impact of the increase in unemployment, and the fact that beta will increase during crisis as bank assets like loans go from essentially debt claims to equity ones), we see a substantial difference in this market-based stress test approach relative

to the Fed's most recent stress test results. Particularly, the average common tier-1 equity capital ratio for these banks declines to 3.4 percent based on this market test, relative to the stress test's minimum TCE ratio of over 2x this amount (9 percent). This capital shortfall would result in a tangible common equity ratio well below the 4.5% trigger for "prompt corrective action" for all of these banks except for Goldman Sachs, and casts aspersions on the regulatory community's claims that the largest financial institutions would continue to function as normal in the event of a recession-like shock (OCC 2013).

In Table 7 below, we naively attempt to account for the fact that bank betas will increase during times of distress. We adjust beta upwards, so that after the first 25% decline in equity values, beta increases by 50%. This is a conservative estimate because we calculate the second 25% of equity losses based on the equity that remains after banks have experienced the initial downturn. Even in this conservative case, market-stressed tangible common equity ratios average 3.7%, again well below the 4.5% trigger for prompt corrective action.

Table 7: Projected decline in common equity tier 1 capital ratio under adverse stress scenario (50% decline in equity prices) vs. imputed decline from bank betas

Bank	Beta 1	Beta 2	2016 TCE	TCE 25%	TCE 50%	Market TCE Ratio	Stress TCE Ratio
Bank of America	1.63	2.45	169,337	100,177	38,806	2.9	8.9
Citigroup	1.65	2.48	167,821	98,489	37,456	3.4	9.7
Goldman Sachs	1.29	1.94	79,699	53,980	27,851	5.3	8.4
JP Morgan	1.37	2.06	183,123	120,245	58,313	4.1	9.1
Morgan Stanley	1.71	2.57	63,749	36,477	13,069	3.8	9.4
Wells Fargo	1.29	1.94	148,318	100,463	51,841	4.0	8.6
Average	*1.49*	*2.24*	*135,341*	*84,857*	*37,378*	*3.7*	*9.0*

A less conservative approach would be to decrease pre-stress bank equity by 25% at the initial beta, and then an additional 25% at the heightened beta. So, banks would be left with:

$$TCE_{adverse} = TCE_{2016} - (.25 \times \beta_1 \times TCE_{2016}) - (.25 \times \beta_2 \times TCE_{2016})$$

Using this approach, losses would be much more dramatic; in fact, Bank of America, Citigroup, and Morgan Stanley would reach negative equity values during the adverse stress scenario.

It is helpful given our focus on market-based measures to compare the performance of mark-to-market firms like Goldman Sachs and Morgan Stanley under the current stress test regime to traditional commercial banks that do not mark the vast majority of their assets to market values. In Table 8, we do just this. Using the stress test results for the largest banks (the "advanced approaches" firms: bank holding companies with assets greater than $250B or total foreign exposure of at least $10B), we compare projected declines in common equity tier 1 capital ratios for the mark-to-market firms to their non-mark-to-market counterparts. Perhaps unsurprisingly, the mark-to-market firms perform worst in the adverse stress scenario: Goldman Sachs and Morgan Stanley experience a 42 and 47 percent decline in their capital position, significantly higher than the losses for any of the other advanced approaches firms, including Wells Fargo (22.5 percent), JP Morgan (27.2 percent), Bank of America (26.5 percent), and Citigroup (34.9 percent). Relatedly, these mark-to-market firms tend to recover more significantly by the end of the stress scenario (common equity Tier 1 is 35.2 percent and 37.6 percent below Q4 2016 levels for Goldman and Morgan Stanley) relative to much more minimal gains for the non-mark-to-market firms (Bank of America is in the same capital position at the trough of the adverse stress scenario and the end of the period, JP Morgan and Wells Fargo recover less than 2 percent of losses).

Table 8: Common Equity Tier 1, Actual and Projected at Minimum and End of Adverse Stress Scenario

	Actual Q4 2016	**Ending**	**Minimum**	**% Loss to Ending**	**% Loss to Minimum**
Northern Trust	11.8	11	10.9	6.8%	7.6%
Bank of New York Mellon	12.3	12.8	11.2	+4.1%	8.9%
American Express	12.3	10.8	10.6	12.2%	13.8%
TD Group	13.6	11.9	11.3	12.5%	16.9%
US Banccorp	9.4	7.6	7.6	19.1%	19.1%
Wells Fargo	11.1	8.8	8.6	20.7%	22.5%
PNC Financial	10.6	8.3	8	21.7%	24.5%
Bank of America	12.1	8.9	8.9	26.4%	26.4%
JP Morgan	12.5	9.3	9.1	25.6%	27.2%
HSBC Bank	17.9	12.9	12.9	27.9%	27.9%
Capital One	10.1	7.0	7.0	30.7%	30.7%
Citigroup	14.9	10.8	9.7	27.5%	34.9%
State Street	11.6	8.7	7.4	25.0%	36.2%
Goldman Sachs	14.5	9.4	8.4	35.2%	42.1%
Morgan Stanley	17.8	11.1	9.4	37.6%	47.2%

Combined, these two insights: (1) that a naive market based approach results in capital losses that are over twice as severe as recent stress test results and (2) that mark-to-market firms perform worse on these regulatory stress tests, though they recover more quickly than their non-mark-to-market counterparts; suggest that jubilation over large financial instiutions' stress test performance may be misplaced. The stress tests provide an overly optimistic view of how banks will perform in the next recession-like event, and an

(admittedly naive) market-based approach raises significant cause for concern. The fact that the few trading firms that mark a larger share of their assets to market perform worse on the stress tests should caution that if market information were properly incorporated into the stress test exercise, non-mark-to-market commercial banks would appear significantly worse off in the adverse stress scenario. Bulow (2016) makes this point. He notes that because of "no move to mark to market accounting" and stress tests that "explicitly fail" to take into account market values, the current system does not force banks to respond quickly to signs of distress. Unlike commercial banks, trading firms that mark to market are forced to adjust capital requirements daily. This dynamic adjustment "[makes] their positions safer even with relatively smaller capital margins" (Bulow 2016).

5 Critiques of the stress test and suggestions for improvement

We are not alone in our concern that the current stress test methodology is ill-suited to gauge banks' ability to survive the next downturn. Commenting on the 2016 results, Jeremy Bulow (2016) questions whether the estimates of capital losses (of about 4 percent of assets in 2016, and even lower in the most recent stress tests, around 3.3 percent of assets) are "a comment on banks, or on the stress tests." Sheila Bair, former Chair of the Federal Deposit Insurance Corporation (FDIC) concurs, suggesting that it is would be "hubris for the Fed to believe it has found a magic formula that will predict with accuracy how any of the big banks will truly perform in the next downturn" and "if the purpose of this exercise is to prove big banks have sufficient capital to keep functioning during a crisis without government support, I would say many of them still have some way to go." Kevin Dowd remarked recently that although the purpose of the stress testing program should be to highlight the vulnerability of the banking system and help rebuild it, instead "it has achieved the exact opposite, portraying a weak banking system as strong. This is like having a ship radar system that cannot detect an iceberg in plain view." He points out to variety of modeling errors (the understatement of fat tails and non-linearities, the inability to capture amplification effects, and the ignorance of firesale externalities that are created once distressed financial institutions are forced into asset sales) that reduce his confidence in the stress test results: "everywhere you look, the Fed now seems to be bending the rules in the banks' favor. This stress test appears to be a test that has been designed to be passed."

There are many methodological flaws with the stress test design—they consider only one adverse scenario; they are too "orderly," failing to factor in the contagion effects associated with financial crises and the impact a financial crisis can have on other sectors; and they have become predictable to banks, and thus easy to

game. But perhaps the most troubling aspect of the tests, highlighted by several observers, is their reliance on static, overly complicated, and often unreliable regulatory measures of capital (Bulow and Klemperer 2013, 2015), Haldane and Madouros (2012), Vestergaard and Retana (2013). Paul Singer, who runs the investment fund Elliot Associates, wrote that "there is no major financial institution today whose financial statements provide a meaningful clue about its risks" (Partnoy and Eisinger 2013). Illustrating this point, Haldane (2014) considers a straight horse-race between the most complex measure of a banks' capital position (the Basel Tier-1 ratio) and the simplest market measure (the market value of equity relative to unweighted assets) and finds that the ability of the simple measure to predict bank distress is about 10 times greater than the complex measure.

This is an unfortunate given that the stress tests are an important means of ascertaining bank health and forcing financial institutions to respond promptly to signs of distress. Credible stress testing can be an important capital management tool, since the stigma attached to failure and the rejection of a bank's plan for capital disbursement is likely sufficient to spur under-capitalized banks into action (Goldstein 2017). Here in the US we have observed the power of a well-designed stress test: the first stress test (the Supervisory Capital Assessment Program, or SCAP), contributed significantly to the containment of the crisis. It was of course different than stress tests that followed because it stressed against a live recession, as opposed to a hypothetical tail event. But it is difficult to understand why its general framework—a mark-to-market accounting exercise that forced recapitalization of under-capitalized banks—cannot be more closely replicated by stress tests during normal times. Several authors have proposed more market-based approaches to the stress tests to improve their credibility, which we discuss briefly below.

5.1 Proposed market-based solutions

Bulow and Klemperer (2013) point out that both the numerator and denominator of bank equity ratios are subject to manipulation. Bank equity levels are easily gamed because different banks use significantly different valuations for identical assets (the authors highlight on extreme case—at the end of 2008, the insolvent Royal Bank of Scotland reported the second-highest total capital ratio of the largest UK banks) and risk-weighted assets require regulators to rely on ratings agencies and banks' internal models. The authors point out that the result of the current regulatory system is to create incentives to avoid loss recognition; and the risk weights dictate which businesses banks will participate in: said Jamie Dimon, the CEO of JP Morgan, in response to the Basel II regime "yes, we're going to manage the hell out of RWA." The Bulow and Klemperer (2013) approach, though very detailed, relies on a basic principle: "we rely on markets to determine banks' capital requirements, much as they determine the capital requirements of banks' customers. Most important, using market information yields simple, clear rules...rules that are independent

of organization form and avoid regulatory arbitrage."

In the Bulow and Klemperer (2013) solution, market-based capital regulation does not mean a reliance on the market price of a particular financial institution. Instead, the authors propose determining capital requirements by stressing each class of assets to ascertain how much an individual in the market who does not have a government guarantee would lend against that asset if their only recourse is to that asset and equity in the firm, as opposed to a claim that may force the firm into bankruptcy. The capital requirement for the asset would then be determined as $p - b$, where p is the price of the asset and b is the amount that an firm could borrow by making a non-recourse loan against that asset.

The benefits of this system are several: first, if implemented correctly, it would avoid costly government bailouts entirely: the value of bank assets above and beyond the equity capital they hold would be in the form of non-recourse debt claims, so there would be no way for institutions to be pushed into costly bankruptcy. It would also free regulators from having to determine what the appropriate value or risk-weights are for bank assets: this task could be left to the market. A challenge is the fact that liquid markets do not exist for many classes of bank assets, though Bulow and Klemperer (2013) suggest that a benefit of their approach is that it creates incentives to develop more liquid markets for borrowing, even against illiquid assets, as opposed to the current system, where "banks may sometimes prefer that assets be treated as illiquid so there is greater discretion in valuation."

Acharya et al. (2014) propose a market-based stress test fairly similar in spirit to our naive approach above, building on Acharya et al. (2010) and Brownlees and Engle (2011). Their stress scenario of interest is a 40% decline in the global stock market over a six-month period. Their measure of capital shortfall (Long-Run Marginal Expected Shortfall, or LMRES) captures the (historical) co-movement of a firm with the market, and uses this beta to ascertain the decline in a firm's market capitalization as a result of the stress scenario. Assuming that debt is unchanged over this six month period, while equity falls by LMRES$\times$Market Capitalization, the authors compute their systemic risk measure (SRISK) as the amount of capital an institution would need to raise in the event of crisis. Comparing their results to the widely criticized regulatory stress tests in Europe in 2011, the authors find their measure uncorrelated with the regulatory stress test results, and unlike the stress tests, a significant predictor of realized losses during the sovereign debt crisis of 2011. Acharya and Steffen (2013) propose an alternative means of measuring bank equities' sensitivity to market downturns: the marginal expected shortfall (MES), which measures bank performance when the market experiences its worst 5% trading days over a one-year period. The authors advocate for using this tail-event sensitivity to estimate the impact of a substantial decline in the market on bank capital positions. And more recently Acharya and Steffen (2014) (see also Steffen (2014)) propose yet another approach to stress market-based capital ratios without relying on historical episodes.

In his recent book *Banking's Final Exam,* Morris Goldstein lays out clearly the issues with the current stress test regime and proposes a way forward to ensure that the tests provide credible information about the safety of the banking sector and warnings of imminent distress. His approach is what he refers to as an "eclectic indicator" approach that takes both book value (in the form of the simple, non-risk based leverage ratio) and market value into account. To incorporate the latter, he proposes that risk-based capital measures be replaced with a "risk surcharge" that take into account, among other elements, "market-based measures of bank health (e.g., contingent claim analysis of distance to default, [and] leverage ratios that depend on market capitalization rather than book values)." The consolidation of several bank-capital standards into a single standard is similar to the approach advocated by Greenwood et al. (2017) (although these authors believe there is a role for risk-weighting in the single regulatory capital ratio). Also like Goldstein, these authors believe there is a role for market information in stress testing exercises ("the current system, which has no real role for market-based information, is...far from optimal in this regard), though do not advocate for a fully market-based approach.[6] We too believe that a combination of market-based and non-market-based indicators should be the way forward for the stress tests. Like current reliance on non-market indicators in isolation, reliance on only market-based signals of bank health would have adverse consequences. A market measure of bank health is pro-cyclical: when equity markets are doing well, it will reveal little cause for concern, despite risk possibly building up in the financial sector.

6 Conclusion

The 2017 stress tests stressed banks against a terrifying adverse stress scenario: more than doubling of the unemployment rate to 10%, a decrease in GDP significantly worse than that experienced in the Great Recession, and a 50% decline in US equity values. Each of the 34 stressed institutions achieved a passing grade, paving the way for share buybacks and dividend payments. Federal Reserve estimates suggest that in event of such a scenario, banks will remain well-capitalized, with the largest banks' tangible common equity ratios falling to a minimum of 9 percent. Many in the regulatory community interpret recent stress test results as a sign of the financial sector's resiliency: Federal Reserve Chairwoman Janet Yellen believes it unlikely we will witness another financial crisis in our lifetimes, future Chairman Jerome Powell stated that

[6]Specifically, the authors "propose that whenever the Fed designs a CCAR stress scenario, it should be publicly accountable after the fact to explain how its assumptions for loan losses and other outcomes can be reconciled with the information in bank stock prices and credit-default-swap (CDS) spreads—particularly at times when these market prices are sending off pessimistic signals. We have in mind...the period from early 2007 to mid-2008, when bank stocks fell by about 50%. If a CCAR adverse scenario is being drawn up in a mid-2008 like environment, it seems hard to argue that it shouldn't take on board the growing market skepticism about the state of bank balance sheets. Moreover, doing so should serve to heighten the pressure on regulators to push for a rapid recapitalization of the banking system. We recognize that any market indicator can be driven by noise as well as news, and so we do not advocate for a mechanical rule tying marker prices to CCAR assumptions or to recapitalization requirements.

the results suggest that even during a severe recession, banks would remain well-capitalized and be able to continue financial intermediation without government intervention. Mark Carney has made essentially the same proclamation in the UK, arguing that capital holdings are ten times that of their pre-recession levels, so "this substantial capital and huge liquidity gives banks the flexibility they need to continue to lend to U.K. businesses and households, even during challenging times."

We believe it is highly unlikely that the 34 largest financial institutions in the United States would show no signs of distress if in the next year unemployment reached 10% and the stock market fell by 50%. The fact that all of these firms were stressed and deemed to remain "well-capitalized" in event of such a scenario reflects the deficiencies of the stress tests, not the health of the financial sector. Market measures (like price-to-book ratios and the ratio of market value of banks' equity/assets) reveal that banks are as risky today as they were in the pre-crisis era. This does not appear to be a byproduct of the current low interest rate environment, and suggests that declining bank profitability will remain a concern for financial stability even as interest rates rise. The divergence between the market perception of bank stability and the stress test results raises significant concern for the credibility of the stress test exercise and should caution against regulatory complacency.

At the onset of the Great Recession, policymakers failed to force large banks to recapitalize, or even to end large transfers of wealth to equity holders (in the form of share repurchases and dividend payments), despite market signals making clear that these firms were in distress. If the goal of the stress test is to prevent such a misstep at the onset of the next recession, in their current state they appear ill-suited for this task. A reform of the stress test methodology that places a much greater emphasis on market valuation of bank assets, perhaps similar in design to Bulow and Klemperer (2013) or Acharya et al. (2014) would be a positive step. Relatedly, an emphasis on accounting rules that encourage firms to mark their asset valuations to market values will help regulators reliably gauge bank health. We believe there is need for more work—from both the academic and policy-making community—on how best to design the financial regulatory regime to take into account market information about banks' risk.

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