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Bank Capital and Real GDP Growth

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Bank Capital and Real GDP Growth

Nina Boyarchenko, Domenico Giannone, and Anna Kovner

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Abstract

We find evidence that bank capital matters for the distribution of future GDP growth but not its central tendency. Growth in the aggregate bank capital ratio compresses the tails of expected GDP growth, a relationship that is particularly robust in reducing the probability of the worst GDP outcomes. These results suggest a role for regulation to mitigate financial crises, with an additional 100 basis points of bank capital reducing the probability of negative GDP growth by 10 percent at the one-year horizon, even controlling for credit growth and financial conditions, and without a significant drag on expected GDP growth.

Key words: capital ratios, growth-at-risk, quantile regressions, threshold regressions

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1 Introduction

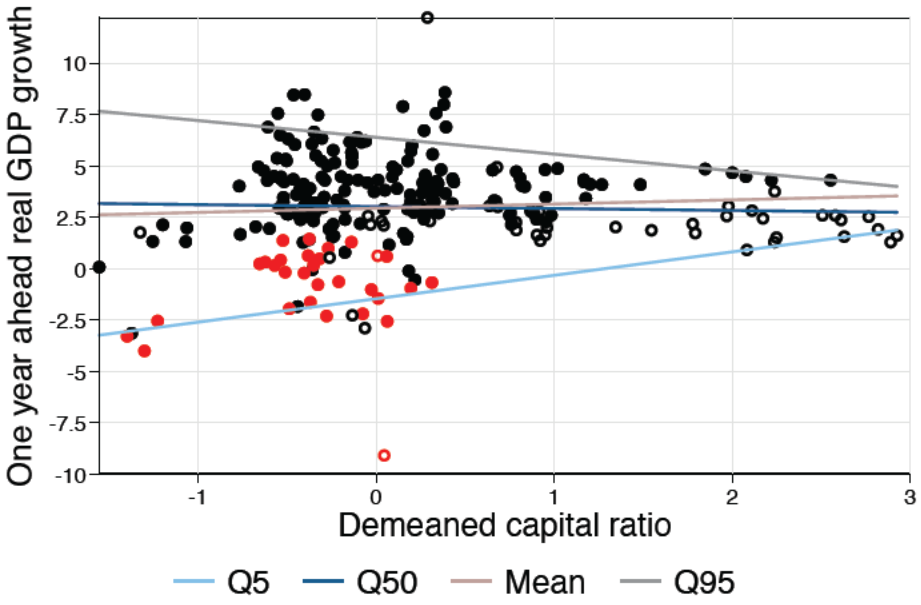
> "Higher levels of bank capital mitigate the risk and adverse effects of a financial crisis but raise the cost of intermediation in normal times."
>
> Seven questions for Janet Yellen on financial stability, Brookings, 2019.

Since the financial crisis, the theoretical macrofinance literature[1] has argued for the importance of bank capital in reducing downside risk of future economic growth. We offer empirical support to that work by mapping the relationship between realized bank capital growth and the distribution of future real GDP growth. We find that increasing bank capital cuts off the expected worst tail of the predicted GDP growth distribution, sharply reducing the probability of the worst GDP outcomes. The tradeoff in terms of the central tendency appears relatively modest, as we estimate limited effects of bank capital on the median predicted GDP growth. However there may be some sacrifice in the right tail, with exuberant growth becoming less likely when banks are better capitalized.

A key contribution of our work is to consider the relationship between capital and the full distribution of economic outcomes, rather than just the relationship at the mean or in the left tail. In this way, we are able to evaluate simultaneously both the potential benefits of capital increases – through the reduction of downside risk – and the potential costs – through the reduction of either the central tendency of growth or upside risk to growth. Figure 1 illustrates our baseline result, which shows the scatter plot of average four-quarter-ahead real GDP growth against realized capital ratios (relative to a trailing five year average), together with the (univariate) quantile regression lines for the 5th, 50th, and 95th quantiles and the OLS regression line. The slope of the 5th quantile best fit line is positive, the 95th quantile slope is negative and the mean/median lines are flat. This means that higher aggregate bank capital ratios are strongly predictive of a smaller left tail of GDP, as the bottom fifth

[1] See e.g. He and Krishnamurthy (2012); Brunnermeier and Sannikov (2014); Gertler and Kiyotaki (2015); Adrian and Boyarchenko (2012) and the literature within.

Figure 1. GDP growth and lagged capital growth. This figure plots one year ahead real GDP growth versus realized capital ratios. Observations shaded in red correspond to NBER recession quarters; hollow circles correspond to observations Q1 2009 and later. Equity capital ratio transitions from the ratio between total equity capital and total assets to the current capital regulatory standard of T1 Common to Risk Weighted assets as comparable fields in regulatory data become available. Capital ratios measured relative to trailing five year averages. Lines show the regressions estimated at the 5th and 95th percentiles as well as the medan and median estimated regression lines.



quantile of future real GDP growth is positively associated with the demeaned capital ratio. But the top fifth quantile is negatively associated with capital ratios and the median is mostly unrelated to capital ratios.

Some of the increased resilience associated with higher capital ratios appears to arise through limiting credit crashes, as we find that higher capital ratios significantly and sharply reduce the likelihood of the worst outcomes for both credit growth and financial conditions. However, the relationship between capital ratios and the left tail of GDP is robust to controlling for both credit growth and financial conditions, meaning that there is a further direct impact of capital ratio growth on the predicted conditional moments of future real GDP growth over and above the indirect impact of capital that occurs through credit and financial conditions. By considering the full distribution of the relationship between capital, credit and outcomes, we add insights both to the work of Brunnermeier, Palia, Sastry, and Sims (2017), which looks at the mean relationship between credit and outcomes, Jordà, Schularick, and Taylor (2013), which focuses on the relationship between credit and GDP conditional on recessions, and Jordà, Richter, Schularick, and Taylor (2021), which considers the duration of recessions conditional on capital growth. The fact that bank capital predicts GDP growth even after controlling for credit is also consistent with theories that suggest there may be nonlinearities in economic outcomes where bank fragilities can amplify the effects of adverse shocks and lead to more severe downturns or, indeed, be a source of adverse shocks themselves.[2]

It is surprising that we do not find much of a relationship between capital and GDP at the median. Micro evidence generally finds that increases in capital requirements are associated with contractions in bank credit supply, at least over the short to medium run (Behn, Haselmann, and Wachtel, 2016; Gropp, Mosk, Ongena, and Wix, 2019; Fraisse, Lé, and Thesmar, 2020; De Jonghe, Dewachter, and Ongena, 2020). This work faces the empirical

[2]See, for example, Mendoza (2010); Brunnermeier and Sannikov (2014); Gertler and Kiyotaki (2015); Adrian and Boyarchenko (2012). For a comprehensive review of the theoretical literature on non-linearities created by financial vulnerabilities, see Ajello, Boyarchenko, Gourio, and Tambalotti (2022).

challenge that identifying the effect of capital on bank credit supply is difficult because higher loan demand can increase capital endogenously via higher profits and retained earnings. Our results suggest that these micro effects do not add up to a large average effect in macroeconomic activity. This could reflect the fact that the analysis is done on a cross section where other banks are stepping in to make up for the change in credit supply, annd that this pattern does not hold in aggregate. It could also be due to a number of other factors. First, banks are not the only providers of credit to non-financial corporations. In fact, in the U.S., bank loans represented only 35 percent of total non-financial corporate credit in 2022, with debt instruments such as commercial paper and corporate bonds representing the other 65 percent. Thus, any aggregate decrease in bank loans could simply be offset by increases in other types of debt. Similarly, if banks do not increase their capital simultaneously, decreases in lending by one bank that increases capital may be offset by increased lending by other banks. Second, periods of economic expansion can correspond to both credit and capital growth, with banks building capital through retained earnings without sacrificing credit provision. Finally, banks may not ration credit proportionally across the full distribution of borrowers. If increases in capital lead banks to reduce credit provision to less productive, riskier borrowers, the impact on average growth is likely to be small, while reducing both the downside to growth due to bank exposure to riskier borrowers and the upside to growth that arises from the possibility of these riskier projects paying off.

Consistent with the hypothesis that higher bank capital growth may result in more rationing of risky borrowers, we find some evidence that capital ratio growth also reduces growth opportunities, as it cuts off the upper tail of GDP growth. This is in line with micro evidence on the impact of stress testing that finds that increases in bank capital requirements led to reallocations of credit away from riskier markets with higher growth potential (Cortés, Demyanyk, Li, Loutskina, and Strahan, 2020). This relationship appears stronger at short horizons, although, in general, the statistical significance is not as robust as we find in the lower quantiles, particularly after including controls for credit growth.

The positive, statistically significant relationship between capital and GDP growth at the 5th percentile persists out to horizons as long as 5 years, suggesting that slow moving bank capital has a long lasting impact. However, the magnitude (and the statistical significance) of the relationship between capital and GDP growth at the 95th percentile appears to fall more quickly, suggesting that the potential sacrifice of exuberant growth in the longer tail at long horizons is not as large, nor as statistically precise as the reduction in the worst outcomes.

The estimated relationship between capital and the left tail of GDP growth is robust to different measures of bank capital, including using levels of bank capital instead of growth rates and using different measures of bank capital. However, an important caveat to the estimated relationships is that we would not necessarily expect the disconnect between bank capital growth and GDP at the median to hold if capital were increased to levels above those captured in our sample. The estimates in this paper are based on capital ratio ranges between 5.5 and 12.9 percent, which are substantially lower than the 20 – 25 percent capital ratios[3] observed pre-WWII. In addition, although it is plausible that in the U.S. market-intermediated credit substitutes somewhat for decreases in bank-intermediated credit, corporate bond and other market debt issuance is supported to some extent by banks. Many nonbank financial intermediaries are intimately related to banks, either because major corporate bond underwriters are subsidiaries of regulated bank holding companies or because banks finance nonbank financial intermediaries.

The rest of the paper is organized as follows. We describe the dataset construction in Section 2. Section 3 describes the baseline relationship between capital and the conditional distribution of future growth. We explore the joint relationship between capital, credit and growth in Section 4. Section 5 explores the robustness of the results with some aditional results relegated to the Appendix. We conclude with implications for policy in Section 6.

[3]See Mitchell (1984) and Walter (2019).

2 Data

2.1 Real outcomes

We measure real outcomes using annualized real GDP growth over h quarters, defined as

$$\Delta \text{GDP}_{t,t+h} \equiv 100 \cdot \left[\left(\frac{\text{GDP}_{t+h}}{\text{GDP}_t} \right)^{4/h} - 1 \right].$$

Figure 2a plots the time series of log real GDP, and Figure 3a the time series of one year ahead real GDP growth. We focus primarily on average one year ahead ($h = 4$) growth, as reflecting the medium term evolution of real outcomes most likely to be relevant for decisions of both economic agents and policy makers.

2.2 Credit data

We measure credit as the sum of the open market paper, corporate bonds, and total loans on the liabilities-side of the domestic non-financial sector's balance sheet in Flow of Funds Table L.100. This departs from the measures used in the literature in two ways. First, we include both loans and debt instruments, instead of focusing on credit provision through loans only. This is a particularly salient point for the U.S. as debt securities represent an increasing fraction of total non-financial borrowing. Second, we focus on debt *borrowed* by the domestic non-financial sector rather than non-financial sector debt *held* by the domestic banking sector, reflecting the gradual shift to greater provision of credit by non-bank financial intermediaries. Using the broad measure of domestic non-financial credit thus allows us to understand the relationship between capital, credit, and real GDP more generally.

We convert the nominal credit series to real terms using the CPI. Figure 2b plots the resultant time series of total real credit extended to the domestic non-financial sector. As with real GDP, we compute the annualized growth rate of real credit to remove trends in

the series. The one year growth rate of real credit is plotted in Figure 3b.

2.3 Financial conditions

We follow the literature and measure financial conditions using the National Financial Conditions Index (NFCI), which provides a weekly estimate of U.S. financial conditions in money markets, debt and equity markets, and the traditional and shadow banking systems. The index is a weighted average of 105 measures of financial activity, each expressed relative to their sample averages and scaled by their sample standard deviations.[4] We convert the weekly time series of NFCI into a quarterly time series by averaging the weekly observations within each quarter, as plotted in Figure 2c.[5]

2.4 Bank capital data

There are a number of trade-offs between compiling a long, consistent time series of data on bank capital and having the right data to understand the relationship between capital, capital requirements and real economic outcomes. The metric most commonly used and for which the longest, consistent time series exist across different countries is the aggregate ratio of equity to assets.[6] We depart from that approach to capture the current regulatory requirements and the extent of intermediation by nonbanks. First, we supplement the panel of commercial banks with data on Bank Holding Companies (BHCs) beginning in 1975. In this way, we sacrifice consistency in panel composition in order to capture more nonbank

[4]The list of indicators is provided here. The methodology for the NFCI is described in Brave and Butters (2012) and is based on the quasi maximum likelihood estimators for large dynamic factor models developed by Doz, Giannone, and Reichlin (2012).

[5]For the attribution of weeks to overlapping quarters we follow the convention of Federal Reserve Economic Data (FRED) Economic Data, which is the source of our data. Weeks that start in one quarter and end in the next one are fully assigned to the latter quarter. For example, a weekly period that starts on Monday August 31 2015 and ends on Friday September 3 2015 is included in the aggregated value for the fourth quarter.

[6]For example, Jordà et al. (2021) construct a series approximating Tier 1 capital which they normalize by total assets. Prior to 1984, they approximate the difference between equity capital and Tier 1 capital to be constant at 1.9%.

intermediaries such as broker dealers.[7] Second, we paste together different measures of equity and assets in order to approximate current capital requirements which are based on Common Equity Tier 1 (CET1) (series begins in 2014) and risk weighted assets (begins in 1996).[8]

The resulting series is shown in Figure 2d. For comparison, a time consistent series constructed only with commercial banks and using total equity over assets is shown in Appendix Figure A.2a. Bank business models and regulatory requirements have changed dramatically over the last century. Therefore, rather than examining levels, we work with capital ratios demeaned relative to a five-year moving average

$$\text{Demeaned capital ratio}_t = \text{Capital ratio}_t - \sum_{l=1}^{20} \frac{\text{Capital ratio}_{t-l}}{20},$$

plotted in Figure 3c.[9] In this way we capture the extent to which bank capital has increased relative to the recent past.

2.5 Sample

We use the longest available sample for our estimation, which is constrained by the availability of capital ratio data. Our main estimation sample thus starts in Q1 1960 and runs through Q2 2022. For specifications that include the NFCI, the estimation sample is restricted by the availability of the NFCI, and thus starts in Q1 1971.

[7] We do this by aggregating U.S. regulatory data on BHCs filing the Y-9C with data from call reports on commercial banks without a top holder, and commercial banks with top holders that do not file the Y-9C. This measure will capture broker dealers that are subsidiaries of bank holding companies, however it will not include stand alone broker dealers. This series is not a consistent panel in the following ways: 1) Y-9C reporting cutoff increases to 500 million in assets in 2006, 1 billion in 2015, and 3 billion in 2018 2) broker-dealers and other financial intermediaries are added to sample as institutions become BHCs after financial crisis (e.g. Goldman Sachs and Morgan Stanley), 3) addition of thrifts to series as thrifts begin to file call reports in 2012.

[8] Prior to 1996 we use Total Equity Capital. After 1996, we use Tier 1 Risk Based Capital. In 2001 we begin to approximate Tier 1 Common Equity, and starting in 2014 we use CET1. We use total assets through 1996 and RWA thereafter as the denominator.

[9] Appendix Figure A.2b plots the demeaned time-consistent capital ratio series constructed only with commercial banks and using total equity over assets.

2.6 Caveats

When evaluating the relationship between bank capital and macroeconomic outcomes, there is no obvious right measure of capital to use. Bank capital may impact aggregate growth through a lending channel – equity allows banks access to uninsured debt and thus limits the effects of a fall in deposits on lending. To the extent that there are regulatory capital requirements and raising equity capital has costly frictions, there is an additional capital channel where banks reduce lending in downturns in order to meet regulatory requirements. In the first case, solvency is the limiting factor, suggesting a capital ratio measure such as equity to assets. The second channel lends itself to a capital measure that analyzes capital in excess of regulatory constraints.[10] The question is particularly salient when trying to compile a long time series of data and variation over time not just on the level of capital requirements, but the type of capital requirement. For example, the financial crisis revealed ex-post that investors valued common equity ratios as a measure of solvency in contrast to capital requirements which were binding on total capital, a measure which included loss absorbing capital other than equity such as subordinated debt with a long maturity.

In the analysis, we present results based on equity ratios with adjustments to build a long time series that converges to CET1 / risk weighted assets. By demeaning relative to long-period trailing averages, we hope to both capture the way in which marginal additional capital affects GDP as well as to estimate counterfactuals that approximate changes to capital requirements.[11] This implicitly assumes that changes to capital requirements are the same as changes to actual capital. If changes to bank buffers to regulatory capital are state dependent, for example, drawing relationships between this analysis and capital requirements is more difficult. For example, the assumption that capital ratios change with capital requirements

[10] We leave aside questions about whether it is the aggregate amount of bank capital that matters, or if it matters how the capital is distributed across banks. Holmstrom and Tirole (1997) argue from a theoretical perspective for the former view, assuming that the risky projects financed by different banks have correlated payoffs.

[11] We estimate an alternative version using capital ratios in levels, and using growth rates of capital ratios. Those results are qualitatively similar.

seems plausible if capital requirements increase, but may be less plausible when requirements are lowered in a recession as envisioned by the Countercyclical Capital Buffer (CCyB).[12] We do not have a long enough time series to estimate if the coefficients on changes in bank capital ratios are symmetric.

The detrended capital ratio shows some heteroskedasticity, as the range of fluctuations has doubled since the mid-90s after the introduction of risk-weighted assets. One possible solution would be to rescale the detrended capital ratio to account for these changes in volatility over time. Such a rescaling, however, would introduce potential look-ahead biases into the estimation. The consequence of not changing the natural scale of the detrended capital ratio is that the regression coefficients estimated will be an average of larger (doubled) coefficients in the first part of the sample and smaller (halved) coefficients in the second part. The increasing volatility of the capital ratio is also likely to generate heteroskedasticity in the residuals, which we account for by conducting heteroskedasticity robust inference.

A potential concern is that the relationships documented between capital and real outcomes may reflect omitted variables rather than a causal link between capital and GDP. Several material factors have changed over time along with bank capital including the nonbank provision of credit, the amount of bank supervision, and the amount of bank competition. Additional possible omitted variables include changes in the separation of ownership and control as banks are increasingly publicly traded (Jensen and Meckling, 1976) as well as changing economies of scale (Hughes and Mester, 2013). To the extent that these changes are correlated with changes in bank capital, our results will be biased in directions that are difficult to establish. However, insofar as these changes are structural and correlate with capital ratios at low frequencies, the biases will mainly affect the interpretation of the predictive relationship at longer horizons.

Finally, capital regulation may be endogenous to macroeconomic conditions, which would suggest that increases in bank capital follow recessions. As shown in Figure 3c, that does not

[12]It is worth noting that the micro evidence that establishes a negative relationship between bank lending and bank capital is primarily established with data points on increases in bank capital, not decreases.

appear to be a feature of the U.S. data. In fact, the fraction of periods with capital increases is similar across recessionary and expansionary sub-samples. This likely reflects the fact that changes in capital are also determined by changes in bank regulation which are not directly correlated with changes in GDP. Further, historical bank capital regulation in the U.S. was focused around capital standards where the binding ratio was often not an equity measure, which meant that even during the boom of the 2000s, bank equity capital was falling.

3 Non-linear relationship between capital and growth

We are interested in studying the relationship between capital ratio growth and the full conditional distribution of real GDP growth. We follow Adrian, Boyarchenko, and Giannone (2019) in characterizing the conditional distribution of future real GDP growth using quantile regressions. In particular, for each horizon h, we parametrize the τ quantile of annualized h quarter real GDP growth as

$$Q_\tau\left(\Delta \text{GDP}_{t,t+h}\right) = \alpha_{\tau,h} + \beta^g_{\tau,h}\Delta \text{GDP}_{t-4,t} + \beta^k_{\tau,h}\text{Demeaned capital ratio}_t + \epsilon_{\tau,h,t}, \quad (1)$$

with $\beta^k_{\tau,h}$ – the relationship between realized demeaned equity capital ratios and the τ^{th} quantile of annualized h quarter real GDP growth – our coefficients of interest. Here and in the rest of the paper, we focus mostly on the conditional distribution of four quarter average log real GDP growth but study how the relationship between capital ratio growth and future real GDP growth changes across horizons in Section 3.2.

3.1 Baseline results

We begin by estimating as a baseline the relationships between capital ratios and the distribution of one year (four quarter) ahead real GDP growth. Table 1 reports the estimated coefficients from the Q5 (Table 1a), Q50 (Table 1b) and Q95 (Table 1c) quantile regressions of one year ahead real GDP growth on lagged real GDP growth and lagged capital ratios.

Consider first the estimates for Q5 regression, which captures the evolution of downside risks to growth. Table 1a shows that capital ratios are positively related to the left tail of future real GDP growth: when capital ratios are high relative to the average capital ratio levels over the previous five years, the bottom fifth percentile of future one year real GDP growth is less negative. The estimated quantile coefficient on the demeaned capital ratio is both statistically and economically significant, with a one percentage point increase in the demeaned capital ratio corresponding to an almost 1 percentage point improvement in the left tail of real GDP growth, a substantial improvement relative to the -1.6% unconditional bottom fifth quantile of one year real GDP growth. Comparing our baseline specification with the specification that only uses realized real GDP growth to predict the distribution of future real GDP growth (Column 1), we see that including capital ratios almost triples the pseudo R^2 of the Q5 regression, again highlighting the economic significance of the demeaned capital ratio in predicting downside risks to future real GDP outcomes.

In contrast, Table 1b shows that capital ratios do not help with predicting the median of future real GDP growth, neither from the perspective of having a statistically significant coefficient nor from the perspective of increasing the pseudo R^2 of the quantile regression. As we discussed in the introduction, this result is perhaps surprising in the context of micro studies that have documented the negative effects of higher capital requirements on credit provision at individual banks.[13] This may reflect that decreases in bank credit provision do not necessarily translate one-for-one into decreases in overall growth. We will come back to the question of the joint relationship between capital ratios, credit, financial conditions and growth in Section 4.

Turning to the right tail of real GDP growth outcomes, Table 1c shows that higher capital ratios are negatively related to the right tail of future real GDP growth: when the demeaned capital ratio is higher, the top fifth percentile of future one year real GDP growth

[13]Notice that, although not statistically significant, the estimated Q50 coefficient on the demeaned capital ratio is negative, so that higher realizations of capital ratios do correspond to decreases in median future real GDP growth.

is less positive. The estimated effect is both statistically and economically significant, with a one percentage point increase in the demeaned capital ratio corresponding to a 0.95 decline in the right tail of future one year real GDP growth, or almost 15% of the level of the unconditional 95th percentile of one year real GDP growth (6.66%). That is, higher capital ratios improve downside risk to future real GDP growth but at the cost of decreases in upside risk to future real GDP growth. Including capital ratios also more than triples the pseudo R^2 of the Q95 regression (Column 1 vs Column 2), though the predictability of the top fifth quantile of average four-quarter-ahead real GDP growth is significantly smaller relative to the predictability of the bottom fifth quantile. This asymmetry in the predictability in the upper and lower quantiles is in line with the growth vulnerability documented by Adrian, Boyarchenko, and Giannone (2021).

We evaluate more broadly the non-linear relationship between the predictor variables and future real GDP growth in Figure 4, which plots the estimated quantile coefficients across quantiles from the quantile regressions of one year real GDP growth on lagged real GDP growth and lagged capital ratios. The figure also plots the 90% confidence intervals computed using Gregory, Lahiri, and Nordman (2018) smooth extended tapered block bootstrap (SETBB) with blocks of length 20 and 1000 simulations. Considering first the estimated coefficients on lagged real GDP growth (left-most column), we see that the relationship between lagged GDP growth and future real GDP growth is mostly linear: the estimated coefficients are roughly equal across quantiles. Including additional predictors does not change the shape of the coefficients across quantiles, and does not decrease the significance of lagged real GDP growth in predicted median average four quarter ahead real GDP growth. In contrast, the bottom right panel of the figure shows that the relationship between the demeaned capital ratio and future real GDP growth is non-linear in both the left and the right tail of the real GDP growth distribution, with the coefficients on the demeaned capital ratio decreasing monotonically with the quantile and becoming negative around the median. Thus, higher capital ratios do not improve the average real GDP growth outlook but do reduce downside

risks and upside opportunities around the baseline mean predicted growth.

3.2 Intertemporal trade-off

Overall, Table 1 and Figure 4 suggest a contemporaneous trade-off at the one year horizon between the tails of the GDP growth distribution: Higher capital ratios predict a decrease in the variability of future real GDP growth (Figure 5b) without an effect on the predicted median (Figure 5a). While the one year horizon may be representative of the medium term evolution of real outcomes most relevant for economic agents, recent literature has documented that financial vulnerabilities evolve at longer horizons (see e.g. Drehmann, Borio, and Tsatsaronis, 2012; Jordà et al., 2013). We now investigate how the relationship between the distribution of future real GDP growth and current equity capital ratios change across the prediction horizon. Table 2 reports the estimated coefficients from the Q5 (Table 2a), Q50 (Table 2b) and Q95 (Table 2c) quantile regressions of annualized real GDP growth on lagged real GDP growth and lagged capital ratios. Table 2a shows that the positive relationship between higher capital ratios and the bottom fifth percentile of real GDP growth persists for up to five years. Although the point estimates of the quantile coefficient on the demeaned capital ratio decline from 1.2 at the one quarter horizon to 0.35 at the five year horizon, the relationship is still economically significant. A one percentage point increase in the demeaned capital ratio implies a 0.35 percentage point improvement in the bottom fifth quantile of five-year-ahead real GDP growth, or almost 40% of the level of the unconditional bottom fifth percentile (0.92). The top right panel of Figure 6 shows that the point estimate is consistently statistically significant with a decline in the point estimate that is monotone across horizons. Notably, although the pseudo R^2 is highest at the one-year-ahead horizon, it remains substantial even at the five-year-ahead horizon.

Turning to the relationship with the right tail of real GDP growth, we see in Table 2c that the negative relationship between the top fifth percentile and the demeaned capital ratio also persists across horizons, though the statistical significance of the point estimates declines

and the point estimate is no longer significant at conventional levels at predictive horizons of around 2.5 years. The bottom right of Figure 6 shows that the decline in the point estimate is also monotone across horizons, and the Q5 coefficient on capital ratios does not converge to the Q95 coefficient even up to 5 years ahead. Putting the estimates across quantiles and horizons together, Table 2 and Figure 6 show that the cost from increased capital ratios is highest for shorter predictive horizons, while the benefit is relatively constant across horizons. That is, it is important to take into account the nonlinear relationship between lagged capital ratios and future real GDP growth even over longer horizons. In contrast, the relationship between lagged GDP growth and future GDP growth appears linear, regardless of the horizon, and the estimated coefficients appear to be converging to 0.

One potential concern with our estimated predicted relationships is the endogeneity of future real activity outcomes and current regulatory changes that lead to capital ratio increases: if regulation is always tightened following downturns, then the additional capital required in the banking sector may lead to lower future growth. However, this mechanism creates an attenuation bias for the estimated median and Q95 coefficients and cannot explain the strong positive relationship between bank capital ratios and the left tail of future GDP growth.

3.3 Understanding the predicted distributions

Putting these estimates together, Figure 7 plots the predicted in-sample and out-of-sample distributions of one year (Figure 7a) and annualized five-year-ahead (Figure 7b) real GDP growth, together with the corresponding realized time series real GDP growth.[14] At the one-year-ahead horizons, we see that the out-of-sample distribution tracks the in-sample distribution but, historically, has more uncertainty around the median (wider distance between

[14]We estimate expanding-window out-of-sample distributions, with the first out-of-sample distribution predicted using 10 years of data (up to Q1 1970). Distribution plotted in quarter t is the predicted distribution for annualized real GDP growth between quarters t and $t+h$. Realized real GDP growth is the realized annualized real GDP growth between quarters t and $t+h$, where $h=4$ in the one year chart and $h=20$ in the five-year-ahead chart.

the top and bottom fifth percentile).

Importantly, the out-of-sample distribution is more pessimistic about the predicted average real GDP growth during the global financial crisis than the in-sample distribution, with both a lower bottom fifth percentile and a lower top fifth percentile, suggesting that the real time distribution does not understate downside risks to the economy. Abrupt, regulation-driven increases in capital ratios lead to noticeable narrowing of the distribution, especially of the out-of-sample distribution, as can be seen in the early 1990s following the introduction of Basel I and in the 2010s following the recapitalization of the U.S. banking system in the wake of the financial crisis. This highlights that, while the out-of-sample estimates are remarkably close to the in-sample estimates, they are only valid over the range of capital ratio realizations "observed" by the estimator. As in any predictive model, the relationship between capital ratios and the conditional distribution of future growth outcomes may thus be substantially different for capital ratios substantially outside those experienced since the 1960s.

At the five-year-ahead horizon, the out-of-sample distribution is somewhat more optimistic than the full-sample distribution in the earlier part of the sample, especially once the Great Moderation period begins. The out-of-sample distribution does settle towards the full-sample distribution in around 2000, and the predicted out-of-sample bottom fifth quantile during the global financial crisis is actually more pessimistic than the full-sample estimate. Appendix Figure A.1 shows that this convergence of the out-of-sample distribution to the full sample distribution comes from a more precise estimate of the positive relationship between bank capital ratios and the downside risk to real GDP growth, and more certainty in the lack of a relationship between bank capital ratios and upside risk to real GDP growth in the long run. Overall, Figure 7b suggests that, although reliable estimation of the five-year-ahead distribution requires a longer time series than estimation of the one-year-ahead distribution, the out-of-sample performance during significant economic downturns remains noticeable.

An alternative way of understanding the implications of changes to the capital ratio for

the predicted real GDP growth distribution is to evaluate how the conditional distribution changes when we consider counterfactual realizations of capital ratios. Figure 8 considers a counterfactual exercise as of Q2 2020, where the counterfactual assumes a demeaned capital ratio two standard deviation lower than the realized demeaned capital ratio (-1.47% vs 0.29% realized demeaned capital ratio; capital ratio 11.13% vs 12.89% realized). This counterfactual exercise can be interpreted as answering the question of what would the distribution of possible real GDP growth outcomes would have looked like if the banking system would have entered the COVID-19 pandemic with capital ratios lower by more than 1.5 p.p. – demeaned capital ratios on par with those observed during the 2007–2009 financial crisis. Figure 8 shows that, at both the one year ahead and five years ahead horizons, the counterfactual distribution with lower bank capital would be much more spread out than the distribution conditional on the actual capital ratios. At the one year ahead horizon, the bottom fifth percentile decreases from -2.47% at the realized capital ratio value to -4.25% for the counterfactual. Although the right tail of the distribution also increases, the improvement in upside risk to one year growth under the counterfactual scenario is much more modest, with the top fifth percentile increasing from 6.52% at the realized capital ratio value to 7.97% for the counterfactual. At the five-year-ahead horizon, the bottom fifth quantile of annualized real GDP growth decreases from 0.62% to 0.02% under the counterfactual scenario, while the top fifth quantile of five-year-ahead annualized real GDP growth increases from 5.19% to 5.90% under the counterfactual.

4 Financial conditions, vulnerabilities and real outcomes

A number of recent papers (see e.g. Adrian et al., 2019; Adrian, Grinberg, Liang, and Malik, 2022; Ghysels, Iania, and Striaukas, 2018; Kiley, 2018, and related literature) study the conditional distribution of near term future real GDP growth and other economic outcomes as a function of an index of realized financial conditions. At the same time, a number of

papers (see e.g. Schularick and Taylor, 2012; Jordà et al., 2021; Greenwood, Hanson, Shleifer, and Sørensen, 2022, and related literature) have highlighted the financial vulnerabilities created in the medium-to-longer run by exuberant credit growth. In this section, we explore whether capital ratios are a mitigating factor to these prior relationships established in the literature.

We proceed as follows. First, we investigate the relationships between future real credit growth, future financial conditions realizations and capital ratios. Understanding the relationship between current capital ratios and future financial vulnerabilities and financial conditions can be informative about the channel through which current capital ratios are related to future real growth outcomes. Second, we study whether capital ratios predict the full conditional distribution of future real GDP growth over and above the predictability from financial conditions and real credit growth. Throughout this section, we focus on the sample common to all three explanatory variables; that is, the sample from Q1 1971 – Q2 2022.

4.1 Nonlinear relationship between capital, financial conditions and credit

We begin with the relationship between the conditional distribution of one-year-ahead real credit growth and capital ratios. As with the conditional distribution of future real GDP growth in Section 3, we parametrize the τ quantile of annualized real credit over h quarters as

$$Q_\tau\left(\Delta\text{credit}_{t,t+h}\right) = \alpha_{\tau,h} + \beta^g_{\tau,h}\Delta\text{GDP}_{t-4,t} + \beta^c_{\tau,h}\Delta\text{credit}_{t-4,t} + \beta^f_{\tau,h}\text{NFCI}_t + \beta^k_{\tau,h}\text{Demeaned capital ratio}_t + \epsilon_{\tau,h,t}.$$

The left column of Table 3 reports the estimated coefficients from the Q5, Q50 and Q95 quantile regression of one-year-ahead real credit growth. Starting with the Q5 quantile

regressions in Table 3a, in column (2) we see that the demeaned capital ratio is positively related to the left tail of future real credit growth, so that higher capital ratios today predict less severe credit contractions in the future. Comparing the pseudo R^2 between columns (1) and (2), we see that including the demeaned capital ratio increases the pseudo R^2 by a third, suggesting that capital ratios do provide predictive information about the bottom fifth quantile of real credit growth. Finally, in column (3), we see that, once we control for contemporaneous financial conditions, capital ratios are not a significant predictor at the one year ahead horizon. That is, in the near term, financial conditions are a better predictor of downside risk to credit growth than bank capital ratios.

Table 4a shows, however, that at horizons longer than one year, bank capital ratios are a significant predictor of the bottom fifth quantile of real credit growth, even after controlling for contemporaneous credit and financial conditions. Furthermore, while tighter financial conditions predict worse tail credit growth outcomes in the near term, the relationship reverses in the longer run, so that tighter financial conditions today predict a smaller left tail of real credit growth at the 4-5 year horizon.

Turning to the other moments of distribution of future real credit growth, Tables 3c and 3e and Tables 4b and 4c show that capital ratios are not related in a statistically significant way to either the median or the right tail of future real credit growth. One potential way of reconciling this non-result with the micro evidence of a negative relationship between capital requirement and credit supply (Behn et al., 2016; Gropp et al., 2019; Fraisse et al., 2020; De Jonghe et al., 2020) is that banks might immediately reduce credit provision to less productive firms when capital ratios rise. At the same time, higher capital ratios today diminish the need for banks to reduce credit provision if conditions deteriorate in the medium run.

Consider now the predictive relationship between capital ratios and future realizations of

financial conditions. In particular, we estimate

$$Q_\tau\left(\text{NFCI}_{t+h}\right) = \alpha_{\tau,h} + \beta^g_{\tau,h}\Delta\text{GDP}_{t-4,t} + \beta^c_{\tau,h}\Delta\text{credit}_{t-4,t} + \beta^f_{\tau,h}\text{NFCI}_t + \beta^k_{\tau,h}\text{Demeaned capital ratio}_t + \epsilon_{\tau,h,t}.$$

The right column of Table 3 reports the estimated coefficients from the Q5, Q50 and Q95 quantile regression of financial conditions in one year's time. Starting with the Q95 quantile regression in Table 3f, in column (2) we see that the demeaned capital ratio is negatively related to the right tail of future financial conditions, so that higher capital ratios today predict less severe tightening of financial conditions in the future. Comparing the pseudo R^2 across columns (1) and (2), we see that including the capital ratio increases the explanatory power of the regression from 39% to 45%, highlighting the predictive information about potential future tightenings of financial conditions contained in capital ratios. Controlling for real credit growth in column (3) does not add any explanatory power and does not reduce the importance of capital ratios as a predictor of Q95 of future financial conditions. Table 5c shows that this negative predictive relationship between capital ratios the right tail of financial conditions realizations persists at horizons up to five years out.

Turning to the other moments of the distribution of future financial conditions, Tables 3b and 3d show that, once we control for credit growth, the demeaned capital ratio is not a statistically significant predictor of either the median or the left tail of financial conditions at the one year horizon. At longer horizons, Table 5a shows that higher capital ratios predict a smaller left tail of financial conditions. That is, while higher capital ratios today reduce the probability of extreme tightening of financial conditions in the future, they also reduce the probability of extreme loosening of financial conditions. This is consistent with theories of financial intermediation, with lower leverage of financial institutions corresponding to less tight financial conditions.

4.2 Nonlinear relationship between financial conditions, financial vulnerabilities and growth

Overall, the results in Tables 3–5 suggest that higher capital ratios reduce downside risk to medium-and-longer term credit growth and the risk of tightening of financial conditions. We now study whether capital ratios contain information about the conditional distribution of future real GDP growth beyond its impact on credit and financial conditions. In particular, we expand quantile regression specification (1) to include credit growth and financial conditions

$$Q_\tau\left(\Delta \text{GDP}_{t,t+h}\right) = \alpha_{\tau,h} + \beta^g_{\tau,h}\Delta \text{GDP}_{t-4,t} + \beta^c_{\tau,h}\Delta \text{credit}_{t-4,t} + \beta^f_{\tau,h}\Delta \text{NFCI}_t + \beta^k_{\tau,h}\Delta \text{Demeaned capital ratio}_t + \epsilon_{\tau,h,t}.$$

Table 6 reports the estimated coefficients from the Q5, Q50 and Q95 quantile regressions for one-year ahead real GDP growth for different combinations of explanatory variables. Across all specifications, including the specification in column (4) which includes future realizations of both real credit growth and financial conditions, higher capital ratios predict smaller left and right tails of one-year-ahead real GDP growth. Thus, capital ratios contain direct predictive information about the conditional distribution of future real GDP growth beyond predicting the distribution of credit growth and financial conditions outcomes. The results in Table 6 and, in particular, in Column (4) of Table 6, highlight that higher capital ratios reduce downside risk to real GDP growth over and above that generated by declines in future credit growth, suggesting that bank capital plays an additional direct role in the economy beyond supporting credit provision.

Table 7 reports the estimated coefficients from the Q5, Q50 and Q95 quantile regressions for annualized real GDP growth across different horizons. The table shows that, while financial conditions and real credit growth predict downside risk to real GDP growth in the

short run, capital ratios remain an economically and statistically significant predictor of the bottom fifth quantile of real GDP at one quarter and one year ahead. At horizons longer than one year, the coefficient on demeaned capital ratios becomes insignificant, and the coefficient on financial conditions switches signs. In the right tail, controlling for real credit growth and financial conditions reduces the statistical significance of capital ratio in the short run, and changes the sign on the point estimate of the coefficient on demeaned capital ratios in the long run. That is, controlling for current financial conditions and credit growth, higher demeaned capital ratios actually predict a larger right tail of real GDP growth in the longer run.

We conclude this section by comparing the conditional distribution of real GDP growth predicted under alternative models. Figure 9 shows that, at the one year horizon, controlling for real credit growth and financial conditions, the predicted distribution has more extreme predictions for the left tail of growth, especially during downturns. At the five year horizon, instead, the expanded model predicts a tighter distribution around median GDP growth than the model that conditions on capital ratios only.

5 Robustness

In this section, we explore the robustness of the relationship between realized capital ratio growth and the conditional distribution of future real GDP growth. We supplement the out-of-sample robustness exercise in Section 3 with four additional exercises: alternative sample cut-offs, alternative standardizations of capital ratios, an alternative estimation approach, and a comparison to the linear models that have been estimated in the prior literature.

5.1 Alternative sample cut-offs

We begin by examining the stability of our baseline results – that higher capital ratios predict a smaller left tail of real GDP growth and a smaller right tail – to alternative samples. In

Table 8, we report the estimated coefficients from the quantile regression (1) for Q5, Q50, and Q95 of one year real GDP growth for our the full sample (Q1 1960 – Q2 2022) as well as for three alternative samples: excluding Q1 2019 – Q2 2022 (excludes real GDP growth observations during COVID-19 pandemic, "Pre-COVID"); excluding Q1 2009 – Q2 2022 (excludes capital observations since the global financial crisis; "Pre-crisis"); and excluding Q1 1996 – Q2 2022 (excludes capital observations after the transition from total assets to RWA as the measure of assets in the capital ratio calculation; "Pre 1996"). While the first two alternative sample cut-offs address any potential concerns about the results being driven by large data outliers, the final exercise addresses potential parameter instability due to definitional shifts in the regulation-consistent capital ratio series.

Across these alternative samples, demeaned capital ratios remain a statistically and economically significant predictor of downside risk to real GDP growth and, in the pre-crisis period, the point estimate of the quantile coefficient on the demeaned capital ratio is twice as large as in the full sample, reflecting the lower volatility of the detrended capital ratio earlier in the sample. In the right tail, the coefficient on the demeaned capital ratio remains negative and, except in the pre-crisis period, statistically significant across alternative sample cut-offs. As can be seen in Appendix Figure A.1, the point estimate of Q95 coefficient is negative starting in 1990 but becomes consistently statistically significant after the global financial crisis. Interestingly, the quantile coefficient on the demeaned capital ratio from the median regression is positive and statistically significant in the pre-crisis sample, suggesting that capital ratio decreases were particularly costly during the pre-crisis period, both from the perspective of the modal path of GDP growth as well as downside risk to GDP growth. This is also consistent with increased growth of the nonbank financial institutions sector.

5.2 Alternative standardizations of capital ratios

In Table 9, we report the estimated coefficients from quantile regression (1) for Q5, Q50, and Q95 of one year real GDP growth for two alternative standardizations of the regulation-

consistent capital ratio: one that demeans the capital ratio relative to a ten year trailing average and one that uses the raw regulation-consistent capital ratio.[15] The results using the capital ratio demeaned relative to a 10 year average are very similar to those using the capital ratio demeaned relative to a 5 year moving average; the point coefficients are slightly smaller but still statistically significant for both the Q5 and the Q95 regression, with similar pseudo-R^2. The raw capital ratio also predicts that increases in capital ratios reduce both upside and downside risk to growth. In addition, the raw capital ratio has a negative relationship with the median of one year ahead real GDP growth, highlighting the importance of taking into account the regulatory environment when comparing capital ratio realizations over time. The last two columns of Table 9 confirm that, while the slow-moving component of capital ratios predicts median growth, it is deviations from that slow moving component that predict downside risk to growth.

5.3 Alternative estimation approach

As argued in Adrian et al. (2019), quantile regressions provide a simple way for characterizing the entire conditional distribution. We now show that our results are genuine features of the data and are robust to the specific estimation method. Instead of quantile regression we estimate a distribution regression, which characterizes the conditional distribution through threshold regressions (Foresi and Peracchi, 1995). For a given threshold κ, we estimate a logistic regression for the probability of average four quarter ahead real GDP growth falling at or below the threshold:

$$\mathbb{P}_t\left(\Delta GDP_{t,t+h} \leq \kappa\right) = \frac{\exp\left\{\alpha_{\kappa,h} + \beta^g_{\kappa,h}\Delta GDP_{t-4,t} + \beta^c_{\kappa,h}\text{Demeaned capital ratio}_t + \epsilon_{\kappa,h,t}\right\}}{1 + \exp\left\{\alpha_{\kappa,h} + \beta^g_{\kappa,h}\Delta GDP_{t-4,t} + \beta^c_{\kappa,h}\text{Demeaned capital ratio}_t + \epsilon_{\kappa,h,t}\right\}}.$$

[15] Additionally, in Appendix A, we show that our results are robust to using a different measure of capital ratio altogether: a time consistent series constructed only with commercial banks and using total equity over assets.

Just as we can trace out the inverse cumulative distribution function by varying the quantile for which the quantile regression is estimated, by estimating threshold regressions for different choices of κ we trace out the cumulative distribution function and thus serves as a natural alternative estimation procedure. The relation between quantile regression and distribution regression is studied in Peracchi (2002) and Chernozhukov, Fernandez-Val, and Melly (2013).

Figure 10 plots the estimated coefficients across thresholds for the one-year-ahead and five-year-ahead horizons, together with heteroskedasticity-robust standard errors around the point estimate. Consistent with past real GDP growth having a linear relationship with future real GDP growth, the coefficient on real GDP growth is roughly constant across cutoffs for both horizons. Turning to the coefficients on the demeaned capital ratio, the right column of Figure 10 shows that the estimated coefficients increase from negative to non-significant as the threshold increases. This is again a re-casting of our baseline result: Higher capital ratios lower the probability of future real GDP growth falling below a low threshold (below 3% at the one year ahead horizon; below 2.25% at the five year ahead horizon). The probability of growth below higher thresholds is instead non-significantly predicted by the capital ratio, in contrast with the results of the quantile regression that pointed to a smaller probability of exuberant growth. Summing up, the threshold-regression estimation approach highlights the robustness of the finding that higher capital ratios predict smaller left tails of the conditional distribution of future real GDP growth, and without a significant drag on normal growth opportunities.

5.4 Relation with the empirical literature on credit, capital and the business cycle

We conclude this section by relating our results to prior literature, examining the relationship between GDP growth, recessions, real credit growth, financial conditions, and capital ratios. This linear approach to studying the relationship between variables of interest is closely related to the approaches undertaken in Brunnermeier et al. (2017) and Jordà et al. (2021).

Credit, capital, and recessions Consider first the relationship between real credit and capital growth and the incidence of recessions. Similarly to Schularick and Taylor (2012), Jordà et al. (2021) and Greenwood et al. (2022), we estimate a logit model for the one-year-ahead probability of NBER recessions as a function of lags of log real credit growth and capital growth

$$\mathbb{P}\left(\text{Recession}_t\right) = \frac{\exp\left\{\alpha + \sum_{l=1}^{5}\beta_{l,c}\Delta\text{credit}_{t-4-l,t-l} + \sum_{l=1}^{5}\beta_{f,l}\overline{\text{NFCI}}_{t-4-l,t-l} + \beta_k\text{Demeaned capital ratio}_{t-4} + \epsilon_t\right\}}{1 + \exp\left\{\alpha + \sum_{l=1}^{5}\beta_{l,c}\Delta\text{credit}_{t-4-l,t-l} + \sum_{l=1}^{5}\beta_{f,l}\overline{\text{NFCI}}_{t-4-l,t-l} + \beta_k\text{Demeaned capital ratio}_{t-4} + \epsilon_t\right\}}.$$

Notice that, if recessions occurred whenever one year real GDP growth dropped below a constant cut-off, this recession logit would correspond exactly to the threshold regressions in Section 5.3.

Table 10a reports the estimated coefficients of the logit regression excluding and including the capital growth terms, respectively. Consider first the estimated coefficients of the logit regression with only real credit growth as predictors. Column (1) confirms the basic result of Schularick and Taylor (2012): while higher credit growth decreases the probability of a recession in the short-run (at the one year horizon), higher credit growth increases the probability of recessions in the long-run (at the one to five year horizon). Column (2) similarly shows that loose financial conditions decrease the probability of a recession in the short run but increase the probability of recessions at the one to five year horizon. Considering the predictive power of capital ratios, Column (3) of Table 10a shows that higher capital ratios decrease the probability of recessions. Comparing the pseudo R^2 across the first three columns, we see that real credit growth has the lowest predictive power (a pseudo R^2 of 2%) while the specification with the demeaned capital ratio has the highest predictive power (pseudo R^2 of 11%). Finally, columns (4) and (5) show that, controlling for the demeaned capital ratio, the relationship between long-run credit growth and future recessions is no longer statistically significant, and the point estimate becomes negative, both in the full sample and in the pre-2009 sample in column (5). The point estimate of the coefficient on the demeaned capital ratio, instead, is only slightly attenuated when we control

for credit growth and financial conditions, suggesting that higher capital ratios attenuate the potential long-run destabilizing effects of credit growth.

Summing up, better capitalization of the banking sector reduces the probability of a recession. This relation is statistically significant and economically relevant, even after controlling for credit and financial conditions. This is in contrast to the results in Jordà et al. (2021), who do not find a relationship between bank capital levels and financial crises. There are important differences, however, between their exercise and ours. First, Jordà et al. (2021) focus on predicting *financial crises* rather than recessions, using a long-history cross-country panel to overcome the small sample of financial crises in any individual country. We focus on predicting NBER recessions as there are only two financial crises in our sample, only one of which corresponds to a recession.[16] Second, we measure credit as total credit borrowed by the domestic non-financial sector through loans and corporate bonds. In contrast, Jordà et al. (2021) measure credit as the loans made to the non-financial sector that are held by banks. This is a particularly salient distinction for the U.S., both as corporate bonds represent an increasingly important source of funding for U.S. corporations and as non-bank financial institutions hold an increasingly larger share of non-financial sector overall debt. Similarly, as we discussed above, while Jordà et al. (2021) measure capital as the ratio of (approximate) Tier 1 capital to total assets for the entire sample, we use a subperiod-specific but regulation consistent definition of the capital ratio.

Credit, capital, and average growth As argued by Brunnermeier et al. (2017), conditioning on recessionary episodes may overstate the detrimental role of credit for growth – and, by extension, understate the benefits of higher capital ratios – as such an approach overlooks any benefits of credit in fueling economic expansions. To that end, we estimate a linear relationship between one year ahead real GDP growth and lags of real GDP growth,

[16] In addition, from a theoretical perspective (see e.g. He and Krishnamurthy, 2012; Brunnermeier and Sannikov, 2014; Adrian and Boyarchenko, 2012), it is not clear that bank capital should only matter for predicting financial crises and not recessions more generally.

real credit growth, financial conditions, and capital growth

$$\Delta \text{GDP}_{t,t+4} = \alpha + \beta_g \Delta \text{GDP}_{t-4,t} + \sum_{l=1}^{5} \beta_{l,c} \Delta \text{credit}_{t-1-l,t-l} + \sum_{l=1}^{5} \beta_{f,l} \overline{\text{NFCI}}_{t-1-l,t-l} + \beta_k \text{Demeaned capital ratio}_{t-1} + \epsilon_t.$$

Table 10b reports the estimated coefficients from the OLS regression. Considering once again the specification with only credit growth first, Column (1) shows that real credit growth is positively related to future real GDP growth in the short-run. That is, higher credit growth is associated in the longer-run with higher recession probabilities and lower average growth but positive growth outcomes in the shorter-run. Next, turning to the specification with financial conditions, Column (2) shows that tighter financial conditions in the longer past correspond to higher average real GDP. Adrian et al. (2022) find a similar reversal in the estimated relationship between credit and real GDP growth across forecast horizons.

Turning to the effect of capital ratios, Column (3) shows that capital ratios are not related in a statistically significant way to future real GDP growth. When we include all the explanatory variables, instead, in Columns (4) and (5), we see that higher credit growth in the short run and tighter financial conditions in the long run still correspond to higher average future real GDP growth, but now the estimated coefficient on the demeaned capital ratio is statistically significant, with higher capital ratios corresponding to higher average real GDP growth.

6 Conclusion

In this paper, we documented that higher capital ratios correspond to a narrowing of the conditional distribution of future real GDP growth around the median. Capital ratios support future real GDP growth over and above their effects on credit growth, suggesting a broader role of bank capital in the economy beyond fueling credit growth.

To understand the implications of our results for countercyclical capital policies, we review the theoretical justifications for countercyclical capital buffers. In financial intermediary general equilibrium models, countercyclical capital requirements act by reducing the cyclicality of banks' ability to take on leverage and thus serve two roles. First, during expansions, countercyclical capital requirements are raised to reduce banks' ability to expand assets and take on greater leverage. During expansions, higher capital requirements thus serve to restrain over-exuberant lending. Second, during contractions, countercyclical capital requirements are lowered, reducing banks' need to shrink their balance sheets thus moderating reductions in bank loans.

In terms of our empirical set up, the activation of a countercyclical capital requirement would lead to higher capital ratios, reducing both the left and the right tail of the real GDP growth distribution. On the other hand, the release of the buffer during downturns would lead to lower capital ratios, making the future distribution of real GDP growth more fragile. Of course this latter effect assumes that changes to capital requirements lead to changes in bank capital ratios, which may not be a realistic assumption if bank managers choose to maintain higher capital during recessions as a projection of strength to investors. An additional caveat to this comes from the fact the estimated relationships between capital growth and GDP growth are based on historical data in which capital requirements did not vary with the business cycle or financial vulnerabilities.

More broadly, our results highlight the complex interactions between bank capital ratios and public policies aimed at supporting economic growth. Our results show that capital ratio growth has predictive power for the tails of future real GDP growth even after controlling for realized future credit growth. Thus, policies that support credit growth may be ineffectual in preventing economic downturns if they are not accompanied by regulations to ensure that financial intermediaries are well capitalized.

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Table 1: Predicting GDP growth tail outcomes. This table reports the coefficients from a quarterly quantile regression of one year ahead real GDP growth on lags of one year real GDP growth and bank equity ratios. Capital ratio is measured relative to lagging five-year averages. It begins with the ratio between total equity capital and total assets and transitions to the current capital regulatory standard of T1 common equity to risk weighted assets as comparable fields in regulatory data become available. 90% confidence intervals computed using Gregory et al. (2018) smooth extended tapered block bootstrap (SETBB) with blocks of length 20 and 1000 simulations reported in parentheses below the point estimates.

(a) Q5

	(1)	(2)
Constant	−2.95	−2.31
	(−5.00, −1.23)	(−3.81, −0.90)
Lagged one year real GDP growth	0.47	0.40
	(0.06, 0.85)	(0.003, 0.74)
Capital ratio		0.99
		(0.56, 1.62)
Pseudo R^2	0.06	0.16
Observations	243	243

(b) Q50

	(1)	(2)
Constant	2.44	2.51
	(1.89, 3.15)	(1.89, 3.31)
Lagged one year real GDP growth	0.21	0.20
	(0.02, 0.33)	(0.01, 0.32)
Capital ratio		−0.04
		(−0.46, 0.32)
Pseudo R^2	0.02	0.02
Observations	243	243

(c) Q95

	(1)	(2)
Constant	7.56	7.66
	(6.72, 9.79)	(6.81, 10.03)
Lagged one year real GDP growth	−0.24	−0.27
	(−0.73, −0.06)	(−0.75, −0.10)
Capital ratio		−0.95
		(−1.92, −0.47)
Pseudo R^2	0.02	0.07
Observations	243	243

Table 2: Predicting GDP growth tail outcomes across horizons. This table reports the coefficients from a quarterly quantile regression of annualized real GDP growth on lags of one year real GDP growth and bank equity ratios. Capital ratio is measured relative to lagging five-year averages. It begins with the ratio between total equity capital and total assets and transitions to the current capital regulatory standard of T1 common equity to risk weighted assets as comparable fields in regulatory data become available. 90% confidence intervals computed using Gregory et al. (2018) smooth extended tapered block bootstrap (SETBB) with blocks of length 20 and 1000 simulations reported in parentheses below the point estimates.

(a) Q5

	1Q	1Y	3Y	5Y
Constant	−4.67	−2.31	−0.07	0.61
	(−6.34, −1.49)	(−3.81, −0.90)	(−1.23, 0.74)	(−0.32, 1.32)
Lagged one year real GDP growth	0.49	0.40	0.18	0.16
	(−0.16, 0.74)	(0.003, 0.74)	(−0.07, 0.41)	(−0.03, 0.39)
Capital ratio	1.26	0.99	0.62	0.35
	(0.42, 2.18)	(0.56, 1.62)	(0.38, 0.98)	(0.17, 0.63)
Pseudo R^2	0.1	0.16	0.11	0.09
Observations	246	243	235	227

(b) Q50

	1Q	1Y	3Y	5Y
Constant	2.30	2.51	2.62	2.73
	(1.55, 3.12)	(1.89, 3.31)	(1.86, 3.11)	(2.17, 3.04)
Lagged one year real GDP growth	0.21	0.20	0.12	0.05
	(−0.01, 0.40)	(0.01, 0.32)	(0.003, 0.35)	(−0.05, 0.19)
Capital ratio	0.22	−0.04	−0.11	−0.15
	(−0.18, 0.57)	(−0.46, 0.32)	(−0.55, 0.14)	(−0.60, −0.02)
Pseudo R^2	0.03	0.02	0.02	0.01
Observations	246	243	235	227

(c) Q95

	1Q	1Y	3Y	5Y
Constant	8.25	7.66	5.66	5.08
	(1.25, 10.28)	(6.81, 10.03)	(5.22, 6.57)	(4.01, 6.02)
Lagged one year real GDP growth	0.14	−0.27	−0.02	0.01
	(−0.27, 1.49)	(−0.75, −0.10)	(−0.20, 0.09)	(−0.13, 0.23)
Capital ratio	−1.21	−0.95	−0.37	−0.40
	(−2.23, −0.21)	(−1.92, −0.47)	(−0.92, 0.14)	(−1.43, 0.06)
Pseudo R^2	0.05	0.07	0.02	0.03
Observations	246	243	235	227

Table 3: Capital, credit and financial conditions. This table reports the coefficients from a quarterly quantile regression of one year ahead real credit growth and NFCI in one year's time on lags of one year real GDP growth, one year real credit growth, financial conditions and bank equity ratios. Capital ratio is measured relative to lagging five-year averages. It begins with the ratio between total equity capital and total assets and transitions to the current capital regulatory standard of T1 common equity to risk weighted assets as comparable fields in regulatory data become available. 90% confidence intervals computed using Gregory et al. (2018) smooth extended tapered block bootstrap (SETBB) with blocks of length 20 and 1000 simulations reported in parentheses below the point estimates.

(a) Q5, credit

	(1)	(2)	(3)
Constant	−3.84	−4.09	−2.99
	(−5.17, −2.34)	(−5.41, −2.40)	(−4.71, −1.59)
Lagged one year real GDP growth	0.21	0.13	0.19
	(−0.19, 0.73)	(−0.37, 0.47)	(−0.30, 0.56)
Lagged one year real credit growth	0.70	0.76	0.59
	(−0.07, 0.60)	(0.33, 0.96)	(0.31, 0.87)
Capital ratio		1.32	0.35
		(0.84, 2.13)	(−0.37, 1.02)
NFCI			−1.24
			(−2.16, −0.53)
Pseudo R^2	0.26	0.33	0.51
Observations	243	243	199

(b) Q5, NFCI

	(1)	(2)	(3)
Constant	−0.80	−0.81	−0.86
	(−0.90, −0.67)	(−0.91, −0.65)	(−1.02, −0.77)
Lagged one year real GDP growth	0.03	0.03	0.01
	(−0.02, 0.06)	(−0.02, 0.07)	(−0.04, 0.04)
NFCI	0.10	0.10	0.11
	(−0.19, 0.12)	(−0.16, 0.13)	(−0.12, 0.14)
Capital ratio		−0.11	0.01
		(−0.26, −0.02)	(−0.05, 0.12)
Lagged one year real credit growth			0.04
			(0.02, 0.08)
Pseudo R^2	0.1	0.12	0.22
Observations	199	199	199

(c) Q50, credit

	(1)	(2)	(3)
Constant	0.37	0.32	0.07
	(−0.93, 1.50)	(−1.19, 1.44)	(−1.44, 1.30)
Lagged one year real GDP growth	0.38	0.32	0.46
	(0.14, 0.88)	(0.19, 0.86)	(0.20, 0.88)
Lagged one year real credit growth	0.65	0.71	0.61
	(0.45, 0.78)	(0.44, 0.80)	(0.42, 0.84)
Capital ratio		0.32	0.08
		(−0.39, 0.60)	(−0.50, 0.46)
NFCI			−0.41
			(−0.93, 0.24)
Pseudo R^2	0.34	0.35	0.45
Observations	243	243	199

(d) Q50, NFCI

	(1)	(2)	(3)
Constant	−0.41	−0.38	−0.38
	(−0.55, −0.19)	(−0.56, −0.17)	(−0.60, −0.16)
Lagged one year real GDP growth	0.09	0.09	0.06
	(0.02, 0.15)	(0.01, 0.14)	(−0.07, 0.12)
NFCI	0.73	0.73	0.74
	(0.54, 1.14)	(0.54, 1.18)	(0.54, 1.22)
Capital ratio		−0.04	−0.02
		(−0.10, 0.12)	(−0.10, 0.21)
Lagged one year real credit growth			0.02
			(−0.02, 0.10)
Pseudo R^2	0.29	0.29	0.3
Observations	199	199	199

(e) Q95, credit

	(1)	(2)	(3)
Constant	4.50	4.45	4.18
	(3.21, 6.37)	(2.87, 6.10)	(2.85, 6.21)
Lagged one year real GDP growth	0.21	0.23	0.35
	(−0.15, 0.51)	(−0.04, 0.62)	(−0.01, 0.70)
Lagged one year real credit growth	0.54	0.54	0.51
	(0.27, 0.79)	(0.26, 0.79)	(0.22, 0.75)
Capital ratio		−0.31	−0.19
		(−1.18, 0.15)	(−0.93, 0.37)
NFCI			0.50
			(0.03, 1.44)
Pseudo R^2	0.32	0.32	0.44
Observations	243	243	199

(f) Q95, NFCI

	(1)	(2)	(3)
Constant	0.81	1.53	1.50
	(−0.21, 1.46)	(0.88, 2.66)	(0.73, 2.67)
Lagged one year real GDP growth	0.16	−0.02	−0.02
	(0.02, 0.47)	(−0.30, 0.12)	(−0.29, 0.10)
NFCI	1.64	1.66	1.67
	(1.42, 2.39)	(1.83, 2.77)	(1.83, 2.99)
Capital ratio		−0.36	−0.34
		(−0.62, −0.02)	(−0.71, 0.17)
Lagged one year real credit growth			0.004
			(−0.12, 0.16)
Pseudo R^2	0.39	0.46	0.46
Observations	199	199	199

Table 4: Predicting credit growth tail outcomes across horizons. This table reports the coefficients from a quarterly quantile regression of annualized real credit growth on lags of one year real GDP growth, one year real credit growth, financial conditions and bank equity ratios. Capital ratio is measured relative to lagging five-year averages. It begins with the ratio between total equity capital and total assets and transitions to the current capital regulatory standard of T1 common equity to risk weighted assets as comparable fields in regulatory data become available. 90% confidence intervals computed using Gregory et al. (2018) smooth extended tapered block bootstrap (SETBB) with blocks of length 20 and 1000 simulations reported in parentheses below the point estimates.

(a) Q5

	1Q	1Y	3Y	5Y
Constant	−4.18	−2.99	−2.38	−1.76
	(−5.85, −2.74)	(−4.71, −1.59)	(−5.07, −0.88)	(−4.60, −0.63)
Lagged one year real GDP growth	0.37	0.19	0.001	0.18
	(−0.13, 0.75)	(−0.30, 0.56)	(−0.50, 0.59)	(−0.19, 0.73)
Lagged one year real credit growth	0.49	0.59	0.38	0.22
	(0.16, 0.82)	(0.31, 0.87)	(0.06, 0.69)	(0.003, 0.51)
Capital ratio	0.10	0.35	1.54	1.47
	(−0.65, 0.80)	(−0.37, 1.02)	(0.77, 2.30)	(0.75, 2.21)
NFCI	−1.50	−1.24	0.17	1.14
	(−2.35, −0.80)	(−2.16, −0.53)	(−0.61, 1.21)	(0.46, 2.02)
Pseudo R^2	0.46	0.51	0.46	0.46
Observations	202	199	191	183

(b) Q50

	1Q	1Y	3Y	5Y
Constant	0.19	0.07	1.52	2.23
	(−1.20, 1.17)	(−1.44, 1.30)	(−0.51, 3.59)	(0.26, 4.00)
Lagged one year real GDP growth	0.29	0.46	0.22	−0.03
	(0.03, 0.62)	(0.20, 0.88)	(−0.24, 0.79)	(−0.53, 0.32)
Lagged one year real credit growth	0.69	0.61	0.32	0.22
	(0.52, 0.90)	(0.42, 0.84)	(0.07, 0.59)	(0.02, 0.50)
Capital ratio	−0.02	0.08	0.22	0.27
	(−0.50, 0.37)	(−0.50, 0.46)	(−1.04, 0.84)	(−0.78, 0.84)
NFCI	−0.67	−0.41	−0.38	0.18
	(−1.19, −0.18)	(−0.93, 0.24)	(−1.28, 0.66)	(−0.68, 0.92)
Pseudo R^2	0.44	0.45	0.29	0.24
Observations	202	199	191	183

(c) Q95

	1Q	1Y	3Y	5Y
Constant	5.07	4.18	5.49	5.14
	(3.80, 6.92)	(2.85, 6.21)	(3.35, 7.82)	(3.23, 7.06)
Lagged one year real GDP growth	0.30	0.35	0.39	0.07
	(−0.12, 0.79)	(−0.01, 0.70)	(0.05, 0.81)	(−0.24, 0.38)
Lagged one year real credit growth	0.83	0.51	0.11	0.30
	(0.53, 1.17)	(0.22, 0.75)	(−0.39, 0.46)	(−0.002, 0.67)
Capital ratio	−0.98	−0.19	0.30	0.29
	(−1.80, −0.40)	(−0.93, 0.37)	(−0.59, 1.21)	(−0.59, 1.06)
NFCI	−0.10	0.50	1.10	0.94
	(−0.74, 0.64)	(0.03, 1.44)	(0.52, 2.31)	(0.47, 1.99)
Pseudo R^2	0.39	0.44	0.25	0.26
Observations	202	199	191	183

Table 5: Predicting financial conditions tail outcomes across horizons. This table reports the coefficients from a quarterly quantile regression of future NFCI realizations on lags of one year real GDP growth, one year real credit growth, financial conditions and bank equity ratios. Capital ratio is measured relative to lagging five-year averages. It begins with the ratio between total equity capital and total assets and transitions to the current capital regulatory standard of T1 common equity to risk weighted assets as comparable fields in regulatory data become available. 90% confidence intervals computed using Gregory et al. (2018) smooth extended tapered block bootstrap (SETBB) with blocks of length 20 and 1000 simulations reported in parentheses below the point estimates.

(a) Q5

	1Q	1Y	3Y	5Y
Constant	−0.55	−0.86	−0.92	−0.78
	(−0.69, −0.39)	(−1.02, −0.77)	(−1.12, −0.71)	(−0.88, −0.61)
Lagged one year real GDP growth	0.004	0.01	−0.04	−0.000
	(−0.04, 0.02)	(−0.04, 0.04)	(−0.11, 0.003)	(−0.06, 0.05)
NFCI	0.53	0.11	−0.01	0.03
	(0.42, 0.62)	(−0.12, 0.14)	(−0.21, 0.06)	(−0.06, 0.30)
Capital ratio	0.03	0.01	0.14	0.05
	(−0.01, 0.17)	(−0.05, 0.12)	(0.05, 0.32)	(−0.07, 0.25)
Lagged one year real credit growth	0.02	0.04	0.06	−0.01
	(0.01, 0.06)	(0.02, 0.08)	(0.01, 0.13)	(−0.05, 0.02)
Pseudo R^2	0.43	0.22	0.18	0.23
Observations	202	199	191	183

(b) Q50

	1Q	1Y	3Y	5Y
Constant	−0.15	−0.38	−0.64	−0.64
	(−0.28, −0.07)	(−0.60, −0.16)	(−1.20, −0.51)	(−1.63, −0.57)
Lagged one year real GDP growth	0.02	0.06	0.03	0.05
	(−0.01, 0.04)	(−0.07, 0.12)	(−0.11, 0.10)	(−0.03, 0.12)
NFCI	0.87	0.74	0.24	0.11
	(0.73, 1.02)	(0.54, 1.22)	(0.10, 0.53)	(0.005, 0.52)
Capital ratio	−0.01	−0.02	0.05	0.02
	(−0.03, 0.06)	(−0.10, 0.21)	(−0.04, 0.48)	(−0.08, 0.52)
Lagged one year real credit growth	0.003	0.02	0.05	0.02
	(−0.01, 0.02)	(−0.02, 0.10)	(0.01, 0.14)	(−0.01, 0.18)
Pseudo R^2	0.6	0.3	0.19	0.27
Observations	202	199	191	183

(c) Q95

	1Q	1Y	3Y	5Y
Constant	0.62	1.50	0.98	2.55
	(0.06, 0.85)	(0.73, 2.67)	(−0.35, 1.69)	(1.99, 4.62)
Lagged one year real GDP growth	0.03	−0.02	0.34	0.13
	(−0.02, 0.15)	(−0.29, 0.10)	(0.23, 0.74)	(−0.12, 0.36)
NFCI	1.40	1.67	0.41	−0.27
	(1.24, 1.84)	(1.83, 2.99)	(−0.23, 1.06)	(−0.79, −0.01)
Capital ratio	−0.16	−0.34	−0.72	−1.17
	(−0.33, 0.06)	(−0.71, 0.17)	(−1.38, −0.32)	(−2.37, −1.18)
Lagged one year real credit growth	−0.004	0.004	−0.004	−0.27
	(−0.04, 0.08)	(−0.12, 0.16)	(−0.18, 0.15)	(−0.59, −0.15)
Pseudo R^2	0.7	0.46	0.3	0.38
Observations	202	199	191	183

Table 6: Predicting GDP growth tail outcomes with alternative models. This table reports the coefficients from a quarterly quantile regression of one year ahead real GDP growth on lags of one year real GDP growth, one year real credit growth, financial conditions and bank equity ratios. Capital ratio is measured relative to lagging five-year averages. It begins with the ratio between total equity capital and total assets and transitions to the current capital regulatory standard of T1 common equity to risk weighted assets as comparable fields in regulatory data become available. 90% confidence intervals computed using Gregory et al. (2018) smooth extended tapered block bootstrap (SETBB) with blocks of length 20 and 1000 simulations reported in parentheses below the point estimates.

(a) Q5

	(1)	(2)	(3)	(4)
Constant	−2.31	−2.64	−2.57	−2.04
	(−4.47, −1.46)	(−4.49, −1.38)	(−4.71, −1.59)	(−4.05, −1.47)
Lagged one year real GDP growth	0.40	−0.11	−0.06	−0.08
	(0.01, 0.96)	(−0.69, 0.26)	(−0.55, 0.34)	(−0.42, 0.37)
Capital ratio	0.99	1.80	1.60	1.35
	(0.49, 1.69)	(1.44, 2.65)	(1.20, 2.54)	(1.01, 2.15)
Lagged one year real credit growth		0.54	0.52	0.52
		(0.36, 0.92)	(0.34, 0.84)	(0.42, 0.93)
NFCI			−0.33	0.93
			(−0.80, 0.40)	(0.50, 1.73)
Future one year real credit growth				−0.01
				(−0.36, 0.12)
Future NFCI				−1.22
				(−1.85, −0.55)
Pseudo R^2	0.16	0.24	0.42	0.47
Observations	243	243	199	199

(b) Q50

	(1)	(2)	(3)	(4)
Constant	2.51	2.23	2.42	2.04
	(1.39, 2.81)	(1.06, 2.70)	(1.33, 3.32)	(1.21, 2.87)
Lagged one year real GDP growth	0.20	−0.03	−0.06	−0.11
	(0.06, 0.42)	(−0.24, 0.23)	(−0.31, 0.18)	(−0.32, 0.13)
Capital ratio	−0.04	0.34	0.18	0.14
	(−0.53, 0.47)	(−0.02, 1.02)	(−0.40, 0.73)	(−0.36, 0.61)
Lagged one year real credit growth		0.23	0.13	−0.13
		(0.07, 0.38)	(0.03, 0.33)	(−0.29, 0.02)
NFCI			−0.48	0.28
			(−0.86, 0.05)	(0.005, 0.74)
Future one year real credit growth				0.43
				(0.28, 0.62)
Future NFCI				−0.65
				(−1.17, −0.09)
Pseudo R^2	0.02	0.06	0.26	0.39
Observations	243	243	199	199

(c) Q95

	(1)	(2)	(3)	(4)
Constant	7.66	6.24	6.17	5.51
	(6.91, 10.38)	(4.71, 8.31)	(4.56, 8.17)	(5.16, 7.05)
Lagged one year real GDP growth	−0.27	−0.41	−0.43	−0.60
	(−0.73, −0.24)	(−1.04, −0.36)	(−1.07, −0.32)	(−1.12, −0.58)
Capital ratio	−0.95	−0.56	−0.47	−0.36
	(−2.33, −0.34)	(−1.48, 0.12)	(−1.44, 0.11)	(−0.97, 0.19)
Lagged one year real credit growth		0.42	0.40	−0.09
		(0.27, 0.92)	(0.28, 0.93)	(−0.17, 0.30)
NFCI			−0.04	−0.68
			(−0.86, 0.65)	(−1.41, −0.18)
Future one year real credit growth				0.58
				(0.33, 0.88)
Future NFCI				0.52
				(−0.21, 1.11)
Pseudo R^2	0.07	0.18	0.32	0.47
Observations	243	243	199	199

Table 7: Predicting GDP growth tail outcomes with full model. This table reports the coefficients from a quarterly quantile regression of annualized real GDP growth on lags of one year real GDP growth, one year real credit growth, financial conditions and bank equity ratios. Capital ratio is measured relative to lagging five-year averages. It begins with the ratio between total equity capital and total assets and transitions to the current capital regulatory standard of T1 common equity to risk weighted assets as comparable fields in regulatory data become available. 90% confidence intervals computed using Gregory et al. (2018) smooth extended tapered block bootstrap (SETBB) with blocks of length 20 and 1000 simulations reported in parentheses below the point estimates.

(a) Q5

	1Q	1Y	3Y	5Y
Constant	−4.19	−2.57	0.24	1.04
	(−6.47, −2.53)	(−4.71, −1.59)	(−1.45, 0.91)	(−0.37, 1.55)
Lagged one year real GDP growth	0.25	−0.06	0.07	0.06
	(−0.20, 0.74)	(−0.55, 0.34)	(−0.16, 0.47)	(−0.08, 0.31)
Capital ratio	1.40	1.60	0.59	0.36
	(0.73, 2.27)	(1.20, 2.54)	(−0.07, 1.05)	(−0.27, 0.70)
Lagged one year real credit growth	0.45	0.52	−0.03	−0.01
	(0.16, 0.82)	(0.34, 0.84)	(−0.30, 0.16)	(−0.15, 0.15)
NFCI	−1.47	−0.33	−0.06	0.55
	(−2.21, −0.77)	(−0.80, 0.40)	(−0.65, 0.57)	(0.23, 1.08)
Pseudo R^2	0.36	0.42	0.35	0.42
Observations	202	199	191	183

(b) Q50

	1Q	1Y	3Y	5Y
Constant	1.95	2.42	2.50	2.58
	(1.06, 2.55)	(1.33, 3.32)	(1.36, 3.24)	(1.82, 3.39)
Lagged one year real GDP growth	−0.03	−0.06	−0.08	−0.005
	(−0.30, 0.16)	(−0.31, 0.18)	(−0.29, 0.12)	(−0.13, 0.16)
Capital ratio	0.38	0.18	0.004	−0.01
	(0.000, 0.90)	(−0.40, 0.73)	(−0.92, 0.47)	(−1.11, 0.24)
Lagged one year real credit growth	0.17	0.13	0.06	0.02
	(0.10, 0.36)	(0.03, 0.33)	(−0.05, 0.33)	(−0.08, 0.15)
NFCI	−0.69	−0.48	−0.11	0.27
	(−1.11, −0.21)	(−0.86, 0.05)	(−0.60, 0.56)	(−0.14, 0.82)
Pseudo R^2	0.28	0.26	0.28	0.32
Observations	202	199	191	183

(c) Q95

	1Q	1Y	3Y	5Y
Constant	7.94	6.17	5.16	3.94
	(6.71, 10.72)	(4.56, 8.17)	(4.57, 6.76)	(3.19, 4.56)
Lagged one year real GDP growth	−0.37	−0.43	−0.03	−0.02
	(−1.21, −0.11)	(−1.07, −0.32)	(−0.17, 0.17)	(−0.14, 0.13)
Capital ratio	−0.44	−0.47	0.16	0.75
	(−1.36, 0.32)	(−1.44, 0.11)	(−0.53, 0.94)	(0.26, 1.49)
Lagged one year real credit growth	0.48	0.40	−0.12	0.003
	(0.34, 1.12)	(0.28, 0.93)	(−0.45, −0.01)	(−0.15, 0.13)
NFCI	0.61	−0.04	0.16	0.30
	(−0.09, 1.67)	(−0.86, 0.65)	(−0.26, 0.66)	(−0.003, 0.73)
Pseudo R^2	0.22	0.32	0.36	0.48
Observations	202	199	191	183

Table 8: Predicting GDP growth tail outcomes: alternative sample cut-offs. This table reports the coefficients from a quarterly quantile regression of one year ahead real GDP growth on lags of one year real GDP growth and bank equity ratios for alternative sample cut-offs. Baseline sample: Q1 1960 – Q2 2022. Capital ratio is measured relative to lagging five-year averages. It begins with the ratio between total equity capital and total assets and transitions to the current capital regulatory standard of T1 common equity to risk weighted assets as comparable fields in regulatory data become available. 90% confidence intervals computed using Gregory et al. (2018) smooth extended tapered block bootstrap (SETBB) with blocks of length 20 and 1000 simulations reported in parentheses below the point estimates.

(a) Q5

	Full sample	Pre-COVID	Pre-crisis	Pre 1996
Constant	−2.31	−2.21	−1.99	−1.97
	(−3.81, −0.90)	(−3.99, −1.10)	(−4.37, −0.83)	(−4.01, −0.33)
Lagged one year real GDP growth	0.40	0.38	0.41	0.38
	(0.003, 0.74)	(0.03, 0.72)	(0.10, 0.86)	(−0.01, 0.79)
Capital ratio	0.99	0.97	2.05	2.32
	(0.56, 1.62)	(0.54, 1.56)	(1.34, 2.94)	(1.45, 3.18)
Pseudo R^2	0.16	0.19	0.22	0.1
Observations	243	236	196	144

(b) Q50

	Full sample	Pre-COVID	Pre-crisis	Pre 1996
Constant	2.51	2.46	2.90	3.30
	(1.89, 3.31)	(1.74, 3.15)	(1.96, 3.64)	(2.21, 4.37)
Lagged one year real GDP growth	0.20	0.22	0.14	0.10
	(0.01, 0.32)	(0.05, 0.38)	(−0.03, 0.33)	(−0.10, 0.33)
Capital ratio	−0.04	−0.03	0.71	−0.18
	(−0.46, 0.32)	(−0.47, 0.34)	(0.38, 1.20)	(−0.82, 0.41)
Pseudo R^2	0.02	0.03	0.06	0.01
Observations	243	236	196	144

(c) Q95

	Full sample	Pre-COVID	Pre-crisis	Pre 1996
Constant	7.66	6.50	7.62	7.66
	(6.81, 10.03)	(5.38, 8.19)	(6.48, 9.34)	(6.47, 9.48)
Lagged one year real GDP growth	−0.27	−0.03	−0.23	−0.10
	(−0.75, −0.10)	(−0.39, 0.23)	(−0.58, 0.02)	(−0.45, 0.19)
Capital ratio	−0.95	−0.83	−0.61	−0.46
	(−1.92, −0.47)	(−1.77, −0.33)	(−1.49, 0.02)	(−1.52, 0.59)
Pseudo R^2	0.07	0.05	0.01	0.02
Observations	243	236	196	144

Table 9: Predicting GDP growth tail outcomes: alternative capital standardization. This table reports the coefficients from a quarterly quantile regression of one year ahead real GDP growth on lags of one year real GDP growth and bank equity ratios for alternative normalizations of the capital ratio. In the baseline, capital ratio is measured relative to lagging five-year averages. It begins with the ratio between total equity capital and total assets and transitions to the current capital regulatory standard of T1 common equity to risk weighted assets as comparable fields in regulatory data become available. 90% confidence intervals computed using Gregory et al. (2018) smooth extended tapered block bootstrap (SETBB) with blocks of length 20 and 1000 simulations reported in parentheses below the point estimates.

(a) Q5

	Baseline	10Y demeaned	Raw	MA5	MA10
Constant	−2.31	−2.40	−4.92	−1.59	−0.64
	(−3.81, −0.90)	(−3.88, −0.75)	(−9.78, −1.81)	(−7.44, 3.14)	(−7.34, 5.02)
Lagged one year real GDP growth	0.40	0.47	0.40	0.46	0.43
	(0.003, 0.74)	(0.05, 0.83)	(0.04, 0.79)	(0.09, 0.80)	(0.10, 0.77)
Capital ratio	0.99	0.86	0.37	−0.19	−0.28
	(0.56, 1.62)	(0.54, 1.44)	(0.01, 0.95)	(−0.85, 0.60)	(−1.16, 0.60)
Pseudo R^2	0.16	0.17	0.06	0.07	0.08
Observations	243	243	243	243	243

(b) Q50

	Baseline	10Y demeaned	Raw	MA5	MA10
Constant	2.51	2.57	4.03	4.36	4.91
	(1.89, 3.31)	(1.94, 3.45)	(2.63, 6.02)	(2.80, 6.17)	(3.01, 7.04)
Lagged one year real GDP growth	0.20	0.19	0.16	0.17	0.16
	(0.01, 0.32)	(−0.01, 0.32)	(−0.03, 0.28)	(−0.02, 0.29)	(−0.02, 0.27)
Capital ratio	−0.04	−0.09	−0.17	−0.22	−0.30
	(−0.46, 0.32)	(−0.38, 0.18)	(−0.34, −0.02)	(−0.40, −0.04)	(−0.52, −0.06)
Pseudo R^2	0.02	0.02	0.04	0.05	0.05
Observations	243	243	243	243	243

(c) Q95

	Baseline	10Y demeaned	Raw	MA5	MA10
Constant	7.66	7.50	12.76	12.14	9.57
	(6.81, 10.03)	(6.59, 9.89)	(10.32, 16.28)	(9.08, 16.35)	(4.57, 15.30)
Lagged one year real GDP growth	−0.27	−0.24	−0.30	−0.23	−0.15
	(−0.75, −0.10)	(−0.75, −0.07)	(−0.81, −0.13)	(−0.74, −0.06)	(−0.67, 0.02)
Capital ratio	−0.95	−0.65	−0.65	−0.62	−0.32
	(−1.92, −0.47)	(−1.05, −0.25)	(−0.98, −0.34)	(−1.10, −0.19)	(−0.96, 0.40)
Pseudo R^2	0.07	0.09	0.09	0.05	0.03
Observations	243	243	243	243	243

Table 10: Linear relationship between capital and real outcomes. This table reports the coefficients from a quarterly logit regression of NBER recession indicators on lags of real credit growth, financial conditions and bank equity ratios (Table 10a), and from a quarterly linear regression of one year ahead real GDP growth on lags of real GDP growth, real credit growth, financial conditions and capital ratio growth (Table 10b). Credit defined as the sum of non-financial corporate business commercial paper and corporate bonds outstanding and total loans extended to the non-financial sectors in the U.S. economy. Capital ratio is measured relative to lagging five-year averages. It begins with the ratio between total equity capital and total assets and transitions to the current capital regulatory standard of T1 common equity to risk weighted assets as comparable fields in regulatory data become available. Heteroskedasticity-robust standard errors included in parentheses below the point estimates.

(a) One year ahead recession probability

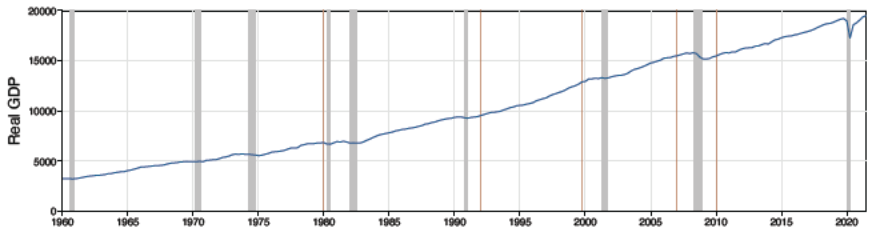
	(1)	(2)	(3)	(4)	(5)
Constant	-2.58	-2.02	-2.14	-3.36	-3.82
	(0.33)***	(0.23)***	(0.21)***	(0.77)***	(0.78)***
L.Y1 real credit growth	-0.01			0.35	0.40
	(0.06)			(0.12)***	(0.12)***
L.Y5-Y1 real credit growth	0.15			-0.09	-0.05
	(0.06)**			(0.15)	(0.15)
L.Y1 average NFCI		0.72		1.60	1.78
		(0.22)***		(0.43)***	(0.43)***
L.Y5-Y1 average NFCI		-0.90		-1.67	-1.72
		(0.41)**		(0.52)***	(0.54)***
L.Capital ratio			-1.44	-1.23	-1.19
			(0.30)***	(0.43)***	(0.46)***
AIC	179.96	146.66	162.45	130.70	117.95
Pseudo R^2	0.02	0.06	0.11	0.21	0.18
N. obs	242	197	242	197	154

(b) One year ahead average growth

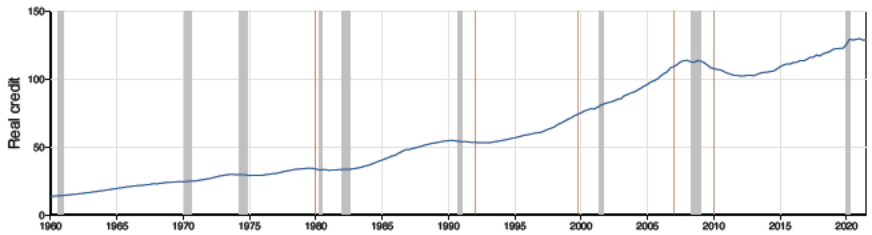
	(1)	(2)	(3)	(4)	(5)
Constant	2.79	3.14	2.83	2.49	3.62
	(0.30)***	(0.27)***	(0.29)***	(0.50)***	(0.45)***
L.Y1 real credit growth	0.22			0.18	0.14
	(0.05)***			(0.05)***	(0.06)**
L.Y5-Y1 real credit growth	-0.07			0.02	-0.07
	(0.05)			(0.07)	(0.08)
L.Y1 average NFCI		-0.62		-0.21	-0.54
		(0.24)**		(0.29)	(0.28)*
L.Y5-Y1 average NFCI		1.44		1.23	1.42
		(0.25)***		(0.28)***	(0.28)***
L.Capital ratio			0.17	0.62	1.36
			(0.15)	(0.26)**	(0.27)***
AIC	1117.42	895.33	1128.24	891.44	647.25
Adj. R^2	0.04	0.10	-0.00	0.13	0.28
N. obs	242	197	242	197	151

Figure 2. Raw data. This figure plots the time series of real GDP, real credit, and aggregate capital ratio, together with NBER recession shadings and capital regulatory regime changes. Credit defined as the sum of non-financial corporate business commercial paper and corporate bonds outstanding and total loans extended to the non-financial sectors in the U.S. economy. Equity capital ratio transitions from the ratio between total equity capital and total assets to the current capital regulatory standard of T1 Common to Risk Weighted assets as comparable fields in regulatory data become available. Notable breaks in the composition of the panel include changes to the Y-9C reporting cut-off to $500 million in 2006q1, the change in charter of financial institutions in the wake of the financial crisis in 2009q1 (e.g. Goldman Sachs, Morgan Stanley), and the addition of thrifts to the time series as they begin filing call reports in 2012q1. Notable changes to the definition of the equity capital ratio occur in 1996q2 where the denominator changes from total assets to risk weighted assets and in 2001q1 where the numerator changes to approximate CET1 from total equity capital. Capital regulatory regime changes defined as: 1970q1: Depository Institutions Deregulation and Monetary Control Act, 1992q1: Basel 1, 1999q4: Graham-Leach-Bliley, and 2010q1: Dodd Frank Act.

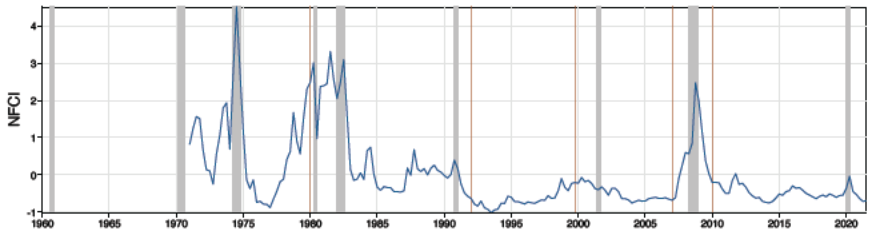
(a) Real GDP



(b) Real credit



(c) NFCI



(d) Equity capital ratio

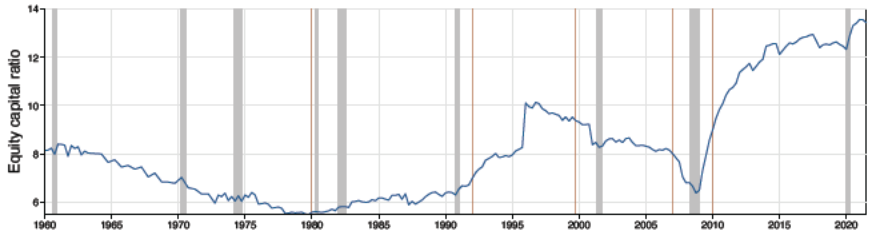
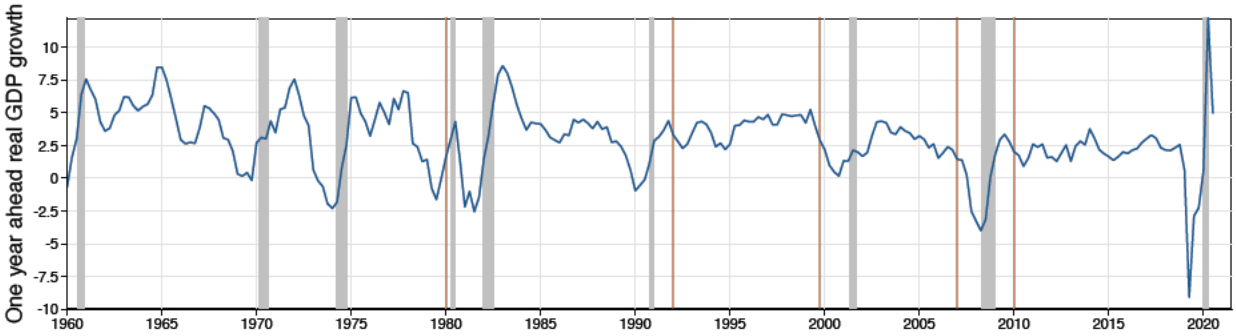
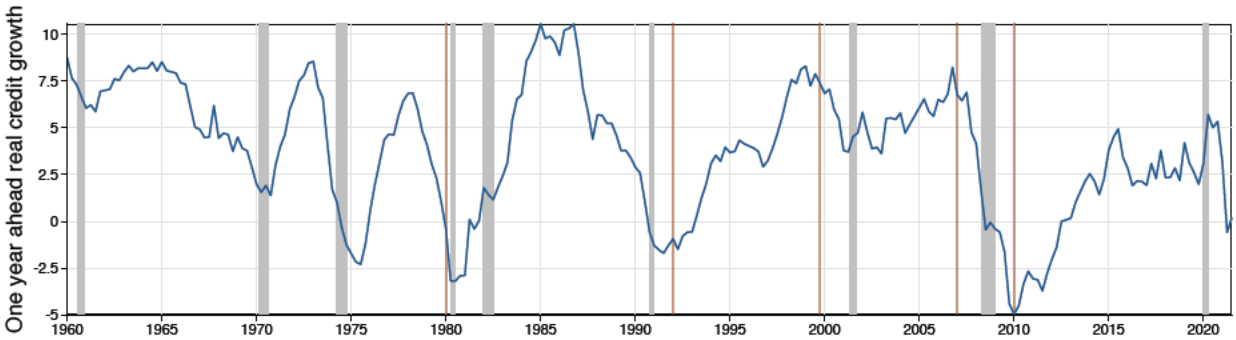


Figure 3. De-trended data. This figure plots the time series of one year ahead growth rate of real GDP and real credit, and equity capital ratio measured relative to lagging five-year averages, together with NBER recession shadings and capital regulatory regime changes. Credit defined as the sum of non-financial corporate business commercial paper and corporate bonds outstanding and total loans extended to the non-financial sectors in the U.S. economy. Equity capital ratio transitions from the ratio between total equity capital and total assets to the current capital regulatory standard of T1 Common equity to Risk Weighted assets as comparable fields in regulatory data become available.

(a) Real GDP growth



(b) Real credit growth



(c) Detrended equity capital ratio

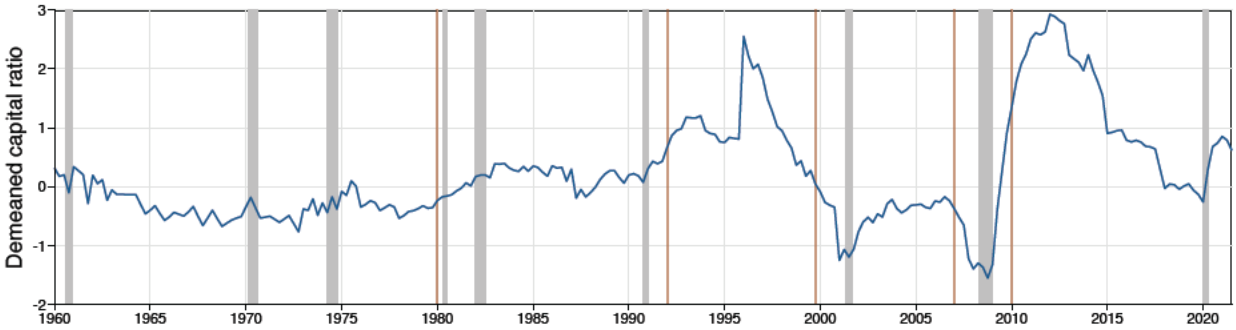


Figure 4. Estimated quantile regression coefficients. This figure plots the estimated coefficients in quantile regression of one year ahead real GDP growth on lags of one year real GDP growth and bank equity ratios. Equity capital ratio transitions from the ratio between total equity capital and total assets to the current capital regulatory standard of T1 Common to Risk Weighted assets as comparable fields in regulatory data become available. Capital ratios measured relative to lagging five-year averages. First row corresponds to the model with lagged real GDP growth only; second row to the full model. We report 90% confidence intervals computed using Gregory et al. (2018) smooth extended tapered block bootstrap (SETBB) with blocks of length 20 and 1000 simulations.

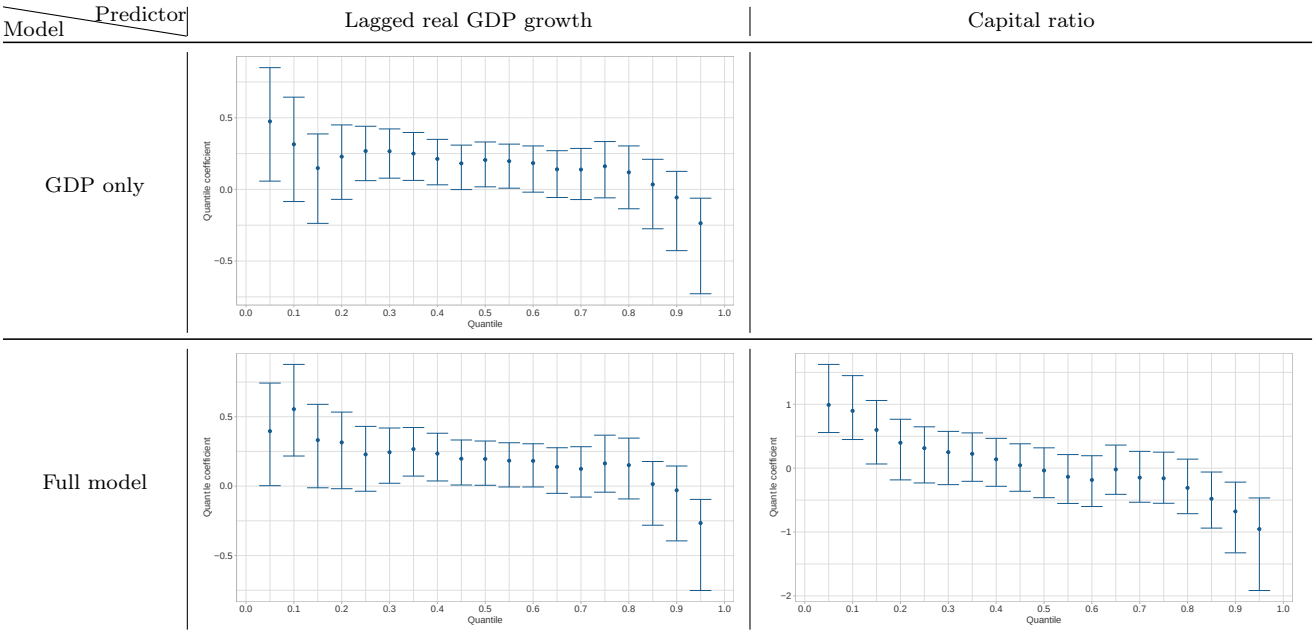
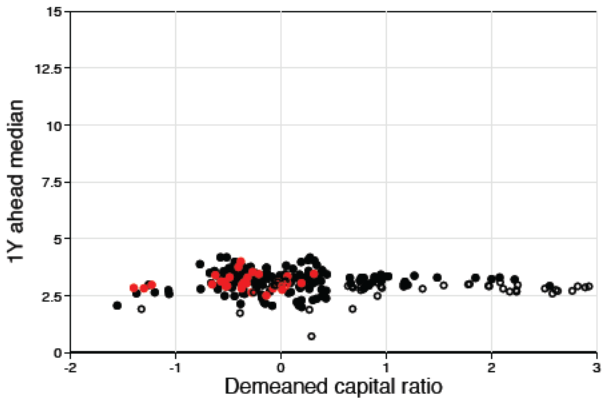


Figure 5. Examining predicted distributions. This figure plots the predicted median one year ahead real GDP growth versus the demeaned capital ratio (Figure 5a), as well as the predicted Q95-Q5 interquantile range of one year ahead real GDP growth versus the demeaned capital ratio (Figure 5b). Observations shaded in red correspond to NBER recession quarters; hollow circles correspond to observations Q1 2009 and later. Equity capital ratio transitions from the ratio between total equity capital and total assets to the current capital regulatory standard of T1 Common to Risk Weighted assets as comparable fields in regulatory data become available. Capital ratios measured relative to lagging five-year averages.

(a) No relationship at the median



(b) Negative relationship with variance

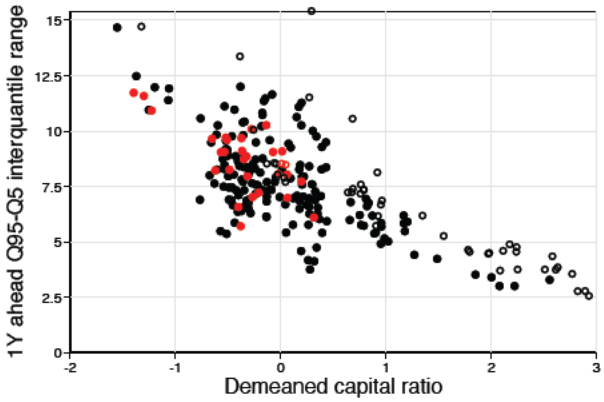


Figure 6. Estimated quantile regression coefficients across horizon. This figure plots the estimated coefficients in quantile regression of annualized real GDP growth on lags of one year real GDP growth and bank equity ratios. Equity capital ratio transitions from the ratio between total equity capital and total assets to the current capital regulatory standard of T1 Common to Risk Weighted assets as comparable fields in regulatory data become available. Capital ratios measured relative to lagging five-year averages. First row corresponds to estimated coefficients for bottom fifth quantile; second row to estimated coefficients for the median; third row corresponds to estimated coefficients for top fifth quantile. We report 90% confidence intervals computed using Gregory et al. (2018) smooth extended tapered block bootstrap (SETBB) with blocks of length 20 and 1000 simulations.

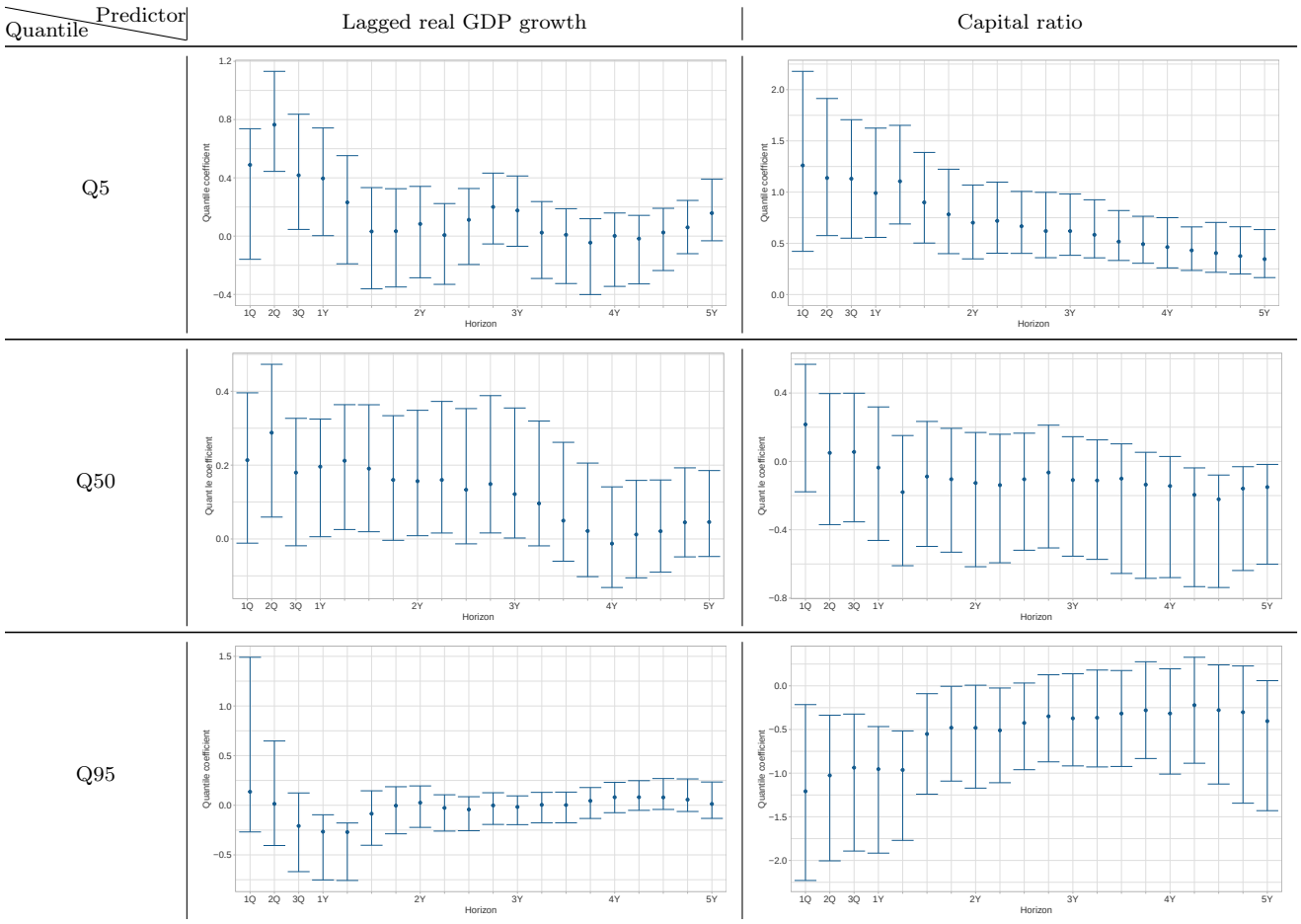
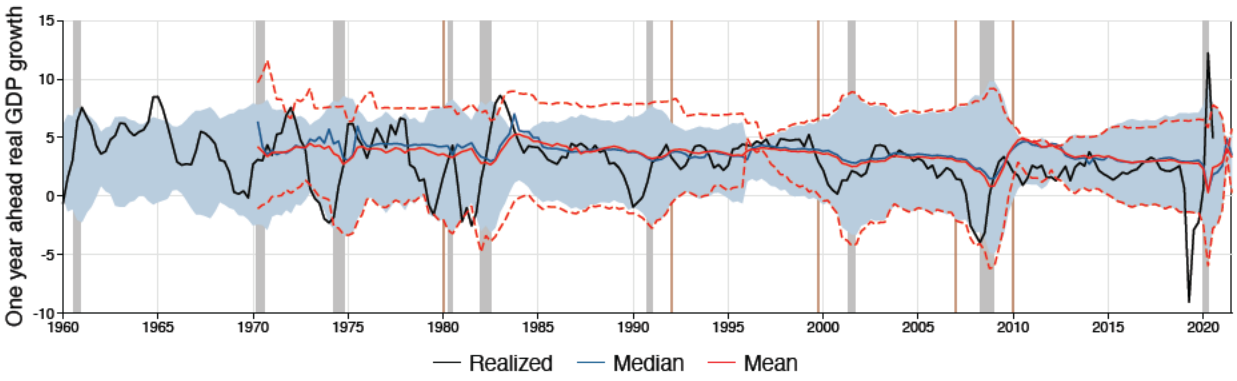


Figure 7. Predicted distributions. This figure plots the time series evolution of the predicted distribution of one year ahead and five-year-ahead annualized real GDP growth, together with NBER recession shadings and capital regulatory regime changes. Distribution predicted using lagged real GDP growth and lagged capital ratios. Blue shaded area corresponds to the in-sample (5%, 95%) interquantile range; the red dashed lines correspond to the out-of-sample (5%, 95%) interquantile range. Capital ratio measured relative to lagging five-year averages. It transitions from the ratio between total equity capital and total assets to the current capital regulatory standard of T1 Common to Risk Weighted assets as comparable fields in regulatory data become available.

(a) One year ahead



(b) Five years ahead

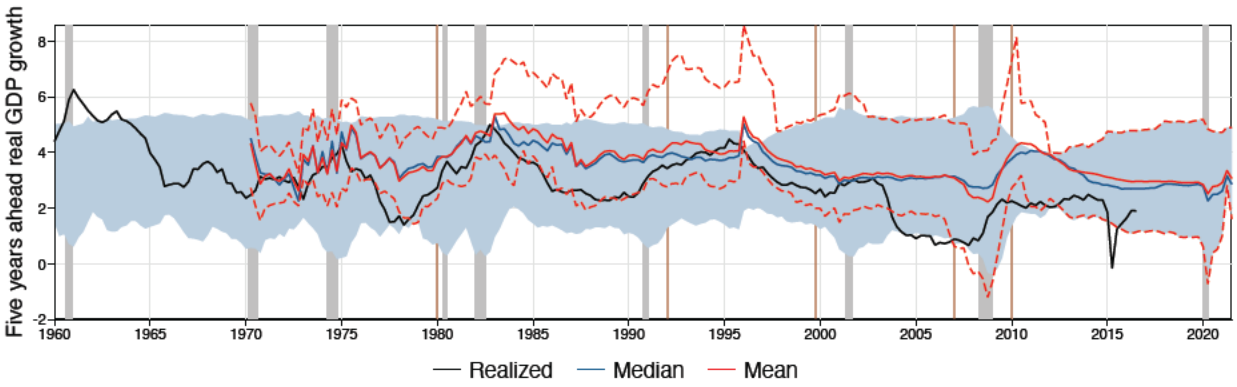
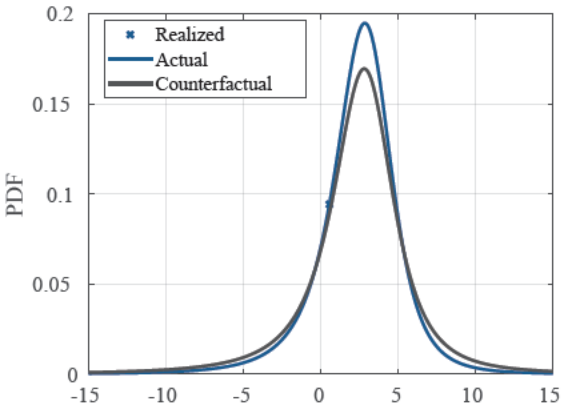
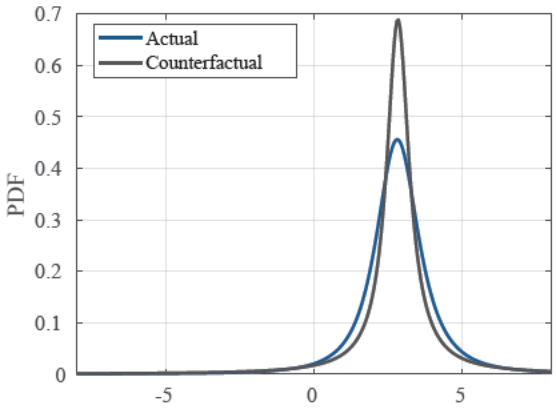


Figure 8. Effect of decreasing capital ratios ahead of the COVID-19 pandemic. This figure plots the actual and counterfactual predicted distributions of annualized real GDP growth over H quarters as of Q1 2020. Counterfactual distribution constructed under assumption of capital ratios two standard deviation lower than observed. Equity capital ratio transitions from the ratio between total equity capital and total assets to the current capital regulatory standard of T1 Common to Risk Weighted assets as comparable fields in regulatory data become available. Capital ratios measured relative to lagging five-year averages.

(a) One year ahead



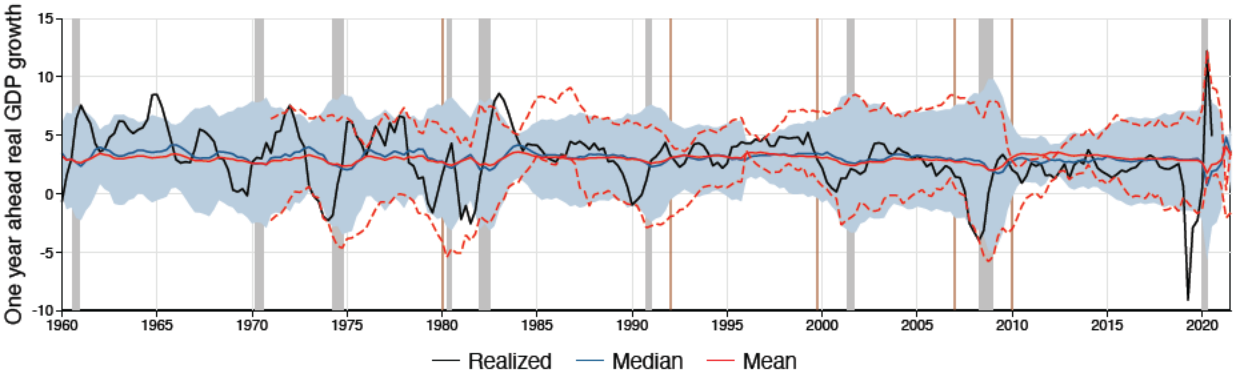
(b) 5 years ahead



	Q5		Median		Q95	
Horizon	Actual	Counterfactual	Actual	Counterfactual	Actual	Counterfactual
1Y	-2.47	-4.25	2.61	2.66	6.52	7.97
5Y	0.62	0.02	2.79	3.06	5.19	5.90

Figure 9. Predicted distributions with alternative predictors. This figure plots the time series evolution of the predicted distribution of one year ahead and five-year-ahead annualized real GDP growth, together with NBER recession shadings and capital regulatory regime changes. Distribution predicted using lagged real GDP growth and lagged capital ratios. Blue shaded area corresponds to the (5%, 95%) interquantile range predicted using lagged real GDP growth and lagged capital ratios only; the red dashed lines correspond to the (5%, 95%) interquantile range predicted using lagged real GDP growth, one year real credit growth, financial conditions and capital ratios. Equity capital ratio transitions from the ratio between total equity capital and total assets to the current capital regulatory standard of T1 Common to Risk Weighted assets as comparable fields in regulatory data become available. Capital ratios measured relative to lagging five-year averages.

(a) One year ahead



(b) Five years ahead

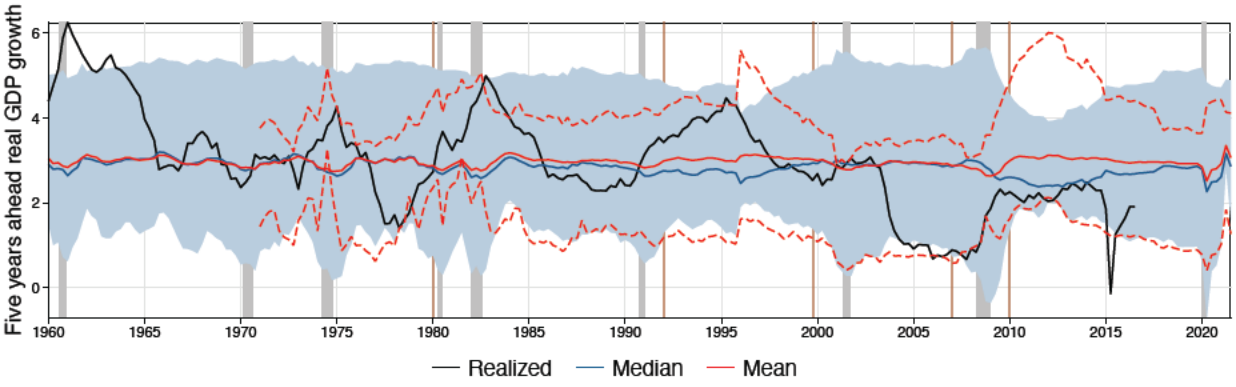
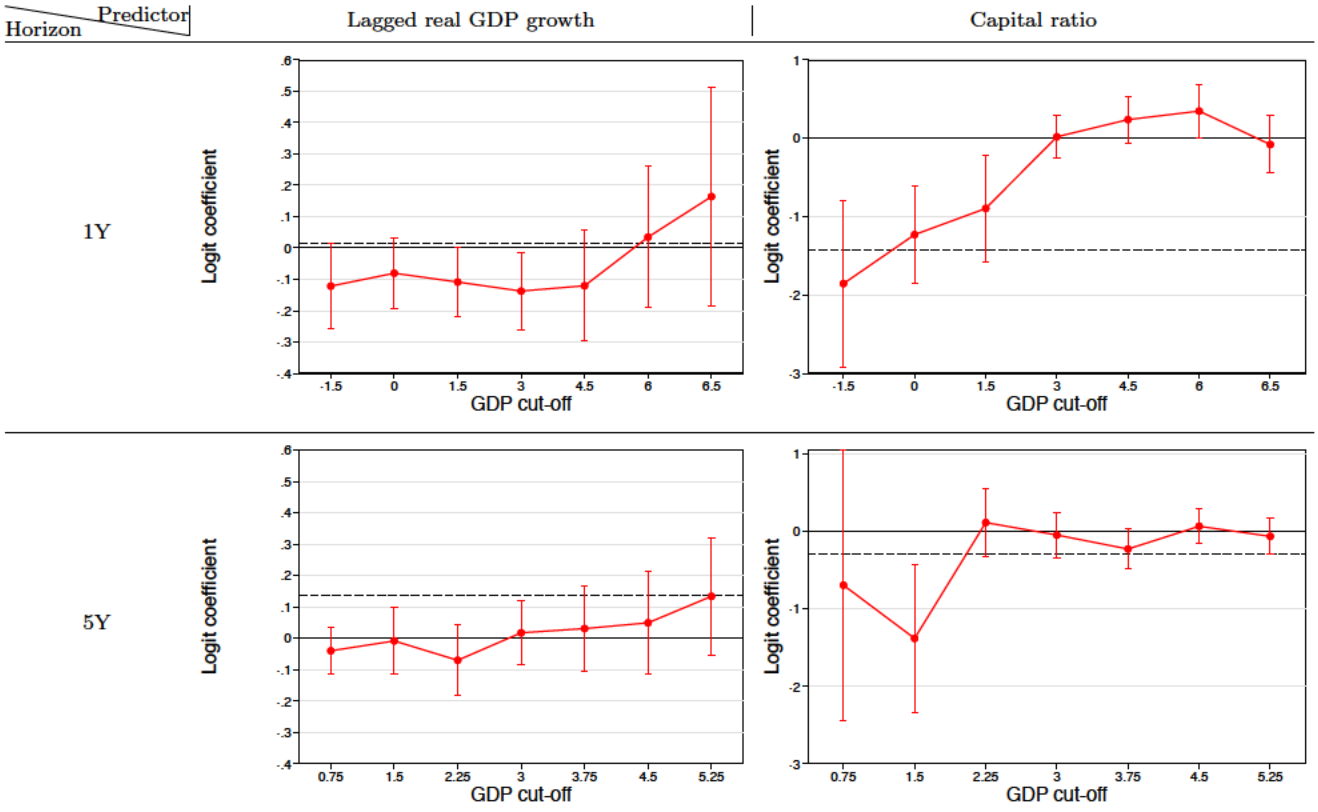


Figure 10. Threshold regression coefficients across thresholds. This figure plots the estimated coefficients in logit regression of one year ahead and five-year-ahead annualized real GDP growth falling below threshold τ on lags of one year real GDP growth and capital ratios. First row corresponds to one year; second row to five-year-ahead. Equity capital ratio transitions from the ratio between total equity capital and total assets to the current capital regulatory standard of T1 Common to Risk Weighted assets as comparable fields in regulatory data become available. Capital ratios measured relative to lagging five-year averages. Dashed line corresponds to estimate from a one-year-ahead logit regression of NBER recessions. 95% confidence bands based on heteroskedasticity-robust standard errors plotted as bars around point estimates.



A Additional results

Table A.1: Predicting components of credit growth tail outcomes. This table reports the coefficients from a quarterly quantile regression of annualized real credit growth on lags of one year real GDP growth, one year real credit growth, financial conditions and bank equity ratios. Equity capital ratio transitions from the ratio between total equity capital and total assets to the current capital regulatory standard of T1 Common to Risk Weighted assets as comparable fields in regulatory data become available. Capital ratios measured relative to lagging five-year averages. 90% confidence intervals computed using Gregory et al. (2018) smooth extended tapered block bootstrap (SETBB) with blocks of length 20 and 1000 simulations reported in parentheses below the point estimates.

(a) Q5

	Dependent variable							
	Total	Bank credit	Non-bank credit	HH credit	Business credit	Business loans	Loans held	Bonds held
Constant	−2.46	−2.46	−4.56	−1.92	−5.06	−6.27	−6.49	−11.68
	(−4.16, −1.03)	(−4.43, −1.05)	(−7.62, −3.83)	(−3.52, 0.30)	(−7.55, −3.67)	(−10.49, −4.69)	(−10.13, −5.11)	(−17.22, −8.85)
Lagged one year real GDP growth	0.08	0.14	0.16	−0.16	0.55	0.58	0.05	−0.58
	(−0.42, 0.42)	(−0.38, 0.52)	(−0.21, 0.67)	(−1.02, 0.16)	(0.22, 1.15)	(0.12, 1.31)	(−0.37, 0.83)	(−1.40, 0.20)
Lagged one year real credit growth	0.53	0.47	0.58	0.55	0.68	0.62	0.79	0.15
	(0.32, 0.74)	(0.26, 0.69)	(0.44, 0.72)	(0.29, 0.80)	(0.45, 0.90)	(0.53, 0.71)	(0.66, 0.92)	(−0.03, 0.33)
Capital ratio	0.44	−0.71	1.97	−1.08	3.32	0.41	4.94	−0.19
	(−0.52, 1.28)	(−1.66, 0.12)	(1.51, 2.91)	(−2.14, −0.15)	(2.40, 4.50)	(−0.57, 1.32)	(4.11, 5.98)	(−1.12, 0.67)
NFCI	−1.41	−2.18	1.17	−1.90	−1.09	−2.18	−0.76	−4.79
	(−2.34, −0.74)	(−3.08, −1.51)	(0.57, 1.88)	(−2.82, −1.29)	(−2.10, −0.32)	(−3.09, −1.36)	(−1.55, 0.14)	(−5.82, −3.97)
Pseudo R^2	0.51	0.53	0.39	0.42	0.56	0.58	0.53	0.29
Observations	199	199	199	199	199	199	199	199

(b) Q50

	Dependent variable:							
	Total	Bank credit	Non-bank credit	HH credit	Business credit	Business loans	Loans held	Bonds held
Constant	0.07	−0.11	0.35	0.56	−0.20	−0.73	−0.01	0.45
	(−1.34, 1.28)	(−1.83, 1.22)	(−1.06, 1.72)	(−1.04, 1.57)	(−2.35, 1.31)	(−3.34, 1.50)	(−1.57, 1.66)	(−3.95, 4.31)
Lagged one year real GDP growth	0.41	0.38	0.11	−0.03	0.52	0.69	0.60	−0.14
	(0.12, 0.83)	(0.07, 0.85)	(−0.53, 0.51)	(−0.46, 0.33)	(0.21, 1.06)	(0.29, 1.31)	(0.34, 1.09)	(−1.10, 0.46)
Lagged one year real credit growth	0.62	0.70	0.51	0.76	0.54	0.54	0.28	0.48
	(0.52, 0.73)	(0.62, 0.78)	(0.38, 0.64)	(0.69, 0.83)	(0.42, 0.66)	(0.41, 0.66)	(0.17, 0.40)	(0.35, 0.61)
Capital ratio	0.47	0.32	3.04	0.66	0.62	1.27	0.77	5.70
	(−0.16, 1.02)	(−0.38, 0.97)	(2.55, 3.79)	(−0.13, 1.54)	(−0.06, 1.21)	(0.61, 1.83)	(0.09, 1.34)	(4.91, 6.51)
NFCI	−0.40	−0.59	0.68	−0.21	−0.57	−1.00	−1.13	3.53
	(−0.89, 0.27)	(−1.16, 0.15)	(0.11, 1.14)	(−0.86, 0.68)	(−1.17, 0.13)	(−1.60, −0.37)	(−1.64, −0.38)	(2.79, 4.37)
Pseudo R^2	0.45	0.47	0.31	0.54	0.39	0.38	0.4	0.37
Observations	199	199	199	199	199	199	199	199

(c) Q95

	Dependent variable:							
	Total	Bank credit	Non-bank credit	HH credit	Business credit	Business loans	Loans held	Bonds held
Constant	4.22	4.96	4.42	6.09	4.73	5.90	6.28	21.93
	(3.00, 6.19)	(3.66, 7.34)	(2.54, 6.32)	(4.90, 9.45)	(3.42, 6.94)	(4.73, 8.37)	(4.89, 8.34)	(17.48, 30.22)
Lagged one year real GDP growth	0.35	0.18	0.68	−0.10	0.27	0.25	0.57	0.88
	(−0.03, 0.68)	(−0.16, 0.58)	(0.29, 1.29)	(−0.57, 0.42)	(−0.21, 0.66)	(−0.26, 0.65)	(0.20, 0.99)	(−0.27, 2.03)
Lagged one year real credit growth	0.53	0.54	0.79	0.76	0.73	0.68	0.33	0.40
	(0.39, 0.66)	(0.47, 0.62)	(0.62, 0.97)	(0.56, 0.95)	(0.58, 0.88)	(0.62, 0.74)	(0.24, 0.42)	(0.24, 0.55)
Capital ratio	−0.80	−1.21	1.72	−2.17	0.35	−1.49	−2.83	0.18
	(−1.60, −0.10)	(−2.15, −0.56)	(0.94, 2.47)	(−3.15, −1.13)	(−0.37, 1.06)	(−2.42, −0.92)	(−3.85, −2.28)	(−1.04, 1.40)
NFCI	0.49	0.30	0.30	0.13	−0.13	−0.12	−0.05	4.40
	(−0.01, 1.38)	(−0.08, 1.35)	(−0.39, 0.98)	(−0.63, 1.14)	(−0.72, 0.55)	(−0.55, 0.81)	(−0.36, 1.08)	(3.24, 5.60)
Pseudo R^2	0.44	0.4	0.43	0.37	0.32	0.41	0.43	0.45
Observations	199	199	199	199	199	199	199	199

Table A.2: Predicting GDP growth tail outcomes. This table reports the coefficients from a quarterly quantile regression of one year ahead real GDP growth on lags of one year real GDP growth and bank equity ratios. Equity ratio constructed as total equity capital over total assets of commercial banks only. Capital ratios measured relative to lagging five-year averages. 90% confidence intervals computed using Gregory et al. (2018) smooth extended tapered block bootstrap (SETBB) with blocks of length 20 and 1000 simulations reported in parentheses below the point estimates.

(a) Q5

	(1)	(2)
Constant	−2.95	−2.75
	(−5.00, −1.23)	(−4.57, −1.03)
Lagged one year real GDP growth	0.47	0.54
	(0.06, 0.85)	(0.15, 0.94)
Capital ratio		2.14
		(1.05, 3.31)
Pseudo R^2	0.06	0.09
Observations	243	243

(b) Q50

	(1)	(2)
Constant	2.44	2.67
	(1.89, 3.15)	(2.07, 3.49)
Lagged one year real GDP growth	0.21	0.18
	(0.02, 0.33)	(−0.01, 0.31)
Capital ratio		−0.52
		(−1.11, −0.01)
Pseudo R^2	0.02	0.02
Observations	243	243

(c) Q95

	(1)	(2)
Constant	7.56	7.42
	(6.72, 9.79)	(6.69, 9.73)
Lagged one year real GDP growth	−0.24	−0.28
	(−0.73, −0.06)	(−0.73, −0.11)
Capital ratio		−2.12
		(−3.16, −1.54)
Pseudo R^2	0.02	0.16
Observations	243	243

Table A.3: Predicting GDP growth tail outcomes across horizons. This table reports the coefficients from a quarterly quantile regression of annualized real GDP growth on lags of one year real GDP growth and bank equity ratios. Equity ratio constructed as total equity capital over total assets of commercial banks only. Capital ratios measured relative to lagging five-year averages. 90% confidence intervals computed using Gregory et al. (2018) smooth extended tapered block bootstrap (SETBB) with blocks of length 20 and 1000 simulations reported in parentheses below the point estimates.

(a) Q5

	1Q	1Y	3Y	5Y
Constant	−6.04	−2.75	−0.09	0.99
	(−8.06, −3.11)	(−4.57, −1.03)	(−1.47, 0.63)	(0.04, 1.44)
Lagged one year real GDP growth	0.99	0.54	0.18	0.08
	(0.40, 1.34)	(0.15, 0.94)	(−0.05, 0.44)	(−0.04, 0.25)
Capital ratio	4.05	2.14	−0.47	−0.70
	(2.96, 5.33)	(1.05, 3.31)	(−1.33, 0.27)	(−1.26, −0.09)
Pseudo R^2	0.14	0.09	0.04	0.1
Observations	246	243	235	227

(b) Q50

	1Q	1Y	3Y	5Y
Constant	2.29	2.67	2.60	2.88
	(1.50, 3.17)	(2.07, 3.49)	(1.81, 3.08)	(2.38, 3.25)
Lagged one year real GDP growth	0.25	0.18	0.12	0.001
	(0.01, 0.44)	(−0.01, 0.31)	(0.004, 0.35)	(−0.10, 0.13)
Capital ratio	−0.17	−0.52	0.09	−0.20
	(−0.81, 0.42)	(−1.11, −0.01)	(−0.32, 0.57)	(−0.75, 0.34)
Pseudo R^2	0.02	0.02	0.02	0
Observations	246	243	235	227

(c) Q95

	1Q	1Y	3Y	5Y
Constant	9.38	7.42	5.79	5.01
	(2.89, 11.48)	(6.69, 9.73)	(5.28, 6.71)	(3.92, 5.91)
Lagged one year real GDP growth	−0.19	−0.28	−0.01	0.03
	(−0.60, 1.04)	(−0.73, −0.11)	(−0.20, 0.12)	(−0.11, 0.25)
Capital ratio	−3.57	−2.12	−1.76	−0.93
	(−4.59, −2.11)	(−3.16, −1.54)	(−2.40, −1.16)	(−1.99, −0.42)
Pseudo R^2	0.15	0.16	0.07	0.04
Observations	246	243	235	227

Table A.4: Predicting credit growth tail outcomes across horizons. This table reports the coefficients from a quarterly quantile regression of annualized real credit growth on lags of one year real GDP growth, one year real credit growth, financial conditions and bank equity ratios. Equity ratio constructed as total equity capital over total assets of commercial banks only. Capital ratios measured relative to lagging five-year averages. 90% confidence intervals computed using Gregory et al. (2018) smooth extended tapered block bootstrap (SETBB) with blocks of length 20 and 1000 simulations reported in parentheses below the point estimates.

(a) Q5

	1Q	1Y	3Y	5Y
Constant	−5.14	−2.46	−1.90	−1.30
	(−6.78, −3.88)	(−4.16, −1.03)	(−4.78, −0.04)	(−3.96, 0.06)
Lagged one year real GDP growth	0.57	0.08	0.32	0.55
	(0.11, 0.99)	(−0.42, 0.42)	(−0.36, 1.06)	(0.15, 1.21)
Lagged one year real credit growth	0.63	0.53	0.03	−0.15
	(0.35, 0.95)	(0.27, 0.79)	(−0.38, 0.30)	(−0.41, 0.08)
Capital ratio	1.24	0.44	−0.37	−0.57
	(0.40, 2.33)	(−0.52, 1.28)	(−1.79, 0.46)	(−1.52, 0.04)
NFCI	−1.11	−1.41	−1.36	−0.58
	(−1.96, −0.44)	(−2.34, −0.74)	(−2.18, −0.27)	(−1.23, 0.12)
Pseudo R^2	0.48	0.51	0.38	0.38
Observations	202	199	191	183

(b) Q50

	1Q	1Y	3Y	5Y
Constant	−0.40	0.07	1.68	2.18
	(−1.71, 0.49)	(−1.34, 1.28)	(0.01, 3.48)	(0.48, 3.96)
Lagged one year real GDP growth	0.32	0.41	0.02	−0.06
	(0.05, 0.65)	(0.12, 0.83)	(−0.54, 0.53)	(−0.68, 0.29)
Lagged one year real credit growth	0.71	0.62	0.39	0.29
	(0.56, 0.91)	(0.46, 0.83)	(0.20, 0.70)	(0.10, 0.63)
Capital ratio	0.87	0.47	1.79	2.32
	(0.35, 1.51)	(−0.16, 1.02)	(0.98, 2.65)	(1.55, 3.60)
NFCI	−0.50	−0.40	0.20	0.50
	(−1.03, 0.04)	(−0.89, 0.27)	(−0.55, 1.28)	(−0.37, 1.44)
Pseudo R^2	0.44	0.45	0.31	0.28
Observations	202	199	191	183

(c) Q95

	1Q	1Y	3Y	5Y
Constant	5.13	4.22	5.64	4.73
	(3.84, 6.90)	(3.00, 6.19)	(3.59, 8.23)	(3.23, 6.93)
Lagged one year real GDP growth	0.36	0.35	0.48	0.22
	(−0.04, 0.86)	(−0.03, 0.68)	(0.16, 0.94)	(−0.10, 0.50)
Lagged one year real credit growth	0.75	0.53	0.08	0.18
	(0.48, 1.09)	(0.26, 0.76)	(−0.41, 0.39)	(−0.15, 0.49)
Capital ratio	−2.30	−0.80	−0.13	1.52
	(−3.34, −1.57)	(−1.60, −0.10)	(−1.16, 1.17)	(0.79, 2.29)
NFCI	−0.04	0.49	1.16	1.40
	(−0.72, 0.83)	(−0.01, 1.38)	(0.57, 2.39)	(0.95, 2.27)
Pseudo R^2	0.39	0.44	0.24	0.25
Observations	202	199	191	183

Table A.5: Predicting financial conditions tail outcomes across horizons. This table reports the coefficients from a quarterly quantile regression of future NFCI realizations on lags of one year real GDP growth, one year real credit growth, financial conditions and bank equity ratios. Equity ratio constructed as total equity capital over total assets of commercial banks only. Capital ratios measured relative to lagging five-year averages. 90% confidence intervals computed using Gregory et al. (2018) smooth extended tapered block bootstrap (SETBB) with blocks of length 20 and 1000 simulations reported in parentheses below the point estimates.

(a) Q5

	1Q	1Y	3Y	5Y
Constant	−0.52	−0.82	−0.90	−0.85
	(−0.68, −0.34)	(−1.03, −0.75)	(−1.13, −0.59)	(−1.01, −0.63)
Lagged one year real GDP growth	0.01	0.02	−0.004	0.01
	(−0.04, 0.03)	(−0.02, 0.06)	(−0.06, 0.06)	(−0.03, 0.06)
NFCI	0.50	0.14	−0.04	0.06
	(0.36, 0.57)	(−0.02, 0.22)	(−0.30, 0.06)	(−0.06, 0.30)
Capital ratio	−0.04	−0.10	0.04	0.19
	(−0.19, 0.14)	(−0.20, 0.26)	(−0.33, 0.33)	(−0.08, 0.51)
Lagged one year real credit growth	0.02	0.03	0.03	−0.003
	(0.005, 0.05)	(0.01, 0.07)	(−0.04, 0.08)	(−0.04, 0.03)
Pseudo R^2	0.43	0.22	0.15	0.25
Observations	202	199	191	183

(b) Q50

	1Q	1Y	3Y	5Y
Constant	−0.15	−0.41	−0.48	−0.68
	(−0.30, −0.08)	(−0.70, −0.26)	(−0.97, −0.19)	(−1.93, −0.55)
Lagged one year real GDP growth	0.02	0.09	0.04	0.06
	(0.004, 0.05)	(0.01, 0.17)	(−0.08, 0.12)	(0.04, 0.15)
NFCI	0.87	0.65	0.15	0.14
	(0.74, 1.03)	(0.40, 1.11)	(−0.03, 0.41)	(−0.000, 0.68)
Capital ratio	−0.05	−0.22	−0.21	0.19
	(−0.09, 0.07)	(−0.40, 0.24)	(−0.74, 0.66)	(−0.05, 1.62)
Lagged one year real credit growth	0.01	0.01	0.03	0.02
	(−0.005, 0.02)	(−0.04, 0.06)	(−0.02, 0.08)	(−0.005, 0.13)
Pseudo R^2	0.6	0.31	0.19	0.28
Observations	202	199	191	183

(c) Q95

	1Q	1Y	3Y	5Y
Constant	0.70	1.02	1.57	2.52
	(0.03, 1.00)	(−0.10, 1.87)	(0.96, 2.92)	(1.96, 4.68)
Lagged one year real GDP growth	0.01	0.04	0.11	0.20
	(−0.04, 0.15)	(−0.14, 0.27)	(−0.15, 0.36)	(0.05, 0.50)
NFCI	1.35	1.49	0.07	−0.28
	(1.15, 1.84)	(1.31, 2.39)	(−0.97, 0.45)	(−0.77, 0.15)
Capital ratio	−0.27	−0.40	−2.05	−1.68
	(−0.57, 0.52)	(−1.34, 0.76)	(−4.56, −2.12)	(−3.35, −0.97)
Lagged one year real credit growth	−0.01	0.08	0.12	−0.27
	(−0.05, 0.05)	(−0.003, 0.23)	(−0.01, 0.31)	(−0.62, −0.15)
Pseudo R^2	0.69	0.44	0.27	0.34
Observations	202	199	191	183

Table A.6: Predicting GDP growth tail outcomes with alternative models. This table reports the coefficients from a quarterly quantile regression of one year ahead real GDP growth on lags of one year real GDP growth, one year real credit growth, financial conditions and bank equity ratios. Equity ratio constructed as total equity capital over total assets of commercial banks only. Capital ratios measured relative to lagging five-year averages. 90% confidence intervals computed using Gregory et al. (2018) smooth extended tapered block bootstrap (SETBB) with blocks of length 20 and 1000 simulations reported in parentheses below the point estimates.

(a) Q5

	(1)	(2)	(3)	(4)
Constant	−2.75	−2.52	−2.15	−2.15
	(−5.53, −1.70)	(−5.33, −1.39)	(−4.48, −0.69)	(−2.66, −0.08)
Lagged one year real GDP growth	0.54	0.44	0.45	0.45
	(0.16, 1.22)	(−0.17, 0.94)	(0.04, 1.02)	(0.06, 0.81)
Capital ratio	2.14	2.53	1.80	1.80
	(1.87, 3.96)	(2.04, 4.12)	(0.99, 3.03)	(−0.58, 1.05)
Lagged one year real credit growth		0.07	0.05	0.05
		(−0.16, 0.54)	(−0.26, 0.31)	(−0.27, 0.20)
NFCI			−0.68	−0.68
			(−1.26, 0.19)	(0.36, 1.70)
Pseudo R^2	0.09	0.1	0.31	0.31
Observations	243	243	199	199

(b) Q50

	(1)	(2)	(3)	(4)
Constant	2.67	2.64	2.85	2.85
	(1.72, 3.07)	(1.62, 2.94)	(1.99, 3.64)	(1.66, 3.15)
Lagged one year real GDP growth	0.18	−0.03	−0.10	−0.10
	(0.003, 0.35)	(−0.12, 0.31)	(−0.38, 0.10)	(−0.26, 0.19)
Capital ratio	−0.52	−0.11	−0.60	−0.60
	(−0.76, 0.47)	(−0.87, 0.37)	(−1.18, −0.11)	(−1.46, −0.31)
Lagged one year real credit growth		0.18	0.10	0.10
		(−0.01, 0.26)	(0.002, 0.27)	(−0.33, −0.03)
NFCI			−0.87	−0.87
			(−1.27, −0.41)	(−0.24, 0.50)
Pseudo R^2	0.02	0.05	0.26	0.26
Observations	243	243	199	199

(c) Q95

	(1)	(2)	(3)	(4)
Constant	7.42	6.11	6.30	6.30
	(6.73, 10.01)	(4.68, 8.18)	(4.67, 8.36)	(5.90, 7.78)
Lagged one year real GDP growth	−0.28	−0.32	−0.29	−0.29
	(−0.72, −0.21)	(−0.91, −0.27)	(−0.88, −0.12)	(−1.03, −0.51)
Capital ratio	−2.12	−1.22	−1.79	−1.79
	(−3.39, −1.63)	(−2.22, −0.51)	(−2.95, −1.14)	(−3.66, −1.94)
Lagged one year real credit growth		0.33	0.24	0.24
		(0.16, 0.79)	(0.08, 0.74)	(−0.30, 0.15)
NFCI			−0.41	−0.41
			(−1.25, 0.33)	(−1.94, −0.65)
Pseudo R^2	0.16	0.21	0.35	0.35
Observations	243	243	199	199

Table A.7: Predicting GDP growth tail outcomes with full model. This table reports the coefficients from a quarterly quantile regression of annualized real GDP growth on lags of one year real GDP growth, one year real credit growth, financial conditions and bank equity ratios. Equity ratio constructed as total equity capital over total assets of commercial banks only. Capital ratios measured relative to lagging five-year averages. 90% confidence intervals computed using Gregory et al. (2018) smooth extended tapered block bootstrap (SETBB) with blocks of length 20 and 1000 simulations reported in parentheses below the point estimates.

(a) Q5

	1Q	1Y	3Y	5Y
Constant	−4.91	−2.15	0.56	1.55
	(−7.20, −3.05)	(−4.48, −0.69)	(−0.94, 1.14)	(0.35, 2.20)
Lagged one year real GDP growth	0.52	0.45	0.22	0.12
	(0.05, 1.03)	(0.04, 1.02)	(−0.05, 0.64)	(−0.10, 0.43)
Capital ratio	2.56	1.80	−0.35	−0.46
	(1.70, 3.61)	(0.99, 3.03)	(−1.16, 0.28)	(−1.38, 0.09)
Lagged one year real credit growth	0.27	0.05	−0.17	−0.14
	(−0.04, 0.63)	(−0.26, 0.31)	(−0.45, −0.01)	(−0.32, −0.01)
NFCI	−1.27	−0.68	−0.52	−0.06
	(−2.08, −0.59)	(−1.26, 0.19)	(−0.99, 0.01)	(−0.42, 0.43)
Pseudo R^2	0.36	0.31	0.33	0.38
Observations	202	199	191	183

(b) Q50

	1Q	1Y	3Y	5Y
Constant	2.57	2.85	2.18	2.48
	(1.80, 3.26)	(1.99, 3.64)	(0.98, 2.59)	(1.81, 2.90)
Lagged one year real GDP growth	−0.06	−0.10	−0.05	0.02
	(−0.37, 0.12)	(−0.38, 0.10)	(−0.26, 0.14)	(−0.12, 0.19)
Capital ratio	−0.64	−0.60	1.27	0.50
	(−1.29, −0.07)	(−1.18, −0.11)	(0.80, 2.19)	(−0.23, 1.50)
Lagged one year real credit growth	0.13	0.10	0.09	0.01
	(0.05, 0.29)	(0.002, 0.27)	(0.01, 0.36)	(−0.06, 0.20)
NFCI	−0.93	−0.87	0.33	0.34
	(−1.41, −0.50)	(−1.27, −0.41)	(−0.001, 1.00)	(0.19, 0.86)
Pseudo R^2	0.27	0.26	0.31	0.32
Observations	202	199	191	183

(c) Q95

	1Q	1Y	3Y	5Y
Constant	10.64	6.30	5.29	3.89
	(9.54, 13.43)	(4.67, 8.36)	(4.71, 6.94)	(2.93, 4.59)
Lagged one year real GDP growth	−0.48	−0.29	−0.04	−0.05
	(−1.36, −0.22)	(−0.88, −0.12)	(−0.23, 0.15)	(−0.20, 0.08)
Capital ratio	−6.30	−1.79	−0.03	0.71
	(−7.50, −5.42)	(−2.95, −1.14)	(−0.73, 0.85)	(0.09, 1.99)
Lagged one year real credit growth	0.21	0.24	−0.12	0.07
	(0.06, 0.85)	(0.08, 0.74)	(−0.42, −0.01)	(−0.07, 0.22)
NFCI	−1.63	−0.41	0.12	0.37
	(−2.38, −0.61)	(−1.25, 0.33)	(−0.26, 0.69)	(0.06, 0.82)
Pseudo R^2	0.3	0.35	0.35	0.45
Observations	202	199	191	183

Table A.8: Predicting GDP growth tail outcomes: alternative sample cut-offs. This table reports the coefficients from a quarterly quantile regression of one year ahead real GDP growth on lags of one year real GDP growth and bank equity ratios for alternative sample cut-offs. Baseline sample: Q1 1960 – Q2 2022. Equity ratio constructed as total equity capital over total assets of commercial banks only. Capital ratios measured relative to lagging five-year averages. 90% confidence intervals computed using Gregory et al. (2018) smooth extended tapered block bootstrap (SETBB) with blocks of length 20 and 1000 simulations reported in parentheses below the point estimates.

(a) Q5

	Full sample	Pre-COVID	Pre-crisis	Pre 1996
Constant	−2.75	−2.52	−2.93	−1.93
	(−4.57, −1.03)	(−4.48, −0.99)	(−5.33, −1.52)	(−3.99, −0.19)
Lagged one year real GDP growth	0.54	0.54	0.61	0.40
	(0.15, 0.94)	(0.17, 0.92)	(0.27, 1.06)	(−0.002, 0.81)
Capital ratio	2.14	2.76	2.86	2.81
	(1.05, 3.31)	(1.84, 3.84)	(1.96, 3.73)	(1.92, 3.64)
Pseudo R^2	0.09	0.14	0.15	0.11
Observations	243	236	196	144

(b) Q50

	Full sample	Pre-COVID	Pre-crisis	Pre 1996
Constant	2.67	2.55	2.89	3.29
	(2.07, 3.49)	(1.87, 3.24)	(1.84, 3.79)	(2.20, 4.40)
Lagged one year real GDP growth	0.18	0.21	0.19	0.10
	(−0.01, 0.31)	(0.04, 0.35)	(0.01, 0.40)	(−0.10, 0.33)
Capital ratio	−0.52	−0.31	−0.12	−0.16
	(−1.11, −0.01)	(−0.90, 0.24)	(−0.66, 0.41)	(−0.83, 0.45)
Pseudo R^2	0.02	0.03	0.03	0.01
Observations	243	236	196	144

(c) Q95

	Full sample	Pre-COVID	Pre-crisis	Pre 1996
Constant	7.42	7.05	7.50	7.60
	(6.69, 9.73)	(5.91, 8.75)	(6.32, 9.31)	(6.36, 9.41)
Lagged one year real GDP growth	−0.28	−0.17	−0.22	−0.15
	(−0.73, −0.11)	(−0.52, 0.08)	(−0.58, 0.03)	(−0.51, 0.15)
Capital ratio	−2.12	−1.97	−2.20	−2.33
	(−3.16, −1.54)	(−3.01, −1.26)	(−3.20, −1.47)	(−3.30, −1.42)
Pseudo R^2	0.16	0.1	0.1	0.04
Observations	243	236	196	144

Table A.9: Predicting GDP growth tail outcomes: alternative capital standardization. This table reports the coefficients from a quarterly quantile regression of one year ahead real GDP growth on lags of one year real GDP growth and bank equity ratios for alternative normalizations of the capital ratio. Equity ratio constructed as total equity capital over total assets of commercial banks only. Capital ratios measured relative to lagging five-year averages. 90% confidence intervals computed using Gregory et al. (2018) smooth extended tapered block bootstrap (SETBB) with blocks of length 20 and 1000 simulations reported in parentheses below the point estimates.

(a) Q5

	Baseline	10Y demeaned	Raw	MA5	MA10
Constant	−2.75	−3.18	−1.34	−0.77	−0.35
	(−4.57, −1.03)	(−4.97, −1.36)	(−5.08, 2.67)	(−5.25, 3.82)	(−6.22, 4.95)
Lagged one year real GDP growth	0.54	0.66	0.43	0.43	0.43
	(0.15, 0.94)	(0.26, 1.05)	(0.08, 0.76)	(0.09, 0.75)	(0.10, 0.76)
Capital ratio	2.14	1.36	−0.20	−0.28	−0.32
	(1.05, 3.31)	(0.52, 2.49)	(−0.81, 0.22)	(−0.97, 0.22)	(−1.12, 0.38)
Pseudo R^2	0.09	0.09	0.07	0.08	0.09
Observations	243	243	243	243	243

(b) Q50

	Baseline	10Y demeaned	Raw	MA5	MA10
Constant	2.67	2.64	5.00	4.96	5.11
	(2.07, 3.49)	(1.99, 3.54)	(3.24, 6.96)	(3.24, 6.87)	(3.32, 7.13)
Lagged one year real GDP growth	0.18	0.20	0.14	0.13	0.14
	(−0.01, 0.31)	(0.01, 0.33)	(−0.04, 0.27)	(−0.05, 0.25)	(−0.04, 0.26)
Capital ratio	−0.52	−0.36	−0.27	−0.27	−0.30
	(−1.11, −0.01)	(−0.95, 0.09)	(−0.46, −0.10)	(−0.45, −0.08)	(−0.48, −0.10)
Pseudo R^2	0.02	0.03	0.06	0.07	0.06
Observations	243	243	243	243	243

(c) Q95

	Baseline	10Y demeaned	Raw	MA5	MA10
Constant	7.42	7.95	14.63	13.19	11.53
	(6.69, 9.73)	(7.28, 10.22)	(12.36, 19.17)	(9.92, 17.52)	(7.18, 17.33)
Lagged one year real GDP growth	−0.28	−0.28	−0.23	−0.23	−0.23
	(−0.73, −0.11)	(−0.74, −0.12)	(−0.70, −0.03)	(−0.70, −0.05)	(−0.74, −0.05)
Capital ratio	−2.12	−1.68	−0.95	−0.75	−0.55
	(−3.16, −1.54)	(−2.42, −1.22)	(−1.37, −0.70)	(−1.24, −0.33)	(−1.21, 0.06)
Pseudo R^2	0.16	0.17	0.14	0.08	0.05
Observations	243	243	243	243	243

Table A.10: Linear relationship between capital and real outcomes. This table reports the coefficients from a quarterly logit regression of NBER recession indicators on lags of real credit growth, financial conditions and bank equity ratios (Table A.10a), and from a quarterly linear regression of one year ahead real GDP growth on lags of real GDP growth, real credit growth, financial conditions and capital ratio growth (Table A.10b). Credit defined as the sum of non-financial corporate business commercial paper and corporate bonds outstanding and total loans extended to the non-financial sectors in the U.S. economy. Equity ratio constructed as total equity capital over total assets of commercial banks only. Capital ratios measured relative to lagging five-year averages. Heteroskedasticity-robust standard errors included in parentheses below the point estimates.

(a) One year ahead recession probability

	(1)	(2)	(3)	(4)	(5)
Constant	-2.58	-2.02	-1.94	-3.65	-3.05
	(0.33)***	(0.23)***	(0.20)***	(0.61)***	(0.72)***
L.Y1 real credit growth	-0.01			0.33	0.30
	(0.06)			(0.10)***	(0.11)***
L.Y5-Y1 real credit growth	0.15			0.09	0.02
	(0.06)**			(0.09)	(0.11)
L.Y1 average NFCI		0.72		1.46	1.28
		(0.22)***		(0.41)***	(0.42)***
L.Y5-Y1 average NFCI		-0.90		-1.80	-1.99
		(0.41)**		(0.48)***	(0.48)***
L.Capital ratio			-1.34	-1.48	-2.24
			(0.46)***	(0.59)**	(0.78)***
AIC	179.96	146.66	173.33	133.67	117.41
Pseudo R^2	0.02	0.06	0.05	0.19	0.19
N. obs	242	197	242	197	154

(b) One year ahead average growth

	(1)	(2)	(3)	(4)	(5)
Constant	2.79	3.14	2.95	3.04	4.12
	(0.30)***	(0.27)***	(0.29)***	(0.44)***	(0.60)***
L.Y1 real credit growth	0.22			0.14	0.09
	(0.05)***			(0.05)***	(0.06)
L.Y5-Y1 real credit growth	-0.07			-0.10	-0.25
	(0.05)			(0.06)*	(0.09)***
L.Y1 average NFCI		-0.62		-0.25	-0.49
		(0.24)**		(0.33)	(0.34)
L.Y5-Y1 average NFCI		1.44		1.23	1.22
		(0.25)***		(0.28)***	(0.28)***
L.Demeaned capital ratio			-0.48	0.55	0.61
			(0.35)	(0.63)	(0.53)
AIC	1117.42	895.33	1127.33	895.87	668.31
Adj. R^2	0.04	0.10	0.00	0.11	0.17
N. obs	242	197	242	197	151

Figure A.1. Expanding sample estimated coefficients. This figure plots the estimated expanding sample coefficients on capital ratios from a quarterly quantile regression of annualize real GDP growth on lags of one year real GDP growth and bank equity ratios. Equity capital ratio transitions from the ratio between total equity capital and total assets to the current capital regulatory standard of T1 Common to Risk Weighted assets as comparable fields in regulatory data become available. Capital ratios measured relative to lagging five-year averages. 90% confidence intervals computed using Gregory et al. (2018) smooth extended tapered block bootstrap (SETBB) with blocks of length 20 and 1000 simulations reported around point estimates.

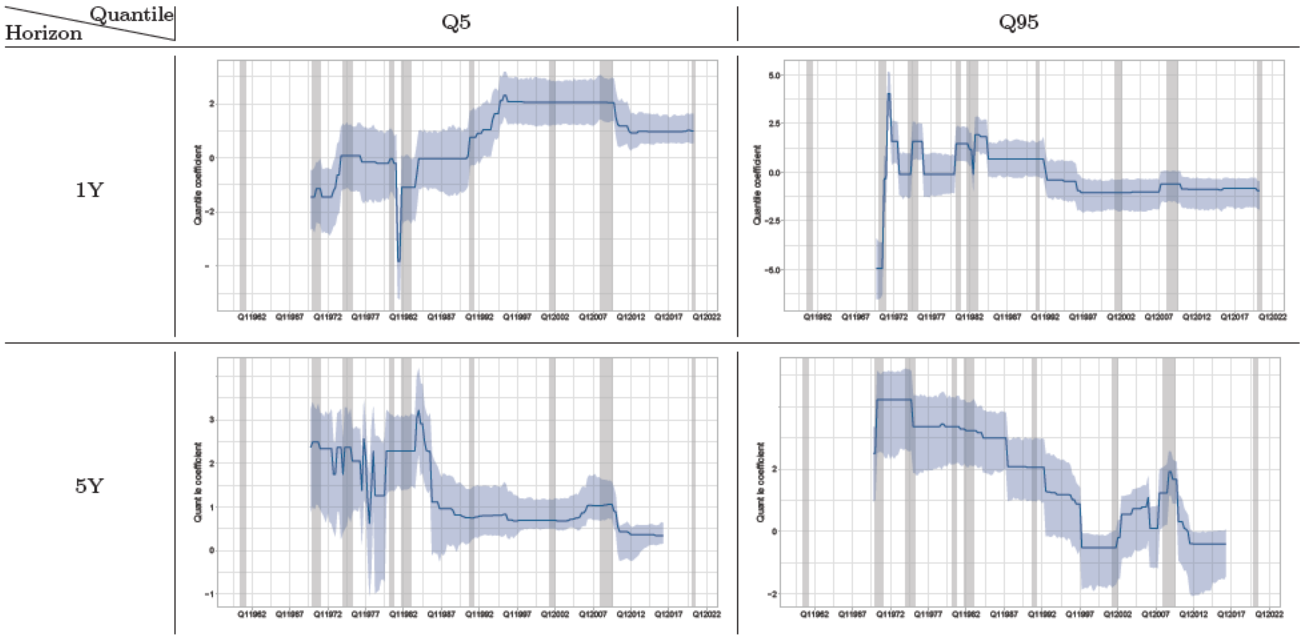
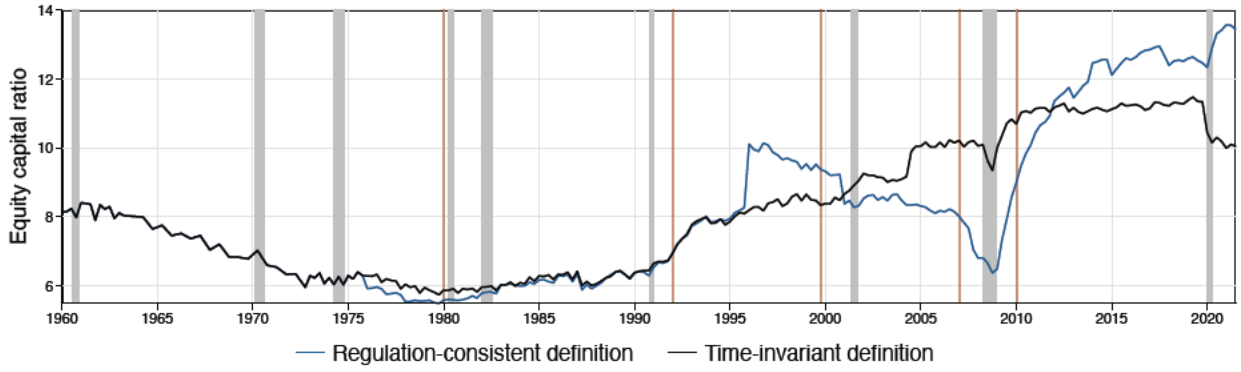


Figure A.2. Alternative measure of equity capital ratio. This figure plots the raw time series of the equity capital ratio and the equity capital ratio demeaned relative to a trailing five year average, together with NBER recession shadings and capital regulatory regime changes. "Regulation consistent" equity ratio transitions from the ratio between total equity capital and total assets to the current capital regulatory standard of T1 Common to Risk Weighted assets as comparable fields in regulatory data become available. "Time consistent" equity ratio constructed as total equity capital over total assets of commercial banks only. Source: Authors' calculations from Call Report data. Thrifts begin filing call reports as of 2012q1.

(a) Equity capital ratio



(b) Capital ratio relative to lagging five-year averages

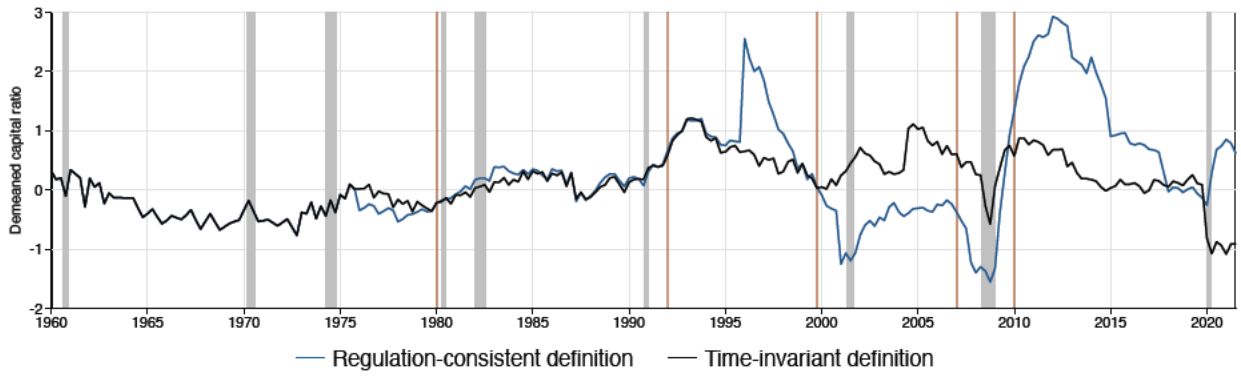


Figure A.3. Estimated quantile regression coefficients. This figure plots the estimated coefficients in quantile regression of one year ahead real GDP growth on lags of one year real GDP growth and bank equity ratios. Equity ratio constructed as total equity capital over total assets of commercial banks only. Capital ratios measured relative to lagging five-year averages. First row corresponds to the model with lagged real GDP growth only; second row to the full model. 90% confidence intervals computed using Gregory et al. (2018) smooth extended tapered block bootstrap (SETBB) with blocks of length 20 and 1000 simulations reported around point estimates.

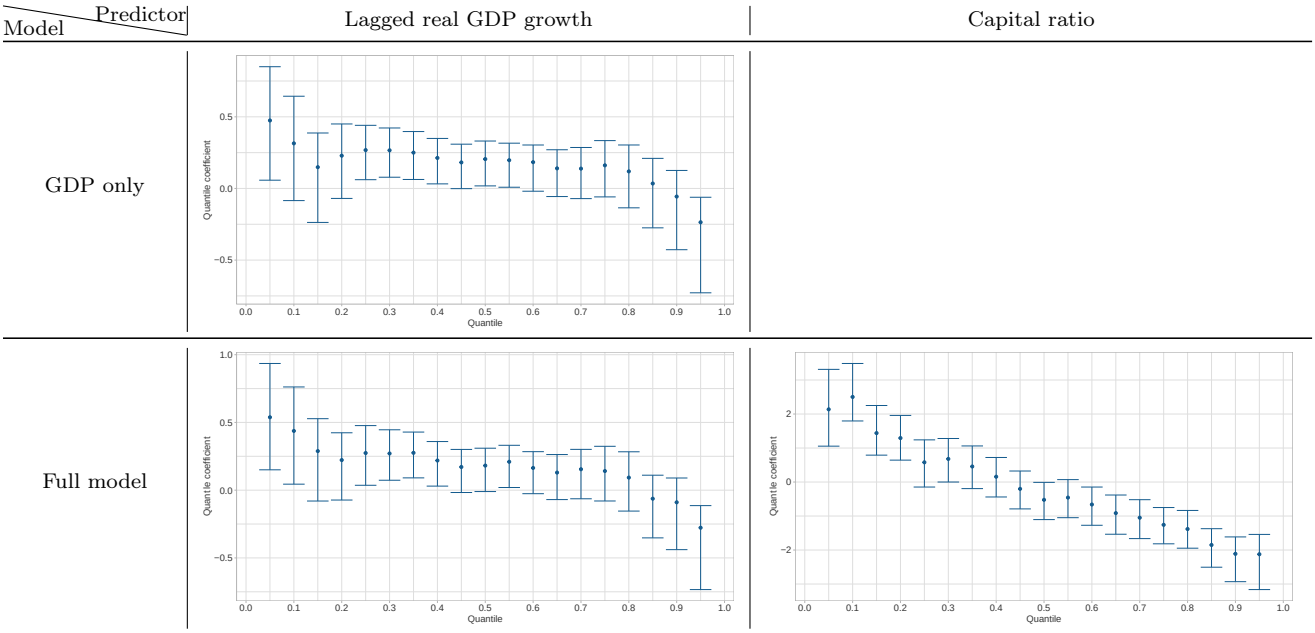


Figure A.4. Estimated quantile regression coefficients across horizon. This figure plots the estimated coefficients in quantile regression of annualized real GDP growth on lags of one year real GDP growth and bank equity ratios. Equity ratio constructed as total equity capital over total assets of commercial banks only. Capital ratios measured relative to lagging five-year averages. First row corresponds to estimated coefficients for bottom fifth quantile; second row to estimated coefficients for the median; third row corresponds to estimated coefficients for top fifth quantile. 90% confidence intervals computed using Gregory et al. (2018) smooth extended tapered block bootstrap (SETBB) with blocks of length 20 and 1000 simulations reported around point estimates.

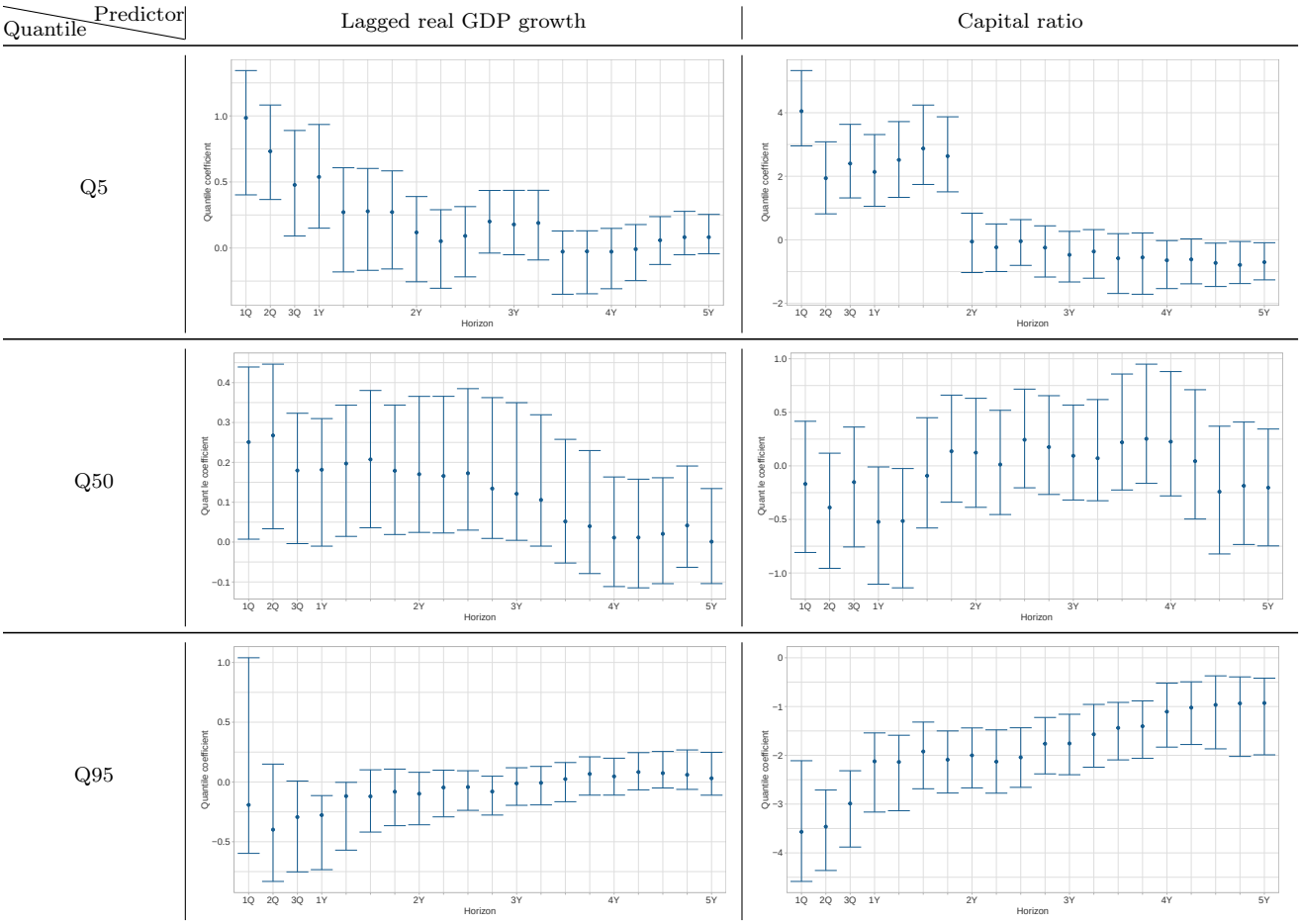
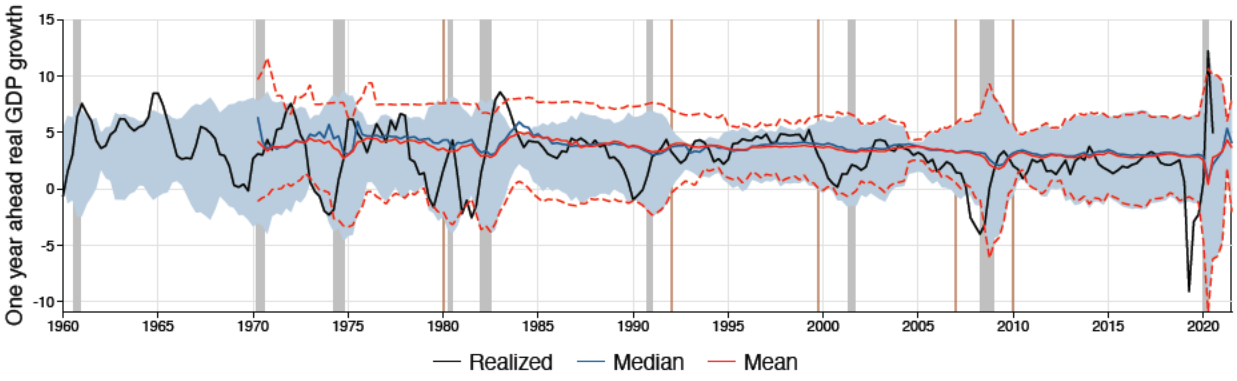


Figure A.5. Predicted distributions. This figure plots the time series evolution of the predicted distribution of one year ahead and five-year-ahead annualized real GDP growth, together with NBER recession shadings and capital regulatory regime changes. Distribution predicted using lagged real GDP growth and lagged capital ratios. Blue shaded area corresponds to the in-sample (5%, 95%) interquantile range; the red dashed lines correspond to the out-of-sample (5%, 95%) interquantile range. Equity ratio constructed as total equity capital over total assets of commercial banks only. Capital ratios measured relative to lagging five-year averages.

(a) One year ahead



(b) Five years ahead

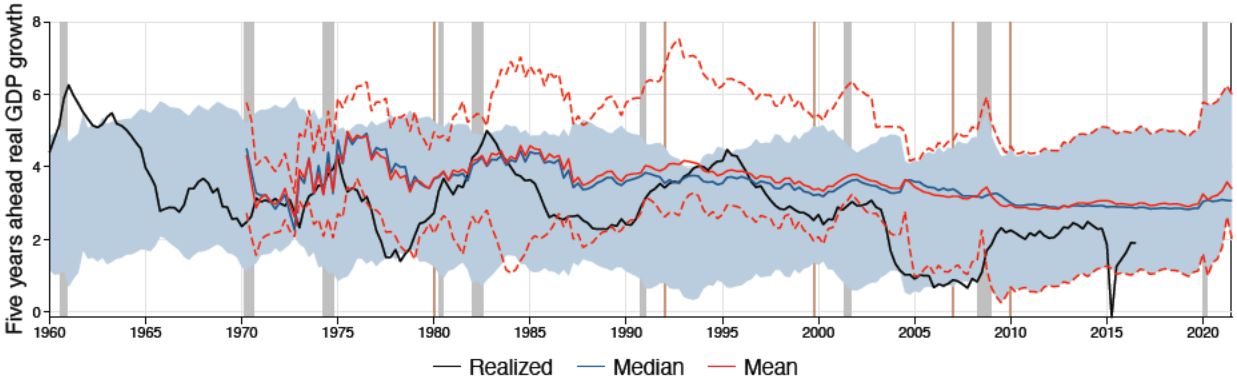
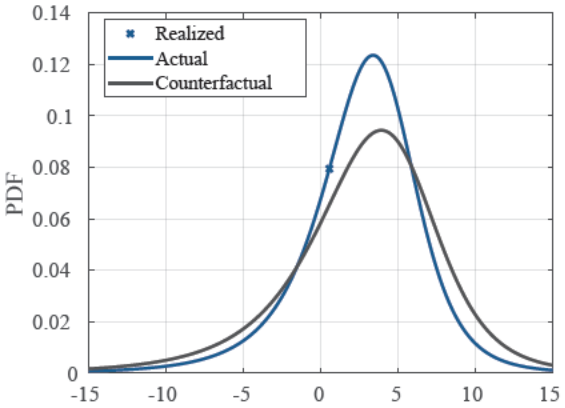
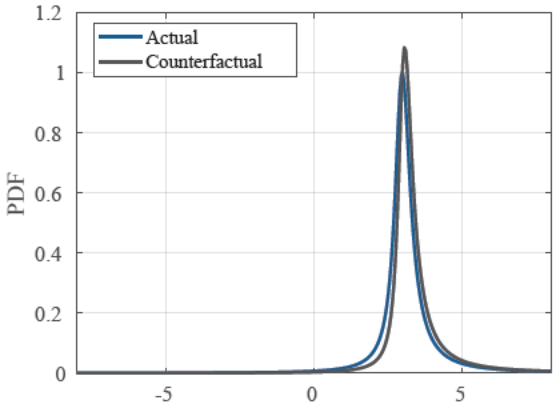


Figure A.6. Effect of decreasing capital ratios ahead of the pandemic. This figure plots the actual and counterfactual predicted distributions of annualized real GDP growth over H quarters as of Q1 2020. Counterfactual distribution constructed under assumption of capital ratios two standard deviations lower than observed. Equity ratio constructed as total equity capital over total assets of commercial banks only. Capital ratios measured relative to lagging five-year averages.

(a) One year ahead



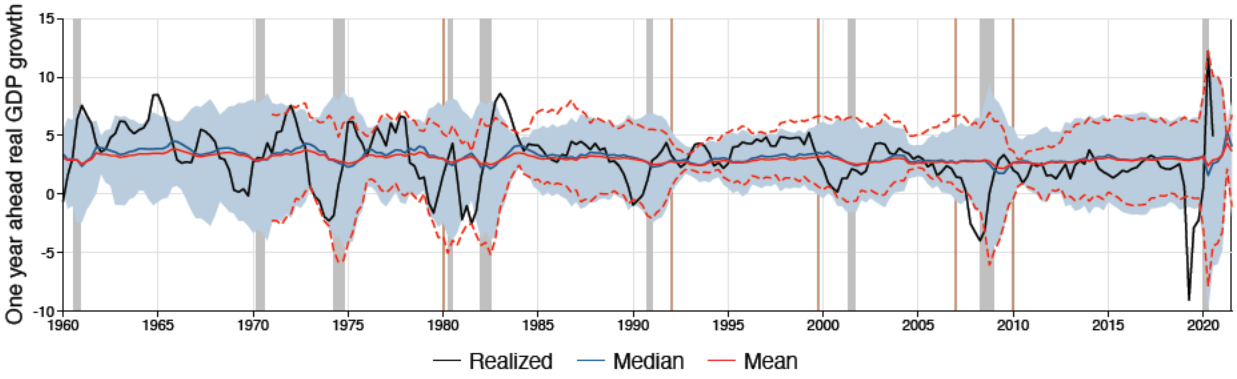
(b) 5 years ahead



	Q5		Median		Q95	
Horizon	Actual	Counterfactual	Actual	Counterfactual	Actual	Counterfactual
1Y	-4.57	-6.84	2.91	3.19	8.56	10.39
5Y	1.62	2.27	3.04	3.23	5.79	6.65

Figure A.7. Predicted distributions with alternative predictors. This figure plots the time series evolution of the predicted distribution of one year ahead and five-year-ahead annualized real GDP growth, together with NBER recession shadings and capital regulatory regime changes. Distribution predicted using lagged real GDP growth and lagged capital ratios. Blue shaded area corresponds to the (5%, 95%) interquantile range predicted using lagged real GDP growth and lagged capital ratios only; the red dashed lines correspond to the (5%, 95%) interquantile range predicted using lagged real GDP growth, one year real credit growth, financial conditions and capital ratios. Equity ratio constructed as total equity capital over total assets of commercial banks only. Capital ratios measured relative to lagging five-year averages.

(a) One year ahead



(b) Five years ahead

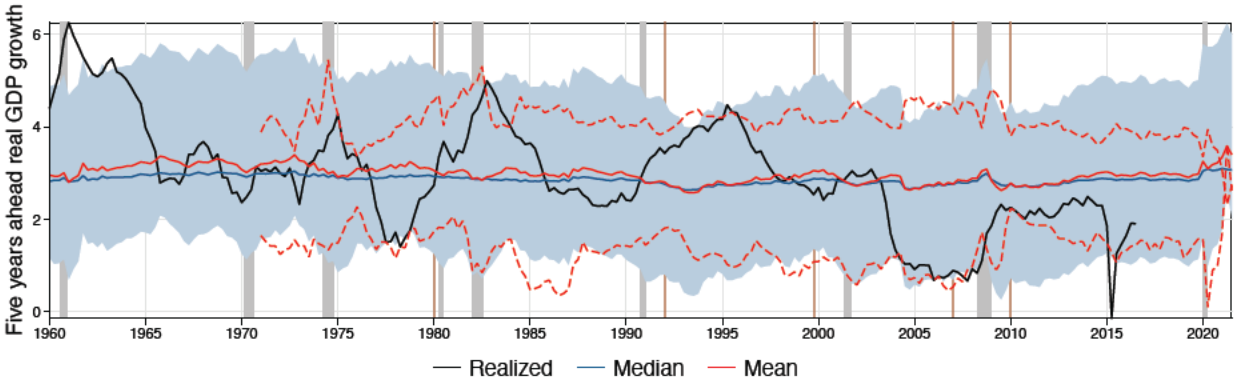


Figure A.8. Threshold regression coefficients across thresholds. This figure plots the estimated coefficients in logit regression of one year ahead and five-year-ahead annualized real GDP growth falling below threshold τ on lags of one year real GDP growth and capital ratios. First row corresponds to one year ahead; second row to five-year-ahead. Equity ratio constructed as total equity capital over total assets of commercial banks only. Capital ratios measured relative to lagging five-year averages. Dashed line corresponds to estimate from a one-year-ahead logit regression of NBER recessions. 95% confidence bands based on heteroskedasticity-robust standard errors plotted as bars around point estimates.