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The Macroeconomic Effects of Bank Capital Requirement Tightenings: Evidence from a Narrative Approach

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Abstract

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Narrative Approach, Bank Capital Requirements, Local Projections

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The Macroeconomic Effects of Bank Capital Requirement Tightenings: Evidence from a Narrative Approach*

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Bank capital regulations are intended to enhance financial stability in the long run, but may, in the meanwhile, involve costs for the real economy. To examine these costs we propose a narrative index of aggregate tightenings in regulatory US bank capital requirements from 1979 to 2008. Anticipation effects are explicitly taken into account and found to matter. In response to a tightening in capital requirements, banks temporarily reduce business and real estate lending, which temporarily lowers investment, consumption, housing activity and production. A decline in financial and macroeconomic risk helps sustain spending in the medium run. Monetary policy also cushions negative effects of capital requirement tightenings on the economy.

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1 Introduction

Since the 2008/2009 financial crisis advanced economies around the world have introduced new financial stability policy measures. Among the most prominent measures are bank capital-based policy instruments, such as risk-weighted capital ratios, leverage ratio caps, or countercyclical capital buffers. These policy tools aim at increasing the resilience of the financial sector to shocks and might also be activated to dampen credit dynamics during buoyant times. However, experience with capital-based regulation policies is limited, especially concerning the transmission of these instruments to the real economy.

There have been warnings about the costs of the regulations, and no consensus in policy and academic circles about magnitudes and the duration of the effects of raising bank capital requirements has been reached yet.[1] The reason might be that identifying the macroeconomic effects of a tightening in bank capital regulation is not trivial. Bank capital is highly endogenous and fluctuates due to a plethora of causes. To identify the effects of bank capital regulation in a way that is useful for policy one needs to separate movements in bank capital due to regulatory changes from its other potential drivers.

We propose a narrative approach in the spirit of Romer and Romer (2010) and Fieldhouse et al. (forthcoming) to identify exogenous changes in the aggregate bank capital ratio. Specifically, we create a narrative index of permanent tightenings in US capital requirements in a sample from 1979 to 2008, based on detailed readings of legislative documents.[2] We identify six events which fall into this time span: three in the first half of the 1980s, when the US supervisory authorities introduced numerical capital requirements, and three in the early-1990s in relation to the first Basel Accord and a strengthening of regulators' resolution powers. (In the robustness analysis we extend our sample to 2016 and include Basel II.5 and Basel III.) In all cases a large share of US banks raised their capital ratios simultaneously and significantly, as documented in academic publications. The stated purpose of the regulations and their often lengthy introduction process make clear

[1]Regulators anticipate relatively mild negative effects (Macroeconomic Assessment Group, 2010), while the financial industry predicts rather large costs (Institute of International Finance, 2011). Among academics, for example, Cochrane (2014) argues: "My view, expressed nicely by Admati and Hellwig's book, is that there is zero social cost to lots more bank equity." Calomiris (2015), by contrast, states: "A higher required equity ratio [...] will permanently reduce the supply of lending relative to a world with lower equity ratio requirements."

[2]Here we focus on capital requirement *tightenings*, but our approach could be extended in future work to loosenings and to analyze their transmission to the economy (and possible asymmetries between tightenings and loosenings).

that these policy changes were structural in nature and were implemented to address long-run features of the banking system, rather than as immediate stabilization policies. Thus, we take them to be unrelated to the financial cycle and the business cycle, which we substantiate by statistical tests for exogeneity. Furthermore, the administrative introductory process of the regulations typically involves first a preliminary formulation of the new rules and a request for public comment, as well as a decision on and publication of the final rule, before the regulation becomes effective. We exploit this staggered introduction of the new regulation to study anticipation effects of changes in capital regulation.

We introduce the capital requirement index (CRI) into local projections, as proposed by Jordà (2005), to assess the dynamic responses of key macroeconomic and financial variables to these capital requirement tightening events. Our main results are as follows.

- A tightening in capital requirements leads to a delayed, permanent increase in the aggregate bank capital ratio. Banks first reduce their assets and only then increase capital.
- The events have significantly negative effects on bank lending and production, which are *temporary*, i.e. last about two years.
- We also inspect closely the transmission mechanism. Negative effects on bank loan volumes induced by the regulation trigger a temporary decline in investment, consumption and housing starts. Negative wealth and income effects after the capital requirement changes matter for short-run household spending dynamics as well. By contrast, a decline in risk helps sustaining household spending in the medium run.
- Monetary policy also cushions the negative effects of capital requirement tightenings on the economy.
- We detect evidence for anticipation effects. Bank assets, production and the monetary policy rate start adjusting about 6 months before the new rules become effective.

So far, the debate on regulatory bank capital policies has been informed mostly by findings from empirical microeconometric studies and structural models. The former type of studies assesses the effects of changes in banking regulation on credit supply at disaggregated (bank or loan) levels (see e.g., Aiyar et al., 2014 and Jiménez et al., 2017). Those studies often find large short-run effects of capital requirement changes on bank lending. They provide a high level of econometric credibility, but leave open questions about the transmission to the real economy and whether changes in credit supply are permanent or transitory and disregard general equilibrium effects.

Inference on the macroeconomic effects of aggregate bank capital policies to date stems mainly from DSGE models.[3] Progress has been made in incorporating features of the financial sector into these models to make them suitable for the analysis of macroprudential policy issues. Yet, findings often remain highly sensitive to the specific friction included, shock considered or calibration chosen. It is therefore often difficult to draw policy conclusions from these models. Lindé et al. (2016) provide a thoughtful discussion about the challenges and shortcomings of current macroeconomic models.

There is one other paper investigating the dynamic macroeconomic effects of capital requirements. Meeks (2017) studies the impact of changes in *microprudential* capital requirements for the UK, identifying shocks via timing restrictions from institutional arrangements. Like us, he finds a temporary contraction of economic activity. We inspect the transmission mechanism in more detail compared to Meeks (2017).

Our main contributions are as follows. Our paper is - to the best of our knowledge - the first to assess the dynamic macroeconomic effects of changes in aggregate regulatory capital requirements.[4] We build and use a narrative regulation index, which follows an established tradition in analyzing policy changes.[5] General equilibrium and anticipation effects are taken into account. We closely investigate the transmission mechanism to the real economy. This includes an analysis of the role of monetary policy in cushioning real and credit market effects of the regulation. We also assess short- to medium-run effects on financial and macroeconomic risk. There is a growing consensus that first and second moments are interrelated, and

[3]For example, Gerali et al. (2010), Darracq Pariès et al. (2011), Quint and Rabanal (2014), or Clerc et al. (2015).

[4]Berrospide and Edge (2010) investigate the effect of variations in bank capital on lending, but do not distinguish regulatory from non-regulatory movements in bank capital.

[5]Narrative approaches have been used to analyze e.g. oil price shocks (Hamilton, 1985), changes in monetary policy (Romer and Romer, 1989, Romer and Romer, 2004, Cloyne and Hürtgen, 2016), tax policy (Poterba, 1986, Romer and Romer, 2010), government spending (Ramey and Shapiro, 1998, Ramey, 2011, Owyang et al., 2013), or financial crises (Romer and Romer, 2017). Richter et al. (2018) investigate the effects of changes in another financial stability instrument, namely loan-to-value ratios, employing a narrative approach.

this needs to be accounted for by theorists and policy makers (see, e.g., Adrian and Liang 2018).

The structure of the paper is as follows. In Section 2, we provide a narrative analysis of changes in bank capital regulation in the US. In Section 3, we outline our methodology. Section 4 contains our main results together with robustness analyses. In Section 5, we inspect the transmission mechanism more closely. We also compare effects of the regulation with effects of changes in another financial disturbance, the excess bond premium, see Gilchrist and Zakrajšek (2012). This helps us to better understand the transmission mechanism of capital requirement changes and to verify the validity of our identification approach. We conclude in Section 6.

2 A narrative analysis of changes in aggregate bank capital requirements

Our narrative analysis of changes in bank capital requirements has three objectives: first, to identify events in which regulatory capital requirements were changed for a large share of US banks at once and to classify if the policy change was binding or not; second, to identify the exact dates at which the policy changes were first proposed to the public, finalized and became legally effective; third, to identify the motivation for each change in capital regulation and to determine if these are unrelated to the current financial cycle and the business cycle.

The primary sources for our narrative analysis are official publications of changes in bank capital requirements in the *Federal Register*. Final rules published by the regulators in the *Federal Register* usually include a detailed discussion about the background and the motivation of the policy change. We complement this source with information obtained from the *Federal Reserve Bulletin* and some technical reports published by the FDIC. Finally, we also draw on academic literature from law and economics as changes in capital regulation usually sparked academic work on this event at the time. These academic publications helped us direct the search about the significant regulatory changes in the official outlets. A detailed description of the narrative analysis can be found in Appendix A.

2.1 Identifying significant changes in bank capital regulation

Table 1 presents the key changes we identify in US bank capital requirements. Numerical capital adequacy guidelines were first introduced in Dec. 1981 for the US. Required capital ratios still differed across the three main regulators, the Federal Deposit Insurance Corporation (FDIC), the Federal Reserve System (Fed) and the Office of the Comptroller of the Currency (OCC), but were set in the range between 5% and 6% of capital over unweighted assets. While multinational banks were at first exempt from the requirements, the Fed and the OCC subjected them to similar requirements in Jun. 1983 in the wake of Congressional pressure for higher adequacy ratios. Most multinational banks already fulfilled the requirements of 5% by that time. Therefore we do not account for this change in our baseline CRI (as elucidated by putting the date in grey font in Table 1), but analyze robustness with respect to including the event further below. US Congress demanded stronger and more uniform regulatory capital adequacy ratios in its International Lending and Supervision Act (ILSA) from Nov. 1983. This led to a common set of capital adequacy guidelines by the Fed, OCC and FDIC in Apr. 1985. The common capital requirements were set to 5.5% across all banks. Even though this meant a nominal capital adequacy easing for smaller (community) banks, the overall effect seems to have been a tightening in aggregate bank capital: Baer and McElravey (1993) find a shortfall of bank capital comparable to the one after the introduction of Basel I. We include both the ILSA passing and the regulatory response date into our indicator as the Congress act strengthened the regulators' hand against some court rulings in favor of banks, as well as for consistency with the 1991 legislation (see below).[6]

From the mid-1980s onwards, there were consultations for an international framework of bank capital requirements under the name of Basel Committee on Banking Supervision.[7] The capital requirements of the Basel Accord ("Basel I"), became binding for the US in Dec. 1990. Their main novelty was the introduction of risk weights for different asset classes, and specification of capital ratios of tier 1

[6]In Feb. 1983, the Fifth Court of Appeal in the case "First National Bank of Bellaire v. Comptroller of the Currency" had nullified a regulatory action by the OCC against the bank, declaring the regulator's capital-adequacy rule "capricious and arbitrary" (see e.g. Posner and Weyl, 2013). After ILSA, court decisions generally acknowledged regulators' primacy over setting capital requirements (see Appendix A).

[7]The committee operated under the name of *Basle* Committee up to 1999, when the mostly German-speaking inhabitants of Basel suggested a change of name (Tarullo, 2008, fn. 2, p. 1).

and 2 capital to risk-weighted assets of 4% and 8%, respectively (see e.g. Tarullo, 2008, p. 55). Several empirical investigations show that Basel I led to significant adjustments on bank capital ratios.[8] Around the same time, there was also renewed legislative pressure for a tougher implementation of capital adequacy rules. After the Savings and Loans Crisis had revealed fundamental weaknesses of the US banking system, the US Congress demanded faster action against banks with inadequate capitalization. In the FDIC Improvement Act of Dec. 1991, Congress gave very specific instructions how to implement so-called "prompt corrective action" measures against weakly capitalized banks. It also prescribed regulators to implement the new rules within a year, which duly led to regulatory changes becoming effective in Dec. 1992. Aggarwal and Jacques (2001) show that both events led to significant capital ratio build-ups by banks, which is why we include both dates in our indicator.

There were two more large regulatory changes before the global financial crisis. In Jan. 1997, the Market Risk Amendment adapted the Basel risk weights to also take into account market risk, thus affecting capital ratios of all banks. Importantly, banks were allowed to use their internal models to assess these risks. In Apr. 2008, after more long rounds of international negotiations, Basel II became effective in the US. However, for both events it is not clear whether they had a tightening or loosening effect on banks' capital ratios. Gehrig and Iannino (2017b), in a study on European banks, argue that in both cases large banks actually lowered their de-facto capital ratios by the use of internal models. We do not include the two events into our baseline indicator, but check for robustness of our main findings in including the Jan. 1997 event. Following Cerutti et al. (2017), we do not include Basel II into the baseline index.

Our baseline sample excludes the reform packages of Basel II.5 and III, which were introduced only after the crisis. The regulatory changes introduced by these packages were manifold, and among others included higher bank capital requirements, which effectively increased bank capitalization (see e.g., Cerutti et al. 2017 and Cohen and Scatigna 2016). Therefore, we also check for robustness using a longer sample and including these two dates.

In our baseline analysis, we use a binary indicator of regulatory capital requirements with ones for the months of CRI changes and zeros otherwise. This ignores that some events may have affected the banking system (and the econ-

[8] See e.g. Haubrich and Wachtel (1993), Berger and Udell (1994), Jacques and Nigro (1997), or Van Roy (2008).

omy) more than others. As a robustness check, we also (tentatively) weight the events and account for differing numbers of affected banks and increases in capital ratios. Given that quantification in our context is not straightforward and that key results are almost identical to those using our baseline unweighted CRI, the alternative weightings schemes and the results are not presented here. Instead we refer the interested reader to Appendix C.

2.2 Timing

In general, the legal procedure associated with a change in the rules for bank capital requirements is as follows. Two events in our CRI represent Congress acts which specifically suggest changes in bank capital regulation by the regulators. In the case of Basel Accords, international consultations lead to regulatory change. In all cases except the Congress acts, regulators at some point publish a set of *proposed rules* in the Federal Register, and banks and other stakeholders are invited to send comments. Together with a discussion of received comments on the proposals, the regulators then publish a set of *final rules* of the envisaged changes. The public at this point has a clear idea on which changes to expect. The final rules often include a detailed purpose and a motivation, a background and an overview of the regulation. They also specify a date as of which the rules will become effective. This "effective date" is the date we focus on in our analysis. We do our best to specify comparable dates for the US Congress acts (our second and fifth event), see Appendix D.1 for details. After the effective date, there is usually a phase-in after which the rules fully apply. End of phase-in periods are not considered explicitly here due to the lack of additional information for half of the events.[9]

In columns 2 and 3 of Table 2, we list the dates of proposed and final rules for each of the main policy events. The information in Table 2 shows that changes in bank capital regulation follow a staggered introduction process and are anticipated with substantial leads. These policy events could therefore be interpreted as news shocks about tightenings in capital requirements. If we think of the anticipation horizon as the time between publication of the proposed or final rules and of the

[9] While the Dec. 1981 numerical guidelines and the Dec. 1992 prompt corrective action measures were explicitly introduced without a phase-in, the Apr. 1985 common guidelines and the Basel I reforms had explicit phase-ins of 12 and 24 months (see Federal Register, Vol. 50, No. 53/ Mar. 19, 1985, p. 11139, and Vol. 54, No. 17/ Jan. 27, 1989, p. 4193). ILSA (our second event) did not specify a time until when regulators should take actions. The FDICIA (our fifth event) stated a time window of 12 months.

effective date, we obtain horizons of $\{6, 8, 9, 57, 9, 5\}$ months for the proposed rule and of $\{6, 7, 1, 23, 4, 3\}$ for the final rule. Basel I with its lengthy international negotiations is an outlier. Without Basel I the median anticipation horizons are at 8 months (differences between proposed rules and effective dates) and at 4 months (differences between final rules and effective dates). We have no clear prior whether banks should be expected to act already on the proposed rules, or on the more specific final rules. In our econometric exercise, we will therefore allow for anticipation effects assuming an average anticipation horizon of 6 months. This choice is also supported by a newspaper search of the first mentioning of the new regulations (Appendix D.2) as well as by an ex-post analysis on when markets first reacts based on bank excess return dynamics (Appendix D.3). However, we show below that our results are robust to using anticipation horizons of 4, 8 or 10 months.

2.3 Motivation for tighter capital requirements

The motives for the changes in bank capital regulation in our index are virtually always broad, long lasting and structural in nature. Moreover, the policy changes are slowly drafted and subject to lengthy negotiations between bankers, politicians and regulators. As illustrated above, this results in a considerable time lag between the announcement of the new policy rule, the date at which the rule becomes effective, and the date at which the regulations finally become binding for banks after the phase-in. While it is true that some of the policy changes were introduced after periods of financial turbulences, they always addressed the underlying fundamental weakness in the financial system revealed by the turbulence, not the turbulence itself. Our readings of the official documents at the time therefore corroborate the assertion in Elliott et al. (2013) that "[s]upervisors have never instituted a countercyclical capital regime, in which capital requirements would explicitly fluctuate with the credit cycle." (p. 34). We therefore conclude that the policy changes captured by our CRI were not motivated by cyclical consideration but are unrelated to the current business cycle and financial cycle.

To illustrate one example of our readings of the policy statements, we detail the relevant passages for our first event, the introduction of numerical capital-adequacy ratios in Dec. 1981, and Appendix A lists similar relevant quotes for all events in our CRI. We find two quotes particularly telling about the regulators' motivation. For the FDIC, this is a paragraph in the "Statement of Policy on

Capital Adequacy" in the Federal Register (Vol. 46, No. 248/Dec. 28, 1981, p. 62693):

> *This policy statement is intended to clearly set forth qualitative criteria to be considered in determining adequacy of bank capital, to inject more objectivity and consistency into the process of determining capital adequacy, to provide nonmember banks with clearly defined goals for use in capital and strategic planning and to address the issue of disparity in capital levels among banks in different size categories by adopting uniform standards regardless of the size of the institution.*

The corresponding announcement published in the Federal Reserve Bulletin conveys a similar point on the motivation (Federal Reserve Bulletin/Vol. 68, No.1/Jan. 1982, p. 33):

> *Objectives of the capital adequacy guidelines program are to address the long-term decline in capital ratios, particularly those of the multinational group; introduce greater uniformity, objectivity, and consistency into the supervisory approach for assessing capital adequacy; provide direction for capital and strategic planning to banks and bank holding companies and for the appraisal of this planning by the agencies; and permit some reduction of existing disparities in capital ratios between banking organizations of different size.*

We also test statistically for exogeneity of the CRI. To do so, we try to predict our CRI events using probit regressions on the following lagged variables from our main analysis below: the bank capital ratio, changes in industrial production and the core PCE deflator, the Federal Funds rate, changes in bank loans and the BAA spread (for details on the series, see Section 3 and Appendix E). We include the variables one at a time to avoid overfitting (Vittinghoff and McCulloch, 2007). None of the variables significantly enters the equation (Table 3), implying that the regulations cannot be forecast using macro and financial data and thus do not appear to react to the state of the business cycle and the financial cycle.[10]

Finally, in our robustness checks below we include an extensive range of other shock indicators, as well as recession and financial crisis dummies. Results are not affected, which should soothe potential concerns that our regulatory events pick up episodes of financial turmoil.

[10] This finding is robust to a battery of different model specifications and variable transformations. We refer to Appendix B for more details.

3 Methodology and data

With the baseline index of six regulatory events at hand, we are in the position to explore the dynamic effects of a regulatory bank capital requirement tightening on macroeconomic and financial variables. We first set up a simple model without anticipation effects, then we extend the model to include anticipation effects.

Let y_{t+h} be the response variable of interest, i.e. the capital ratio, its denominator, its numerator, or, alternatively, a loan aggregate, a loan spread, an asset price or a macroeconomic variable, and x_{t-1}, a set of control variables. We set up the local projections approach (without anticipation effects) suggested by Jordà (2005) as follows (see also Fieldhouse et al., forthcoming):

$$\widetilde{y}_{t+h} = c^h + \beta^h(L)\widetilde{x}_{t-1} + \gamma^h(L)CRI_{t-1} + u_{t+h}, \tag{1}$$

where $\widetilde{y}_{t+h} = y_{t+h} - y_{t-1}$ and $\widetilde{x}_t^i = x_t^i - x_{t-1}^i$ (where x_t^i is an element of x_t) for all non-stationary variables and $\widetilde{y}_{t+h} = y_{t+h}$ and $\widetilde{x}_t^i = x_t^i$ for all stationary variables (for details on the transformation see Appendix E).

The regression equation includes deterministic regressors c^h (a constant, a linear trend and a quadratic trend). Moreover, the lagged CRI enters the equation, as three of the regulatory changes became effective on the last day of the respective month, and the other three in the second half of the month (see Table 1), but results do not depend on whether only lagged or also contemporaneous CRIs enter the equation. Specifically, we include 2 lags of the CRI and of the control variables (as, e.g., in Ramey, 2016).

While equation (1) does not allow for anticipation of the regulatory events, we now set up a model where agents are allowed to act $\widetilde{h}$ months prior to the effective dates. Following Mertens and Ravn (2012) we modify the model as follows:

$$\widetilde{y}_{t+h} = d^h + \delta^h(L)\widetilde{x}_{t-1} + \tau^h(L)CRI_{t+\widetilde{h}} + e_{t+h}, \tag{2}$$

where the term $\tau^h(L)CRI_{t+\widetilde{h}}$ comprises 2 lags of the CRI, the contemporaneous CRI and leads of the CRI up to $\widetilde{h} = 6$ months.

In both models the set of control variables includes the logarithms of industrial production, of the core PCE deflator and of bank loan volumes (defined as the sum of real estate loans, commercial and industrial (C&I) loans as well as consumer loans, divided by the core PCE deflator); the Federal Funds rate; the BAA spread, defined as Moody's BAA yield minus the 10-year Treasury constant maturity rate; and the left-hand-side variable (if not among the previously listed variables).

We rely on monthly data from 1979M8 to 2008M8. The starting point corresponds to Paul Volcker's appointment as chairman of the Federal Reserve, and we end before the global financial crisis. These choices help exclude structural instabilities due to major changes in monetary regimes or the global financial crisis. We will explore other model specifications and sample periods in the robustness section below. Details of all series (including those used in the robustness analysis) are provided in Appendix E. We only note here that for data on bank assets and liabilities we rely on the H.8 statistic published by the Federal Reserve Board. The H.8 statistic is the only database for banking variables which is available at a monthly frequency. The drawback of the H.8 is that it does not contain information on regulatory capital. Hence, in our empirical analysis we use book capital, constructed as the difference between total assets and total liabilities, as our measure of bank capital.[11]

Figure 1 plots key macroeconomic and financial variables together with our six regulatory events. The main message from the graphs is that no uniform pattern after the CRI changes is directly apparent. While, for example, after the second and the last three events the capital ratio gradually rises, this is not the case after the other two events. And production falls after the first and the fourth events, but not otherwise. This suggests that our key variables are primarily driven by other influences than banking regulation, and that each study explaining them needs to account for this feature. Our approach here is to use the exogenous regulation index.

For all horizons h we define the sample based on the time series of the dependent variable at horizon $h = 0$. Thus the vector of explanatory variables is the same across different horizons, allowing for better comparability across specifications. The sequence of parameter estimates $\{\gamma_1^h\}_{h=1}^H$ or $\{\tau_1^h\}_{h=1}^H$, for the model without and with anticipation effects, respectively, yields the impulse response of y_t to an exogenous tightening in regulatory capital requirements, i.e. to a change in the CRI from 0 (no event) to 1 (a regulatory event). Hence we obtain the impulse responses horizon by horizon. Standard errors are computed using the

[11] See Adrian and Shin (2014) for a similar approach to compute the capital ratio of security brokers and dealers. We also note that the H.8 contains disaggregated statistics for small, foreign and large banks only from 1985 onwards. Hence, we cannot assess the effects of tighter capital requirements on small and large banks separately. Doing so would require starting our analysis in 1985, in which case we would lose too many events.

heteroscedasticity and autocorrelation consistent covariance estimator of Newey and West (1987). In the figures below, we provide point estimates (solid lines) as well as 68% and 90% confidence intervals (dark and light shaded areas) for the model with anticipation effects and 90% confidence intervals (dotted lines) for the model without anticipation effects.

4 Main results

4.1 Bank-sector and aggregate effects of capital requirement tightenings

We start the macroeconometric analysis by assessing how banks adjust the capital ratio, the level of bank capital and total assets to a regulatory tightening in bank capital requirement.

Figure 2 shows that in both models (with and without anticipation effects) the capital ratio increases permanently after a regulatory tightening of capital requirements (even though the response from the model without anticipation effects is much less significant than the one from the model with anticipation effects). There is a two-year delay in the reaction of the bank capital ratio, which likely reflects the phase-in periods of changes in bank capital requirements, or sluggish adjustment of capital buffers. Our finding that the bank capital ratio increases permanently – which is by no way implied by our identification – gives further confidence that our narrative approach does indeed identify episodes of changes in capital requirements that are unrelated to the cycle, as the regulations specify permanent increases in the capitalization of banks. If our index captured some sort of temporary recessionary aggregate demand shocks, there would be no reason for banks to permanently raise their capital ratio. The increase in the capital ratio also comes at a meaningful size. A "representative" CRI tightening in our sample leads to a 30 basis points increase in the aggregate capital ratio. This shows that our index picks up decisive regulatory events, especially given that the level of our (non-regulatory) capital ratio is at 6.9% on average over the six events.

Banks can adjust to higher capital requirements in various ways: by reducing the size of their balance sheet, by increasing the level of capital, or by a combination of both. Differentiating at which margin banks choose to adjust is crucial for understanding the transmission to the real economy. We find that banks first reduce their assets temporarily. The level of bank capital increases only after some time, but then does so permanently. Once capital has been built up, banks slowly extend their balance sheet back towards the pre-regulation value. The model with anticipation effects reveals that banks start shrinking their assets 6 months before the effective dates, and the response tends to be larger and more significant when anticipation effects are taken into account.[12]

The local projections model explaining the capital ratio corresponds to the first-stage regression in an instrumental-variable (IV) local projections approach. While the point estimates from the IV local projections are identical to the estimates from the standard local projections up to a scaling (Ramey and Zubairy, 2018), the IV setup yields, in addition, information on the relevance of the CRI for bank capitalization, which we can exploit to further understand the relation between our CRI and the bank capital ratio. Based on the regressions for the capital ratio, we compute the Newey and West (1987) robust F-statistic up to 48 horizons after the regulatory changes (see Fieldhouse et al. (forthcoming) for a similar approach). In the model without anticipation effects we find its maximum to be at almost 10 within 38 months after the regulatory changes (dotted line in Figure 3), suggesting that the CRI is sufficiently relevant for the future capital ratio.[13] In the model with anticipation effects the relevant F-statistic is even larger, exceeding 13 at a forecast horizon of 34 months (solid line in Figure 3). Overall, while the CRI would lend itself as a strong instrument for the book capital ratio at longer horizons, we prefer to use straightforward local projections as we do not have the appropriate regulatory bank capital ratio at our disposal for our sample.

We now analyze the transmission of a tightening of bank capital requirements to key macroeconomic and lending variables (Figure 4).

Industrial production falls temporarily, with a maximum decrease of about 3% reached roughly a year after the regulatory change.[14] The response of the PCE deflator is barely significant, which is why we do not show it here and in the remainder of the paper. The Federal Funds rate is lowered significantly, probably as a reaction to the decrease in production, and then returns to baseline. We will

[12]From the figure it seems that the dynamics of the capital ratio (in percentage points) are entirely driven by the dynamics of bank capital (in percent). This is not surprising given that banks are highly levered, with assets being more than 12 times larger than bank capital on average over our sample period.

[13]F-statistics are much lower when the dates of proposed or final rules are used instead (not shown), never exceeding 7. This supports our focus on the effective dates.

[14]We also look at the reaction of GDP (interpolated from quarterly to monthly) to anticipated changes in capital requirements. We find a similar shape as for the impulse response function of industrial production. In terms of magnitudes, GDP declines by a maximum of 1%.

examine more formally below to what extent monetary policy has smoothed out negative economic effects of the capital requirement changes.

The decline of production seems due to a decline in loan volumes. The shape of the loan response resembles the one of bank assets, with a maximum drop of about -5% reached after almost 20 months.[15] Finally, the BAA spread increases after about 8 months and remains significantly elevated for roughly one year. The rising spread and the declining loan volume suggest that negative credit supply effects dominate after a tightening in capital requirements.

As in the case of bank assets, bank loans as well as industrial production decline *before* the regulatory changes become effective, and troughs are reached slightly earlier and are deeper with anticipation effects. Results from the model with anticipation effects where the decline in loans precedes the decline in production are somewhat more plausible than those from the model without anticipation effects. The policy rate starts falling half a year before the effective date. The (implausible but insignificant) initial increase which resulted from the model without anticipation effects might be due to misspecification, i.e. omission of anticipation effects.

The responses of production, loans or spreads relative to the response of the (non-regulatory) capital ratio are large compared to other studies which analyze the macroeconomic effects of capital requirement changes (e.g. Meeks, 2017, and Table 4B in Dagher et al., 2016 for an overview). However, the average capital ratio over our six events, which is 6.9%, is also much smaller than the levels of ratios considered in other studies. In Macroeconomic Assessment Group (2010) and Aiyar et al. (2014), for example, banks depart from a capital ratio of about 11%. Considering the effects on loans compared to those on *relative* changes in the bank capital ratio (changes in the ratio over the level of the ratio), our results are in fact very similar in magnitude to the findings from the microeconometric literature (see e.g., Aiyar et al. 2014). Furthermore, our CRI is a very accurate measure of capital requirement regulation and we should therefore see larger effects of our CRI compared to noisier measures of capital requirement regulation. In fact, studies using narrative shock measures typically find relatively large economic

[15] The fall in loans exceeds the one in bank assets. Almost half of assets are loans (as in January 2017), whereas the other half consists in treasury and agency securities (15% of assets), other securities (6%), other loans and leases (8%), cash assets (14%) and other assets (8%). We also look at dynamics of the other bank asset categories after anticipated changes in the CRI and find most other categories to fall or not move significantly, but treasury and agency securities to rise. This helps explaining the (percentage) reaction of assets in comparison to the one of loans.

effects of those shocks (see, e.g., Table 3a in Cloyne and Hürtgen 2016 for the case of monetary policy shocks).

Overall, we find notable, but temporary effects of capital requirement tightenings on loans and production. Anticipation effects seem to matter: Banks start adjusting their lending, non-financial corporations their production and the central bank the interest rate about 6 months prior to the effective dates. Hence, in the remainder of the analysis we proceed with the model which allows for anticipation effects, i.e. the econometric specification in equation (2).

4.2 Robustness analysis

In this section we perform a battery of changes to our model setup to ensure that our baseline results are robust against plausible changes to the modeling approach and the variables included. In Figure 5 we plot our key baseline results together with point estimates from these alternative models.

First, we test whether our results depend on the anticipation horizon. Figure 5a shows results with average anticipation horizons of 4, 8 and 10 months as well as the baseline 6 months. Results are very similar. In general, no additional effects are found earlier than 6 months before the effective dates. The model which allows for an anticipation horizon of 4 months does not fully capture the negative loan response which we obtain with our baseline model. One may also argue that time leads between information becoming available to the public and effective dates differ a lot across events, and question the use of an *average* anticipation horizon. To address this issue, we form a new index where we shift the ones of our baseline CRI forward by the time leads between final rule and effective dates of the individual events. Given the exceptionally long lead between the final rule and the effective date, we have shifted the one for Basel I by the second largest time lead of 7 months forward. For rough consistency with the model with an average anticipation horizon we include 9 lags of the altered index in the local projections. To present results in the same figure, we have shifted impulse response functions left by our average anticipation horizon. Overall, the analysis suggests that an average anticipation horizon of 6 months is a reasonable and robust choice.

Second, one might wonder whether 2 lags of the CRI and of controls are sufficient to capture the dynamics of the system. Figure 5b shows that increasing the lag length of the control variables or, alternatively, the CRI from 2 to 12 does not alter our key findings.

Third, our events represent permanent capital regulations, and one may argue that we should therefore rather use the cumulated CRI. When we do so, the effects on loans and production are slightly more short-lived, but results are very similar overall.

Fourth, we alter the sample period (Figure 5c). We begin in 1983 which broadly marks the beginning of the Great Moderation and at the same time ensures that we keep all events but the first in the CRI. Our key results do not change. Further, we extend our sample to include the global financial crisis and the post-crisis period and end in 2016M12. To account for the zero lower bound of nominal interest rates and to capture unconventional monetary policy we extent the Federal Funds rate with the shadow short rate from Krippner (2015) from Nov. 2008, the announcement date of QE1, onwards. Results are unchanged. We note that Basel II.5 and Basel III remain excluded from this extended sample given our maximum forecast horizon of 4 years. Hence, we also reduce the maximum forecast horizon to 3 years in order to include Basel II.5 and to 2 years in order to include both Basel II.5 and Basel III. Again, the impulse responses for those horizons closely resemble those from the extended baseline model. Hence, altering the sample period and adding post-2008 events do not affect our key results.

Fifth, we experiment with several alternative definitions of the CRI. As a first check, we remove each of the six events one by one in order to understand whether any of the events dominates our results (Figure 5d). The responses remain very similar, also when Basel I, the only international event, is excluded. We also remove simultaneously the last two events, which were the only events when the Fed was not among the regulators. One might expect an altered coordination between monetary policy and banking regulation. Responses are again very similar, only the loan reaction is slightly weaker (Figure 5e). We then add, one by one, events discussed in Section 2.1 but initially not included in our baseline CRI (Jun. 1983 and Jan. 1997, in gray in Table 1). Finally we exclude the dates when Congress passed legislation that finally led to changes in capital requirements (ILSA in Nov. 1983 and FDICIA in Dec. 1992). Our results are also robust against those changes.

Sixth, we include additional controls one by one to ensure that our results are not contaminated by other shocks (Figures 5f-5h). We add the EBP constructed in Gilchrist and Zakrajšek (2012) as a measure of financial shocks. The EBP captures a risk premium that reflects systematic deviations in the pricing of US corporate bonds relative to the issuers' expected default risk. We also include a measure of the medium-term financial cycle, the Basel credit-to-GDP gap, which has been suggested as an early warning indicator for financial crises, as well as a Savings and Loan crisis dummy variable with ones throughout 1988 and zeros otherwise.[16] By adding those variables to our model, we make sure that our CRI is not contaminated by direct influences of financial crises. Furthermore, we include the TED spread to capture market liquidity; a measure of monetary policy shocks constructed by Romer and Romer (2004) and updated by Coibion et al. (2017); utilization-adjusted total factor productivity growth from Fernald (2012), which captures technology shocks; the exogenous tax changes from Romer and Romer (2010) and the military spending news from Ramey (2011) as measures of fiscal policy shocks; the change of the real oil price; and a dummy variable which equals 1 at NBER recessions dates and 0 otherwise. Results are all confirmed.

5 Additional analyses

In this section, we first analyze the transmission mechanism in some detail, including the role of monetary policy in cushioning the effects of bank capital regulation on the economy. We then compare the effects of changes in the CRI with those of a change in the EBP, another type of credit supply shock.

5.1 Transmission mechanism

5.1.1 Loans and spreads

We first analyze the responses of the two largest loan categories within our bank loan volume variable, which are C&I and real estate loan volumes. The responses of the loan sub-aggregates might help understand which type of borrower is affected most in terms of a reduction in credit supply: entrepreneurs or real estate loan holders. Banks reduce both types of loans (Figure 6). The maximum decline for both loan categories is at -5%. The drop is more persistent for real estate loans.

We also show responses of the C&I loan rate spread, defined as the bank prime loan rate minus the 2-year Treasury bill rate; and the mortgage rate spread, defined as the 30-year mortgage rate minus the 10-year Treasury constant maturity rate. Unlike the BAA spread, these spreads tend to decline. Both are based on lending

[16] We follow the dating of banking crises by Laeven and Valencia (2013). In their database, the Savings and Loan crisis represents the only banking crisis in the US in our sample.

to the safest borrowers, so their decline might reflect some portfolio rebalancing of banks towards safer debtors.[17]

5.1.2 Non-financial corporations and households

We next aim to understand how the reduction of lending translates into investment and consumption. Figure 7 shows that (fixed private non-residential) investment exhibits a hump-shaped decline; the trough of -5% is reached after about 20 months after the effective dates.

The figure also shows impulse responses of personal consumption expenditures, housing starts, the unemployment rate and asset prices. Consumption declines temporarily after the regulatory events, by about 1%, but the reaction turns insignificant about 1.5 years after the regulatory event. Similarly, while housing starts decrease by up to 10%, the response is also only temporarily significant.

The initial negative responses of consumption and housing starts can be explained by banks reducing their lending to households, but we also find evidence for negative wealth and income effects. House and stock prices (in real terms) tend to decline, while the unemployment rate rises.

5.1.3 Risk

While higher bank capital requirements are supposed to enhance financial stability in the long run, it is an open question how they affect risk in the short and medium run.

In Figure 8, we show impulse responses to an increase in the CRI of the following variables: stock market volatility; *bank* stock market volatility; a measure of systemic risk of the commercial banking system (ΔCoVaR), taken from Adrian and Brunnermeier (2016); macroeconomic uncertainty, taken from Jurado et al. (2015)[18]; as well as a measure of risk aversion. The latter is related to the price of high-volatility stocks relative to the price of low-volatility stocks. It measures the attitude towards risk and is borrowed from Pflueger et al. (2018).[19]

[17] Unfortunately, for our sample we only have the bank prime rate and the 30-year fixed rate mortgage average at our disposal.

[18] We also inserted separately the measures of financial uncertainty and real uncertainty from Ludvigson et al. (2015), and results are very similar to those for macroeconomic uncertainty.

[19] The authors argue that when risk aversion is high, the valuation of high vs. low volatility stocks should be small. Specifically, they compute the difference between the book-to-market ratio of the lowest-volatility quintile of stocks and the book-to-market ratio of the most volatile quintile of stocks (the “price of volatile stocks”, PVS_t). The authors kindly shared their (quar-

All of these measures decline significantly one to three years after the regulatory events. This suggests that tighter capital requirements have stabilizing effects on financial markets and the real economy in the short and medium run. This is all the more remarkable, as the shock is contractionary (i.e. lowers real activity). The finding for risk aversion suggests that agents might become less worried about risk when bank capital ratios are higher.

5.1.4 The role of monetary policy – a counterfactual experiment

We have seen above that the central bank lowers the monetary policy rate considerably after a capital requirement tightening. This suggests that monetary policy cushions the negative effects of the regulation on lending and the real economy. In order to tentatively quantify these effects we carry out a counterfactual experiment. We assess how selected variables would have reacted had there been no monetary policy response to the regulatory event.[20]

In Figure 9, we show the responses of production, the bank capital ratio and the policy interest rate to changes in the CRI from our baseline (black solid lines and shaded areas) together with point estimates of the counterfactual impulse responses (red dashed lines). The first finding is that the monetary policy reaction enables banks to adjust their capital ratio to higher values faster by stabilizing the economy.[21] Second, monetary policy cushions the negative effects on economic activity due to the regulation. It is effective with a delay, both because the monetary policy rate drops most strongly with a delay, and because monetary policy has delayed effects on the economy. However, monetary policy seems to significantly help in preventing longer-lasting negative effects of the regulation. One implication is that the negative effects of capital requirement tightenings might be larger at the zero lower bound of nominal interest rates.

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terly) series with us, and we use the (negative) interpolated series $-\text{PVS}_t$ as a proxy for risk aversion.

[20]The counterfactual experiment is implemented as follows. We augment out baseline model with contemporaneous and lagged (updated) Romer-Romer monetary policy shocks (Romer and Romer, 2004, and Coibion et al., 2017, see Appendix E). Impulse responses to monetary policy shocks are obtained as coefficients of the contemporaneous Romer-Romer measure in local projection regressions. We then feed monetary policy shocks into our baseline model which fully offset the response of the Federal Funds rate to the CRI increase.

[21]This is consistent with the empirical study by Buch et al. (2014), who find an increase in the bank capital ratio after an unexpected monetary policy easing. Expansionary monetary policy shocks increase bank profits by increasing credit demand and reducing loan defaults. Hence bank capital increases by more than bank assets and the bank capital ratio rises.

5.2 Comparison with an EBP shock

How do the effects of a regulatory shock compare with those of another, not policy-induced, financial shock affecting the credit supply? One widely used and well-understood financial shock measure that is available on a monthly basis over our sample period is the excess bond premium (a risk premium that reflects systematic deviations in the pricing of US corporate bonds relative to the issuers' expected default risk; henceforth EBP), see Gilchrist and Zakrajšek (2012) and applications, e.g., in Abbate et al. (2016), Furlanetto et al. (forthcoming), and Caldara et al. (2016).

We add the EBP to our baseline model and adopt a specification similar to one for the model used by Gilchrist and Zakrajšek (2012).[22] Figure 10 shows impulse responses to a change in the EBP by 1 percentage point (black line and shaded areas), together with the point estimates for a regulatory shock from our baseline model (blue dotted line).[23]

There are some notable differences between the effects of CRI and EBP changes. An increase in the EBP leads to a decline in the capital ratio as a consequence of the resulting recession. It also has longer-lasting effects on the economy than capital regulation. Reasons for this may be that business loans decline more persistently and the monetary policy rate drops less strongly after the EBP increase. Another difference is that real estate loans and the house price are barely affected by the EBP change. Note that consumption also moves strongly and persistently after the change in the EBP, despite the lack of reactivity of housing loans and the house price. This might be explained by the increase in the unemployment rate, as well as by the decline in stock market wealth. The latter falls more strongly and persistently after the EBP than after the CRI shock. Moreover, lending spread reactions are more front-loaded, which is not surprising given that the EBP has been constructed from corporate bond spreads. Finally, the risk measures tem-

[22]We include the EBP contemporaneously and with 2 lags. The set of controls are our CRI, the controls from our baseline model and the term spread. Augmenting the number of lags for the EBP or the other explanatory variables from 2 to 6 (mirroring Gilchrist and Zakrajšek, 2012 who use 2 lags in their quarterly VAR model) does not alter our key findings. Moreover, we take the EBP to be predetermined with respect to all variables. In their empirical analysis, Gilchrist and Zakrajšek (2012) adopt a recursive scheme to identify shocks to the EBP and order the EBP after slow-moving (macroeconomic) variables and before fast-moving (financial) variables. Our findings with respect to key variables are very similar to Gilchrist and Zakrajšek (2012) and, hence, our approach here can serve as a simple approximation.

[23]Magnitudes are comparable, as the maximum BAA spread reactions are almost identical. Hence, there is no need to normalize one of the shocks.

porarily rise after the EBP increase, unlike after the CRI change.[24] This finding is interesting in the light of Adrian (2017) who illustrates that an easing of financial conditions lowers GDP volatility in the short run (over the first 5 quarters) and then increases it (and vice versa for a worsening of financial conditions). Using somewhat different volatility measures, we find this confirmed after the EBP change, but not after a change in our regulatory policy. Hence, the evolution of volatility seems to be dependent on the driver.

Overall, we find some reactions to be very different after the two shocks, e.g. bank leverage or volatility have opposite signs. Results are plausible and suggest that we clearly disentangle our capital regulation shock from this other financial shock.

6 Conclusion

In this paper, we aim to fill a gap in the literature on the macroeconomic effects of regulatory capital requirement policies. So far, inference is drawn mainly from either microeconometric empirical studies largely neglecting dynamic, general equilibrium and anticipation effects, or from structural models depending heavily on the frictions and shocks included as well as the calibration used. We propose a novel indicator of aggregate regulatory capital requirement tightenings for the US from 1979 to 2008. The indicator includes six episodes of exogenous bank capital tightenings. We provide ample evidence that it successfully disentangles regulation-induced from other developments. This evidence is based on narratives, statistical (exogeneity) tests, careful account of controls in our regressions, and the resulting behavior of key variables like the bank capital ratio, lending, or risk, also in comparison to another financial shock.

Using local projections of changes in this capital requirement indicator on various macroeconomic and financial variables, we conclude that aggregate capital requirement tightenings lead to notable, but temporary credit crunches and contractions in economic activity. This result lends support to the assertion of Hanson et al. (2011), Admati and Hellwig (2013) and Admati et al. (2014) that higher capital requirements are not associated with substantial medium to long-run costs for the economy. The regulation seems to affect risk and agents' risk perceptions, which helps dampen negative effects on spending. Moreover, an aggressive mone-

[24]This latter result is in line with Caldara et al. (2016) who in their baseline identification scheme find that uncertainty temporarily rises after an increase in the EBP.

tary policy easing after the regulatory events helps the economy to recover quickly from the regulation-induced recession.

What does this imply for policy makers? First, transitory negative effects of capital requirement tightenings on real activity and bank loans, relative to the effects on the bank capital ratio, are found to be larger than those that previous studies report (e.g. Macroeconomic Assessment Group, 2010), but in the range of what microeconomic studies find. To assess the side effects of regulation it seems important that policy makers take into account general equilibrium and anticipation effects and carefully identify exogenous financial stability policy changes. Second, monetary policy can support bank capital-based regulation policy by lowering the policy rate in a timely manner. This cushions negative effects of capital requirement tightenings on real activity and loan markets and at the same time helps banks adjust their capital ratios more quickly. We emphasize that this implies by no means that central banks should lower interest rates after and, hence, counteract *countercyclical* bank-capital policies which are intended to curb credit and asset price booms in order to prevent bubbles and subsequent major financial stabilities and which we do not investigate here. Third, our results for monetary policy also imply that at the zero lower bound real effects on capital requirement tightenings may be larger.

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7 Tables and Figures

Table 1: Capital requirement index (CRI)

Date	Event
Dec. 17, 1981	FDIC, Fed and OCC set numerical guidelines for CR
Jun. 20, 1983	Fed and OCC apply CRs to multinational banks
Nov. 30, 1983	International Lending and Supervision Act (ILSA) passed
Apr. 18, 1985	Common CR guidelines by FDCI, Fed and OCC for all banks
Dec. 31, 1990	Basel I effective
Dec. 19, 1991	FDIC Improvement Act passed
Dec. 19, 1992	Prompt Corrective Action effective
Jan. 1, 1997	Market Risk Amendment effective
Apr. 1, 2008	Basel II effective
Jan. 1, 2013	Basel II.5 effective
Jan. 1, 2014	Basel III effective

Notes: CR = capital requirement(s); FDIC = Federal Deposit Insurance Corporation; Fed = Federal Reserve System; OCC = Office of the Comptroller of the Currency. There was no aggregate easing of capital requirements during the sample. Black: events included in the baseline CRI. Gray: events not included in the baseline CRI, but considered in the robustness analysis. An exception is the Basel II event, which is never included because of the maximum horizon we choose for our baseline setup.

Table 2: Dates of proposed rules, final rules and effective dates

Change	Proposed rule	Final rule	Effective date
num. CRs	Jun. 23, 1981	Jun. 23, 1981	Dec. 17, 1981
ILSA	Mar. 7, 1983	Apr. 21, 1983	Nov. 30, 1983
com. CRs	Jul. 20, 1984	Mar. 19, 1985	Apr. 18, 1985
Basel I	Mar. 27, 1986	Jan. 18, 1989	Dec. 31, 1990
FDICIA	Mar. 5, 1991	Aug. 2, 1991	Dec. 19, 1991
PCA	Jul. 7, 1992	Sep. 29, 1992	Dec. 19, 1992

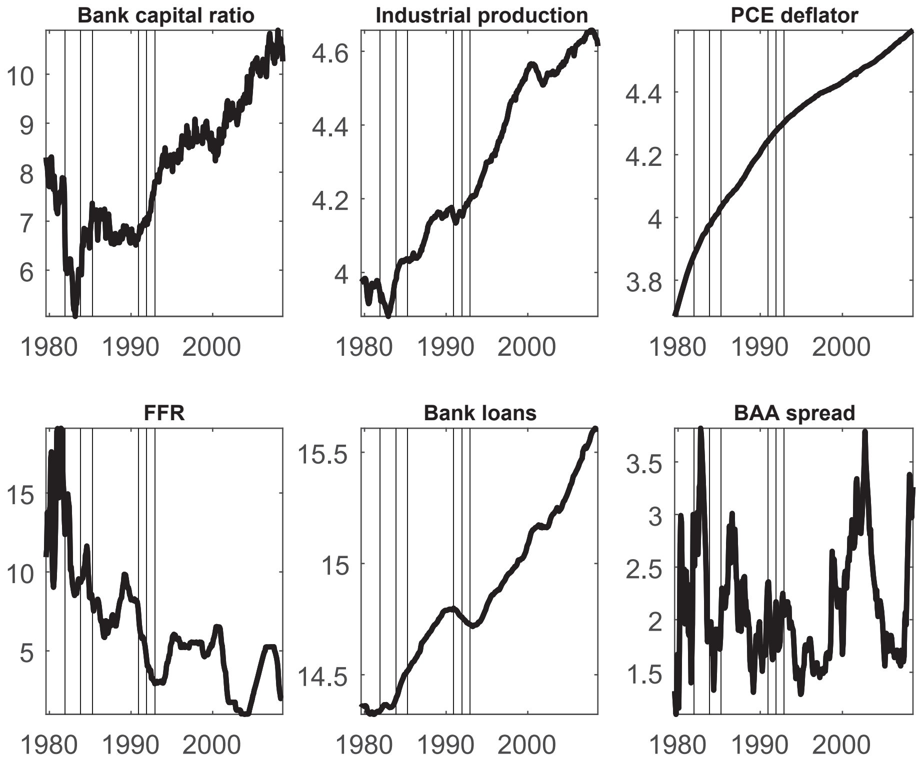
Notes: Dates of the publication of proposed and final rules by the regulators (or comparable for the 1981 event and Congress acts). See text for details.

Table 3: Probit estimation results

Regressors	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Bank capital ratio$_{t-1}$	-0.33						-0.48
	(0.30)						(0.53)
Δ_{t-1}log(Industrial production)		-0.43					-0.60
		(0.27)					(0.63)
Δ_{t-1}log(PCE deflator)			0.22				0.37
			(1.62)				(2.46)
FFR$_{t-1}$				0.04			-0.08
				(0.05)			(0.30)
Δ_{t-1}log(Bank loans)					-0.15		0.08
					(0.35)		(1.42)
BAA spread$_{t-1}$						0.08	-0.20
						(0.43)	(1.55)

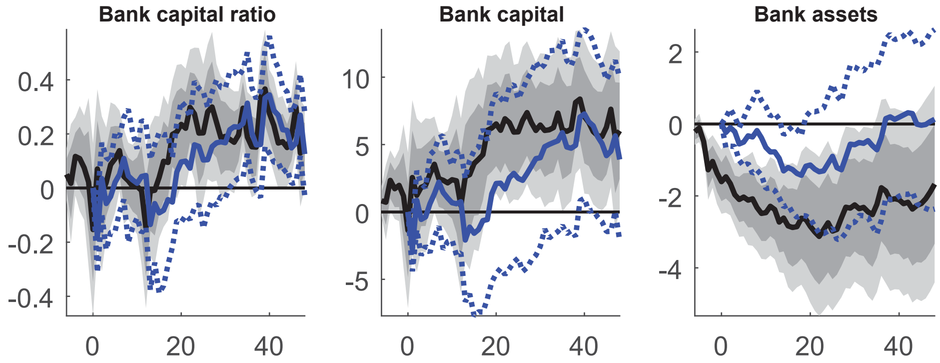
Notes: Dependent variable is CRI$_t$. A constant enters the regression, as well as month-on-month differences in %. Robust standard errors in parentheses. ** $p < 0.01$, * $p < 0.05$.

Figure 1: Key variables and events (Aug. 1978 – Aug. 2008)



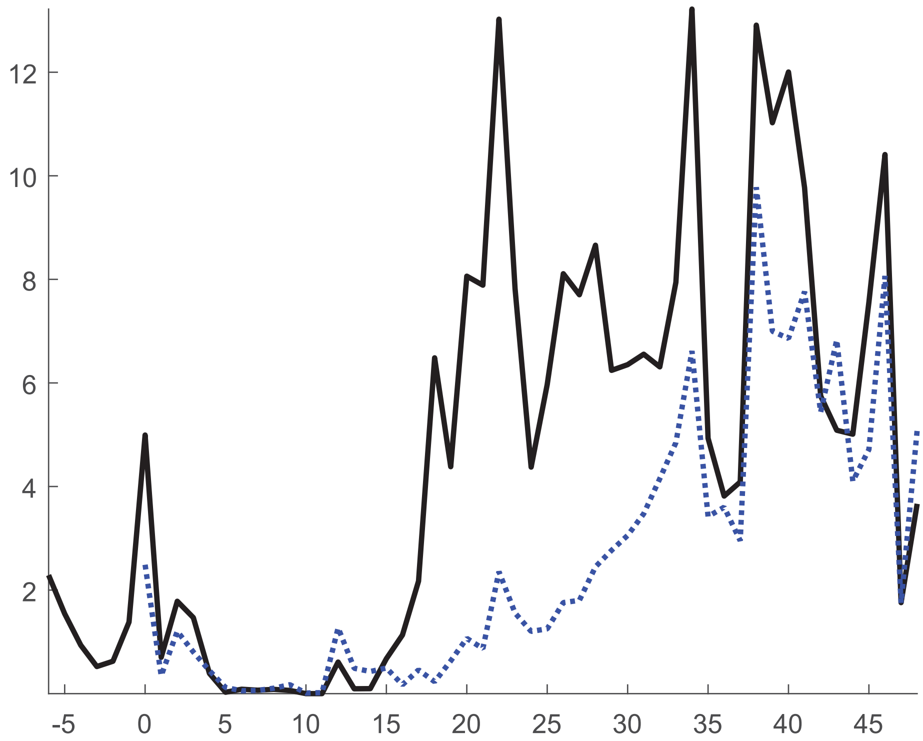
Notes: Industrial production, PCE deflator and bank loans in logs, other variables in %. Vertical bars represent our CRI events. See text for details.

Figure 2: Banks' adjustment to a capital requirement tightening, with and without anticipation effects



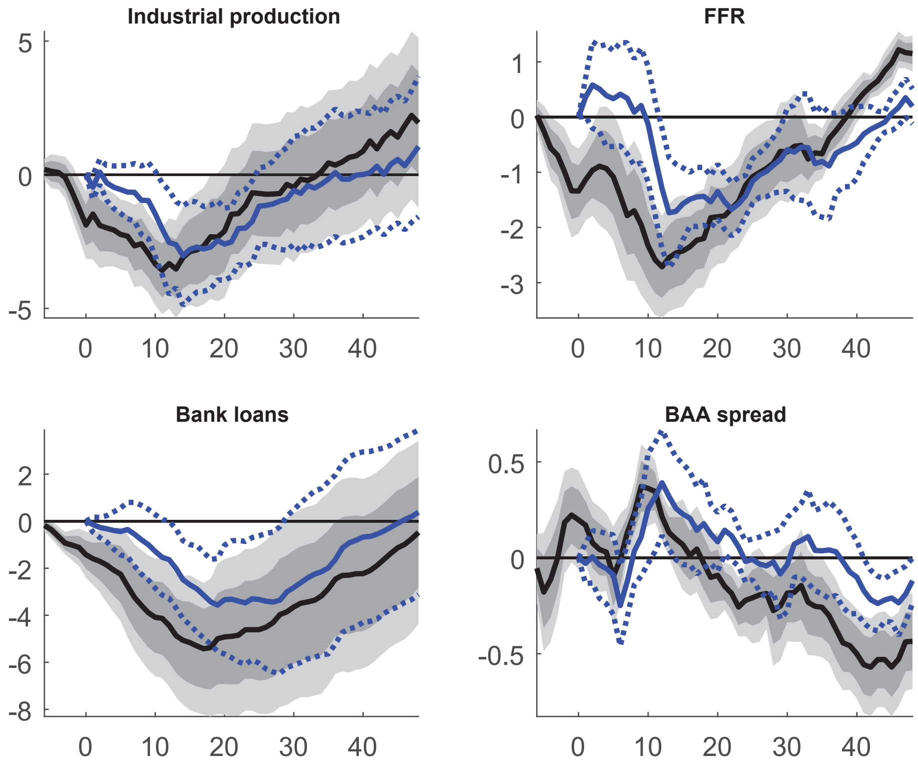
Notes: Bank capital ratio in percentage points, capital and assets in %. Point estimates (black (blue) solid line: with (without) anticipation effects), 68% and 90% confidence bands from the model with anticipation effects (dark and light shaded areas), 90% confidence bands from the model without anticipation effects (blue dotted lines).

Figure 3: Relevance of the CRI for the bank capital ratio (F-statistics)



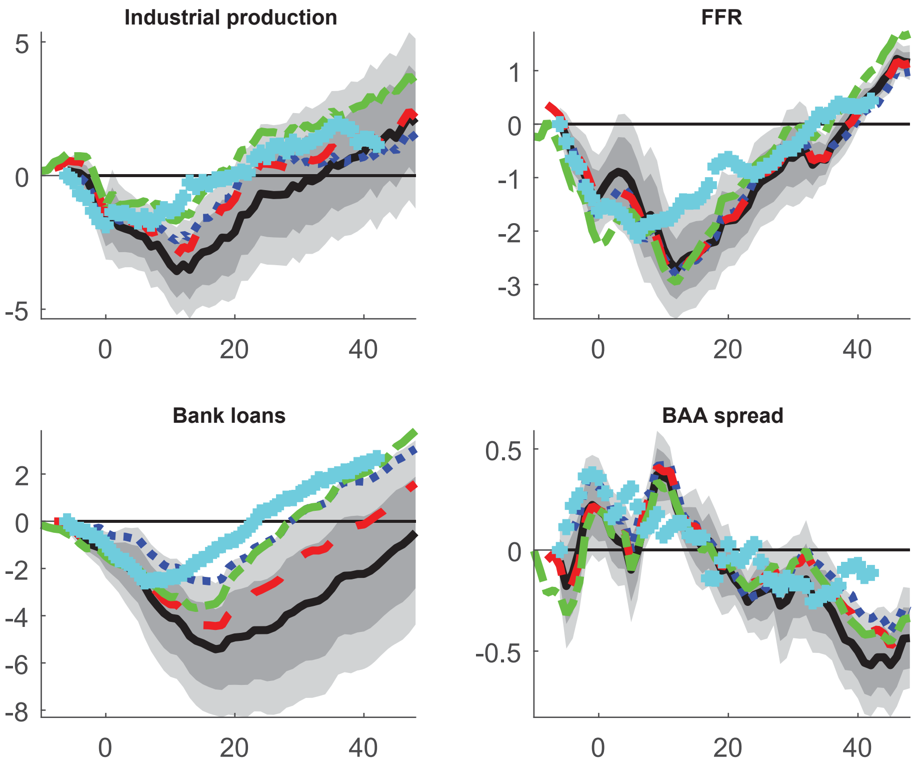
Notes: Newey and West (1987) robust F-statistic. Black solid line: model with anticipation effects, effective dates. Blue dotted: model without anticipation effects, effective dates. X-axis: horizons.

Figure 4: Reactions of key variables to a capital requirement tightening, with and without anticipation effects



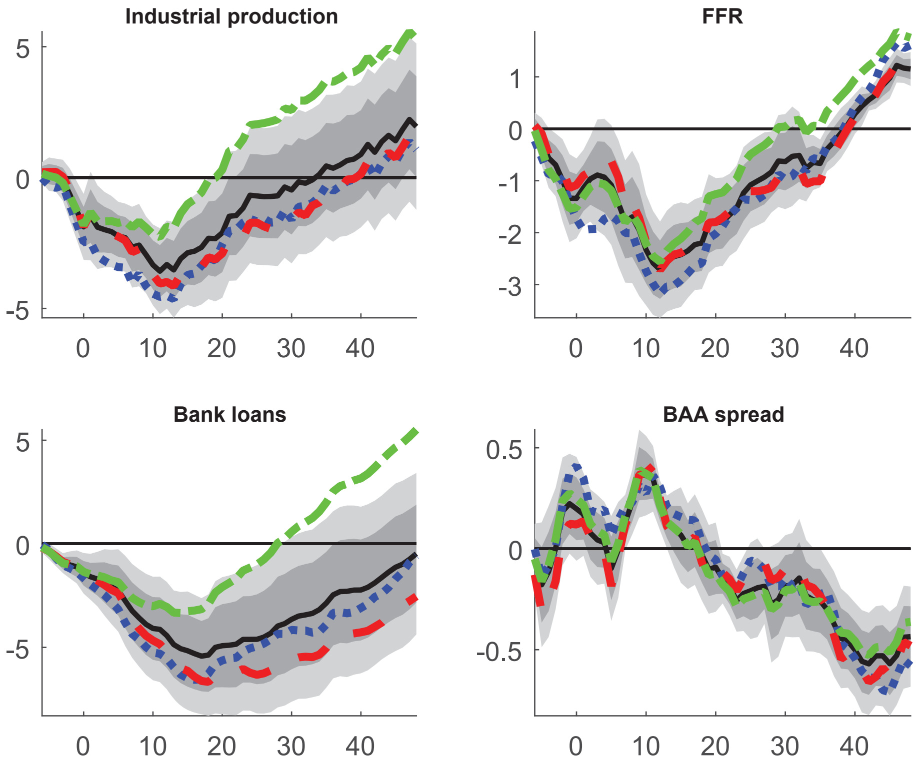
Notes: Federal Funds rate and BAA spread in percentage points, industrial production and loans in %. Point estimates (black (blue) solid line: with (without) anticipation effects), 68% and 90% confidence bands from the model with anticipation effects (dark and light shaded areas), 90% confidence bands from the model without anticipation effects (blue dotted lines).

Figure 5a: Robustness analysis: Altering anticipation horizons



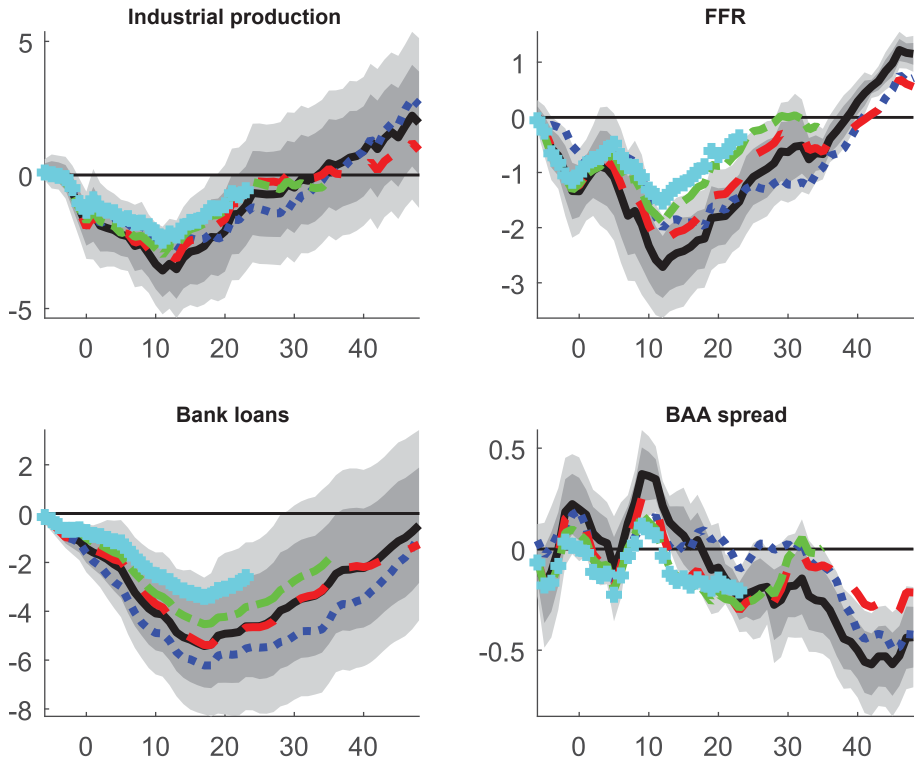
Notes: Black solid line: baseline model with a 6-month average anticipation horizon (with confidence bands). Blue dotted: average anticipation horizon of 4 months. Red dashed: average anticipation horizon of 8 months. Green dash-dots: anticipation horizon of 10 months. Cyan with crosses: individual anticipation horizons

Figure 5b: Robustness analysis: Changing the number of lags and cumulating the CRI



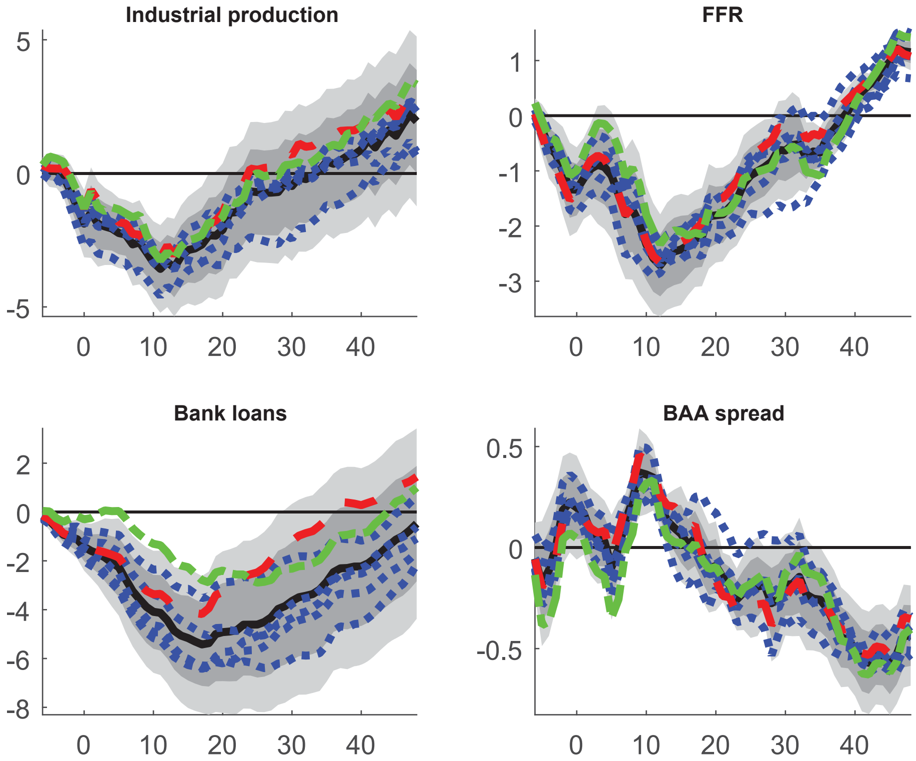
Notes: Black solid line: baseline model (with confidence bands). Blue dotted: 12 lags of controls. Red dashed: 12 lags of CRI. Green dash-dots: cumulated CRI.

Figure 5c: Robustness analysis: Altering the sample period



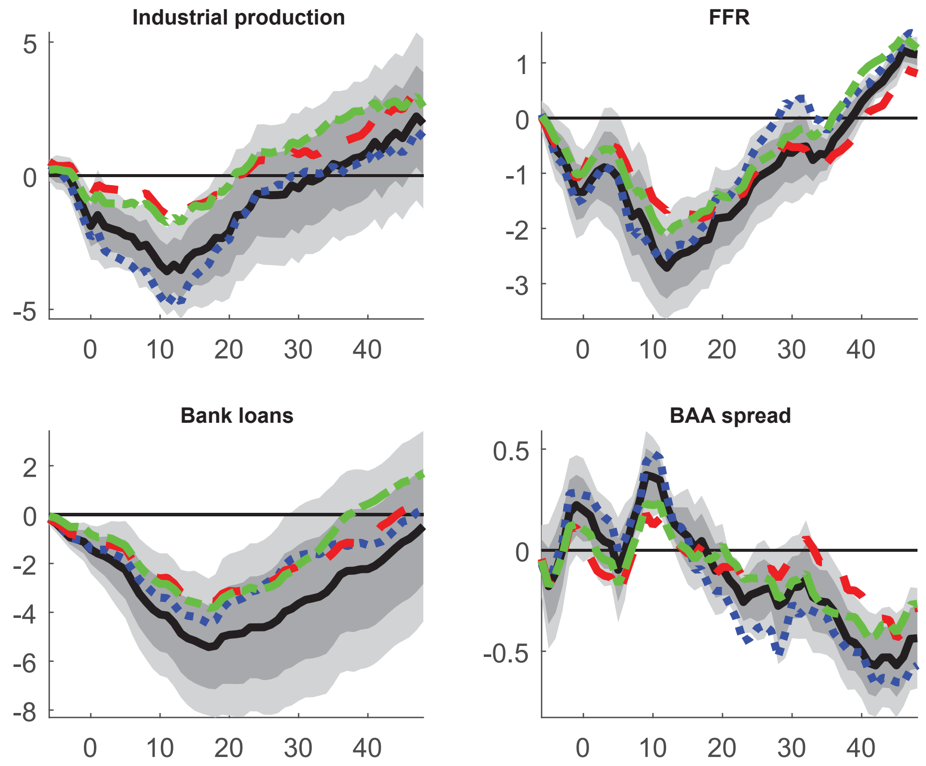
Notes: Black solid line: baseline model (with confidence bands). Blue dotted: 1983-2008. Red dashed: 1979-2016. Green dash-dots: 1979-2016 (incl. Basel II.5, forecast horizon 36 months). Cyan with crosses: 1979-2016 (incl. Basel II.5 and Basel III, forecast horizon 24 months). When we extend the sample to 2016, we link the shadow short rate provided by Leo Krippner to the Federal Funds rate, see text for details.

Figure 5d: Robustness analysis: Changes in the CRI (1/3) - removing individual events



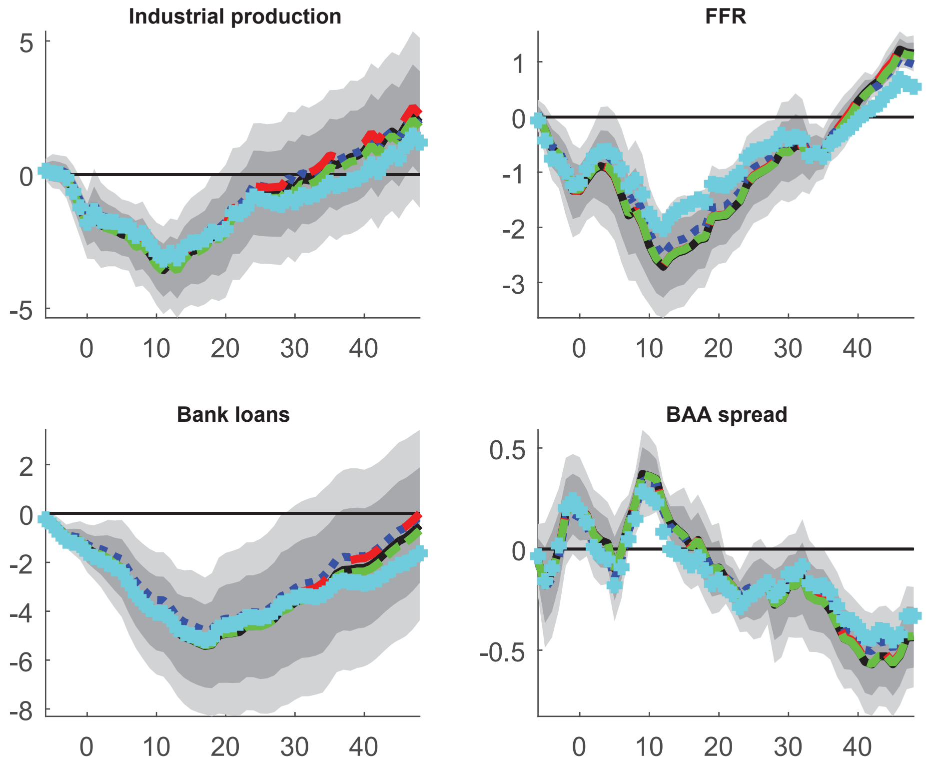
Notes: Black solid line: baseline model (with confidence bands). Red dashed line: remove Basel I (the only international event). Blue dotted: remove other events one by one. Green dash-dots: remove 1991 and 1992 events when the Fed did not act as a regulator.

Figure 5e: Robustness analysis: Changes in the CRI (2/3) - adding capital requirement events



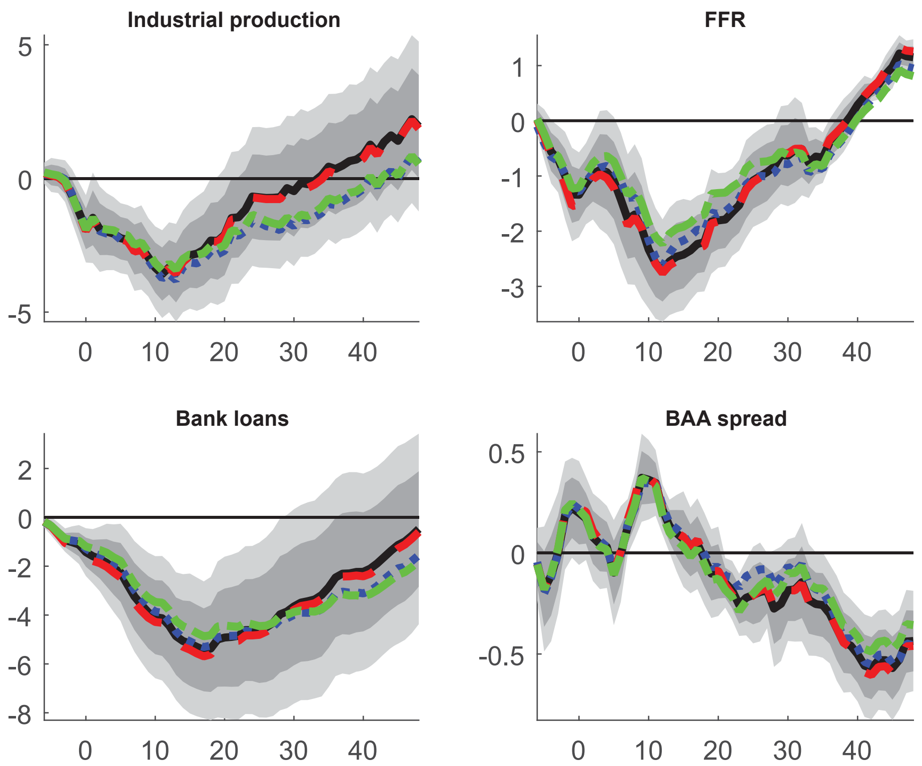
Notes: Black solid line: baseline model (with confidence bands). Blue dotted: only effective dates (no Congress acts). Red dashed: include Jun. 1983 event. Green dash-dots: include Jan. 1997 event.

Figure 5f: Robustness analysis: Additional controls (1/3)



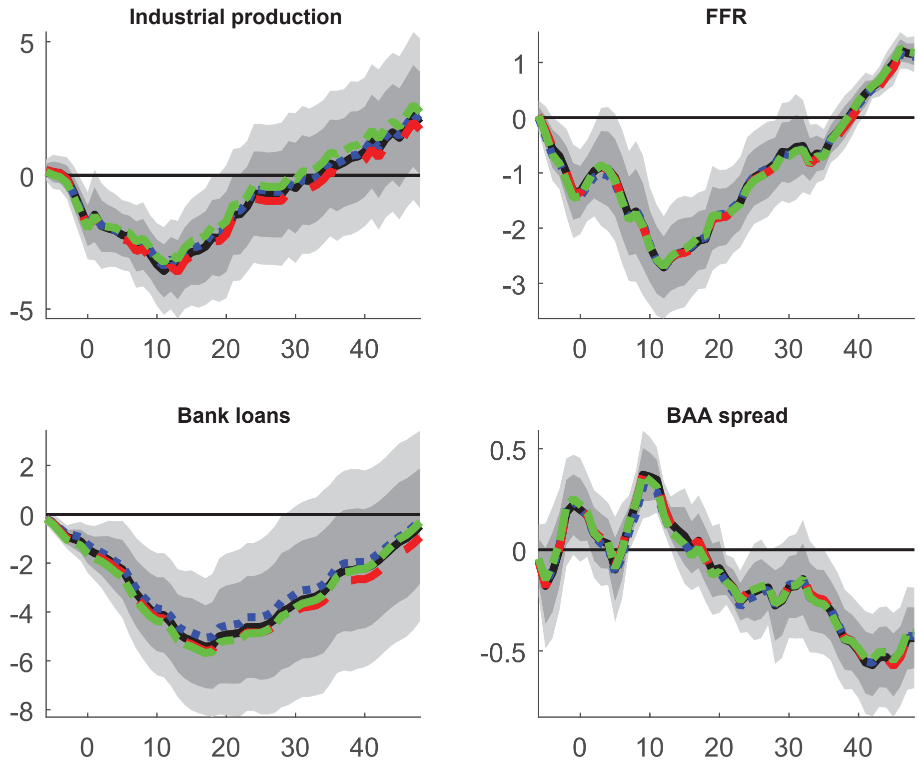
Notes: Black solid line: baseline model (with confidence bands). Blue dotted: add excess bond premium. Red dashed: add Basel credit-to-GDP gap. Green dash-dots: add Savings and Loan crisis dummy. Cyan with crosses: add TED spread.

Figure 5g: Robustness analysis: Additional controls (2/3)



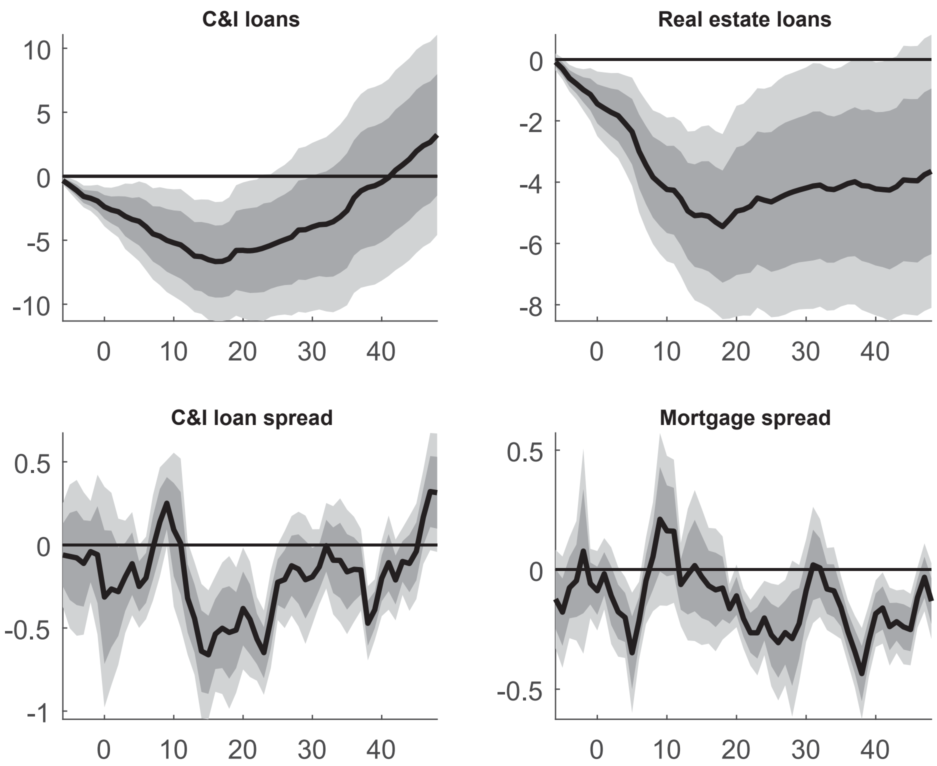
Notes: Black solid line: baseline model (with confidence bands). Blue dotted: add Romer-Romer monetary policy shock measure. Red dashed: add Fernald utilization-adjusted TFP growth. Green dash-dots: add oil price.

Figure 5h: Robustness analysis: Additional controls (3/3)



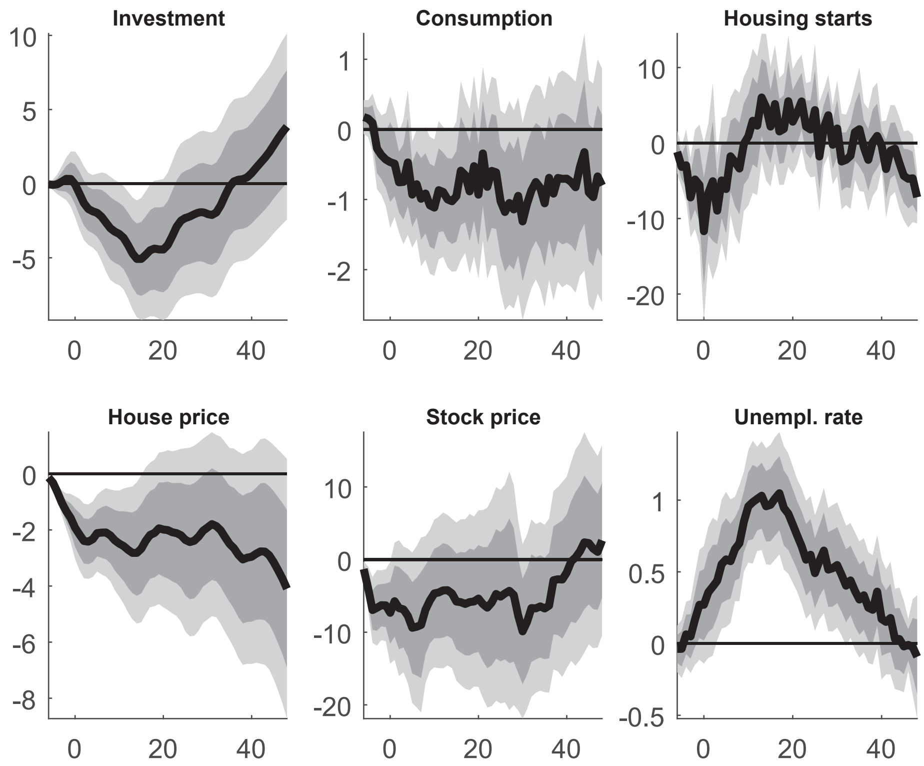
Notes: Black solid line: baseline model (with confidence bands). Blue dotted: add Romer-Romer tax changes. Red dashed: add Ramey military spending news. Green dash-dots: add NBER recession dummy.

Figure 6: Transmission to loans and spreads



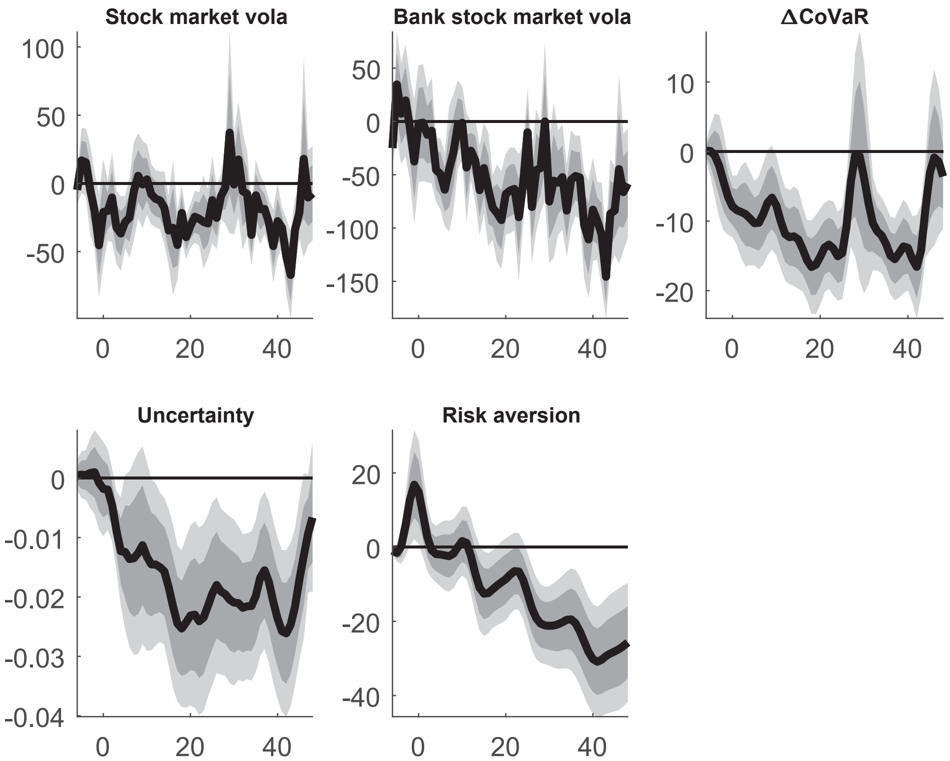
Notes: Loans in %, spreads in percentage points. Point estimates (black solid line), 68% and 90% confidence bands (dark and light shaded areas).

Figure 7: Transmission to non-financial corporations and households



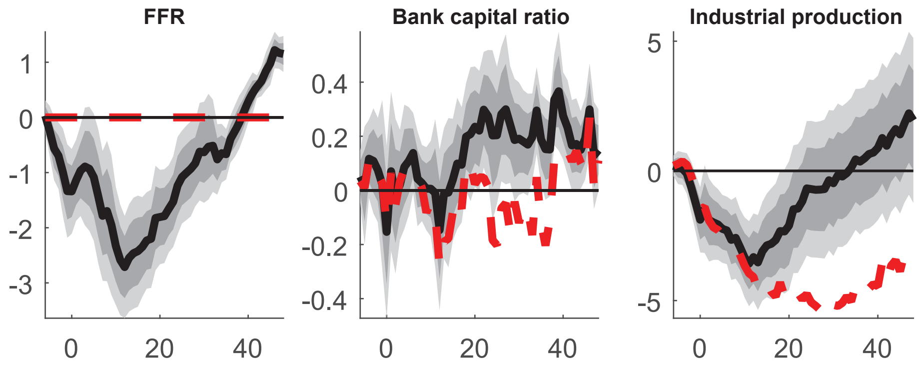
Notes: Unemployment rate in percentage points, other variables in %. Point estimates (black solid line), 68% and 90% confidence bands (dark and light shaded areas).

Figure 8: Transmission to risk



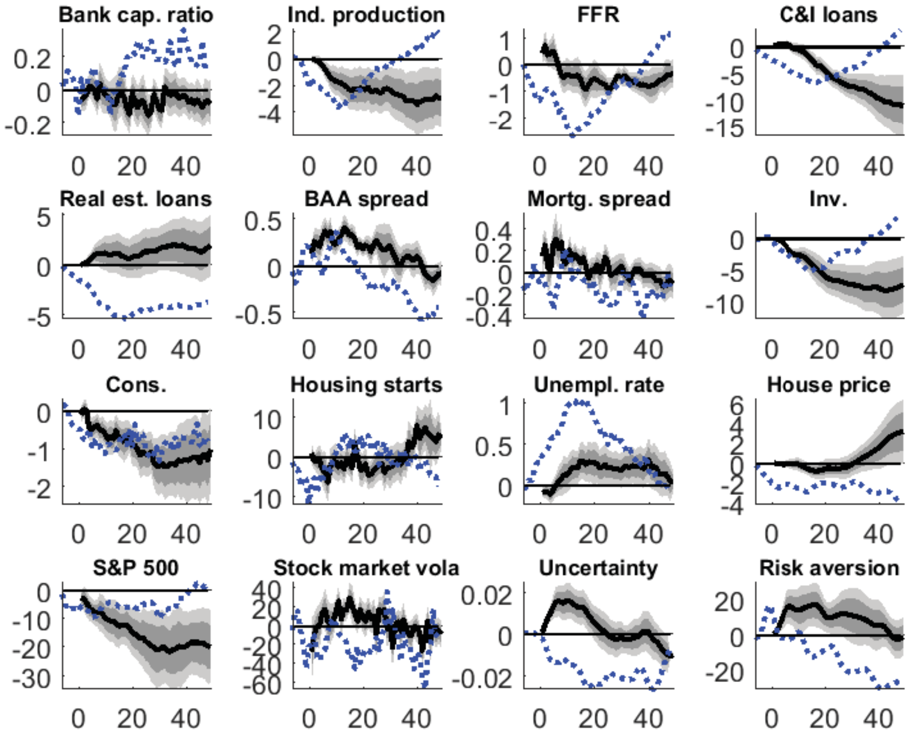
Notes: Stock market volatility measures and ΔCoVaR in %. Risk aversion in percentage points. Uncertainty is the macroeconomic uncertainty measure taken from Sydney Ludvigson's webpage, see Appendix E for details. Point estimates (black solid line), 68% and 90% confidence bands (dark and light shaded areas).

Figure 9: Role of monetary policy (counterfactual experiment)



Notes: In percentage points (bank capital ratio, FFR) and % (industrial production). Black solid line with confidence bands: baseline model. Red dashed: point estimates of counterfactual impulse responses (no policy interest rate reaction); see text for details.

Figure 10: Comparison of effects of changes in the excess bond premium to changes in the CRI



Notes: In percentage points (bank capital ratio, FFR, spreads, unemployment rate, risk aversion) and % (all other variables). Black solid line with confidence bands: responses to a 1 percentage point increase in the excess bond premium (EBP). Blue dotted: point estimate of our baseline model.

Appendix

A Building our narrative CRI indicator

This section motivates our choices for our regulatory capital requirement index (CRI). In particular, we aim to identify those points in time when regulatory capital requirements changed for US banks in the aggregate. Besides this, we have two main goals in reading through the related material – mostly academic articles as well as "final rules" published in the *Federal Register*. First, we are interested in the motivation stated for the regulatory changes. Overall, we mainly find structural and long-term goals stated by the regulators, but never cyclical considerations. Second, we want to find the exact date of when banks became subject to the new rules.[25]

Dec. 1981: Regulatory agencies set numerical guidelines. From the 1930s up to the early 1980s, bank supervisors had relied solely on judgmental case-by-case decisions in bank supervision. No numerical prescriptions existed about adequate aggregate bank capital ratios.[26] However, a series of banking failures in the 1970s and early 1980s, together with historically low capital ratios, made supervisors rethink the issue. In Dec. 1981, the three supervisory agencies in the US, the Federal Deposit Insurance Corporation (FDIC), the Federal Reserve System (Fed), and the Comptroller of the Currency (OCC), for the first time announced explicit numerical capital adequacy ratios valid for a large share of banks under their supervision. The targets varied across the agencies and for different types of banks, but were mostly between 5% and 6% of primary capital to assets.[27] The FDIC's motives for introducing numerical bank capital guidelines are summarized in the following statement of policy (Federal Register/Vol. 46, No. 248/Dec. 28, 1981, p. 62693).

> *This policy statement is intended to clearly set forth qualitative criteria to be considered in determining adequacy of bank capital, to inject more objectivity and consistency into the process of determining capital adequacy, to provide nonmember banks with clearly defined goals*

[25]See Subsection 2.2 in the paper for a general discussion of the implementation schedule of regulatory capital requirement changes. Also see Table 2 in Appendix D.1 below for an overview on the implementation of each event in our CRI.

[26]The regulatory capital prescription for *individual* banks within the scope of "Regulation ABC" are found to have been largely ineffective by Peltzman (1970), Dietrich and James (1983) and Marcus (1983).

[27]For banks supervised by Fed and the OCC "[a] minimum level of primary capital to total assets is established at 5% for regional organizations and 6% for community organizations. Generally, regional and community banking organizations are expected to operate above the minimum primary capital levels." (Federal Reserve Bulletin/Vol. 68, No.1/Jan. 1982, p. 34). The FDIC instead imposed "a threshold capital-to-assets ratio of 6% and a minimum ratio of 5%." (FDIC, 2003)

for use in capital and strategic planning and to address the issue of disparity in capital levels among banks in different size categories by adopting uniform standards regardless of the size of the institution.

Hence, the 1981 change in capital regulation seems not to have been a response to cyclical developments in the US, but motivated by low frequency considerations. The announcement published in the Federal Reserve Bulletin makes this assertion even more poignantly (Federal Reserve Bulletin/Vol. 68, No.1/Jan. 1982, p. 33):

Objectives of the capital adequacy guidelines program are to address the long-term decline in capital ratios, particularly those of the multinational group; introduce greater uniformity, objectivity, and consistency into the supervisory approach for assessing capital adequacy; provide direction for capital and strategic planning to banks and bank holding companies and for the appraisal of this planning by the agencies; and permit some reduction of existing disparities in capital ratios between banking organizations of different size.[28]

The 1981 capital standard changes are generally thought to have had a palpable effect on the financial industry. Keeley (1988) and Wall and Peterson (1987, 1988) find that the newly introduced capital ratios were largely binding for banks.

Jun. 1983: Fed and OCC apply capital requirements also to multinational banks. In the face of deteriorating capital ratios for large multinational banks and imbalances revealed in the wake of the less developed country debt crisis of 1982, both Fed and OCC also subjected multinational banks to the 5% capital requirements valid for regional banks. The OCC imposed regulations, while the Fed changed its guidelines (see *Banking Expansion Reporter* 2, no. 12, Jun. 20, 1983, p. 11). Tarullo (2008) argues that this step was "regarded as an effort to stave off congressional action" (p. 37) towards the prescription of tougher bank capital requirements (see next event below).

However, it is very questionable as to what degree these capital requirements were effectively binding for banks. First, they only affected a subset of 17 (though large) banks. Second, the multinational banks to a great extent already fulfilled the requirements at the time they became prescribed. In this line of argument, Tarullo (2008) cites Reinicke (1995) as suggesting that "the banking agencies took this step not only because of congressional pressure but also because 12 of the 17 large banks had improved their capital ratios to at least the minimum levels set by the guidelines." (footnote 31, p. 37). Already by the end of 1983, all but two

[28]Note that despite the stated goal to "address the long-term decline in capital ratios, *particularly those of the multinational group*", no minimum capital requirements were imposed on them: "Capital guidelines for the relatively small number of multinational organizations will continue to be formulated and monitored on an individual basis (...)" (Federal Reserve Bulletin/Vol. 68, No.1/Jan. 1982, pp. 33f.). See also the next event (Jun. 1983).

multinational banks fulfilled the capital requirement of 5% (ibid., footnote 32, p. 37).

For these reasons, we do not include the Jun. 1983 event into our baseline CRI series. However, we show in the robustness analysis that the inclusion of this date does not alter our findings.

Nov. 1983: International Lending and Supervision Act. In late 1983, US Congress passed the International Lending Supervision Act (ILSA), which specifies that each "appropriate Federal Banking Agency shall cause banking institutions to achieve and maintain adequate capital by establishing minimum levels of capital" (Public Law 98-181 – Nov. 30, 1983, Sec. 908, a 1). The act was passed in response to two events. First, as a reaction to the less developed country debt crisis of 1982. Although the legislative action responded to an immediate banking crisis, the motive for the ILSA was generally long-term, as argued by Smith (1984), pp. 425f.:

> *When Congress responded to the debt crisis with legislation in 1983, it sought not only to address the immediate liquidity problems of the distressed debtor countries but also to adopt long-range structural reforms for the international financial system. The International Lending Supervision Act of 1983, passed as part of the debt crisis package, imposes new controls on foreign lending that are aimed at preventing a recurrence of the debt buildup.*

Second, the ILSA reacted to a ruling by a federal court, which in the case "First National Bank of Bellaire v. Comptroller of the Currency" had found the capital adequacy decisions of the OCC "capricious and arbitrary" (Posner and Weyl, 2013, p. 4) in Feb. 1983, and overruled the regulatory decision by the OCC.[29] Both Posner and Weyl (2013) and Tarullo (2008) attribute some of the motivation behind ILSA to strengthen regulators' way in setting capital requirements after this court ruling.[30] Mitchell (1984), footnote 2, p. 20, points it even more definitely:

> *(...) the Fifth Circuit Court of Appeals reversed a cease and desist order issued by the Comptroller of First National Bank of Bellaire on grounds of inadequate capital. Uncertainty about supervisors' authority to enforce their guidelines undoubtedly motivated the section in the International Lending Supervision Act establishing minimum capital requirements.*

[29] See First National Bank of Bellaire v. Comptroller of the Currency, 697 F.2d 674 (5th Cir. 1983).

[30] Posner and Weyl (2013) even seem to see it as the main objective of ILSA: "In response to the Bellaire decision, Congress enacted the International Lending Supervision Act of 1983 (12 U.S.C. §3907), which provided that the determination of capital requirements lies in bank regulators' discretion."

In later cases, e.g. Frontier State Bank Oklahoma City v. FDIC (702 F.3d 588, 596-97 [2012]), courts upheld regulators' dominion in setting capital requirements (Posner and Weyl, 2013, p. 5). Therefore, ILSA potentially tightened the implementation of capital requirements by strengthening regulators' legal position towards banks.

Thus, given the argument in Jacques and Nigro (1997) that a similar law enacted by Congress had large effects on bank behaviour in the early 1990s (see below), and noting the potential signaling effect of the ILSA against the court ruling in First National Bank of Bellaire v. OCC, we treat the Congress passing ILSA as an event of its own. The robustness section will furthermore show that our results are fully robust to leaving out this event.

Apr. 1985: Harmonization of capital requirements across regulators. About one and a half years after passage of the ILSA, the regulatory agencies introduced rules with regard to common capital adequacy requirements. The new minimum capital standards were set uniformly at 5.5% for the ratio of primary capital to assets. In general, the new standards increased capital requirements for larger banks, while keeping them mostly unaltered for smaller banks.[31]

On March 19, the FDIC announced the final ruling and stated the motives for the tighter capital requirement (Federal Register/Vol. 50, No. 53/Mar. 19, 1985, p. 11128):

> *Several factors have, however, emerged over the past few years which are accentuating the potential demands on bank capital. The deregulation of interest rates on bank liabilities together with a weakening of loan portfolios brought about by shocks in the domestic and world economy have caused a decline in bank profitability and increased levels of risk within the system. The competition for financial services has intensified on both an intra-industry and inter-industry basis, placing additional pressures on bank profitability. Further, because of the growing interdependency within the system, problems in one institution can have repercussions on other institutions arguing for stronger capital levels in both individual banks and the system as a whole. Increasing levels of off-balance sheet risks are also a factor in the need for higher capital.*

The excerpt from the final rule shows that the tightening in capital requirements was mostly motivated by structural changes in the financial industry, like

[31] There was a small decline for community banks supervised by the FDIC: "The minimum primary capital ratio for large banking organizations increased from 5% to 5.5% of adjusted total assets, while community banks' capital requirements fell from 6% to 5.5%." (FDIC, 2003). For the Fed, while the "minimum level" of capital ratios had also been 5% for regional banks supervised by the Fed, those banks with capital ratios below 5.5% had already been under the "very strong presumption that the bank is undercapitalized" since Dec. 1981 (Federal Reserve Bulletin/Vol. 68, No.1/Jan. 1982, p. 34), so de-facto minimum levels were not affected much.

deregulation, increased network effects as well as a growing shadow bank sector. The change in capital regulation thus aimed at addressing (non-cyclical) trends and not short-run financial imbalances. Moreover, the changes envisaged by ILSA in 1983 lead to rules floated for comments by regulators on Jul. 20, 1984 (Federal Register/Vol. 49, No. 141/Jul. 20, 1984, p. 29400), which became effective on Apr. 18, 1985 only (Federal Register/Vol. 50, No. 53/Mar. 19, 1985, p. 11128), so there was a considerable lag between design and implementation of the new rules.

The 1985 regulatory changes seem to have had a large effect on bank capital. Baer and McElravey (1993) estimate that the resulting shortfall of bank capital was comparable in magnitude to that which the introduction of risk weights by Basel I generated. Also Posner (2014) lists the 1985 regulatory change as a "major change" in bank-capital regulation (p. 4).

However, we show below that results do not change when we remove the Apr. 1985 event.

Dec. 1990: The Basel I Capital Accord. The next major overhaul in bank capital regulation in the US occurred in late 1990 with the implementation of the Basel Accord on Capital Regulation ("Basel I"). With the Basel Accord, capital regulation was for the first time based on risk-adjusted asset volumes. There was a long run-up to the introduction of Basel I. The three US regulatory agencies first issued a risk-based capital proposal for public comment on Mar. 27, 1986 (Federal Register/Vol. 51, No. 59/Mar. 27, 1986, p. 10602). However, in reaction to the proposal many commentators asserted that without similar requirements for foreign banks, the envisaged requirements would put US banks at a competitive disadvantage. In light of those concerns, the US banking agencies began working with the Bank of England on the development of a common approach. The OCC published a proposal based upon a joint US/UK risk-based capital agreement in 1987 (Federal Register/Vol. 53, No. 116/Jun. 17, 1987, p. 23045). The scope of the international convergence effort expanded further when the Cooke Committee under the auspices of the Bank of International Settlement in Basel took the US/UK proposal under consideration and addressed the possibility of expanding the agreement to include all countries represented on the Committee.[32] The Basel Committee on Banking Regulation then issued the final agreement in bank capital regulation in 1988, and the US regulators published the final rule on Jan. 27, 1989 (Federal Register/Vol. 54, No. 17/Jan. 27, 1989).

The Federal banking agencies state their motives for the change in capital regulation – besides concerns about a competitive disadvantage of US banks – in the final rule:

> *These final risk-based capital guidelines have a twofold purpose: To make capital requirements more sensitive to differences in risk profiles*

[32]The Cooke Committee on capital regulation was composed of members of the G10 countries plus Switzerland and Luxembourg.

among banking organizations and to aid in making the definition of bank capital uniform internationally.

The final regulation was the outcome of a lengthy discussion in an international organization. Furthermore, although the final rule was published in 1989, banks and regulators were supposed to take actions to implement the rules only from 1991 onwards (the effective date of the amendment was Dec. 31, 1990, see Federal Register/Vol. 54, No. 17/Jan. 27, 1989, p. 4186). Full implementation had to be guaranteed by Dec. 31, 1992 (ibid.). Hence, we treat the change in capital regulation due to the introduction of the Basel Capital Accord as principally unrelated to the business and financial cycle because of the lengthy negotiations and the pre-announced enforcement and mandatory phase-in dates.

The central component of Basel I was the weighting of different assets according to their perceived riskiness. Less risky assets received smaller weights, forcing banks to hold less capital for these assets on their balance sheet. For example, cash received zero weights, claims on banks within the OECD 20% risk-weights, loans secured by mortgages 50% and claims on the private sector 100% (see e.g. Tarullo, 2008, p. 58). Furthermore, two types of capital were specified: tier 1 capital (paid-up share capital, common stock or disclosed reserves) and tier 2 capital (other reserves, hybrid capital instruments and subordinated debt), see ibid., p. 57. Bank capital ratios of tier 1 capital to risk-weighted assets and of tier 1 and 2 capital to risk-weighted assets had to be 4% and 8%, respectively (ibid., p. 55). Again, there is evidence in the literature that the Basel I regulations affected bank capital significantly. Berger and Udell (1994) find that "capital-deficient banks [i.e. those with risk-based capital below the new standards] represent more than one fourth of the nation's total banking assets" (p. 588). Jacques and Nigro (1997), using a three stage-least squares approach, conclude that "the risk-based capital standards brought about significant increases in capital ratios and decreases in portfolio risk of banks which already met the new risk-based standards" (p. 544). There is some disagreement about the main channels of adjustment, in particular for weakly capitalized US banks. Haubrich and Wachtel (1993) argue that they mainly shifted to less risky assets (government securities instead of mortgages and commercial loans), while Van Roy (2008) finds they mainly increased their capital holdings. However, both papers agree that there were substantial effects on bank capital ratios.

Dec. 1991: The FDIC Improvement Act. Almost simultaneous with Basel I, US Congress passed a law with strict new guidelines for FDIC bank resolutions. This FDIC Improvement Act (FDICIA) had as main goals "to require the least-cost resolution of insured depository institutions, to improve supervision and examinations, to provide additional resources to the Bank Insurance Fund" (Public Law 102-242 – Dec. 19, 1991, preamble). The central prescription was to use "prompt corrective action to resolve the institutions at the least cost to the insurance funds" (ibid., Section 121). For this aim, the FDIC was supposed to classify banks as "well capitalized", "adequately capitalized", "undercapitalized", "significantly undercapitalized" and "critically undercapitalized" (ibid., Section 132). For example, banks with capital ratios of at least 10 percent total risk-based, at least 6% Tier-1 risk-based, and at least 5% leverage were categorized as well-capitalized (FDIC, 2003). On the other hand, banks with less than two percent of tangible equity to total assets were considered "critically undercapitalized" and to be placed in receivership within 90 days (Federal Register/Vol. 57, No. 189/Sep. 29, 1992, p. 44869). The Act specifies that affected regulators should "promulgate final regulations [which] shall become effective not later than one year after the date of enactment [Dec. 19, 1991]" (ibid.).

The fact that Congress passed very specific rules and a tight implementation deadline in this act seems to have induced banks to increase capital pre-emptively as to avoid the risk of falling under the prompt corrective action scheme. Aggarwal and Jacques (2001) suggest that both adequately capitalized and under-capitalized banks increased their capital ratio as a response to the provision. In particular, the authors show that the majority of weak banks increased their capital holdings substantially between the passing of the FDIC Improvement Act in Dec. 1991 and the prompt corrective action becoming effective one year later. We thus include both dates in our baseline CRI, but show in our robustness section that results do not change when we remove the Dec. 1991 passing of the FDICIA.

Dec. 1992: Prompt Corrective Action effective. Fitting its strict definitions of adequate capital, the FDICIA also specified an exact timetable for the regulators' implementation of rules (Public Law 102-242 – Dec. 19, 1991, Section 131(b)):

> *Each appropriate Federal banking agency (...) shall, after notice and opportunity for comment, promulgate final regulations (...) not later than 9 months after the date of enactment of this Act, and those regulations shall become effective not later than 1 year after that date of enactment.*

Thus, exactly one year after the passing of FDICIA, the Prompt Corrective Action provisions by the FDIC became effective on Dec. 19, 1992 (Federal Register/Vol. 57, No. 189/Sep. 29, 1992, p. 44866). Before that, the new rules had been proposed and issued in final form on Jul. 1 (see Federal Register/Vol. 57, No. 127/Jul. 1, 1992, p. 29226) and Sept. 29, 1992 (see Federal Register/Vol. 57, No. 189/Sep. 29, 1992, p. 44869, respectively. As mentioned above, Aggarwal and Jacques (2001) show that while banks seem to have acted already on the Dec. 1991 passing of the FDICIA, they further adjusted their capital considerably after the Dec. 1992 Prompt Corrective Action (PCA) becoming effective.

Jan. 1997: Market Risk Amendment. On Jan. 1, 1997, the Basel I framework was complemented to include measures of market risk (Federal Register/Vol. 61, No. 174/Sep. 6, 1996). However, as banks were free to develop their own internal models to assess these risks, it is not clear a priori whether this had a tightening or easing effect on overall capital requirements. For example, in a recent study on European banks, Gehrig and Iannino (2017b) find that while the Market Risk Amendment reduced the riskiness of the least risky quartile of banks, it significantly increased it for the upper quartile (mostly larger banks with more developed internal models).

Moreover, its effect on overall capital requirements seems not to have been very large – e.g. Posner (2014) does not include this legislation into his enumeration of "the major changes to [capital adequacy] regulations" between 1981 and 2013. We thus choose not to include this date into our baseline specification, but show that results are robust to including the date.

Apr. 2008: Basel II. On Apr. 1, 2008 Basel II became effective as the outcome of long international negotiations – after a first publication on the topic in Jun. 2004, the first proposed rule had been issued in Sept. 2006 (Federal Register/Vol. 72, No. 235/Dec. 7, 2007), and the effective date for the US was in fact more than a year later than for Europe. Basel II was designed around the three pillars of minimum capital requirements, supervisory review and market discipline. The first pillar was thought to set appropriate capital ratios via regulation on credit risk (since Basel I), market risk (since the Market Risk Amendment) and operational risk (new in Basel II). The second pillar aimed to improve supervisory oversight of banks by setting up a framework to deal with systemic and liquidity risk, but also reputational and legal risks. Finally, the third pillar intended to increase market discipline on banks by introducing more unified disclosure requirements for banks. However, Basel II seemed outdated by the time of its introduction, which coincided roughly with the onset of the Financial Crisis.

As with the Market Risk Amendment, it is disputed whether the introduction of Basel II had palpable effects on US banks' capital – first because its capital requirement rules were rather pro-cyclical (Repullo and Suarez, 2013), second because its reliance on internal risk-weighting might have counteracted the additional notional capital requirements. In a blog post, Gehrig and Iannino (2017a) argue that

> *The main drivers of [the evolving capital shortfalls during the 1990s and 2000s] appear to be the self-regulatory options introduced into the Basel process with the amendment for market risk (1996) and culminating in the introduction of internal models for credit risk in Basel II (2006). Rather than providing incentives for better risk management for the larger and internationally active banks, precisely those sophisticated banks used internal models to carve out even more equity in order to increase return on equity and at the same time reduce resilience.*[33]

[33] Note that the dates refer to the implementation dates for European banks instead of the effective dates for US banks.

Moreover, as Basel II is not represented in the index by Cerutti et al. (2017), we will not include it either into our baseline CRI.

Jan. 2013: Basel II.5. Even before Basel II had become effective in the US, the Basel Committee met to discuss amendments about capital adequacy and Value at Risk models (Basle Committee on Banking Supervision, 2011). The resulting package of supplements set up in a reaction to the global financial crisis came to be known as Basel II.5, effective in the US by Jan. 1, 2013 (Federal Register/Vol. 77, No. 169/Aug. 30, 2012, p. 53060). In a nutshell, it included a move from Value at Risk to Stressed Value at Risk, efforts to include credit margins and default risk in risk weights, new charges for securitized assets on banks' balance sheets and a new measure to correlate asset positions on banks' portfolios. Moreover, it intended to correct the treatment of trading and banking bank capital (see Pepe, 2013).

The regulators stated several goals that they hoped to achieve by the measures (Federal Register/Vol. 77, No. 169/Aug. 30, 2012). The motivation for modeling standards mentions the objective to "provide banks with incentive to model specific risk more robustly" (p. 53072). Similarly, the regulatory changes on debt and security positions aim at increasing "risk sensitivity, transparency, consistency in application, and reduced opportunity for regulatory capital arbitrage" (p. 53074). None of these stated goals implies stabilization policies; instead they all suggest long-term objectives. Different to Basel II, Basel II.5 did have effects on bank capital according to Cerutti et al. (2017). Our baseline sample ends before the global financial crisis, so Basel II.5 is not included in our baseline sample. In the robustness section, we will, however, extend our sample and the CRI there will include the event.

Jan. 2014: Basel III. Shortly after Basel II.5, the Basel III framework was adopted in the US, representing the latest stage of this reform package to date. Its main content features stronger capital requirements, a minimum leverage ratio and liquidity requirements. Of most interest for us is the increase in minimum Tier 1 capital (CET1) from 4% over risk-weighted assets under Basel II to 6% under Basel III (from 2015 on). Specifically, this 6% minimum risk-weighted capital ratio is composed of 4.5% of CET1, plus an extra 1.5% of "Additional Tier 1". On top of this, Basel III introduced two more capital buffers: a discretionary countercyclical buffer, which enables national supervisors to require up to additional 2.5% of CET1 capital over risk-weighted assets when financial conditions are good, and a mandatory capital conservation buffer of 2.5% of risk-weighted assets (only from 2019 onwards). Moreover, there will be a surcharge in CET1 capital for global systemically important banks, phased in from 0.625% in 2016 to up to 2.5% for some banks in 2019 (as of 2017, large US banks are put into "buckets" ranging from 1% to 2.5% capital requirements according to their systemic importance).[34]

[34] For a current list of these buckets, see https://www.federalreserve.gov/econresdata/notes/feds-notes/2017/are-basels-capital-surcharges-for-global-systemically-important-banks-too-small-20170223.html

Finally, banks will have to hold a leverage ratio (Tier 1 capital over total consolidated assets) of 5% (6% for systemically important financial institutions). With a final rule published in Oct. 2013, it became effective already on Jan. 1, 2014. The motivation for Basel III by the US regulators mentions the avoidance of future banking crises as its main goal, while downplaying the immediate effects on banks (Federal Register/Vol. 78, No. 198/Oct. 11, 2013, p. 62026):

> *The final rule addresses [several weaknesses which became evident during the financial crisis] by helping to ensure a banking and financial system that will be better able to absorb losses and continue to lend in future periods of economic stress. This important benefit in the form of a safer, more resilient, and more stable banking system is expected to substantially outweigh any short-term costs that might result from the final rule. (...)*

> *The agencies' analysis also indicates that the overwhelming majority of banking organizations already have sufficient capital to comply with the final rule. In particular, the agencies estimate that over 95 percent of all insured depository institutions would be in compliance with the minimums and buffers established under the final rule if it were fully effective immediately [i.e. Oct. 11, 2013].*

There do not yet exist any definitive estimates of the effects of the Basel III regulatory changes, also because these have not fully come into effect yet. However, an early OECD study estimated a small negative effect of the Basel III implementation on growth in its member countries, even though bank capital ratios should rise substantially (Slovik and Cournède, 2011). Moreover, Cohen and Scatigna (2016) collect estimates from several ex-ante studies aiming to quantify the effects of Basel III on lending and growth (see their Tables 1 and 2 on page 57). Overall, the studies cited there predict a drag on GDP growth between 5 and 60 basis points for between 4 and 9 years after the implementation. We follow Cerutti et al. (2017) in including Basel III in our index when we extend our sample to include the crisis and post-crisis periods.

B Further probit estimation results

Table B.1: Further probit estimation results (1/4)

Regressors	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Bank capital ratio$_{t-12}$	-0.49						-0.43
	(0.34)						(1.03)
Δ_{t-12}log(Industrial production)		-0.20					-0.11
		(0.27)					(0.72)
Δ_{t-12}log(PCE deflator)			0.11				-0.32
			(0.46)				(2.15)
FFR$_{t-12}$				0.08			0.07
				(0.04)			(0.15)
Δ_{t-12}log(Bank loans)					-0.06		-0.18
					(0.35)		(0.77)
BAA spread$_{t-12}$						0.30	-0.06
						(0.30)	(1.46)

Notes: Dependent variable is CRI$_t$. A constant enters the regression, as well as month-on-month differences in %. Robust standard errors in parentheses. ** $p < 0.01$, * $p < 0.05$.

Table B.2: Further probit estimation results (2/4)

Regressors	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Bank capital ratio$_{t-24}$	-0.51						-0.74
	(0.27)						(1.04)
Δ_{t-24}log(Industrial production)		-0.10					-0.18
		(0.22)					(0.75)
Δ_{t-24}log(PCE deflator)			0.92				1.13
			(0.61)				(1.14)
FFR$_{t-24}$				0.09			0.01
				(0.07)			(0.16)
Δ_{t-24}log(Bank loans)					-0.08		-0.20
					(0.73)		(1.76)
BAA spread$_{t-24}$						0.12	-0.24
						(0.31)	(1.25)

Notes: Dependent variable is CRI$_t$. A constant enters the regression, as well as month-on-month differences in %. Robust standard errors in parentheses. ** $p < 0.01$, * $p < 0.05$.

Table B.3: Further probit estimation results (3/4)

Regressors	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Bank capital ratio$_{t-1}$	-0.00						-0.00
	(0.00)						(0.00)
$\mathbf{\Delta}_{t-1}$log(Industrial production)		0.04					-0.03
		(0.08)					(0.12)
$\mathbf{\Delta}_{t-1}$log(PCE deflator)			-0.12				-0.11
			(0.22)				(0.38)
FFR$_{t-1}$				0.00			0.00
				(0.00)			(0.00)
$\mathbf{\Delta}_{t-1}$log(Bank loans)					-0.02		-0.03
					(0.22)		(0.27)
BAA spread$_{t-1}$						-0.00	-0.00
						(0.00)	(0.00)

Notes: Dependent variable is CRI$_t$. A constant enters the regression, as well as year-on-year differences, as indicated by $\mathbf{\Delta}$, in %. Robust standard errors in parentheses. ** $p < 0.01$, * $p < 0.05$.

Table B.4: Further probit estimation results (4/4)

Regressors	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Bank capital ratio$_{t-12}$	-0.00						-0.00
	(0.00)						(0.00)
$\mathbf{\Delta}_{t-12}$log(Industrial production)		-0.03					-0.02
		(0.05)					(0.09)
$\mathbf{\Delta}_{t-12}$log(PCE deflator)			-0.29				-0.27
			(0.21)				(0.31)
FFR$_{t-12}$				-0.00			-0.00
				(0.00)			(0.00)
$\mathbf{\Delta}_{t-12}$log(Bank loans)					-0.07		-0.02
					(0.16)		(0.34)
BAA spread$_{t-12}$						0.00	0.00
						(0.00)	(0.00)

Notes: Dependent variable is CRI$_t$. A constant enters the regression, as well as year-on-year differences, as indicated by $\mathbf{\Delta}$, in %. Robust standard errors in parentheses. ** $p < 0.01$, * $p < 0.05$.

C Weighted versions of our baseline CRI

In our baseline analysis we use a binary indicator of regulatory capital requirements with ones for the months of CRI changes and zeros otherwise. This ignores that some events may have affected the banking system (and the economy) more than others. On the other hand, given that requirements were not always the same across regulators and affected banks differently, it seems much harder to quantitatively compare the capital requirement changes across events than for other narrative time series studies.[35]

We nevertheless attempt to construct two alternative indices for our baseline sample, in which we broadly weight individual events along two dimensions: the extent of regulatory changes (how many banks were affected by the event?) and the intensity (if affected, how much did bank capital ratios have to adjust?).

As concerns the intensity of the regulation, we assign three different values (0.46, 0.92, 1.38), from a rather small effect to a large one. As concerns the question how many banks were affected by the event, we differentiate between a weight of 0.67 (only some types of banks were affected, there were long phase-ins, or or banks' adjustments were already partially accomplished; see below for details) or 1.33 (if none of the before applies). The weights were chosen such that the average of the six events equals 1, as for our baseline CRI. Consequently, we consider for all specifications a comparable change from 0 (no event) to 1 ("typical" or average event).[36] Table C.5 provides an overview.

We weight the 1981 introduction of numerical capital requirements as a strong tightening (intensity: 1.38). Without any previous aggregate capital requirements in place, these were set to 5% for regional banks and 6% for community banks. We fully weight the extent (extent: 1.33), referring to a quote by Wall and Peterson (1987) that the "overwhelming majority of BHCs [bank-holding companies] are heavily influenced by regulatory forces." (p. 598). Next, we consider the 1983 passing of the International Lending and Supervision Act (ILSA) by Congress. On the one hand, this act strengthened supervisors' hands against court rulings as outlined above. On the other hand, it indicated a strengthening of capital requirements without any specific details or a time frame for changes to be implemented. Also Posner (2014) does not include the 1983 date into his list of "major changes of [capital adequacy] regulations" (p. 5). Overall, we decide to give the lowest weight of 0.46 to the intensity for this event. On the contrary, at that time it seemed likely that all banks would face higher capital requirements, so that we set the extent of the 1983 ILSA event to 1.33. However, when regulators actually unified requirements in 1985, it turned out that the capital requirements of 5.5% increased for regional banks, but *decreased* for communal banks. The FDIC even argued that "[w]ith almost 96% of the banks in the nation not being impacted by this regulation and with the time permitted for other institutions to achieve compliance, it is not expected that there would be any meaningful adverse impact on bank consumers in terms of either the availability or the cost of credit." (Federal

[35] For example, in the case of monetary policy (Romer and Romer, 2004), tax policy (Romer and Romer, 2010) or government spending (Ramey, 2011) it seems easier to compare different events over time. These events can be expressed in basis points or dollar terms, and are arguably more linear in their effect than steady increases in banks' regulatory capital ratios. Note, however, that the narrative studies in Romer and Romer (1989) and Ramey and Shapiro (1998) also use unweighted dummy indicators like in our baseline specification.

[36] All dates which are gray in Table 1 receive a weight of zero.

Register/Vol. 50, No. 53/Tuesday, Mar. 19, 1985, p. 11130). Moreover, almost 18 months elapsed between Congress act and regulatory changes, giving banks time to prepare. On the other hand, Baer and McElravey (1993) argue that banks were facing a shortfall of bank capital comparable to that caused by the introduction of Basel I. We try to take into account both statements by weighting the 1985 event with an intermediate intensity of 0.92 (there was a palpable capital shortfall, but also some phase-in allowed for banks to adjust), and an extent of 0.67 (only a small percentage of banks of the regional type were affected by the tightening).

Table C.5: Weights to build weighted CRIs

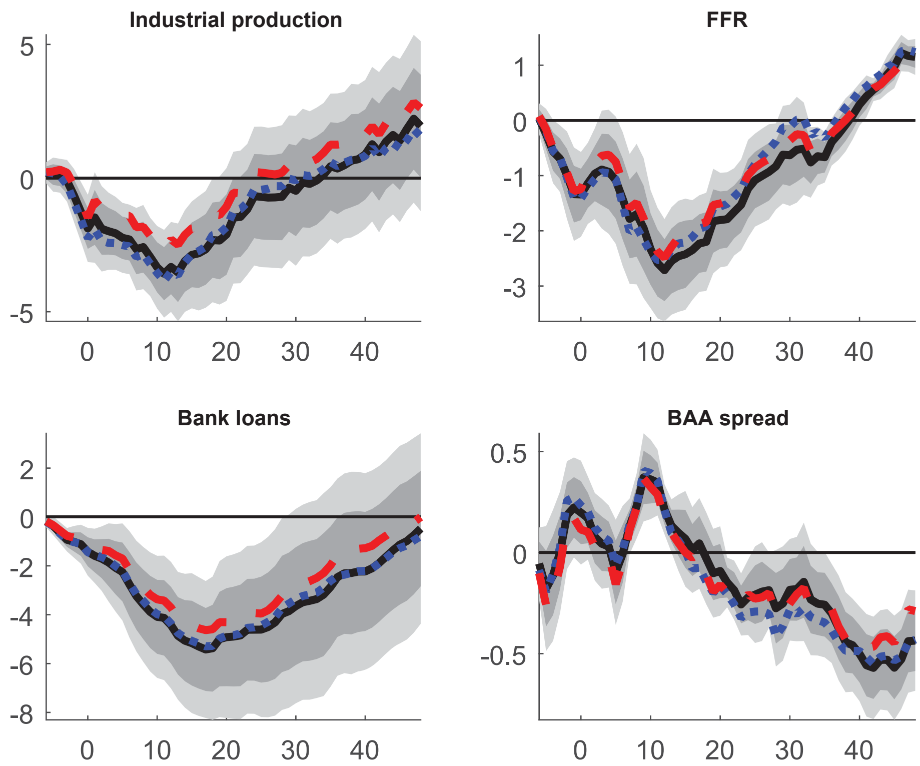
Effective date	Change	Intensity (0.46-1.38)	Extent (0.67/1.33)
Dec. 17, 1981	num. CRs	1.38	1.33
Nov. 30, 1983	ILSA	0.46	1.33
Apr. 18, 1985	com. CRs	0.92	0.67
Dec. 31, 1990	Basel I	1.38	0.67
Dec. 19, 1991	FDICIA	0.92	1.33
Dec. 19, 1992	PCA	0.92	0.67

Note: "Intensity" measures how strongly affected banks had to adjust capital (intensive margin) and "extent" how many firms were affected (extensive margin). Intensity is ranked 1.38 (large effect), 0.92 (medium effects) or 0.46 (small effects), and extent is ranked either 0.67 (only some bank types affected, long phase-ins, or not purely tightening) or 1.33 (otherwise). See text for details.

The introduction of Basel I is similarly ambiguous in its quantitative effects. There were veritable increases in bank capital to 8%, however with a relatively long phase-in of two years. Furthermore, the introduction of risk weights led to tougher requirements, but was relatively coarse and allowed for regulatory arbitrage in the following. Therefore we specify an intensity of 1.38 for the Basel-I event, but an extent of only 0.67. The passing of the FDIC Improvement Act by Congress in late 1991 did not call for higher capital requirements, but by demanding tougher resolution of inadequately capitalized banks, it gave both adequately and inadequately capitalized banks an incentive to increase their capital ratios, see Aggarwal and Jacques (2001). We weight this act by an intensity of 0.92 (no prescription of capital requirements, but much stronger enforcement of existing ones) and by an extent of 1.33 (given that effects were widespread). Similarly, we weight the intensity of the Prompt Corrective Action (PCA) measures by the regulators with a 0.92. On the one hand, the time between final rule and effective date is particularly short for this event. The final rule was passed on Sept. 29 and became binding already on Dec. 19, 1992. On the other hand, the regulatory changes were very explicitly prescribed in the FDICIA, so we do not change the intensity from the one for the Congress act, i.e. 0.92. However, we assign an extent weight of only 0.67 to the introduction of the Prompt Corrective Action (PCA) resolution measures by the regulators one year later, as many banks had already adjusted their capital ratios as a response to the Congress act, see again Aggarwal and Jacques (2001).

Key results are almost identical when we carry out the analysis using weighted CRIs to those using our baseline unweighted CRI. Impulse responses of our key macroeconomic and lending variables to the CRI change are available upon request.

Figure C.1: Robustness analysis: Changes in the CRI - unweighted vs. weighted CRI



Notes: Black solid line: baseline model (with confidence bands). Blue dotted: narrative “intensity” measure of events. Red dashed: narrative “extent” measure of events.

D Anticipation

We are interested in possible anticipation effects before the regulations became effective. If banks or the wider public receive detailed information about planned capital regulation, they might be expected to act accordingly. Here, we pursue three avenues to gauge plausible horizons for such anticipation. First, based on the legislative or administrative procedure through which our events were introduced, we identify dates when the future regulation was first mentioned in a raw form to the public (usually in the form of so-called “proposed rules”), and when the finalized rules were communicated (the so-called "final rules"). Second, we check when the new regulation was mentioned in newspapers for the first time, based on a search in the historical newspaper-articles database Factiva. Third, we assess when markets first reacted to regulatory changes, by looking at banks' excess return dynamics at the time of and before effective dates. All three approaches in fact suggest very similar average anticipation horizons of around half a year.

D.1 Proposed and final rules

For the introduction of numerical capital-adequacy guildelines in Dec. 1981, there were no directly related proposed nor final rules issued beforehand.[37] However, before that there had been review of capital adequacy practices between the regulators, which explicitly reviewed the different definitions of capital and approaches to capital adequacy (Federal Financial Institutions Examination Council [FFIEC], Annual Report 1979). This review lead to a proposed rule by the FFIEC published in the Federal Register on Jun. 23, 1981, which envisaged common capital adequacy standards.[38] Although this proposal was never followed by a concrete final rule due to disagreement across the regulators (see Ashcraft, 2001), we can view it as a first public announcement that capital adequacy guidelines would be introduced. We thus set the proposed for the 1981 event to Jun. 23 of that year, and also the final rule although there was none published (our results would not change for setting the final rule anticipation horizon to any value between 0 and 6 months as for the proposed rule).

The introduction of the "International Lending and Supervision Act" (ILSA) by Congress forces us to make some assumptions about when rules became known to the public. We assume that the introduction of the bill into Congress on Mar. 7, 1983, can be interpreted as a proposal of the "rule".[39] Moreover, the publication of a joint memorandum by the Fed, FDIC and OCC ("Program of Improved Supervision and Regulation of International Lending") on Apr. 7, 1983, and even more so the congressional testimony by FDIC Chairman William M. Isaac calling for tougher regulation on Apr. 20 and 21, 1983, convince us that Apr. 1983 is the

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[37] In fact, the introduction by the FDIC states in the Federal Register that "[b]ecause this is a Statement of Policy, it is not subject to sections 553 (b) through (d) of the Administrative Procedure Act and may be issued in final form without having been issued as a proposal.", see Federal Register/Vol. 46, No. 248/Dec. 28, 1981, p. 62694. Instead, the policy is specified to be effective immediately. Similarly, the Fed and OCC announced the effective capital adequacy guidelines in the Federal Reserve Bulletin of Jan. 1982 (pp. 33ff.).

[38] "The Federal Financial Institutions Examination Council is proposing to recommend a uniform definition of capital for use by the three federal bank supervisory agencies (Board of Governors of the Federal Reserve System, Federal Deposit Insurance Corp. and Office of the Comptroller of the Currency) for purposes of determining the adequacy of bank capital for supervisory purposes. The Examination Council is taking this action in order to promote uniformity in supervisory policies among the bank regulatory agencies", see Federal Register/Vol. 46, No. 120/Jun. 23, 1981, p. 32498.

[39] See https://www.govtrack.us/congress/bills/98/s695

month when the final shape of ILSA became clear to the public.[40] Therefore, we interpret this month as the final rule month for the ILSA date.

For the following introduction of the common numerical capital-adequacy guidelines in Apr. 1985, we have much more precise dates. The Federal Register states the date when rules were proposed and comments asked for (Jul. 20, 1984, see Federal Register/Vol. 49, No. 141/Jul. 20, 1984, p. 29400) and the issuance of the final rule (Mar. 19, 1985, see Federal Register/Vol. 50, No. 53/Mar. 19, 1985, p. 11128).

For Basel I, there was an exceptionally long time between proposed and final rule and the effective date. Rules for comment were proposed as early as Mar. 27, 1986 (see Federal Register/Vol. 51, No. 59/Mar. 27, 1986, p. 10602). Final rules were published on Jan. 18, 1989 (see Federal Register/Vol. 54, No. 17/Jan. 27, 1989, p. 4186).

The FDIC Improvement Act was introduced in Congress on Mar. 5, 1991.[41] We choose this date as the proposed rule date. On Aug. 2, 1991, the committee voted to issue a report to the full chamber recommending that the bill be considered further (ibid.), we consider this date to reflect the time when rules became clearer and choose it as our final rule date.

Finally, the following Prompt Corrective Action took a quick road to implementation. Rules were proposed by regulators by Jul. 7, 1992[42], and a final rule was published on Sept. 29, 1992 (see Federal Register/Vol. 57, No. 189/Sep. 29, 1992, p. 44866).

The dates are listed in columns 2 and 3 of Table 2. If we think of the anticipation horizon as the months between proposed or final rule and the effective date, we obtain horizons of $\{0, 8, 9, 57, 9, 5\}$ months for the proposed rule and of $\{0, 7, 1, 23, 4, 3\}$ for the final rule. We note that Basel I with its lengthy preparations is quite an outlier. Without Basel I the median anticipation horizons are at 8 (differences between proposed rules and effective dates) and at 4 (differences between final rules and effective dates). We have no clear prior whether banks

[40] FDIC Chairman William M. Isaac stated that "[a]s bank supervisors, we failed to effectively caution American banks to restrain foreign lending growth. Although portfolio concentrations were identified and commented upon, sufficiently firm steps were not taken to limit concentrations and the leveraging of bank capital. Without question our supervisory efforts need buttressing." (see "International Bank Lending: Hearings Before the Subcommittee on Financial Institutions Supervision, Regulation and Insurance of the Committee on Banking, Finance, and Urban Affairs, House of Representatives, Ninety-eighth Congress, First Session, Apr. 20 and 21, 1983")

[41] See https://www.govtrack.us/congress/bills/102/s543

[42] "In early July, the Board of Governors of the Federal Reserve System (Federal Reserve Board) (57 FR 29226, July 1, 1992), the Federal Deposit Insurance Corporation (FDIC) (57 FR 29662, July 6, 1992), the Office of the Comptroller of the Currency (OCC) (57 FR 29808, July 7, 1992), and the Office of Thrift Supervision (OTS) (57 FR 29826, July 7, 1992) proposed regulations to implement the provisions of section 131 of the Federal Deposit Insurance Corporation Improvement Act of 1991 (FDICLA) (Pub. L. 102-242), which is entitled 'Prompt Corrective Action'.", see Federal Register/Vol. 57, No. 127/Jul. 1, 1992, p. 29226.

should be expected to act on the proposed already, or on the more specific final rule.

D.2 Newspaper search

Another potential channel of anticipation could be information about the capital requirement regulation transmitted to a wider public via newspapers. To measure this anticipation, we use the Factiva database provided by Dow Jones which contains historical articles from leading US newspapers. In particular, we focus on those newspapers also used in Baker et al. (2016). These are USA Today, Miami Herald, Chicago Tribune, Washington Post, Los Angeles Times, Boston Globe, San Francisco Chronicle, Dallas Morning News, New York Times, and Wall Street Journal. We isolate articles focused on bank capital regulation by searching for the words "bank(s)", "capital/minimum requirement" and any one of the regulators. Specifically, we use the following search algorithm: ("bank" OR "banks") AND ("bank capital" OR "capital requirement" OR "minimum requirement" OR "minimum capital" OR "capital guideline") AND ("FDIC" OR "F.D.I.C." OR "Federal Deposit Insurance Corporation" OR "Federal Reserve" OR "Fed" OR "OCC" OR "Comptroller of the Currency"). To control for the growing amount of newspaper articles collected on Factiva over time, we normalize the hits we have obtained by the number of all articles in any one month.

With this specification, we find relevant mentions for the last four of our events, see column 4 in Table 2. Specifically, the articles are "Stricter Rules for Banks Proposed", New York Times, Jul. 11, 1984; "Similar Standards for Banks are Set by U.S and Britain", New York Times, Jan. 9, 1987; "Banking Bill Is Voted Down In the House", Wall Street Journal, Nov. 5, 1991; and "Rise Seen In Lending By Banks", New York Times, May 8, 1992. The lack of reporting on the 1981 event prior to the effective date is in line with the abrupt introduction of the new guidelines (without the issuance of proposed and final rules). Interestingly, however, also the International Lending and Supervision Act of 1983 is not mentioned in any newspaper article in the context of capital requirements. This might reflect a generally more limited interest in the topic of capital requirements relative to the late-1980s and early-1990s, or be due to the fact that some newspapers only joined Factiva later. However, we cannot rule out that information on the planned capital requirement changes reached the informed public via other news outlets. For events 3 to 6 the anticipation horizons would be $\{9, 47, 1, 7\}$. Without the Basel I event, the newspaper search would yield a median anticipation horizon of 7, which is close to the average anticipation horizon of 6 which we pick in our baseline model.

D.3 Bank excess return dynamics

As another way to retrieve a plausible anticipation horizon we investigate when markets first reacted to changes in bank regulation. For that purpose we estimate bank excess returns and assess their reaction to changes in the CRI, allowing for various anticipation horizons. Broadly following Fieldhouse et al. (forthcoming), we estimate the regression:

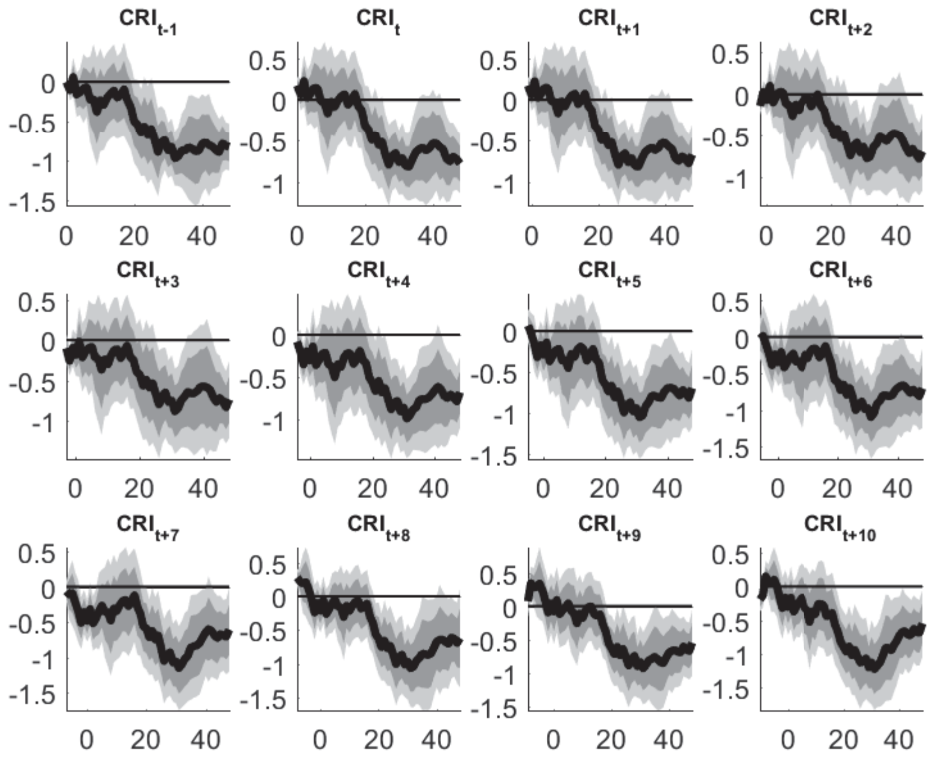
$$BER_t = g + \delta(L)\widetilde{z}_t + \alpha(L)CRI_{t+\tilde{h}} + w_t, \tag{3}$$

where BER_t corresponds to the log ratio of the bank stock returns (i.e. the returns from the "banking" portfolio from Ken French's Data Library[43]) over the market index (i.e. the S&P 500). The banking portfolio includes all institutes with the Standard Industrial Classification (SIC) codes 6000 to 6199, including depository institutions, commercial and national banks, plus e.g. credit unions, S&Ls and financial services. The term $\delta(L)\widetilde{z}_t$ comprises a large number of contemporaneous and 12 lags of explanatory variables. These are the controls we also include in our baseline and extended models (loans, BAA spread, core PCE deflator, industrial production, the Federal Funds rate, the Savings and Loans crisis dummy), returns of "real estate", "insurance" and "trading" portfolios (SIC codes 6300 to 6799) from Ken French's Data Library relative to S&P 500 returns as well as lags of the bank stock returns relative to S&P 500 returns, all suitably transformed. We then cumulate the estimated residuals $\hat{w}_t$ (i.e. the cumulated bank excess returns) and insert them as endogenous variable in model (2).

Models which allow excess returns to respond already 7 to 3 months before the effective dates yield instantaneous or almost instantaneous drops in cumulated bank excess returns. These are only short-lived. When the bank capital ratio rises permanently excess returns fall further. To summarize, markets anticipate the regulatory changes 7 to 3 months in advance.

[43]see http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

Figure D.2: Impulse response of cumulated bank excess returns to past, contemporaneous and leads of the CRI



Notes: In percentage points. Point estimates (black solid line), 68% and 90% confidence bands (dark and light shaded areas).

E Data sources and treatment

Table E.1: Overview of sources and treatment of our data (1/2)

Variable	Details	Transf.	Source
Baseline model variables			
Industrial production	Index 2012=100	d	FRED
Total bank loans, real	Sum of real estate, C&I, consumer bank loans	d, n	Federal Reserve H8
Core PCE deflator	PCE excluding food and energy (chain-type price index 2009=100)	d	FRED
Federal funds rate	extended with the shadow short rate from Leo Krippner from Nov. 2008 onwards	l	FRED, RBNZ webpage[a)]
Baa spread	Moody's seasoned Baa corporate bond yield - 10y Treasury constant maturity rate	l	FRED
Other variables			
Bank capital ratio	(Bank assets - bank liabilities)/bank assets	l	Federal Reserve H8
Bank assets, real		d, n	Federal Reserve H8
Bank capital, real	Bank assets-bank liabilities	d, n	Federal Reserve H8
C&I loans, real		d, n	Federal Reserve H8
Real estate loans, real		d, n	Federal Reserve H8
C&I loan spread	Bank prime rate - 2y Tbill rate	l	FRED
Mortgage spread	30y fixed rate mortgage average in the US - 10y Treasury constant maturity rate	l	FRED
Investment, real	Non-residential priv. fixed investment	d, q	BEA NIPA
Personal consumption expenditure, real		d, n	FRED
Housing starts	New privately owned housing units started	l	FRED
House price, real	Case-Shiller house price	d, n	Robert Shiller's webpage[b)]
S&P 500, real		d, n	Robert Shiller's webpage[b)]
Unemployment rate	Civilian unemployment rate	l	FRED

Notes: We take logarithms for all series but rates, ratios, volatility and inequality measures. "Transf." specifies the data transformation. Most series are in differences (d), some are in levels (l). Whenever the original frequency is quarterly (q), the series has been converted to monthly using the cubic spline (last) method. Series are converted from nominal (n) to real by dividing them with the core PCE deflator.

Notes on individual series:

a) For the shadow short rate data, see https://www.rbnz.govt.nz/research-and-publications/research-programme/additional-research/measures-of-the-stance-of-united-states-monetary-policy

b) See http://www.econ.yale.edu/~shiller/data/ie_data.xls

Table E.2: Overview of sources and treatment of our data (2/2)

Variable	Details	Transf.	Source
Other variables cont.			
Excess Bond Premium (EBP)	see Gilchrist and Zakrajšek (2012)	d	Simon Gilchrist's webpage[c)]
Credit-to-GDP gap	one-sided HP(400000) filtered credit-to-GDP ratio	l, q	BIS
Savings and Loan crisis dummy	with ones in 1988 and zeros otherwise	l	Laeven and Valencia (2013)
TED spread	3m Eurodollar Deposit Rate - 3m Tbill rate	l	Mark Watson's webpage[d)]
Romer Romer mon. pol. shock	see Romer and Romer (2004),	d	Yuri Gorodnichenko's webpage[e)]
	Coibion et al. (2017)	d	
Fernald TFP series	see Fernald (2012)	l, q	FRBSF webpage[f)]
WTI oil price, real	Spot crude oil price: West Texas Intermediate (WTI), dollars per barrel	d, n	FRED
Romer Romer tax shock	see Romer and Romer (2010)	l, q	AER webpage[g)]
Ramey military news fiscal shock	see Ramey (2011)	l, q	Valery Ramey's webpage[h)]
US recession dates	binary series indicating months in recession	l	NBER
Stock market volatility	VIX extended backwards with realized stock market volatility before 1990	l	FRED
Bank stock market volatility	Realized stock market volatility of 45 banks	l	FRED
ΔCoVaR	Systemic risk measure for commercial banks ($\Delta CoVaR_{95}$)	l	Markus Brunnermeier's webpage[i)]
Uncertainty	Macroeconomic uncertainty (forec. horizon: 12 months) from Jurado et al. (2015)	l	Sydney Ludvigson's webpage[j)]
Risk aversion	-PVS, based on difference betw. price of high and low volatility stocks	d, q	Pflueger et al. (2018)

Notes: We take logarithms for all series but rates, ratios and uncertainty. "Transf." specifies the data transformation. Most series are in differences (d), some are in levels (l). Whenever the original frequency is quarterly (q), the series has been converted to monthly using the cubic spline (last) method. Series are converted from nominal (n) to real by dividing them with the core PCE deflator.
Notes on individual series:
c) See http://people.bu.edu/sgilchri/Data/GZ_M_August_2016.csv.zip
d) See
http://www.princeton.edu/~mwatson/ddisk/Stock_Watson_Disentangling_ReplicationFiles_July05_2013.zip
e) For the Romer and Romer (2004) dataset extended by Coibion et al. (2017), see http://eml.berkeley.edu/~ygorodni/
f) See http://www.frbsf.org/economic-research/files/quarterly_tfp.xlsx. Specifically, we use the quarterly series for utilization-adjusted TFP.
g) For the Romer and Romer (2010) dataset, see https://www.aeaweb.org/aer/data/june2010/20080421_app.zip. We use the *exogenous* tax variable based on the change in liabilities, excluding retroactive tax changes. Data are only available until the end of 2007. We filled the remaining months in 2008 with zeros. The results do not change when we stop the analysis which includes the Romer Romer tax shocks in 2007.
h) See http://econweb.ucsd.edu/~vramey/research.html#data
i) See https://scholar.princeton.edu/markus/publications/covar
j) See https://www.sydneyludvigson.com/data-and-appendixes/