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Jose M. Berrospide and Rochelle M. Edge

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The Effects of Bank Capital Buffers on Bank Lending and Firm Activity: What Can We Learn from Five Years of Stress-Test Results?*

Jose M. Berrospide* — **Federal Reserve Board**

Rochelle M. Edge* — **Federal Reserve Board**

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Abstract

We use bank-firm matched data from regulatory filings (FR Y-14) to study how the capital buffers that large U.S. banks must satisfy to "pass" the quantitative component of the Federal Reserve's CCAR stress tests impact banks' C&I lending and firms' C&I loan volumes, overall debt, investment spending, and employment. We find that larger stress-test capital buffers lead to material reductions in bank C&I lending. A 1 p.p. larger capital buffer results in a 2 p.p. lower (four-quarter) growth rate of utilized loans and a 1½ p.p. lower growth rate of committed loans. The effects on firm loan volumes are larger, when we look at the loans that firms obtain from banks subject to stress tests. A firm that borrows from banks that on a weighted-average basis face a 1 p.p. larger stress-test capital buffer, experiences a 4 p.p. lower rate of growth in utilized loans and a 3 p.p. lower rate of growth of committed credit lines. However, when we consider firms' overall debt volumes we find no impact of higher stress-test capital buffers, suggesting that firms can find other sources of credit to substitute for the reduction in loans that they face from banks subject to stress tests. We also find that firm investment and employment are largely unaffected by the capital buffers implied by stress tests. Because in the U.S. the consequences for banks of not meeting their stress-test capital buffers are similar to those of not satisfying an activated countercyclical capital buffer (CCyB), our findings are informative for the effects of the CCyB. Our results suggest that activating the CCyB in the U.S. would likely reduce the lending of the banks to which the CCyB applies, but would likely not impact the overall debt volumes, investment, and employment of the firms that borrow from these banks.

JEL classification: G21, G28

Keywords: bank capital, bank lending, regulatory capital

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1. Introduction

The regulatory capital reforms implemented in response to the 2007-2009 global financial crisis have reignited the early 1990s (post-Basel I) debate on the implications of higher bank capital requirements on bank lending and real activity. While there is broad consensus that post-crisis capital reforms have increased the quantity and quality of bank capital; the risk coverage of bank capital; and, thereby, the resilience of the banking sector, the costs of such reforms in the form of reduced bank lending and restrained real activity remain an open question.[1] This paper revisits this question. Specifically, this paper studies how the capital buffers that large U.S. bank holding companies (henceforth banks) must satisfy, in practice, to "pass" the quantitative component of the Federal Reserve's Comprehensive Capital Analysis and Review (CCAR) stress tests impact banks' commercial and industrial (C&I) lending and firms' C&I loan volumes, overall debt volumes, investment spending, and employment.

The bank-specific capital buffers implied by CCAR represent buffers that would allow banks to face a prolonged period of severe stress, to face sizable realized losses, and to experience large declines in regulatory capital ratios, but would still leave banks with capital levels above minimum requirements and, therefore, healthy enough to continue to intermediate credit. These bank-specific capital buffers reflect an important enhancement to the post-crisis capital regime in that they require banks to have sufficient capital buffers to cover their *forward-looking risks* and still meet minimum capital requirements. To be sure, the CCAR stress tests and the capital buffers they imply are only one component of the strengthened capital requirements faced by large U.S. banks in the post-crisis world. For example, large banks that are considered to be globally, systemically important banks (that is, GSIBs) also face a quantitative risk-based capital surcharge (the so-called GSIB surcharge) and large U.S. banks – as indeed do all banks – also face strengthened capital requirements stemming from the implementation of Basel III capital standards. That said, for large U.S. banks – and particularly over the 2012 to 2016 period that we used for our analysis – the CCAR stress tests and the capital buffers that they imply were typically the most binding capital standard.[2]

[1] See the Federal Reserve Board's November 2018 *Financial Stability Report* for an articulation of the view that the post-crisis capital reforms have increased the resilience of the banking sector (https://www.federalreserve.gov/publications/files/financial-stability-report-201811.pdf)

[2] We would note that under current CCAR stress testing regulations the bank-specific capital buffers that we characterize as being implied by CCAR are *de facto* capital buffers. That is, these buffers reflect the requirement in CCAR that banks maintain capital at levels that would allow them to face severe stress and experience large declines in their regulatory capital ratios but still maintain capital levels above minimum requirements. They do not reflect the implementation of a buffer of any amount through any existing CCAR regulations. This situation is in contrast to buffers like the capital conservation buffer or GSIB surcharge, which are implemented by regulations and, as such, are *de jure* buffers. In our discussion of the various capital buffers that exist in the post-crisis regulatory world, we do not repeatedly specify whether these buffers are *de facto* or *de jure* buffers, because for the purpose of our empirical analysis, this distinction in the nature of buffers has no implications

Our approaches for studying the implications of stress-test capital buffers on banks' C&I lending and firms' C&I loan volumes, overall debt volumes, investment spending, and employment differ slightly depending on the variable in question, although our principal dataset is the same throughout. For examining the impact of higher stress-test capital buffers on bank lending we use data on banks' commercial and industrial (C&I) loans, where an observation in this dataset is the quantity of loans matched to a specific (lending) bank and a specific (borrowing) firm. This data is from the FR Y-14 quarterly regulatory reports filed by the 30 or so bank holding companies subject to the Federal Reserve Board's CCAR exercise on their C&I loan portfolios, which means that these data are collected for the banks that currently participate in the stress tests and have material C&I loan portfolios. In CCAR 2012 and CCAR 2013, the first two publicly-released post-crisis stress tests (both of which are considered in our analysis), 18 bank holding companies – specifically, those with assets greater than $100 billion – participated in the stress tests and of these 16 bank holding companies had material C&I loan portfolios. Since CCAR 2014, 33 bank holding companies – specifically, those with assets greater than $50 billion – have participate in the stress tests and of these 31 bank holding companies have had material C&I loan portfolios. However, we use the smaller set of 16 bank holding companies in our analysis, because they have been in CCAR for all of the five stress-test cycles – that is, 2012 to 2016 – that we use in our panel analysis. This smaller set of 16 bank holding companies accounts for about 66 percent of total banks C&I loans, which is only a little less than the 80 percent of total banks C&I loans accounted for by the larger set of 31 bank holding companies.[3]

Our analysis stops in 2016 largely because of Basel III capital buffers – specifically, the constant capital conservation buffer and the GSIB surcharge – starting to be phased-in in that year.[4] These additional buffers, which are distinct from the buffers implied by CCAR but exist alongside them, present some complications in studying the effects of stress-test capital buffers, since these buffers rather than stress-test capital buffers can be the ones that bind. That said, until 2016 the chances of this happening is quite small given that only one-fourth of these buffers' full amounts were phased-in in 2016. In 2017 and beyond the chances of this happening is much more significant and for this reason we stopped our analysis in 2016.

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[3] In October 2018, the Federal Reserve Board issued for public comment a framework to sort banks into categories that depend on their level of risk and to tailor the regulations that apply to each category of bank. (See the press release at https://www.federalreserve.gov/newsevents/pressreleases/bcreg20181031a.htm.) If adopted, this proposed rule would result in a fewer number of bank holding companies than at present being subjected to CCAR data reporting requirements, although this number would be similar to the number we use in our analysis. These banks would be subject to stress tests at the two-year frequency, while a smaller number of banks would be subject to stress test at the one-year frequency. As of the time of writing, the comment period for this proposed rule had closed, although no final rule had been released.

[4] The maximum allowable size of the Basel III CCyB also started to be phased-in in 2016, although because it was not activated it does not present any complications for our analysis.

Using loan data matched to a specific bank and a specific firm allows us to overcome the typical identification concern associated with disentangling supply- from demand-driven changes in lending. That is, using these data we are able to isolate the impact of higher stress-test capital buffers by controlling for loan demand at the firm level. We do this following an approach similar to Khwaja and Mian (2008), which relies on firms that borrow from multiple banks and within-firm loan-growth comparisons across banks. That is, we examine how loan growth for the same firm differs between banks given differences in the sizes of these banks' stress-test capital buffers and we perform this analysis as a panel for stress-test years extending from 2012 to 2016. For our approach, we follow Bertrand, Duflo, and Mullainathan (2004), and collapse our data into a single pre-treatment and single post-treatment and define loan growth as the percent difference between the average volume of loans in the three quarters before and three quarters after the quarter in which the stress test buffers become known.

We find a negative and significant effect of changes in stress-test capital buffers on loan growth. Specifically, a 1 percentage point higher stress-test capital buffer, measured in terms of the CET1 capital ratio, results in a roughly 2 percentage point lower growth rate of utilized loans and a 1½ percentage point lower growth rate of committed loans. Given that in our sample of firm-bank matched loans, the average growth rate of a utilized loan is 5 percent and that for a committed loan is 4¾ percent, these effects are material. That said, with the average CET1 capital ratio across banks being about 10¾ percent, if banks were to reduce their risk weighted assets and loans to meet the higher capital ratios implied by higher capital buffers then a 1 percentage point higher stress-test capital buffer would imply a 8½ percent reduction in loan growth. Our results suggest a reduction in loan growth about half the size of this amount.

Using our matched bank-firm analysis, we also consider the consequences of banks having higher equity capital ratios on bank lending. Consistent with previous findings in the bank capital literature, we find positive and significant effects of bank capital ratios on lending, suggesting that banks with higher capital ratios lend more. Specifically, we find that a 1 percentage point higher equity capital ratio implies a 5½ percentage point higher rate of bank loan growth, both in terms of utilized and committed credit amounts. The positive effect of equity capital on loan growth is larger than the negative effect associated with the capital buffer, which points to a positive overall effect on loan growth as a result of post-crisis regulations that require higher capital levels.

From the firm's perspective, the effects of higher stress-test capital buffers on loan volumes also seem material when we confine ourselves to looking only at the volume of loans that firms obtain from banks subject to stress tests. We take our individual loan-level data and for each firm aggregate loans across the 16 banks in our sample to obtain for each quarter the volume of the firms' utilized loans and the volume of their committed loans. We also construct a weighted average of the stress-test capital-ratio declines faced by each bank from which the firm borrows, which captures the exposure of each firm to stress-test capital buffers. We then consider the effects of this firm-level stress-tests exposure variable on firm loan growth, where, as with the other regressions, we use the growth rate for average volume of loans in the three quarters before and after the quarter in which the stress-test results are released as our dependent variable. Here we find that a firm that borrows from banks that lead it to face, on a weighted-average basis, a 1 percentage point higher stress-test capital buffers, experiences a roughly 4 percentage point lower rate of growth in utilized loans and a roughly 3 percentage point lower rate of growth of committed lines of credit. Given that in our regressions the average growth rate across firms for their utilized loan volumes is about 8 percent while for their committed loan volumes the amount is about 7 percent, these effects are material. That said – and as noted above – since the average CET1 capital ratio across banks is 10¾ percent, the reduction in firm loan growth that we find is about two to three times smaller than the reduction that would be implied by banks reducing their assets to satisfy the higher capital ratios implied by higher capital buffers.

The FR Y-14 data that we use for our analysis also provides for each loan accompanying firm balance sheet and expenditure information. This data allows us to study the effects of stress-test capital buffers on firm outcomes, such as overall debt volumes and investment spending. For this analysis, we again use firms' exposures to the stress-test capital buffers – calculated using the weighted average of the stress-test capital-ratio declines faced by each bank from which the firm borrows – and we consider how this variable affects firm overall debt growth and investment spending. For both of these firm variables we find essentially no impact of higher stress-test capital buffers. Firm employment is another key firm outcome of interest, although, in this case, the FR Y-14 data does not contain information on this variable. To gauge the impact of capital buffers on employment, therefore, we match firm headquarter locations in the FR Y-14 data with county-level employment and constructed a weighted average of the stress-test capital-ratio declines faced by each bank lending to firms in specific counties as a measure of the county exposure to the stress-test capital buffers. We then consider how this variable affects firm employment at the county level. Here we again find no impact of higher stress-test capital buffers on employment.

In order to check for the robustness of our results, we re-estimate our firm outcome regressions using COMPUSTAT instead of FR Y-14 as the source for firm outcomes variables of debt volumes, investment spending, and employment. This alternative data source implies a smaller set of firms (that is about 3000 publicly traded firms only) but still we find no impact of higher stress-test capital buffers. These results suggest that while firm borrowing from banks subject to stress tests are impacted by stress-test capital buffers, firms have some scope to substitute to other sources of funding and, as such, their overall borrowing and, in turn, their investment spending and hiring is not restrained.

Our paper is related to several strands of the empirical literature that studies the relationship between bank capital and bank lending. For example, our paper is related to the literature that studies the impact of *changes* in bank capital levels or in capital requirements on lending (including, Peek and Rosengreen 1997, Calem and Rob 1999, Gambacorta and Mistrulli 2004, Aiyar, Calomiris, and Wieladek 2014, Mésonnier and Monks 2015, and Gropp, Mosk, Ongena, and Wix 2016, Fraisse, Lé, and Thesmar 2017). Our paper is particularly close to those that study the impact using loan level data (including, Puri, Rocholl, and Steffan 2011, Rice and Rose 2016, Jimenez, Ongena, Peydro, and Saurina 2017, Lambertini and Mukherjee 2016, Calem, Correa, and Lee 2017). In general, this research finds that a 1 p.p. reduction in capital levels or increase in minimum capital requirements reduces bank loan growth, with estimates of the negative impact ranging between 1 to 25 percentage points, albeit with most estimates lying in the lower part of this range. Our findings of a lending reduction in C&I lending of about 2 percentage points is within the range of previous estimates.

Our paper is also related to the literature that considers the impact of the *level* of bank capital on lending (including, Bernanke and Lown 1999, Hancock and Wilcox 1993, Francis and Osborne 2009, Berrospide and Edge 2010, and Carlson, Shan, and Warusawitharana 2013). These papers find a positive relationship between bank capital ratios and lending, though estimates of the size of the effect vary over time and across countries (for example, they find sizable effects for U.S. banks in the early 1990s but modest effects more recently). Our findings of a positive effect of bank capital on lending is consistent with this strand of the literature, but suggest a larger effect of capital during the post-financial crisis period.

Additionally, our paper is related to the literature that studies the effects of stress tests on bank lending as well as other types of bank behavior. With regard to the literature on bank lending, Connolly (2018) examines the effects of the 2009 U.S. bank stress tests (SCAP) on bank syndicated lending and finds that loans from non-tested foreign banks substituted for the reduction in credit from CCAR-tested domestic banks. Also in this literature Cortes, Demyanyk, Li, Loutskina, and Strahan (2018) study the effects of stress tests on the volume and rates charged on small business loans and find that geographic location – and whether the stress tested bank has a branch in that locations – matters for whether credit supply is cut bank. With regard to the literature considering other types of bank behavior, the empirical findings for considering bank risk-taking are quite mixed. Some papers find that banks subject to stress tests cut their credit supply to better manage their risks (Acharya, Berger and Roman 2017, Pierret and Steri 2018), while others find no additional effects on bank lending associated with the larger severity of supervisory stress tests relative to banks' own stress tests (Bassett and Berrospide 2018). Some papers in this latter literature consider bank-modeling practices and, in particular, find that banks may strategically and systematically adjust their internal models to smooth the losses in the stress tests (Niepmann and Stebunovs 2018).

While studying the effects of stress-test capital buffers on bank lending and firm borrowing, investment, and employment is of interest in its own right, it is worth noting that our analysis also provides insights as to the potential effects on bank lending and the macroeconomy of the Basel III countercyclical capital buffer (CCyB). The CCyB is a very new time-varying macroprudential policy tool that has just started to be activated by a number of countries and for which there is little empirical evidence as to its effects. In this regard, our paper – which uses insights from the experiences of the U.S. with stress-test capital buffers to consider the effects of the CCyB on bank lending and firm activity – is similar to the paper of Jimenez *et al*. (2017) – which uses insights from Spain's experiences with dynamic provisioning to inform the effects of the CCyB. The CCyB and the capital buffers implied by stress tests are, however, much more similar to each other than the CCyB is to dynamic provisioning. For example, the CCyB and the bank-specific capital buffer implied by stress tests both supplement minimum capital ratios by time varying amounts and both apply to common-equity tier 1 capital. In contrast, dynamic provisioning applies to tier 2 capital and deducts from bank earnings, which the CCyB and capital buffer implied by stress test do not. To the extent that banks are more concerned about their reported earnings, which may be a more visible measure of their performance, than how much of their capital they can distribute, they could respond differently to dynamic provisioning than they do the CCyB or stress-test capital buffers. Additionally, a bank's rate of loan growth enters directly the Bank of Spain's formula for calculating the bank's general countercyclical provision requirements.[5] This direct influence of loan growth on provisions, because it provides a way for banks to reduce their provisions, could induce more sizable reductions in loan growth in response to an increase in provisions. Indeed, the estimates obtained by Jimenez *et al*. (2017) for the amount by which bank loan growth responds to an increase in capital – in this case tier 2 capital – is very large and an outlier for the literature. Given the greater similarities between the CCyB and the capital buffers implied by stress tests relative to the CCyB and dynamic provisioning, we consider that the estimates that we obtain from our analysis and likely provide a better guide as to the effects of the CCyB

To be sure, however, there are differences between the CCyB and the capital buffers implied by stress tests. One important difference lies in how the size of the CCyB and of the capital buffer implied by CCAR are determined. (The Appendix discussed these differences in detail.) The CCyB depends on what level (between 0 percent and 2.5 percent) policymakers decide to set it at for all of the banks to which the CCyB is

[5] More specifically, in the Bank of Spain's formula total provisions are the sum of specific and general provisions. Specific provisions equal to the level of provisions implied by non-performing loans while general provisions are given by $\alpha \cdot \Delta Loans_t + (\beta - (Specific\ Provisions_t / Loans_t))Loans_t$. Notably general provisions are proportional to the increase in the loan portfolio and the amount that the current ratio of specific provisions to loans are below the average for that of the last credit cycle.

applicable, given policymakers' framework for determining the CCyB.[6] A bank's CCAR capital buffer depends on the scenario in the stress test; the exposure of the bank to the adverse developments that occur in the scenario; and the calculated or *pro forma* amounts that the bank's capital-ratio declines in the stress tests, because these declines affect how much capital a bank must, in turn, fund itself with. Under current regulations, the consequences of not meeting CCAR-implied buffers and the CCyB are similar, in that they imply limitations in the distribution of bank profits, rather than the more serious outcomes that would occur if bank capital ratios were to not only not satisfy buffers but to also not satisfy minimum regulatory requirements.[7] Interestingly, under proposed regulations (specifically, under a proposed rule referred to as the stress capital buffer, SCB, proposal), the consequences of not meeting these buffers, which would still be limitations in the distribution of bank profits in the form of capital distributions and discretionary bonuses, would be the same.[8] Note also, that the banks that must satisfy CCAR capital buffers (currently, bank holding companies with more than $50 billion in assets) encompass the U.S. banks that are currently subject to the CCyB (that is, bank holding companies with more than $250 billion in assets or more than $10 billion in on-balance-sheet foreign exposures) and would be subject under proposed rule (that is, bank holding companies with more than $250 billion in assets).[9]

The paper is organized as follows. Section 2 explains our empirical strategy for examining the effects of stress-test capital buffers on bank lending. Section 3 discusses the data that we use for this analysis. Section 4 presents our empirical results on the effects of stress-test capital buffers on bank lending using two approaches: one that looks at the bank-firm matched data and one that looks at the data aggregated to the firm level to study the impact of the stress tests capital buffers on firm bank borrowing, overall debt and firm investment spending. It also discusses our results on the impact on county-level employment, and at the same time discusses any additional data that we use. Finally, in section 5, we conclude by reviewing our findings

[6] The Federal Reserve Board's framework for determining the setting of the CCyB was published in September 2016. For details, see: https://www.federalreserve.gov/newsevents/pressreleases/bcreg20160908b.htm.

[7] Note that currently not satisfying the CCyB also places restrictions on capital distributions and discretionary bonuses according to a formula, while not satisfying the buffers implied by stress tests results in banks not receiving a non-objection to their capital plans by the Federal Reserve Board.

[8] In April 2018, the Federal Reserve Board released for public comment a proposal to simplify its capital rules for large banks. This proposal included a firm-specific stress capital buffer (SCB), which would in part integrate the forward-looking stress test results with the Board's non-stress capital requirements. Such a buffer would be a *de jure* buffer. For details, see https://www.federalreserve.gov/newsevents/pressreleases/bcreg20180410a.htm.

[9] As discussed in an earlier footnote, in October 2018, the Federal Reserve Board issued for public comment a framework to sort banks into categories that depend on their level of risk and to tailor the regulations that apply to each category of bank. If adopted, this proposed rule would result in the CCyB applying to a fewer number of bank holding companies than at present. Specifically, the CCyB would no longer apply to bank holding companies with more than $10 billion in on-balance-sheet foreign exposures. As of the time of writing, the comment period for this proposed rule had closed, although no final rule had been released.

Note also that the CCyB is a *de jure* buffer while the capital buffers implied by stress tests are *de facto* buffers, although as already noted this does not affect our empirical analysis. Interestingly, also, under the SCB proposal, both the CCyB and capital buffers implied by stress tests would represent *de jure* capital buffers.

of the effects of the stress-test capital buffers on bank C&I lending, firm C&I borrowing, and firm overall debt, investment, and employment. Additionally, in section 5, we consider what our results suggest for the effects of the CCyB, since, as noted earlier, not meeting CCAR-implied buffers and not satisfying an activated CCyB imply similar capital-distribution implications for banks. We explain these facts more fully in Appendix A.

2. Empirical strategy

As noted, we follow two approaches in considering the effects of bank capital requirements on bank lending. The first approach uses C&I bank-firm-level data, which is constructed from loan-level data contained in the FR Y-14 regulatory reports that is collected for the very large banks that are currently subject to the CCAR stress tests and, in the case of C&I, have material C&I loan portfolios. This bank-firm level data allows us in our analysis to better control for loan demand using a within firm estimation method. For this analysis, we consider what different capital-ratio declines under stressed conditions imply for the lending of banks between 2012 and 2016. Our rationale for focusing on capital-ratio declines under stressed conditions stems from the requirement in the post-crisis capital framework for large banks to maintain capital buffers sufficient to enable them to endure a prolonged period of severe stress and still be able to meet minimum capital requirements. The capital-ratio declines that a bank experiences in the stress tests indicates the size of the buffer that the bank must satisfy.

Our second approach considers the firm-level impact of the capital buffers implied by the stress tests. This approach uses data on the loans that firms obtain from all the different banks in our sample, as well as data on firm balance sheets and expenditure information that accompanying the loan information reported by stress-tested banks in the FR Y-14 data. This firm-level data allows us to study the implications of the capital requirements on firm debt volumes and investment spending. COMPUSTAT data enables us to undertake robustness analysis for our results on the effects of capital requirements on debt volumes and investment spending and allows us to consider the effect on employment. With regard to the latter, county level employment data also allows us to gauge the effect of stress-test capital buffers.

2.1. C&I loan bank-firm-level analysis

We start our analysis of the impact on large bank lending of different-sized stress-test capital buffers by using a methodology that follows the Khwaja and Mian's (2008) identification approach, which helps to isolate credit supply changes (*e.g.*, changes in regulatory capital) from shifts in loan demand. To that end, we use multiple bank-firm relationships to control for loan demand and include observed and unobserved firm characteristics, using the following panel regression equation:

$$Loan\ growth_{ijt+1} = \alpha_{ij} + \tau_{jt} + \beta_1 \cdot ST\ Buffer_{it} + \beta_2 \cdot K\ ratio_{it} + \gamma X_{it} + \varepsilon_{ijt+1} \quad (1)$$

In this specification, *Loan growth* is the annual growth rate of C&I loans (either utilized or committed amounts) measured as the log change of loans of BHC *i* to firm *j* after the disclosure of stress tests results in every year. The change in BHC loans – following Bertrand, Duflo, and Mullianathan (2004) – is calculated as the log difference between loan averages 3 quarters after and 3 quarters before the disclosure of stress tests results. *ST Buffer* is the stress-test capital buffer measured as the decline in the tier1 capital ratios (CET1) from start to minimum, of BHC *i* in the stress test exercise of year *t*. *K ratio* is the equity capital to assets ratio of BHC *i* at the beginning of the stress tests exercise in year *t*. This capital ratio is a variable of particular interest, among bank controls, and allows us to assess the extent to which banks with higher levels of capital (also resulting from the higher capital requirements associated with the stress tests) should be less constrained in their lending activities, and thus in a better position to expand their lending. *X* is a vector of other bank controls that include size (log of total assets), the ratio of deposits to total assets, the ratio of liquid assets to total assets, the ratio of net charge-offs to total assets, and the share of C&I loans in total assets. These bank controls are measured at the beginning of the stress tests exercise in year *t*. To tighten identification, we also include firm-bank fixed effects, α_{ij}, to control for relationships between firms and their respective lenders, and firm-time fixed effects, τ_{jt}, that control for observed and unobserved firm heterogeneity that may vary over time. We also interact *ST Buffer* with year dummies to assess the time variation of the impact of the decline in capital on firm outcomes for different stress testing exercises.

Notice that the firm-bank and firm-time fixed effects in the panel regression specification above absorb the effects on the lending of firms that borrow from only one BHC throughout the sample period (single-bank firms), and thus the analysis implicitly focuses only on firms borrowing from multiple banks (multi-bank firms). As in Khwaja and Mian (2008), our regression specification compares how – after information about the size of capital buffers becomes available – the same firm's loan growth from one bank changes relative to another bank that is less affected by the new information (*e.g.*, a smaller forward-looking capital buffer). The within firm comparison absorbs firm-specific changes in credit demand and thus the estimated difference in loan growth can be attributed to differences in bank stress-test capital buffer requirements.

We also consider an alternative specification that replaces firm-bank and firm-time fixed effects with firm, bank, and time fixed effects, denoted by α, δ, and τ, respectively, and firm controls, denoted by *Y*, to specifically account for observed firm characteristics that affect bank lending decisions. In particular, we consider,

$$Loan\ growth_{ijt+1} = \alpha_j + \delta_i + \tau_t + \beta_1 \cdot ST\ Buffer_{it} + \beta_2 \cdot K\ ratio_{it} + \gamma X_{it} + \gamma Y_{jt} + \varepsilon_{ijt+1} \quad (2)$$

This specification ultimately uses fewer observations as BHCs do not report financial information for all their borrowing firms in FR-Y14. Additionally, including firm variables in the regression does not control for firm characteristics as well as focusing only on multi-bank firms in our regression and, as such, this specification does not isolate the effects of a change in bank capital ratios as cleanly. This approach is similar to that used by Jimenez, *et al*. (2017) to examine the effects of bank capital or liquidity on bank lending.

Our expectations in equation (1) and (2) are for a negative sign for the coefficient on the variable *ST Buffer* – that is, $\beta_1 < 0$, and a positive sign for the coefficient on the variable *K ratio* – that is, $\beta_2 > 0$. Our expectation for $\beta_1 < 0$ reflects the general assessment that, all else equal, a bank that needs to satisfy a larger capital buffer as a result of the stress tests will likely want to restore, at least to some extent, its capital ratio back to where it was relative to its required ratio by reducing its loans. Our expectation for $\beta_2 > 0$ is consistent with previous findings in the bank capital literature (*e.g.*, Bernanke and Lown, 1991; Berrospide and Edge, 2010; Carlson *et al*. 2011).

2.2. Firm-level analysis

In our bank-firm analysis above, we hypothesize a negative impact of the higher stress-test capital buffers on the growth of bank loans to client firms. However, such reduction in bank lending may not have any aggregate effect in firm outcomes such as their overall debt volumes, investment spending and employment if firms can offset their reduced bank-specific loan by borrowing more funds from other (smaller) banks, not subject to the CCAR stress tests, or from nonbank financial institutions or institutional investors. We examine the possibility that such substitution occurs by considering a sequence of similarly specified firm-level regressions, albeit with a different firm-outcome dependent variable in each case.

The basic regression equation that we use to investigate the impact of capital buffers on firm outcomes is:

$$Firm\ Outcome_{jt+1} = \alpha_j + \tau_{gt} + \beta \cdot Firm\ ST\ Buffer\ Exposure_{jt} + \gamma Y_{jt} + \varepsilon_{jt+1} \quad (3)$$

where depending on the regression *Firm Outcome* is either the growth in total firm borrowing from the 16 large U.S. banks that we use in our analysis, overall firm debt growth, firm investment spending growth or firm employment growth. As with our bank loan growth analysis above, we calculate all of these changes as log differences between 3-quarter averages in the firm outcome after and 3-quarter averages before the stress test results are disclosed. We look only at multibank firms; that is, firms that borrow from at least 2 banks, with at least one bank in the low-capital decline group (below the median capital decline) and the other one in the high-low capital decline group (above the median capital decline). By construction, this categorization of firms exclude the firms that borrow from multiple banks, with all those banks being in either the low- or high-capital decline groups.

In the first regression of the type described by equation (2) our dependent variable is growth in *Total Firm Borrowing* from the 16 large U.S. banks that we use in our analysis. *Total Firm Borrowing* for firm *j* in year *t* is, in turn, defined as the sum of firm *j*'s C&I borrowing across all of the banks in our sample; that is,

$$Total\ Firm\ Borrowing_{jt} = \sum_{i=1}^{N} Firm\ Borrowing_{ijt} \tag{4}$$

In the second regression of the type described by equation (2) our dependent variable is growth in *Overall Firm Borrowing*, which is, more conveniently, a variable collected in the FR Y-14 dataset as well as a variable in COMPUSTAT (albeit for publicly traded firms only). In the third regression, our dependent variable is growth in *Firm Investment Spending*. Because the FR Y-14 dataset does not have capital expenditures, for our *Firm Investment Spending* equation using our FR Y-14 dataset, firm investment spending is measured as the change in fixed assets. When we use the COMPUSTAT dataset as a robustness check for our results, investment spending is measured as the log change in property, plant and equipment (fixed assets), and for robustness analysis, we measure this variable as log changes in capital expenditures. In the last regression of the type described by equation (2) our dependent variable is growth in *Firm Employment*, although for this specification of our employment growth regression we only use COMPUSTAT data. We do perform some additional regressions to consider the effect of stress-test capital buffers on employment, but defer our discussion of these regressions – for which the dependent variables is *County Employment* –until the end of all of our discussion of equation (2).

With regard to the explanatory variables in equation (2), *Firm ST Buffer Exposure* is a central one and refers to the firm-level exposure to the buffer implied by the stress test. This variable allows us to assess the impact of the bank capital declines in the stress test exercise – and thereby stress-test capital buffers – on firm outcomes. We define *Firm ST Buffer Exposure* as the loan-share weighted average of the post-stress capital decline for the BHCs that each firm borrows from before the stress tests in year t. Thus, *Firm ST Buffer Exposure* for firm *j* borrowing from bank *i*=1,2…,*N* at time *t* is defined as:

$$Firm\ ST\ Buffer\ Exposure_{jt} = \sum_{\forall i} ST\ Buffer_{it} \cdot \frac{loan\ amount_{ijt-1}}{\sum_{\forall i} loan\ amount_{ijt-1}} \tag{5}$$

In other words, *Firm ST Buffer Exposure* measures the amount by which firm *j* is affected by the decline in capital and stress-test capital buffer of bank *i*. This amount depends on the extent that firm *j* borrows from bank *i*, which is given by the volume of loans obtained from bank *i* as a fraction of the total bank loan amount borrowed by the firm from *N* multiple banks. In some of our regression specifications, we also interact *Firm ST Buffer Exposure* with year dummies to assess the time variation of the impact on firm outcomes. The variable *Y* denotes firm controls measured at the beginning of the stress tests exercise such as size (log of total assets), cash to total assets, the leverage ratio (debt to total assets), and the ratios of earnings before interest, taxes and depreciation and amortization (EBITDA), sales, and tangible assets to total assets.

When we use the COMPUSTAT dataset for publicly traded firms, we also include the market to book ratio of assets. Lastly, equation (3) also includes firm fixed effects, denoted by α, to control for unobserved firm heterogeneity and group-time fixed effects, denoted by τ, to control for unobserved firm industry-group that may vary over time.

2.3. County-level employment analysis

As noted, the additional regression that we specify to consider the effect of stress-test capital buffers on employment is defined at the county level. Our dependent variables is *County Employment Growth*, calculated as the growth in the number of employees at industrial firms in the country, and our key variable of interest is *County ST Buffer Exposure*, defined below. The equation we estimate is specified as:

$$County\ Employment\ Growth_{ct+1} = \alpha_c + \beta \cdot County\ ST\ Buffer\ Exposure_{ct} + \gamma Z_{ct} + \varepsilon_{ct+1} \quad (6)$$

and the variable *County ST Buffer Exposure* is as defined as

$$County\ ST\ Buffer\ Exposure_{ct} = \sum\nolimits_{\forall\ j\ w\ HW\ in\ county\ c} \sum\nolimits_{\forall\ i} ST\ Buffer_{it} \cdot \frac{loan\ amount_{ijt-1}}{\sum_{\forall\ j\ w/\ HQ\ in\ county\ c} \sum_{\forall\ i} loan\ amount_{ijt-1}} \quad (7)$$

That is, to calculate the variable *County ST Buffer Exposure* is we take the volume of loans extended by any bank in our sample to any firm with its headquarters in the county in question and consider what fraction of this total sum of loans is extended from for each bank. These fractions are then the weights that are applied to each banks' stress-test capital buffer to obtain the county's specific exposure to stress-test capital buffers. The variable *Z* denotes county controls measured at the beginning of the stress tests exercise such as log wages in the county, log population in the county, and the house price index in the county, while α denotes county fixed effects.

3. Data

We use several sources of data in our empirical analysis, reflecting the fact that our empirical analysis considers the lending, borrowing, and spending behavior of both banks and firms, as well as county-level employment. We describe our data sources following the same order that the equations that we estimate were described in section 2, though we defer our description of the variable *ST Buffer*, which is featured in all of the equations that we estimate either directly or as an input to another variable, to the end of the section. Note that in all of our bank-firm level and firm level regression we winsorize all data at the 1 percent level to minimize the possible impact of outliers.

3.1. C&I loan bank-firm-level analysis

For our bank-firm loan growth equation – equations (1) and (2) – we use loan-level data on C&I loan-portfolios included in the Corporate Schedule of the regulatory filing FR-Y14 together with consolidated bank balance sheet data at the BHC level from the regulatory filings FR Y-9-C. The FR Y-14 Corporate Schedule is collected for the very large BHCs that participate in the CCAR stress tests and have material C&I loan portfolios. Currently there are 30 such BHCs, although we only use information for 16 BHCs; specifically, those for which we have data for CCAR 2012 through CCAR 2016. Our smaller sample of BHCs results from the fact that the first two CCARs involved only 18 BHCs. Of these, one de-banked and left the sample, while another one had too little C&I loan exposure for the data to be collected from it. The data in the FR Y-14 Corporate Schedule includes loan information at the credit facility level for both committed and utilized balances greater than or equal to $1 million in loan, which the terminology of the schedule is "Category 4 and 5" C&I loans.[10] For each loan the FR Y-14 Corporate Schedule also includes accompanying firm balance-sheet and expenditure information, which provides the data for the firm controls that we use in the second variant of our bank-firm loan growth equation; that is, equation (2). The Y-9-C regulatory filing provides the data for the variable *K ratio* as well as the bank controls in equations (1) and (2).

Table 1 provides summary statistics for the variables in our bank-firm regressions. As seen in the upper panel of table, which is for all firms, on average over our five-year period, C&I loans have grown at about 5 percent per year, where this figure is similar for both utilized and committed amounts. As shown in the bottom panel, for firms borrowing from multiple banks (so-called multi-bank firms) the growth rate of C&I loans is larger; specifically, 7 percent and 6 percent for utilized and committed amounts, respectively. These numbers are consistent with the lending behavior of U.S. BHC over the last 5 years. On average C&I loans have grown at a higher rate than total loans, and this is particularly the case for the largest banks (*i.e.*, the banks that currently subject to the CCAR stress tests).

Out of 150,531 firms borrowing from 16 BHCs in our FR Y-14 data-set only 78,265 firms have loan data reported consistently enough over time to allow us calculate their loan growth and since not all firms have loans in each year we ultimately have 248,201 bank-firm-year observations for utilized loans and 331,430 for committed loans. Of these, 10,961 (63,212 bank-firm-year observations) are multibank firms who borrow from two or more banks. That is, about 14 percent of firms in our sample are multibank firms.

[10] Our focus on so-called "Category 4 and 5" loans in the Corporate Loan schedule means that we are excluding C&I loans to U.S. and foreign banks, other depository financial institutions, and non-depository financial institutions, and loans to financial agricultural production and other loans to farmers,

An appeal of the FR-Y14 data set is that it includes a wide range of firm; that is, small and large firms and publicly traded and private firms. Note, however, that the number of observations in table 1 for different firm characteristics differs and is smaller than the number of observations for BHC characteristics, which arises for the reason that not all BHCs report these data uniformly and in many cases, firm-specific characteristics are not reported at all. Nonetheless, the micro-level data from FR Y-14 are the closest data that we have for the United States to credit registry data that have been recently used in the literature – see, for example, Jimenez, *et al*. (2017) for banks in Spain and Puri, *et al*. (2011) for German saving banks – to study the effects of capital requirements. For our bank-firm level analysis our use of the FR Y-14 C&I loan-level data is quite novel. The CET1 ratio for the average BHC in our sample period is 10.8 percent, having increased from 5 percent on average across all BHCs in 2009 to 12 percent in 2016. Note that, while we have more than 300,000 bank-firm level observations, for a very large numbers of these observations the value of the bank variable is identical and realistically we only have 80 (five times 16) independent bank observations.

The Y-9-C regulatory filing that provides the bank-level variables that we use in equations (1) and (2) also has data for aggregate bank C&I loan growth and it is interesting to compare growth rates from the FR Y-9-Cs with those implied by aggregating for all firms the loans reported for each bank in the FR Y-14. Figure 1 provides this comparison. Specifically, it reports the growth rate in C&I loans (utilized amounts) for the average BHC in our sample between 2012 and 2016, using information from supervisory reports FRY-14 and FR Y9C. (We also report growth rates for just the firms that are included both the FR Y-14 and COMPUSTAT data, which we will come back to later.) The figure shows both year-over-year growth rates (panel A) and cumulative growth rates (panel B). In both cases, BHC's C&I loan growth follows very closely the path of similar growth rates calculated using bank-level data from FR-Y9C reports (BHC consolidated financial information).

3.2. Firm-level analysis

Our firm-level analysis involves estimating a number of variants of equation (3) and, as such, the data sources that we use differ depending on the precise equation we are estimating. When we first estimate equation (3) with our *Firm Outcome* variable being the growth in total firm borrowing from the 16 banks in our sample, overall firm debt growth, or firm investment spending growth, the FR Y-14 (where this includes the accompanying firm balance-sheet and expenditure information) is our only source of data. Recall, however, that when we use the FR Y-14 data, firm investment spending is measured as the change in fixed assets. When we re-estimate the above-described equations for the purposes of robustness analysis, we use COMPUSTAT data in all cases to replace the FR Y-14 firm data, except for the variable "growth in total firm borrowing from the 16 banks in our sample." In our analysis using COMPUSTAT data, we additionally estimate equation (3) with our *Firm Outcome* variable being firm employment growth.

Table 3 provides summary statistics for the *Firm Outcome* variables and firm control variables in our firm-level regressions when we use the FR Y-14 data. Table 8 provides similar information for when we use COMPUSTAT data. Notably, the number of firms in our analysis drops substantially when we move to using COMPUSTAT data. To some extent, this reflects the fact that the FR Y-14 data also includes private firms, although this is only part of the reason. Figure 1 – discussed earlier – that provides a comparison of the growth rate in C&I loans implied by the FR Y-14 and FR Y-9-C also shows the growth rate of C&I loans by the firms in our FR Y-14 data base that are also in COMPUSTAT. As can be seen, C&I loan growth using the firms in COMPUSTAT follows a similar trend to the other measures but is much larger, implying that on average publicly traded firms borrow significantly more from large BHCs than firms in FR-Y14, which includes predominantly private firms. Notice also that year-over-year loan growth at firms in FR-Y14 (orange line in panel A) is positive and increases between 2013 and 2015 from 2 to 5 percent, and starts declining to be around 3½ percent by the end of 2016.

3.3. County-level employment analysis

For our county-level employment equation – equations (6) – we use county-level employment data, wage data, and population data from the Bureau of Labor Statistics and county-level house price index data from Core Logic.

3.4. Short-term buffer variable

The variable *ST Buffer* is the key variable in all of the equations that we estimate. This variable enters our equations, either directly or via another variable that uses *ST Buffer* as an input; specifically, *Firm ST Buffer Exposure* and *County ST Buffer Exposure*. The variable *ST Buffer* is equal to the decline in capital that occurs in the CCAR stress test; that is, the difference between CET1 capital ratios at the start of the stress test to its minimum level in the severely adverse scenario. We have observations of this variable for each bank and for each stress test exercise from 2012 through 2016. Figure 2 shows the capital buffers (CET1 capital ratio declines excluding capital distributions) on average across banks for each stress testing exercises between 2012 and 2016. The capital buffers range between 2.2 and 3.5 percentage points, with an average decline of 2.8 percentage points and a standard deviation of 2.6 percentage points during the years in our sample period. The large standard deviation reflects a significant variation in the capital ratio decline across BHCs over the five-year period, which we exploit in our regression analysis.

The source for these CET1 capital ratio declines are the 2012 to 2016 DFA stress test disclosure documents, although these reported declines also reflect the capital distribution decisions (*e.g.,* dividend payout and share repurchases) that banks are assumed to pay in the stress tests.[11] These assumed distributions – which for the first quarter of the stress-test horizon is banks' actual capital actions while for the remaining eight quarters is each banks' average quarterly common stock dividend payments from the previous year and dividend, interest, or principal payments on any other regulatory capital instrument – can, however, be removed from these declines.[12] This leaves us with the declines in capital from losses in the stress test, which is then our variable *ST Buffer* in our regressions.

The bank-specific capital buffer implied by the stress tests – *ST Buffer* – represents the buffer that each participating BHC would need to satisfy in normal times to cover forward-looking risks. This capital buffer represents higher – albeit time variable – capital requirements for which in our regressions we investigate the effects on lending.

Figure 3 shows the evolution of regulatory capital (CET1 ratio) over the period 2009 to 2016 for the average bank in our sample split by the size of their capital buffer. Banks with large (small) buffers are those with a decline in post-stress capital greater (less) than the median decline. The charts shows evidence that the capital buffers have contributed to the increase in regulatory capital after the implementation of the stress tests in 2012. Immediately after the crisis, all banks quickly increased their CET1 capital ratios. However, after 2012, banks with a larger stress-test capital buffers on average (blue line) continue to build their regulatory capital ratios relative to banks with a small buffer (orange line). For these later banks, the CET1 ratio increased up to about 11 percent in 2013 and have slightly decreased afterwards.

4. Results

4.1. C&I loan bank-firm results

Table 2 shows the regression estimates for equations (1) and (2) for the growth rate of C&I loans, using five different specifications for both utilized amounts – columns 1 through 5 – and committed amounts – columns 6 through 10. The regression estimates reported in columns 1, 2, 4, 6, 7, and 9, which correspond to the regression specified in equation (1), include both bank-firm and year-firm fixed effects and thus provide a within firm comparison. The regression estimates reported in columns 3, 5, 8 and 10, which correspond to the regression specified in equation (2), include firm characteristics and replace bank-firm and year-firm fixed effects with firm, bank, and year fixed effects. These later specifications, which use significantly fewer

[11] The DFA stress test results described above are available at the Federal Reserve's website: https://www.federalreserve.gov/supervisionreg/dfa-stress-tests.htm.

[12] For assumptions about historic capital distributions included in DFAST results, see page 3 of disclosure document "Dodd-Frank Act Stress Test 2014: Supervisory Stress Test Methodology and Results," March 2014, available at https://www.federalreserve.gov/newsevents/pressreleases/files/bcreg20140320a1.pdf.

observations and do not isolate the effects of a change in bank capital ratios as cleanly, are only included to investigate which firm characteristics affect their loan growth.

Our results in table 2 show a negative and significant impact of *ST Buffer* on the growth of utilized and committed amounts of C&I loans for the average BHC in our sample. The results in column 1 and 6 indicate a material and economically significant effect: a 1 percentage point increase in the capital buffer (*e.g.*, from 2.8 to 3.8 percent) leads to a decline in C&I lending of about 2.3 percentage points in utilized amounts and about 1.9 percentage points in committed amounts, respectively. Columns 2 and 7, our most preferred specifications, show that this result is robust to the inclusion of bank controls. These results show a reduction in loan growth of about 2 and 1½ percentage points for utilized and committed amounts, respectively. Given that in our sample of firm-bank matched loans, the average growth rate of a utilized loan is 5 percent and that for a committed loan is 4¾ percent, these magnitudes are material in size. That said, since the average CET1 capital ratio across banks being 10¾ percent, if banks were to reduce their risk weighted assets to meet higher capital ratios implied by higher capital buffers then a 1 percentage point higher stress-test capital buffer would imply a 8½ percent reduction in loan growth and the effects that we find are notably smaller.

The results in columns 3 and 8, which include firm characteristics, show an even larger impact of the capital buffer, particularly for committed amounts for which the negative coefficient on *ST Buffer* more than doubles. As discussed above, the identification of the impact on loan growth is less reliable using these specifications as these may account imperfectly for loan demand shifts. However, we notice that in these specifications, all firm characteristics enter the regression equation with the expected sign, and more importantly, the results show that the lending contraction occur at firms with higher leverage and lower credit ratings (specifically, ratings of C and D) – that is, at risky firms. These latter results are consistent with previous findings showing that banks that are more affected by the stress tests adopt more prudent lending practices and cut their credit supply to riskier firms (Acharya, *et al*., 2017; Pierret and Steri, 2018). Finally, columns 4, 5, 9 and 10 show that the impact of capital buffers vary slightly by year, with the effects increasing in 2013 and then gradually diluting in 2014 and 2015, but increasing again in 2016. These results are consistent with bank loan growth increasing between 2013 and 2015 and decreasing in 2016, as shown in figure 1.

We also consider the impact of the equity capital ratios in table 2, which consistent with our expectations is positive and significant; suggesting that banks with higher capital ratios lend more. Further, in our preferred specifications, columns 2 and 7, the positive effect of equity capital on loan growth is larger than the negative effect of the capital buffer. More specifically, our findings suggest that a 1 percentage point increase in equity capital leads to about 5½ percentage point increase in BHC's loan growth in both utilized and committed amounts.

In summary, our findings using the bank-firm matched data on C&I lending of stress-test banks suggest material effects of bank capital ratios on large-bank lending decisions. We find material effect of stress-test capital buffers on bank lending, although we do find that this lending contraction occurs disproportionately at risky firms. Moreover, the larger and positive effect associated with the equity capital ratio points to a positive effect associated with the post-crisis regulatory reform affecting the largest BHCs, as the large capital increases induced by the new and more stringent regulation seem to place banks in a better position to expand their lending.

4.2. Firm-level results using FR Y-14 data

As we discussed when we presented our empirical strategy, the negative impact of the stress-tests capital buffers on bank lending that we find need not translate into aggregate effects in firm outcomes. This is for the reason that firms could potentially substitute their bank loans with other borrowing sources such as loans from smaller banks, loans from nonbank financial institutions, or bond issuances in capital markets. In this section, we study the extent to which this substitution has taken place using data from the FR Y-14 corporate schedule on firm borrowing from banks subject to the stress tests, overall debt volumes, and investment spending. (We do not consider firm employment here since this information is not included in the FR Y-14 data collection.)

Table 4 shows the regression estimates for equation (3) for four different specifications and with either utilized C&I loan volumes – columns 1 through 4 – or committed C&I loan volumes – column 5 through 8 – as the dependent variable. The impact of *Firm ST Buffer Exposure* is negative and significant in all specifications suggesting that firms that rely on loans from banks that face larger stress-test capital buffers (that is, firms with large stress-test capital buffer exposures) borrow less from banks that face smaller stress-test capital buffers. The coefficients on *Firm ST Buffer Exposure* in columns 1 and 5 indicate that for the average firm, a 1 percentage point increase in its exposure leads to a decline in their bank borrowing of about 4 percentage points in utilized amounts and about 3 percentage points in committed amounts, respectively. This result is robust to the inclusion of firm-specific characteristics, with effects of a similar magnitude for utilized and committed amounts as shown in columns 3 and 7, respectively.

Notice that the negative impact of stress-test capital buffers on firms' bank borrowing is double that of the magnitude reported in the previous subsection for the regressions undertaken at the bank-firm level. This discrepancy – specifically for columns 1, 2, 5, and 6 – appears to arise from the fact that the negative impact of stress-test capital buffers is more sizable at banks that account for a larger share of firm loans. As before, the results seem to vary by year, with the negative effect decreasing from 2013 through 2015 but increasing again in 2016. Firm controls enter the regression with the expected sign and shows that larger and more leveraged firms tend to take fewer loans, both utilized and committed amounts, from the banks in our sample.

Panel A of figure 4 provides an illustration of the results that we find for bank loan growth and report in table 4. Firms with low exposures (below median exposure) to the bank capital buffers (blue line) show stronger rates of growth in their bank borrowing relative to firms with high exposures (above median exposure) to bank capital buffers (orange line). This is particularly the case between 2013 and 2015, when loan growth is positive and about 7.5 percent and 4.8 percent for low- and high-exposure firms, respectively. After 2016, bank lending drops significantly for both types of firms. Panel A of figure 5 shows the same illustration for public and private firms and shows a much larger differential between low-exposure (blue line) and high-exposure (orange line) private firms than for publicly traded firms. [13]

Table 5 shows the regression estimates for equation (3), again for four different specifications, and with firm's overall debt as the dependent variable. These results are shown for all firms – columns 1 through 4 – and for publicly traded firms – columns 5 through 8 – and private firms – columns 9 through 12. In this case, we do not find evidence of a significant impact of exposure to stress-test capital buffers on firms' overall debt. The coefficients on *Firm ST Buffer Exposure* are mostly negative but insignificant for all and for public firms in our sample, suggesting that overall debt growth is explained by factors other than the capital buffer implied by the capital-ratio declines, such as firm observed and unobserved characteristics, as well as industry and year effects. We find a marginally significant negative impact of exposure on debt in 2013, with all of this impact coming from private firms. This result reflects the fact that unlike public firms, private firms have more limited access to substitute bank loans by raising debt in capital markets, although this result is only for one year. More generally, our results provide supporting evidence for the potential substitution of funding sources at the firm level. As discussed above, firms seem to be substituting their C&I loans from banks subject to stress tests, possibly to loans from other (smaller) banks and from nonbank financial institutions, or with debt from capital markets. Columns 3, 7, and 11, which add firm controls to the regression equations, show that larger and more leveraged firms exhibit comparatively lower debt growth than more profitable (higher EBITDA) firms.

Panel B of figure 4 illustrates the results that we find for firms' overall debt growth and report in table 5. Overall debt has grown at a decreasing rate for all firms during our sample period, from about 15 percent in 2013 to about 5 percent in 2016 on average. Despite the lower growth in overall debt, and consistent with our regression results, there is no significant differences in the growth rates between firms

[13] Publicly traded firms within FRY-14 are identified based on ticker information and Committee on Uniform Security Identification Procedures (CUSIP) numbers.

with low-exposure (that is, below median exposure and shown by the blue line) and those with high-exposure (that is, above median exposure and shown by the orange line). Panel B of figure 5 shows the same illustration for public and private firms and for both types of firms – and similar to the overall results – shows little differential between low-exposure (blue line) and high-exposure (orange line). This finding suggests that even though private firms have limited access to capital markets and thus much less scope than publicly traded firms to replace the reduced lending from the banks subject to stress tests, they still have some scope either from borrowing from banks not subject to stress tests or from nonbank financial institutions.

Table 6 shows the regression results for equation (3), again for four different specifications, and with investment spending as the dependent variable. As in table 5, we look at the impact on investment for all firms, as well as for publicly traded and private firms. As expected, and consistent with our result that firms do not see a significant impact of exposure on their overall debt, we do not find consistent evidence of a significant effect on investment spending either. The coefficient on *Firm ST Buffer Exposure* is negative but insignificant in almost all specifications, although it is negative and marginally significant in years 2013 and 2014 for private firms – columns 10 and 12. Our regression results in column 12, which also account for firm-specific characteristics explaining firm investment decisions, seems to suggest that a 1 percentage point increase in firm exposure to the capital declines in stress tests lead to approximately 1 percentage point reduction in the investment spending of private firms in 2013 and 2014. This result is also consistent with the impact of the capital buffers on the overall debt of private firms. As we discussed, this result reflects the fact that unlike public firms, private firms have more limited access to substitute bank loans by raising debt in capital markets, and thus may face some difficulties in funding their investment spending when bank credit supply contracts. That said, as we noted before, these results are only for a couple of years of our sample.

In summary, our regression analysis of the impact of firm exposure to stress tests capital-ratio declines using firm-level outcomes suggests a substitution in the funding sources of corporations to fund their investment spending. These findings are particularly the case of public firms, which seem to substitute bank loans from the largest banks with other forms of borrowing, which may include loans from other smaller banks outside the CCAR exercise, loans from nonbank financial institutions and bond issuance held by institutional investors. We generally also obtain similar results for private firms, although for a couple of years in our sample our regression results suggest some effects.

4.3. County-level employment results

As noted in section 2, given the absence of any information on firm employment from the FR Y-14 data, we consider the effect of stress-test capital buffers on employment growth at the county – rather than firm – level. In particular – and as described by equation (7) in subsection 2.3 – using information on the geographic location of corporations that borrow from BHCs in the FR Y-14 data, we collapse firms loan information for each bank in our sample to the county level and then construct exposure to the post-stress capital declines at the county level. We then consider how county stress-test capital buffer exposure affect county level employment growth. This analysis is more limited than the ideal firm-level data analysis but allows us to gauge the impact of exposure on firm employment within counties.

Table 7 shows the results of the county-level regression on employment described by equation (6). Consistent with the previous findings on firm overall debt and investment, we do not find evidence that exposure to bank post-stress capital declines negatively affects the hiring of employees at the county level. Instead, county employment is explained by variables beyond the stress-test capital buffer exposures such as wages, population, and a house price index. These factors explain about one-third of the employment variation at the county level.

In line with our firm-level results, which found no effect of firm-specific stress-test capital buffer exposures on firm outcomes such as overall debt growth and investment spending growth between 2012 through 2016, our county-level analysis finds no effect of county-specific stress-test capital buffer exposures on county-level employment growth. As with the firm-level results, these county-level results also suggest that firms manage to substitute bank loans with other funding sources. As such, our finding seem to suggest that there are no real effects associated with the reduction in bank credit supply associated with the capital buffers that the banks in our sample must implicitly satisfy to "pass" the quantitative component of the CCAR stress tests.

4.4. Robustness analysis using firm-level results using COMPUSTAT data

As discussed earlier, the firm financial information from the FR Y-14 data that we use for our firm-level analysis is reported by the lending bank – not the borrowing firm – and not all banks report these data uniformly and in many cases firm-specific characteristics are not reported at all. To address these potential issues with the data, we match bank and loan information in the FR Y-14 data with financial data on borrowing firms from COMPUSTAT and repeat with this data our regression analysis for bank borrowing, overall debt, investment, and employment.[14] This matching produces information for about 3000 firms borrowing from multiple banks, out of which about 1600 have consistent and consecutive loan information as to construct our loan growth variable.[15]

[14] Firm matching of FRY-14 data and COMPUSTAT data is based on common firm identifiers such as tax identification numbers.

[15] In unreported regressions, and as another robustness exercise, we use a restricted set of FRY-14 firms that remain in the sample at least three consecutive years and conduct a similar analysis looking at total bank borrowing, overall debt volumes, and investment spending. We obtain very similar results than those shown in tables 4 through 6.

Table 8 shows summary statistics for the firms in our merged FR Y-14-COMPUSTAT data. In general, firms in COMPUSTAT are larger than firms in FR-Y14, which is unsurprising given that latter data source includes both private and publicly traded firms. Similarly, COMPUSTAT firms have lower leverage than the firms in the FR-Y14 dataset (30 percent versus 40 percent, respectively) and operate with smaller share of tangible assets to total assets (77 percent versus 90 percent). Additionally, as we noted in section 3, publicly traded firms in COMPUSTAT have exhibited more sizable increases in their borrowing more from large BHCs than their counterparts in FR-Y14 (11 percent versus 5 percent on average as reported in tables 1 and 8 and also apparent in figure 1). Using the merged FR Y-14-COMPUSTAT data, we conduct the firm-level analysis and study the impact of firm exposure to stress-test capital buffers on firm total bank borrowing, overall debt, investment, and employment using regression specifications similar to that described in equation (3).

Our empirical results using the more restricted sample of large and publicly traded firms from the merged data are similar to our previous findings using the larger sample. Table 9 shows the results for firm borrowing from the 16 banks in our sample, both utilized and committed amounts, using four specifications of equation (3). As before, the impact of *Firm ST Buffer Exposure* is negative and significant across all specifications. Interestingly, the negative coefficient on exposure in column 1 is larger than our estimates using the larger sample in the FR-Y14 data, which included private firms. The results suggest that a 1 percentage point increase in the exposure of a publicly traded firm reduces their bank loan growth by about 7 percentage points relative to firms with relatively low exposure. As shown in column 5, the borrowing reduction of an increase in firm stress-test exposure in terms of committed amounts is smaller, about 2 percentage points. As before, these results are robust to the inclusion of firm-specific characteristics, though the magnitude of the effects is smaller: about a 5 percentage point decline in utilized amounts and about a 2 percent decline in committed amounts.

The effects of *Firm ST Buffer Exposure* on firm borrowing from 16 banks in our sample seems to vary overtime, decreasing from 2013 through 2015 and then increasing again in 2016. Notably – and as shown in column (4), which accounts for firm characteristics – relative to the larger sample of firms in the FR-Y 14 data, for publicly traded firms in the restricted sample the negative impact on utilized amounts seems to become insignificant in the last two years. This latter finding suggests a diluting effect of stress-test capital buffers over time. Firm controls, which now draw on firm information from COMPUSTAT, enter the regression with the expected sign and show that larger firms (as measured by the sales to assets ratio) and more leveraged firms see a larger reduction in bank borrowing relative to smaller and less leveraged firm. This result is also consistent with the view that banks more affected by the post-stress capital-ratio declines reduce their credit supply to risky firms. Panel A of figure 6 illustrates our findings on the effects of *Firm ST*

Buffer Exposure on firm borrowing from banks subject to stress tests. As seen from the chart, which looks very much like the corresponding (public firm) chart in figure 5, firms with low exposure to bank stress-test capital buffers (blue line) exhibit larger growth rates in bank loans relative to firms with high exposure (orange line). Similarly, panel B of figure 6 shows little differential in the growth rate of overall debt between low-exposure (blue line) and high-exposure (orange line) firms.

Table 10 shows the results for firm overall debt, investment spending, and employment, again using four specifications of equation (3). Columns 1 and 9 show negative and significant effects on total firm debt and firm employment growth. However, these results are not robust to the inclusion of firm controls. After we include firm-specific characteristics, as shown in columns 2, 6, and 10, there is no evidence that the firm exposure to the larger stress tests capital buffers reduce overall debt, investment spending, and employment, respectively. In columns 4 and 12, after controlling for firm characteristics, the coefficient on exposure is mostly negative but insignificant between 2012 and 2016 for overall debt and employment. Column 8 shows no impact of exposure on firm investment, except for a marginally significant reduction in 2015, after controlling for firm characteristics. Firm outcomes are explained by other factors such as firm size, leverage, and the ratio of tangible assets to total assets.

In summary, our findings in the firm-level analysis using our merged data are consistent with those using the larger FR Y-14 data. That is, we find that firm exposures to stress-test capital buffers do impact firm borrowing from the banks subject to stress tests but we find no effect of these exposures on firms' total borrowing – suggesting that firms can substitute with other sources of funding – and, in turn, no effect on investment spending, and employment,

5. Concluding remarks

In this paper we study how the capital buffers that U.S. banks must satisfy in order to "pass" the quantitative component of the CCAR stress tests impact banks' C&I lending as well as the C&I loan volumes, overall debt volumes, investment spending, and employment of the firms that borrow from these banks. We find that larger stress-test capital buffers lead to material reductions in banks' C&I lending. Specifically, a 1 percentage point larger capital buffer is associated with a roughly 2 percentage point lower (four-quarter) growth rate of utilized loans and a 1½ percentage point lower growth rate of committed loans. We also find that larger stress-test capital buffers lead to material reductions in firms' C&I loan volumes. Specifically, a firm that borrows from BHCs that on a weighted-average basis have a 1 percentage point higher bank capital buffer, exhibits a roughly 4 percentage point lower rate of growth in utilized loans and a roughly 3 percentage point lower rate of growth of committed lines of credit. That said, we find essentially no impact of larger stress-test capital buffers on firms' overall debt volumes, which suggests that firms are able to find other sources of credit to substitute for reduction in their loans from banks subject to stress tests. Likewise, we find that firm investment spending and firm employment are also largely unaffected by stress-test capital buffers.

The results that we obtain for the effects of stress-test capital buffers on bank lending, firm borrowing from banks in our sample, firm overall debt volumes, and firm investment spending and employment, while informative in their own right, can also provide insights on how the CCyB, if activated in the U.S., may also impact these variables. These insights can be drawn from the fact that, under current regulations, the consequences of not meeting stress test implied capital buffer and the CCyB are similar. In particular, both imply limitations on the distribution of bank profits, rather than the more serious outcomes that would occur if bank capital ratios were to not only not satisfy buffers but to also not satisfy minimum regulatory requirements. With regard to the effect of the CCyB our results suggest that activation would likely reduce the lending of the banks to which the buffer applied, where notably these banks are very similar to the 16 banks that we used in our analysis. However, such an activation would have minimal impact on the overall debt volumes, investment spending, and employment of the firms that borrow from these banks.

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Appendix: CCAR stress-test capital buffers, the CCyB, and the "Stress Capital Buffer" proposal

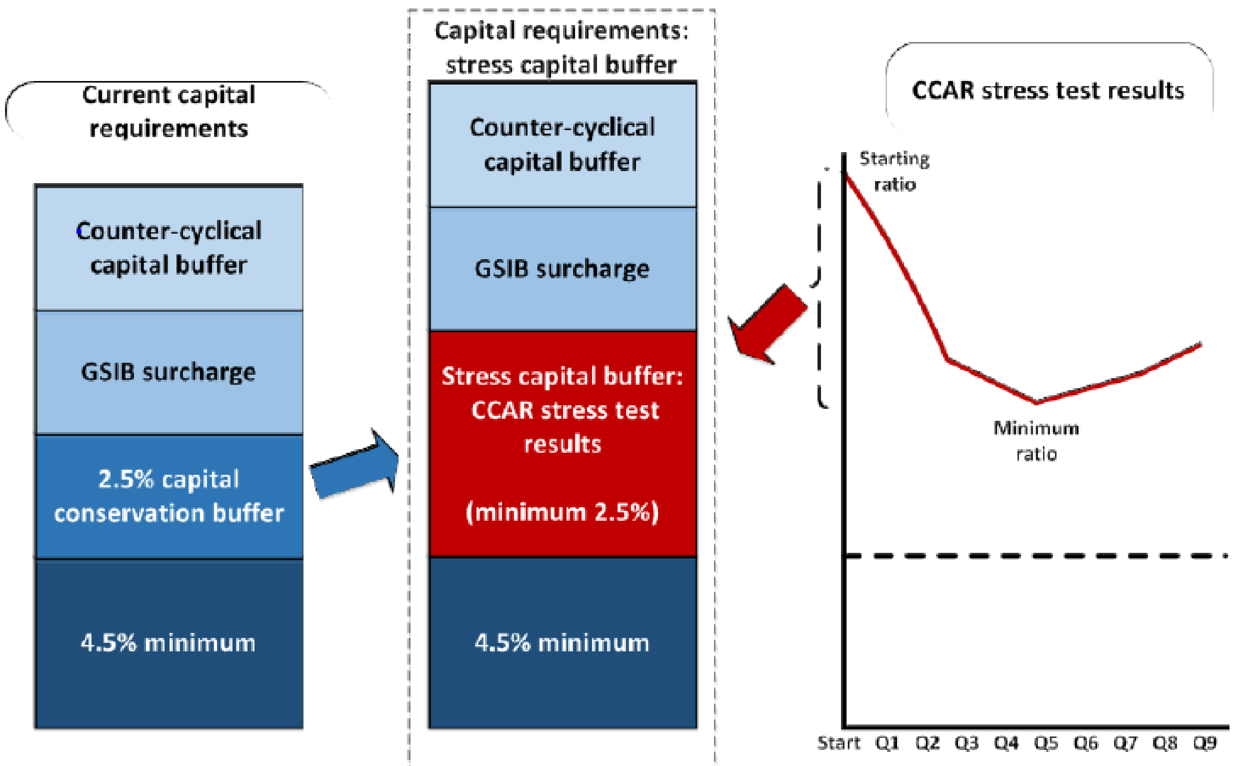
The CCAR stress testing process that involves the Federal Reserve Board analyzing and reviewing the capital distribution plans of BHCs (henceforth banks) reflects an important change in the post-capital regime, which is the requirement that banks must satisfy capital buffers – above regulatory minima – to cover *forward-looking risks*. That is, banks must satisfy capital buffers that would allow them to face a prolonged period of severe stress, resulting in sizable realized losses and declines in actual capital ratios, but that would nonetheless still leave then able to meet minimum capital requirements and, thereby, able to intermediate credit. Currently, the consequence of a bank not holding sufficient capital buffers so as to allow them to satisfy minimum capital requirements even after a prolonged period of severe stress (as characterized by the CCAR stress scenario), is that the Federal Reserve Board would object to their capital distribution plans, based on quantitative concerns. Recall that above we called these buffers "stress-test capital buffers," noted that they were *de facto* capital buffers, and noted that for each bank they were equal to the calculated or *pro forma* amounts of the BHC capital ratios decline in the stress tests.

The post-crisis Basel III capital regime includes several other buffers that all became fully phased-in as of the start of 2019. These buffers – all of which are *de jure* buffers – include the capital conservation buffer of 2½ percentage point applicable to all banks, the global systemically important bank (GSIB) surcharge applicable to the 8 U.S. GSIBs, and (if activated) the CCyB, which can be set up to 2½ percent, applicable to the 16 U.S. internationally active BHCs (or advanced approaches BHCs). The Stress Capital Buffer (SCB) proposal, which the Federal Reserve Board released for public comment in April 2018 (see https://www.federalreserve.gov/newsevents/pressreleases/bcreg20180410a.htm) as a way to simplify its capital rules for large banks, combines these three buffers/surcharges and would also be a *de jure* buffer. Although – and importantly, because this is how the SCB would reflect the forward-looking capital buffers implied by stress tests – the SCB would calibrate the capital conservation buffer to be the maximum of 2½ percentage point or the stress-test capital buffer, similar to the ones we study here.[16] The right-side bar in appendix figure 1 shows how the SCB would be calculated given the forward-looking capital buffer implied by stress tests, the GSIB surcharge, and (if activated) the CCyB,

[16] There is a small technical difference between the buffer in the Federal Reserve Board's April 2018 SCB proposal and the stress-test capital buffers used in our analysis, with respect to plan capital distributions. The buffer in the SCB proposal includes four quarters of capital distributions (quarters four through seven of the 9-quarter planning horizon) in addition to the decline in capital that occurs in the stress test. Our calculation of the stress-test capital buffers include only the decline in capital that occurs in the stress test and excludes any capital distributions.

while the left-side bar shows for comparison capital requirements are currently calculated. The chart to the right depicts a decline in a bank's capital ratio such as that which might occur for a bank in the stress tests and shows how this decline would be translated into that bank's SCB, provided the decline were greater than 2.5 percentage point. (Another bank's SCB would reflect its decline in its capital ratio, again, provided that decline were greater than 2.5 percentage points.) Clearly, therefore, under the SCB proposal the size of the stress-test capital buffer would impact the SCB in the same way that activation of the CCyB would, and it is this similarity that leads us to study how banks and firms respond to differences across banks and over time in stress-test capital buffers to inform the effects of the CCyB.

Appendix Figure 1: Illustration of Stress Capital Buffer



Note: Figure 1 from Tarullo, D., 2016. "Next steps in the evolution of stress testing." Speech given at Yale University School of Management Leaders Forum, September 26, 2016.

There is, however, one point worth noting with regard to us extrapolating to the CCyB how stress-test capital buffers associated with the 2012 to 2016 CCARs influenced bank lending and key firm outcomes. As of the time of writing the SCB is still only a proposal and not a regulation and for the period that we consider the consequences of a bank's capital ratios not exceeding its stress-test capital buffer is that Federal Reserve Board would object to the bank's capital distribution plans based on quantitative concerns. Under the SCB proposal, the consequences of a bank's capital ratios not surpassing minimum capital requirements by at least SCB would be that the bank would face maximum payouts in its capital distributions and discretionary bonuses, where this would depend on the extent to which the BHC was not satisfying the SCB. To be sure, these specific consequences are a little different, although to the extent that both mean that the bank is prevented from making its desired capital distributions, the consequences are similar. It is also worth noting another difference, which is that if the CCyB is activated, banks would have one year to satisfy the larger SCB before maximum payouts would start to take effect, whereas with the buffer implied by stress-test results the SCB that it would imply would need to be satisfied more immediately.

Note also that for the period that we consider the consequences of a bank's capital ratios not exceeding its stress-test capital buffer the capital conservation buffer and GSIB surcharge were being phased in and, as such, were either zero or quite small. (Specifically, the capital conservation buffer was 0.625 percentage point in 2016 and the GSIB surcharge was also small but different for each bank). As noted in section 1, this was one of the reasons we stopped our analysis in 2016. Additionally, for the period that we consider these buffers were not added to the stress-test capital buffer but rather existed alongside the buffers implies by stress tests, although because they were small, in practice, they were not the binding buffer.

Table 1: Summary Statistics for Bank-Firm observations

This table provides summary statistics for all balance sheet variables in the regression analysis using bank-firm observations for the lending by the 16 BHCs in our sample to nonfinancial firms in the FR Y-14Q data. The table reports the number of observations, mean, standard deviation, minimum and maximum values for both BHC variables and firm variables. Source: FR Y-9C, FR Y-14, and FDIC Summary of Deposits.

Variable	Obs.	Mean	Std. Dev.	Min	Max
CCAR BHC VARIABLES					
Total Loan growth	248,201	0.050	0.753	-2.559	2.699
Total committed amount growth	331,430	0.047	0.507	-1.609	1.686
CET1 Capital ratio	331,430	0.106	0.012	0.075	0.163
Tier1 Capital ratio	331,430	0.122	0.011	0.104	0.182
Tier1 Capital ratio Drop (ST Buffer)	331,430	0.028	0.024	-0.014	0.088
Size (log Total assets)	331,430	20.334	1.153	18.288	21.670
Equity / TA	331,430	0.113	0.014	0.077	0.149
ROA	331,430	0.010	0.005	-0.003	0.025
Deposit / TA	331,430	0.614	0.141	0.053	0.796
Liq. Asset / TA	331,430	0.298	0.089	0.146	0.696
Charge-off / TA	331,430	0.377	0.255	-0.001	1.427
C&I Loan / TA	331,430	0.121	0.069	0.002	0.265
Firm Variable					
Size (log Total assets)	257,561	4.273	2.944	-3.972	11.036
Cash / TA	255,956	0.099	0.111	0.000	0.381
Ebitda / TA	256,093	0.077	0.095	-0.064	0.324
Leverage	250,492	0.348	0.260	0.000	0.856
Sales / TA	256,443	2.147	1.530	0.169	5.450
Operating Margin	159,817	0.104	0.112	-0.052	0.398
Tangible Assets/TA	253,060	0.886	0.187	0.347	1.000
Rating A Dummy	324,505	0.146	0.353	0.000	1.000
Rating B Dummy	324,505	0.899	0.301	0.000	1.000
Rating C Dummy	324,505	0.054	0.225	0.000	1.000
Rating D Dummy	324,505	0.005	0.072	0.000	1.000

CCAR BHC and FIRM DATA

Variable	Obs.	Mean	Std. Dev.	Min	Max
CCAR BHC VARIABLES					
Total Loan growth	63,212	0.066	0.818	-2.559	2.699
Total committed amount growth	90,453	0.060	0.507	-1.609	1.686
CET1 Capital ratio	90,453	0.106	0.012	0.075	0.163
Tier1 Capital ratio	90,453	0.122	0.011	0.104	0.182
Tier1 Capital ratio Drop (ST Buffer)	90,453	0.028	0.024	-0.014	0.088
Size (log Total assets)	90,453	20.422	1.118	18.288	21.670
Equity / TA	90,453	0.112	0.015	0.077	0.149
ROA	90,453	0.010	0.004	-0.003	0.025
Deposit / TA	90,453	0.606	0.160	0.053	0.796
Liq. Asset / TA	90,453	0.315	0.092	0.146	0.696
Charge-off / TA	90,453	0.368	0.268	-0.001	1.427
C&I Loan / TA	90,453	0.110	0.069	0.002	0.265
Firm Variable					
Size (log Total assets)	84,192	7.042	2.337	-3.972	11.036
Cash / TA	83,815	0.078	0.095	0.000	0.381
Ebitda / TA	83,949	0.056	0.074	-0.064	0.324
Leverage	82,334	0.363	0.219	0.000	0.856
Sales / TA	84,065	1.325	1.198	0.169	5.450
Operating Margin	52,808	0.094	0.087	-0.052	0.398
Tangible Assets/TA	83,795	0.813	0.217	0.347	1.000
Rating A Dummy	90,103	0.329	0.470	0.000	1.000
Rating B Dummy	90,103	0.926	0.261	0.000	1.000
Rating C Dummy	90,103	0.083	0.276	0.000	1.000
Rating D Dummy	90,103	0.008	0.089	0.000	1.000

Table 2: Impact of post-stress capital declines on BHC loan growth – Panel regressions

This table reports the regression estimates of equation (1). The dependent variable is the loan growth after each of the DFAST exercises between 2012 and 2016 for utilized and committed amounts. All specifications include year and bank fixed effects. Robust standard errors are shown in brackets. *, **, and *** denote statistical significance at 10%, 5%, and 1%, respectively.

	Utilized amounts					Committed amounts				
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ST Buffer	-2.324***	-1.710***	-2.974***			-1.850***	-1.480***	-3.662***		
	[0.350]	[0.385]	[0.238]			[0.208]	[0.225]	[0.124]		
ST Buffer x year 2012				-1.318*	-2.258***				-2.139***	-2.141***
				[0.704]	[0.478]				[0.423]	[0.253]
ST Buffer x year 2013				-3.382***	-3.980***				-2.956***	-3.289***
				[0.521]	[0.349]				[0.290]	[0.171]
ST Buffer x year 2014				-2.081***	-2.468***				-2.005***	-3.305***
				[0.505]	[0.290]				[0.290]	[0.147]
ST Buffer x year 2015				-0.924**	-2.464***				-0.719***	-3.432***
				[0.465]	[0.343]				[0.263]	[0.167]
ST Buffer x year 2016				-2.659***	-5.831***				-3.057***	-9.610***
				[0.862]	[0.480]				[0.445]	[0.259]
Equity Capital ratio		5.656***	2.210***	5.201***	2.886***		5.230***	-0.856***	5.147***	1.542***
		[1.046]	[0.568]	[1.078]	[0.630]		[0.608]	[0.290]	[0.627]	[0.318]
Bank Size		0.645***	0.782***	0.599***	0.525***		0.660***	1.140***	0.640***	0.643***
		[0.132]	[0.081]	[0.138]	[0.097]		[0.075]	[0.043]	[0.084]	[0.048]
Bank ROA		1.79	1.588*	0.916	2.600**		1.312	1.592***	-1.508	0.347
		[1.984]	[0.909]	[2.193]	[1.099]		[1.105]	[0.486]	[1.240]	[0.564]
Bank Net-Charge-off / TA		0.197***	0.215***	0.167***	0.218***		0.180***	0.147***	0.129***	0.161***
		[0.042]	[0.022]	[0.043]	[0.023]		[0.022]	[0.012]	[0.024]	[0.013]
Bank Liq. Asset / TA		0.823***	0.462***	0.909***	0.949***		0.402***	-0.895***	0.600***	-0.03
		[0.238]	[0.151]	[0.251]	[0.168]		[0.136]	[0.081]	[0.142]	[0.086]
Bank Deposit / TA		-0.801***	0.182	-1.004***	-0.559***		-0.843***	1.325***	-0.898***	0.371***
		[0.258]	[0.167]	[0.269]	[0.204]		[0.161]	[0.092]	[0.166]	[0.100]
Bank C&I Loan / TA		2.402***	1.893***	2.439***	2.457***		1.147***	-0.970***	1.313***	-0.412**
		[0.505]	[0.301]	[0.513]	[0.314]		[0.301]	[0.163]	[0.312]	[0.168]
Firm Size			-0.071***		-0.072***			-0.040***		-0.041***
			[0.008]		[0.008]			[0.004]		[0.004]
Firm Cash/TA			0.451***		0.449***			0.113***		0.111***
			[0.060]		[0.060]			[0.025]		[0.025]
Firm Leverage			-0.538***		-0.539***			-0.151***		-0.151***
			[0.026]		[0.026]			[0.013]		[0.013]
Firm Ebitda			0.568***		0.569***			0.249***		0.249***
			[0.059]		[0.060]			[0.026]		[0.026]
Firm Sales / TA			0.014**		0.014**			0.003		0.002
			[0.006]		[0.006]			[0.003]		[0.003]
Firm Rating A Dummy			0.094***		0.090***			0.064***		0.057***
			[0.022]		[0.022]			[0.008]		[0.008]
Firm Rating B Dummy			0.074***		0.081***			-0.006		0.007
			[0.022]		[0.022]			[0.010]		[0.010]
Firm Rating C Dummy			-0.128***		-0.122***			-0.148***		-0.137***
			[0.025]		[0.025]			[0.011]		[0.011]
Firm Rating D Dummy			-0.238***		-0.229***			-0.249***		-0.231***
			[0.061]		[0.061]			[0.036]		[0.036]
Observations	248201	248201	187643	248401	187643	331430	331430	249016	331430	249016
Year Fixed effects	No	No	Yes	No	Yes	No	No	Yes	No	Yes
Firm Fixed effects	No	No	Yes	No	Yes	No	No	Yes	No	Yes
Year - Firm Fixed Effects	Yes	Yes	No	Yes	No	Yes	Yes	No	Yes	No
Bank-Firm FE	Yes	Yes	No	Yes	No	Yes	Yes	No	Yes	No
R-squared	0.81	0.81	0.27	0.81	0.27	0.67	0.67	0.3	0.67	0.31

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Table 3: Summary Statistics for Firm-level observations

This table provides summary statistics for all balance sheet variables in the regression analysis using firm-level observations. The table reports the number of observations, mean, standard deviation, minimum and maximum values for firm variables. Source: FR Y-14.

Variable	Obs.	Mean	Std. Dev.	Min	Max
Firm Variable					
Firm Exposure to ST Buffer	31,758	0.025	0.015	-0.014	0.088
Total Loan growth	31,758	0.080	0.842	-2.614	2.694
Total Committed amount growth	38,713	0.072	0.532	-1.637	1.729
Growth in total debt	30,981	0.107	0.553	-2.290	2.540
Growth in Capex	22,571	0.100	1.513	-8.454	8.880
Growth in Fixed Assets	32,109	0.086	0.409	-1.624	2.246
Size (log Total assets)	28,167	5.620	2.519	-5.185	10.387
Cash / TA	33,375	0.085	0.100	0.000	0.381
Ebitda / TA	33,419	0.062	0.084	-0.064	0.324
Leverage	32,728	0.368	0.239	0.000	
Sales / TA	33,477	1.690	1.372	0.169	5.450
Operating Margin	20,733	0.094	0.099	-0.052	0.398
Tangible Assets/TA	33,287	0.840	0.213	0.347	1.000
Rating A Dummy	38,246	0.202	0.402	0.000	1.000
Rating B Dummy	38,246	0.907	0.291	0.000	1.000
Rating C Dummy	38,246	0.073	0.260	0.000	1.000
Rating D Dummy	38,246	0.007	0.083	0.000	1.000

Table 4: Impact of exposure to post-stress capital declines on firm borrowing – Panel regressions

This table reports the regression estimates of equation (2). The dependent variable is the firm's total loan growth after each of the DFAST exercises between 2012 and 2016 for utilized and committed amounts. All specifications include industry x Year and bank fixed effects. Robust standard errors are shown in brackets. *, **, and *** denote statistical significance at 10%, 5%, and 1%, respectively.

	Utilized Amounts				Committed Amounts			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Firm Exposure	-4.351***		-4.256***		-3.302***		-3.025***	
	[0.655]		[0.724]		[0.298]		[0.329]	
Firm Exposure x year 2012		-4.055***		-4.063***		-1.579***		-1.173**
		[1.204]		[1.385]		[0.521]		[0.547]
Firm Exposure x year 2013		-5.147***		-5.235***		-3.815***		-3.847***
		[0.956]		[1.037]		[0.481]		[0.502]
Firm Exposure x year 2014		-5.073***		-4.865***		-3.529***		-3.118***
		[0.878]		[0.982]		[0.459]		[0.497]
Firm Exposure x year 2015		-3.014***		-2.502**		-3.132***		-2.661***
		[0.960]		[1.086]		[0.420]		[0.461]
Firm Exposure x year 2016		-5.184***		-6.390***		-5.678***		-5.902***
		[1.417]		[1.614]		[0.615]		[0.668]
Firm size			-0.064***	-0.065***			-0.055***	-0.055***
			[0.013]	[0.013]			[0.008]	[0.008]
Firm Cash/TA			0.812***	0.812***			0.146**	0.144**
			[0.153]	[0.153]			[0.071]	[0.071]
Firm Leverage			-0.560***	-0.562***			-0.236***	-0.238***
			[0.055]	[0.055]			[0.030]	[0.030]
Firm Ebitda			0.396***	0.395***			0.231***	0.230***
			[0.144]	[0.144]			[0.078]	[0.078]
Firm Sales/TA			0.02	0.019			0.001	0
			[0.015]	[0.015]			[0.009]	[0.009]
Observations	31758	31758	27385	27385	38713	38713	32563	32563
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry x Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.26	0.26	0.27	0.27	0.32	0.32	0.35	0.35

Table 5: Impact of exposure to post-stress capital declines on firm overall debt – Panel regressions
This table reports the regression estimates of equation (2) for all, publicly traded and private firms. The dependent variable is the firm's overall debt growth after each of the DFAST exercises between 2012 and 2016. All specifications include industry x Year and bank fixed effects. Robust standard errors are shown in brackets. *, **, and *** denote statistical significance at 10%, 5%, and 1%, respectively.

	All Firms				Public				Private			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Firm Exposure	-0.349		-0.205		-0.185		0.023		-0.767*		-0.639	
	[0.341]		[0.320]		[0.539]		[0.474]		[0.450]		[0.441]	
Firm Exposure x year 2012		0.069		0.077		0.064		0.383		-0.318		-0.541
		[0.549]		[0.534]		[0.849]		[0.802]		[0.739]		[0.732]
Firm Exposure x year 2013		-1.008		-1.046*		0.37		0.484		-1.798**		-1.861**
		[0.626]		[0.577]		[1.027]		[0.922]		[0.794]		[0.738]
Firm Exposure x year 2014		0.087		0.212		-0.243		0.171		0.091		0.096
		[0.553]		[0.524]		[0.846]		[0.774]		[0.740]		[0.715]
Firm Exposure x year 2015		-0.875*		-0.536		-0.393		-0.34		-2.022***		-1.193
		[0.495]		[0.456]		[0.650]		[0.578]		[0.779]		[0.744]
Firm Exposure x year 2016		0.654		1.033		-0.574		-0.249		1.257		1.681
		[0.770]		[0.752]		[1.004]		[0.962]		[1.178]		[1.156]
Firm size			-0.271***	-0.271***			-0.201***	-0.200***			-0.296***	-0.296***
			[0.018]	[0.018]			[0.029]	[0.029]			[0.023]	[0.023]
Firm Cash/TA			0.074	0.078			0.292*	0.294*			-0.03	-0.022
			[0.104]	[0.104]			[0.163]	[0.164]			[0.132]	[0.132]
Firm Leverage			-1.250***	-1.250***			-1.381***	-1.381***			-1.205***	-1.203***
			[0.046]	[0.046]			[0.073]	[0.073]			[0.058]	[0.058]
Firm Ebitda			0.231**	0.231**			0.243	0.243			0.234**	0.234**
			[0.094]	[0.094]			[0.165]	[0.165]			[0.114]	[0.114]
Firm Sales/TA			-0.022	-0.023			-0.072**	-0.071**			-0.014	-0.014
			[0.014]	[0.014]			[0.032]	[0.032]			[0.016]	[0.016]
Observations	32154	32154	31170	31170	12110	12110	11791	11791	20044	20044	19379	19379
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry x Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.25	0.25	0.33	0.33	0.25	0.25	0.33	0.33	0.25	0.26	0.34	0.34

Table 6: Impact of exposure to post-stress capital declines on firm investment – Panel regressions

This table reports the regression estimates of equation (2) for all, publicly traded and private firms. The dependent variable is the firm's investment (change in fixed assets) after each of the DFAST exercises between 2012 and 2016. All specifications include industry x Year and bank fixed effects. Robust standard errors are shown in brackets. *, **, and *** denote statistical significance at 10%, 5%, and 1%, respectively.

	All Firms				Public				Private			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Firm Exposure	-0.358		-0.168		-0.251		-0.073		-0.543		-0.334	
	[0.241]		[0.244]		[0.299]		[0.299]		[0.358]		[0.364]	
Firm Exposure x year 2012		1.060***		1.170***		0.353		0.607		1.535**		1.633***
		[0.409]		[0.396]		[0.498]		[0.511]		[0.613]		[0.583]
Firm Exposure x year 2013		-0.722		-0.673		-0.4		-0.1		-1.017		-1.075*
		[0.450]		[0.444]		[0.587]		[0.575]		[0.634]		[0.626]
Firm Exposure x year 2014		-0.869**		-0.659		-0.172		-0.038		-1.474**		-1.256**
		[0.412]		[0.416]		[0.520]		[0.498]		[0.600]		[0.623]
Firm Exposure x year 2015		-0.552*		-0.351		-0.368		-0.351		-0.8		-0.361
		[0.325]		[0.321]		[0.381]		[0.370]		[0.543]		[0.549]
Firm Exposure x year 2016		-0.814		-0.406		-0.741		-0.302		-1.15		-0.767
		[0.508]		[0.503]		[0.635]		[0.633]		[0.791]		[0.779]
Firm size			-0.186***	-0.186***			-0.154***	-0.154***			-0.201***	-0.201***
			[0.015]	[0.015]			[0.021]	[0.021]			[0.020]	[0.020]
Firm Cash/TA			0.152**	0.153**			0.326***	0.329***			0.072	0.069
			[0.071]	[0.071]			[0.105]	[0.105]			[0.094]	[0.093]
Firm Leverage			-0.149***	-0.152***			-0.099**	-0.100**			-0.178***	-0.182***
			[0.030]	[0.030]			[0.042]	[0.042]			[0.040]	[0.040]
Firm Ebitda			0.278***	0.279***			0.301***	0.301***			0.273***	0.276***
			[0.070]	[0.070]			[0.094]	[0.094]			[0.090]	[0.090]
Firm Sales/TA			-0.012	-0.012			-0.012	-0.012			-0.012	-0.013
			[0.012]	[0.012]			[0.025]	[0.025]			[0.014]	[0.014]
Observations	33359	33359	31979	31979	12802	12802	12355	12355	20557	20557	19624	19624
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry x Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.27	0.27	0.3	0.3	0.28	0.28	0.31	0.31	0.26	0.26	0.3	0.3

Table 7: Impact of exposure to post-stress capital declines on county employment growth – Panel regressions

This table reports the regression estimates of equation (2) for the growth of employment at the county level after each of the DFAST exercises between 2012 and 2016. All specifications include year and county fixed effects. Robust standard errors are shown in brackets. *, **, and *** denote statistical significance at 10%, 5%, and 1%, respectively.

	(1)	(2)	(3)	(4)
County Exposure	0.016		0.037	
	[0.038]		[0.038]	
County Exposure x year 2012		0.005		0.016
		[0.063]		[0.062]
County Exposure x year 2013		0.026		0.022
		[0.061]		[0.062]
County Exposure x year 2014		0.017		0.031
		[0.062]		[0.063]
County Exposure x year 2015		-0.062		-0.014
		[0.091]		[0.093]
County Exposure x year 2016		0.052		0.108
		[0.062]		[0.066]
Log Wages			-0.023**	-0.023**
			[0.010]	[0.010]
Log Population			-0.223***	-0.224***
			[0.062]	[0.063]
House price index			0.014***	0.014***
			[0.003]	[0.003]
Observations	13029	13029	12767	12767
R-squared	0.33	0.33	0.33	0.33

Table 8: Summary Statistics for Y-14 – COMPUSTAT firm-level observations

This table provides summary statistics for all balance sheet variables in the regression analysis using firm-level observations from a merged sample of firms in both FR Y-14 and COMPUSTAT datasets. The table reports the number of observations, mean, standard deviation, minimum and maximum values for firm variables.

Variable	Obs.	Mean	Std. Dev.	Min	Max
Firm Variable					
Firm Exposure to ST Buffer	6,344	0.027	0.014	-0.011	0.088
Total Loan growth	6,344	0.108	0.899	-2.243	2.636
Total Committed amount growth	6,341	0.081	0.381	-0.966	1.108
Growth in total debt	5,368	0.116	0.292	-0.409	1.188
Growth in Capex	5,226	0.014	0.403	-0.962	0.943
Growth in Fixed Assets	5,408	0.062	0.141	-0.240	0.482
Growth in Employment	5,292	0.033	0.100	-0.189	0.324
Size (log Total assets)	5,707	7.989	1.387	1.910	10.264
Cash / TA	5,707	0.085	0.107	0.003	0.802
Ebitda / TA	5,702	0.012	0.031	-0.408	0.103
Leverage	5,297	0.295	0.161	0.000	0.605
Sales / TA	5,702	0.318	0.309	0.000	1.576
Operating Margin	5,684	0.030	0.037	-0.385	0.140
Tangible Assets/TA	5,658	0.771	0.208	0.380	1.000
MTB assets	5,305	1.790	0.934	0.797	6.324
MTB equity	5,305	3.342	3.100	0.524	15.129
Rating A Dummy	5,707	0.144	0.351	0.000	1.000
Rating B Dummy	5,707	0.561	0.496	0.000	1.000
Rating C Dummy	5,707	0.087	0.281	0.000	1.000
Rating D Dummy	5,707	0.025	0.156	0.000	1.000

Table 9: Impact of exposure to post-stress capital declines on firm borrowing – Panel regressions

This table reports the regression estimates of equation (2) for the Y-14 – COMPUSTAT merged sample. The dependent variable is the firm's total loan growth after each of the DFAST exercises between 2012 and 2016 for utilized and committed amounts. All specifications include industry x Year and bank fixed effects. Robust standard errors are shown in brackets. *, **, and *** denote statistical significance at 10%, 5%, and 1%, respectively.

	Utilized Amounts				Committed Amounts			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Firm Exposure	-7.265***	-4.923**			-2.445***	-1.583***		
	[1.948]	[2.311]			[0.476]	[0.546]		
Firm Exposure x year 2012			-6.774**	-4.243			-3.200***	-3.098***
			[3.119]	[3.419]			[0.731]	[0.848]
Firm Exposure x year 2013			-7.840***	-7.504**			-3.091***	-1.19
			[2.889]	[3.290]			[0.882]	[0.984]
Firm Exposure x year 2014			-8.982***	-6.891**			-1.746**	-0.84
			[2.602]	[3.020]			[0.764]	[0.866]
Firm Exposure x year 2015			-6.007**	-3			-2.070***	-1.502**
			[2.371]	[2.873]			[0.609]	[0.697]
Firm Exposure x year 2016			-10.219***	-3.655			-2.572***	-0.73
			[3.525]	[4.291]			[0.921]	[1.020]
Firm size		-0.139		-0.137		-0.094***		-0.093***
		[0.095]		[0.095]		[0.030]		[0.030]
Firm Cash/TA		1.213***		1.210***		-0.175		-0.183
		[0.447]		[0.448]		[0.141]		[0.142]
Firm Leverage		-1.093***		-1.109***		-0.468***		-0.470***
		[0.297]		[0.298]		[0.092]		[0.091]
Firm Ebitda		0.682		0.652		0.575**		0.581**
		[0.734]		[0.736]		[0.270]		[0.269]
Firm Sales/TA		-0.538***		-0.534***		-0.160***		-0.168***
		[0.160]		[0.161]		[0.057]		[0.056]
MTB Assets		0.547		0.55		-0.171		-0.162
		[0.398]		[0.398]		[0.131]		[0.131]
Tang. Asset/TA		0.066		0.064		0.078***		0.078***
		[0.045]		[0.045]		[0.016]		[0.016]
Observations	6344	4879	6344	4879	8270	6181	8270	6181
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry x Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.26	0.27	0.26	0.27	0.35	0.36	0.35	0.36

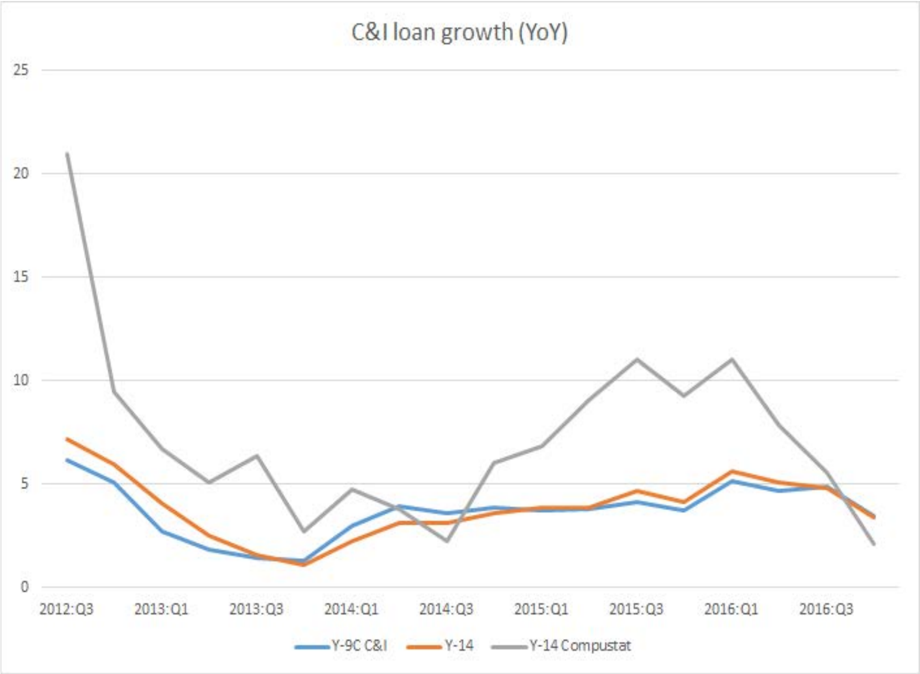
Table 10: Impact of exposure to post-stress capital declines on firm overall debt, investment, and employment – Panel regressions
This table reports the regression estimates of equation (2) for the Y-14 – COMPUSTAT merged sample for all, publicly traded and private firms. The dependent variables are the firm's overall debt growth, investment (change in fixed assets), and change in number of employees, after each of the DFAST exercises between 2012 and 2016. All specifications include industry x Year and bank fixed effects. Robust standard errors are shown in brackets. *, **, and *** denote statistical significance at 10%, 5%, and 1%, respectively.

	Total debt				Investment				Employment			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Firm Exposure	-0.754**	-0.329			-0.152	-0.05			-0.228**	0.034		
	[0.350]	[0.385]			[0.138]	[0.154]			[0.096]	[0.106]		
Firm Exposure x year 2012			-0.121	-0.088			0.14	0.121			-0.086	0.332*
			[0.615]	[0.730]			[0.236]	[0.276]			[0.157]	[0.178]
Firm Exposure x year 2013			-0.857	-0.756			-0.147	0.005			-0.176	0.111
			[0.637]	[0.700]			[0.230]	[0.248]			[0.159]	[0.180]
Firm Exposure x year 2014			-1.503**	-0.889			-0.142	0.072			-0.462***	-0.134
			[0.648]	[0.638]			[0.223]	[0.242]			[0.149]	[0.156]
Firm Exposure x year 2015			-0.583	-0.048			-0.390**	-0.360*			-0.155	-0.081
			[0.421]	[0.447]			[0.178]	[0.191]			[0.132]	[0.148]
Firm Exposure x year 2016			-1.306**	-0.094			-0.094	0.294			-0.430**	-0.069
			[0.551]	[0.625]			[0.257]	[0.289]			[0.189]	[0.200]
Firm size		-0.087***		-0.087***		-0.030***		-0.031***		-0.065***		-0.066***
		[0.026]		[0.026]		[0.011]		[0.011]		[0.008]		[0.008]
Firm Cash/TA		0.131		0.129		0.189***		0.190***		0.173***		0.174***
		[0.127]		[0.127]		[0.052]		[0.052]		[0.034]		[0.034]
Firm Leverage		-1.097***		-1.099***		-0.128***		-0.128***		-0.094***		-0.094***
		[0.084]		[0.084]		[0.036]		[0.036]		[0.025]		[0.025]
Firm Ebitda		-0.045		-0.051		0.585***		0.588***		0.233***		0.233***
		[0.236]		[0.236]		[0.123]		[0.122]		[0.061]		[0.061]
Firm Sales/TA		-0.103		-0.102		-0.008		-0.008		-0.013		-0.012
		[0.078]		[0.079]		[0.021]		[0.021]		[0.015]		[0.015]
MTB Assets		0.031		0.032		-0.187***		-0.186***		-0.051		-0.052
		[0.123]		[0.122]		[0.047]		[0.047]		[0.038]		[0.038]
Tang. Asset/TA		0.092***		0.092***		0.059***		0.059***		0.027***		0.027***
		[0.016]		[0.016]		[0.006]		[0.006]		[0.004]		[0.004]
Observations	7560	6077	7460	6077	7833	6442	7833	6442	7516	6230	7516	6230
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry x Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.32	0.39	0.32	0.39	0.51	0.56	0.51	0.56	0.56	0.6	0.56	0.6

Figure 1: C&I loan growth in FR-Y14 and COMPUSTAT

Figure 1 plots the growth of commercial and industrial (C&I) loans between 2012 and 2016 for the 16 BHCs in our sample using data from regulatory reports FR-Y9C and FR Y-14 (blue and orange lines, respectively), and the merged FR Y-14-COMPUSTAT dataset (gray line). Panel A shows year-over-year growth rates and panel B shows cumulative growth rates.

Panel A: Year over Year (YoY) growth rates



Panel B: Cumulative growth rates (2012:Q3 = 1)

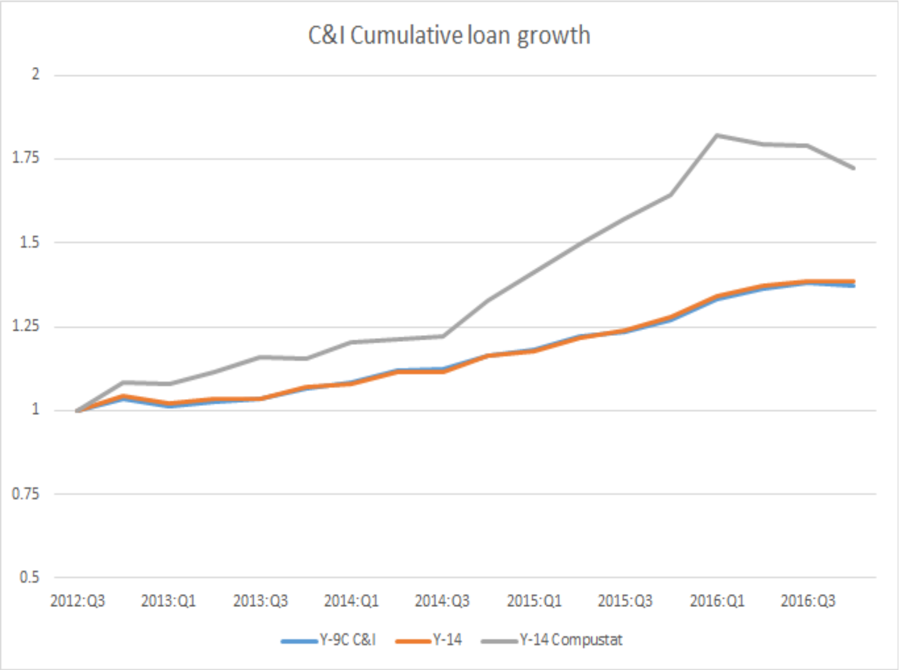
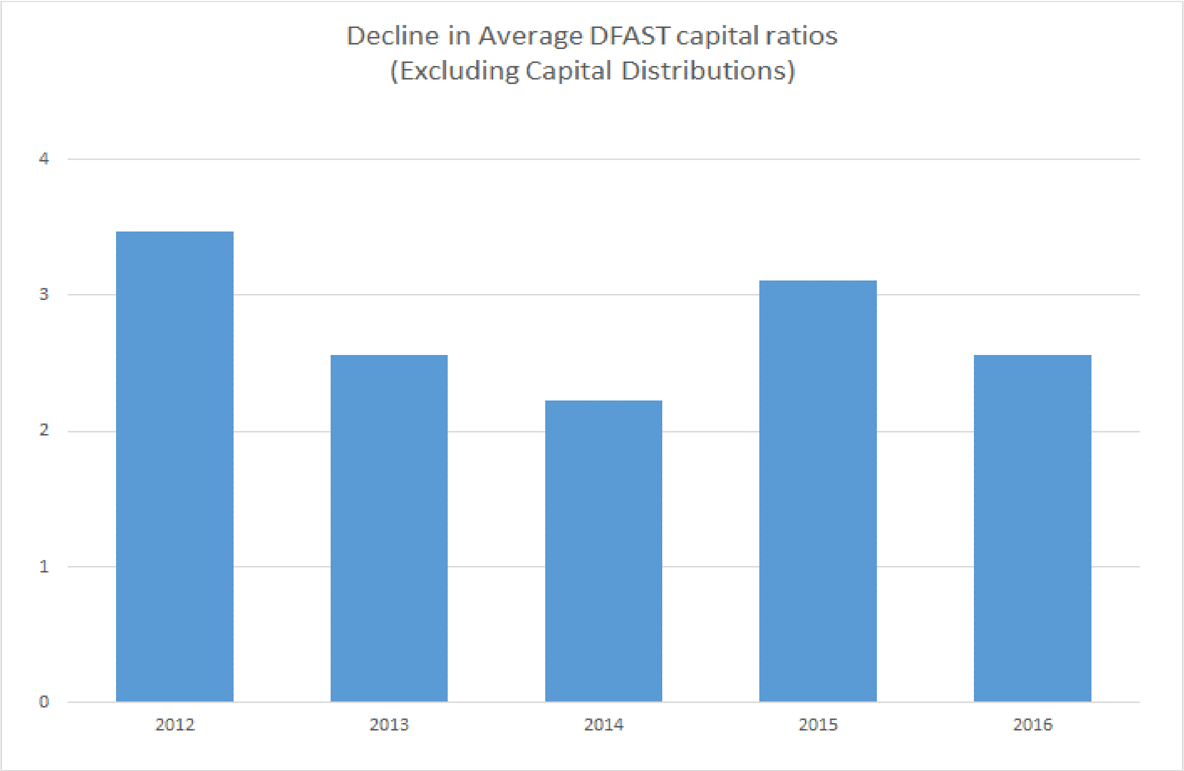


Figure 2: Decline in post-stress capital ratios: 2012 – 2016

Figure 2 shows the decline in post-stress CET1 ratios (from start to minimum) for the average BHC between 2012 and 2016. Capital declines exclude bank capital distributions in the form of dividend payouts and net capital repurchases.



	2012	2013	2014	2015	2016
mean	3.5	2.6	2.2	3.1	2.6
median	3.3	2.8	1.2	2.2	2.3
std dev	2.0	2.7	2.5	2.9	2.0

Figure 3: CET1 ratio by BHCs with large and small post-stress capital declines

Figure 3 plots the CET1 capital ratios for the BHCs in our sample with large and small post-stress capital declines (stress-test capital buffers) between 2009 and 2016 (blue and orange lines, respectively). BHCs with large and small capital buffers are banks for which their 5-year average capital buffer between 2012 and 2016 is above or below the median capital gap.

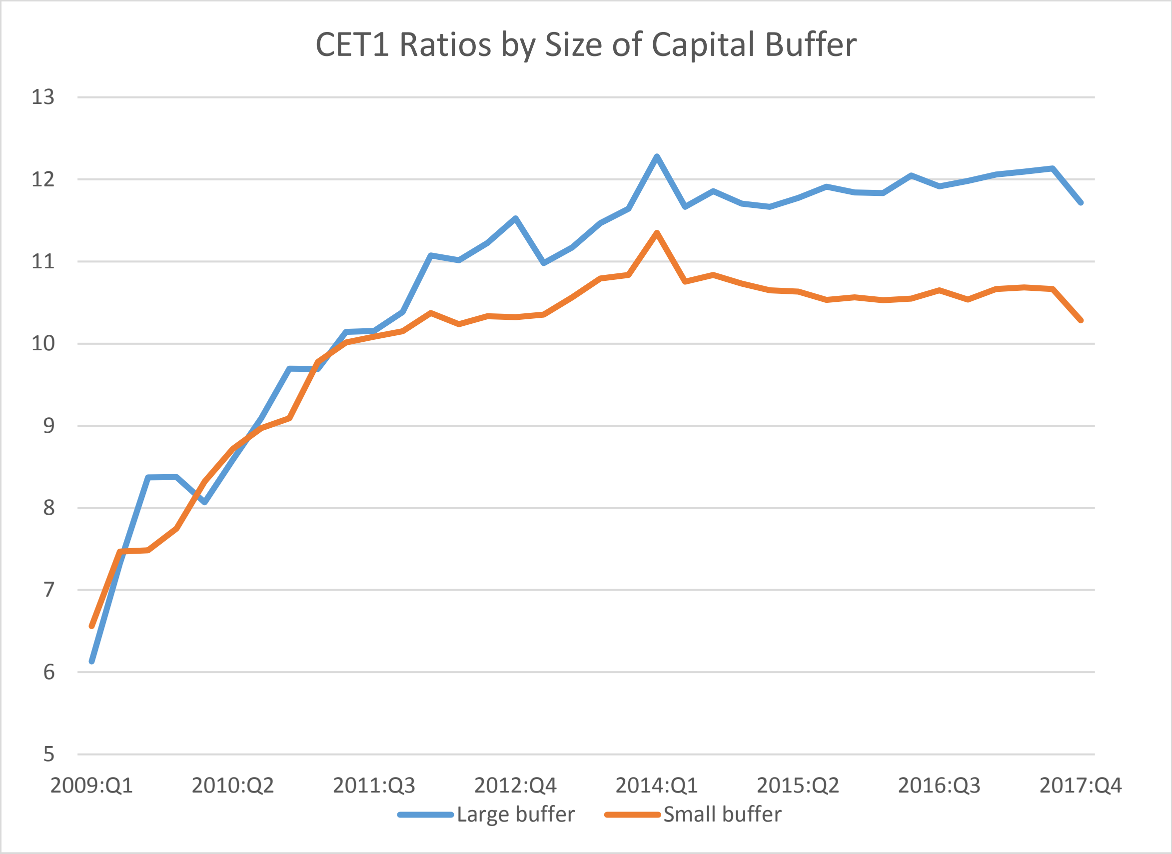
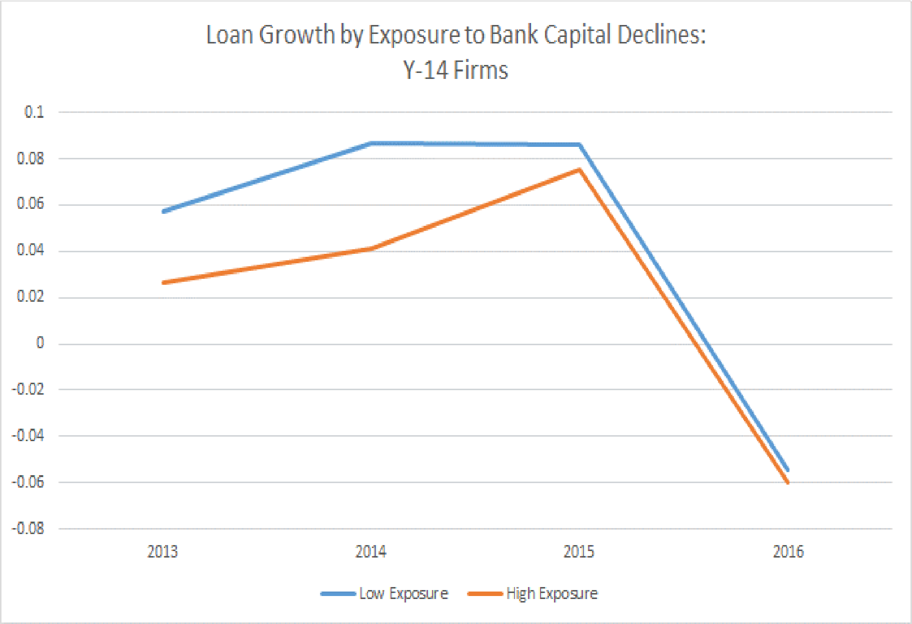


Figure 4: Annual Growth in Bank Loan and Overall Firm Debt, 2013-2016 – FRY-14 Firms

Figure 4 plots the annual growth (after stress tests results are disclosed) of firm borrowing between 2013 and 2016 using data from regulatory reports FR Y-14. The figure shows bank loan growth (panel A) and overall debt growth (panel B), by the size of the firm exposure to the post-stress capital declines (low-exposure firms in blue and high-exposure firms orange lines, respectively).

Panel A: Firm borrowing (loan) growth



Panel B: Firm overall debt growth

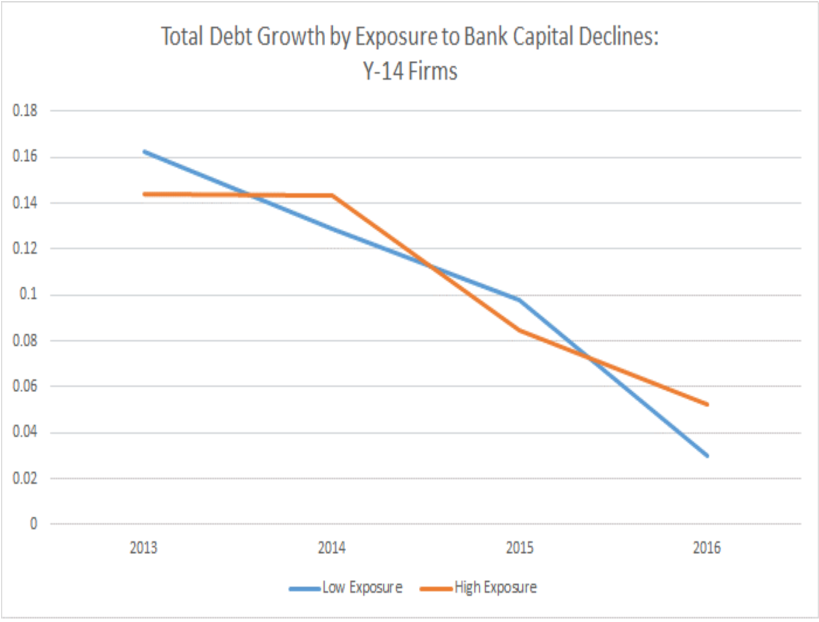


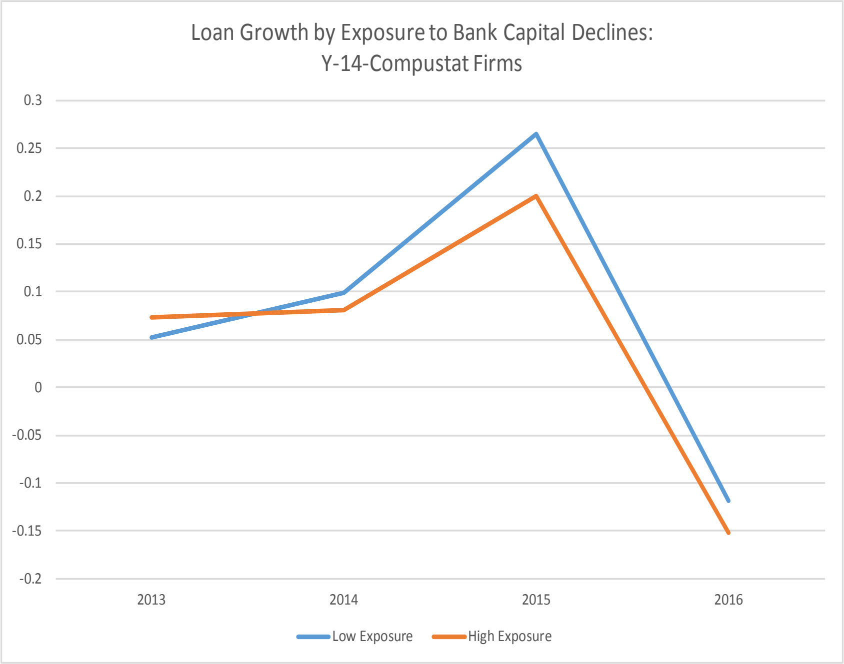
Figure 5: Annual Growth in Bank Loan and Overall Debt, 2013-2016 – Publicly traded and Private firms in FRY-14

Figure 5 plots the annual growth (after stress tests results are disclosed) of firm borrowing between 2013 and 2016 using data from regulatory reports FR Y-14. The figure shows bank loan growth and overall debt growth for publicly traded firms (left column) and private firms (right column), by the size of the firm exposure to the post-stress capital declines (low-exposure firms in blue and high-exposure firms orange lines, respectively).

Figure 6: Annual Growth in Bank Loan and Overall Firm Debt, 2013-2016 – Firms in FRY-14-COMPUSTAT data

Figure 6 plots the annual growth (after stress tests results are disclosed) of firm borrowing between 2013 and 2016 using the FR Y-14-COMPUSTAT merged dataset. The figure shows bank loan growth (panel A) and overall debt growth (panel B), by the size of the firm exposure to the post-stress capital declines (low-exposure firms in blue and high-exposure firms orange lines, respectively).

Panel A: Firm borrowing (loan) growth



Panel B: Firm overall debt growth