

Calibrating Macroprudential Policy to Forecasts of Financial Stability

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CEBRA Policy Workshop

**Boston, MA
July 9, 2017**

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Overview

Since the financial crisis, the introduction of explicit macroprudential responsibilities at central banks and financial regulatory agencies has created a need for new measures of financial stability.

Many have been proposed, but they require further transformation / calibration to become policy indicators.

We propose a transformation into transition probabilities between states of greater and lesser financial stability.

Forecasts of these state probabilities can then be used within a decision theoretic framework proposed by Kahn and Stinchcombe (*AER*, 2015) to provide policy suggestions calibrated to current circumstances.

Macroprudential policy

The macroprudential policy that we focus on is the setting of the countercyclical capital buffers (CCyB) established with the Basel III capital reforms.

The Basel III capital requirement is for

- 4.5% ratio of common equity Tier 1 (CET1) instruments to RWA
- 6% ratio of overall Tier 1 capital instruments to RWA
- 8% ratio of total capital (Tier 1 plus Tier 2) to RWA
- 4% leverage ratio of Tier 1 capital to total average assets

Basel III added the capital conservation buffer (CCB) and the countercyclical capital buffer (CCyB) as macroprudential tools.

The CCB requires an additional buffer of CET1 of at least 2.5% of RWA above the regulatory minimum.

This buffer is to be divided into quartiles, such that as CET1 ratio falls, increasingly more limitations are placed on capital distributions and certain discretionary bonus payments.

Countercyclical capital buffers

The CCyB was established as a separate, supplemental tool that would increase regulatory capital requirements for select firms when policymakers judge that systemic risk is elevated above normal conditions.

The CCyB ranges from 0% to 2.5% depending on the deliberations of the relevant national regulatory authority.

As the CCyB is considered to be a macroprudential tool, the setting of its level is most directly linked to the condition of the overall financial environment rather than the condition of individual firms.

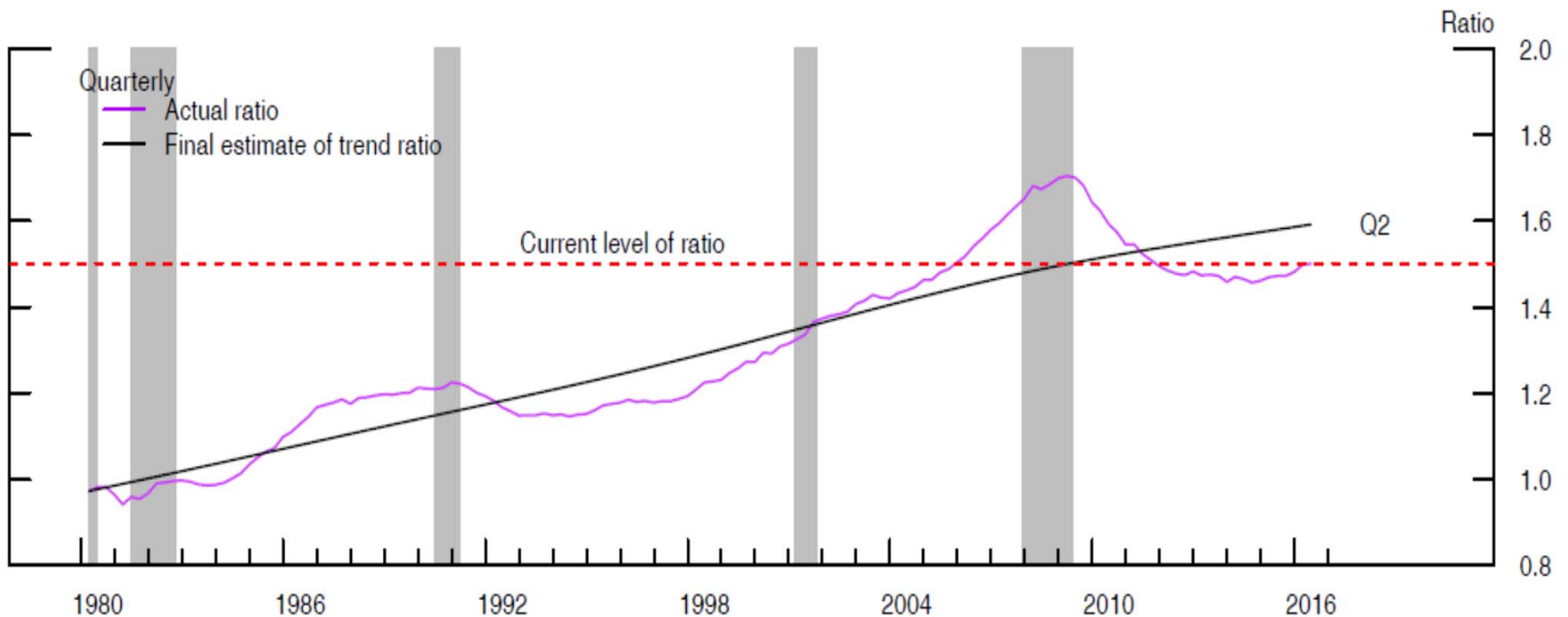
The setting of this level depends on analysis of current macroeconomic, financial, and supervisory information, including measures of financial stability.

In particular, the BCBS has advocated the use of a country's ratio of private, nonfinancial credit to nominal GDP, appropriately detrended, as a key reference variable.

Credit-to-GDP ratio

Drehmann et al. (2011) argue that the gap between the ratio of private, non-financial credit-to-GDP and its long-term backward-looking trend performs best as an indicator for the build-up of “system-wide vulnerabilities that typically lead to banking crises.” Challenges arise with respect to the “long-term” trend.

Private nonfinancial sector credit-to-GDP ratio and trend



Note: Calculated using an HP filter with lambda=400,000.

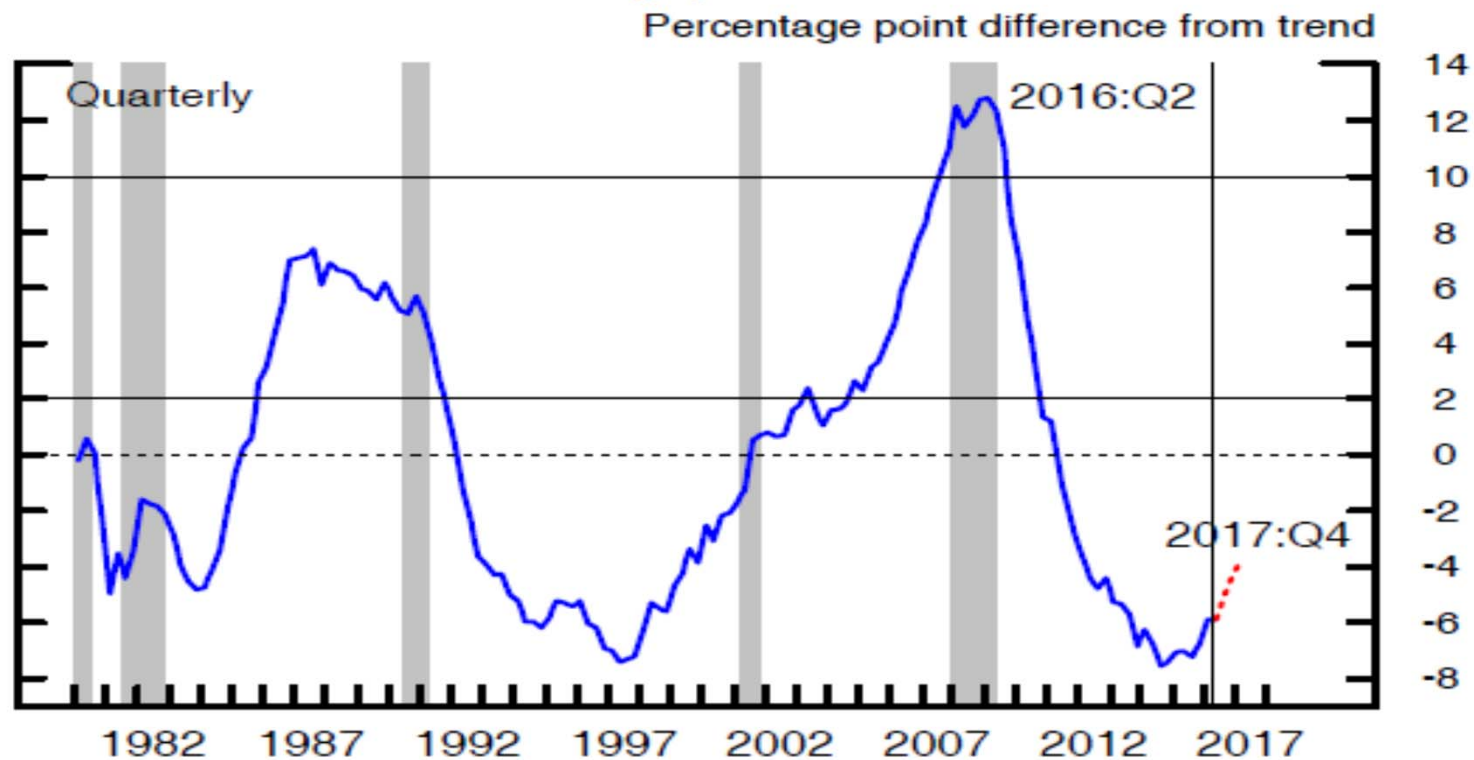
Source: Financial Accounts of the United States, NIPA, and staff calculations.

Credit-to-GDP ratio (cont.)

Drehmann et al. (2011) propose one-sided HP filtering using the λ parameter of 400,000, which suggests that “financial cycles are four times longer than standard business cycles.”

Edge & Meisenzahl (2011) present challenges to this choice.

Guide 1: Credit-to-GDP gap



Credit-to-GDP ratio (cont.)

Jim Hamilton (2016) wrote a paper entitled:
“Why You Should Never Use the Hodrick-Prescott Filter”

- (1) The HP filter produces series with spurious dynamic relations that have no basis in the underlying data-generating process.
- (2) The one-sided filter produces series that do not have the properties sought by most potential users of the HP filter.
- (3) A statistical formalization of the problem produces values for the smoothing parameter far below 1600 for quarterly data.

Building on work by Brave and Butters (2012), we examine the quarterly log first differences of private credit and GDP. In particular,

$$\Delta \ln (\text{GDP}_t) = \alpha_S + \beta_S \left[\Delta \ln (\text{GDP}_{t-1}), \Delta \ln (C_t), \Delta \ln (C_{t-1}) \right] + \sigma \varepsilon_t$$

We propose that underlying the data are two states corresponding to higher and lower degrees of financial stability, denoted S^+ , S^-

Markov-switching model

$$\Delta \ln(\text{GDP}_t) = \alpha_S + \beta_S \left[\Delta \ln(\text{GDP}_{t-1}), \Delta \ln(C_t), \Delta \ln(C_{t-1}) \right] + \sigma \varepsilon_t$$

2 states: higher and lower degrees of financial stability; i.e., S^+ , S^-

$$\pi_{ijt} = \Pr(S_t = S^i | S_{t-1} = S^j, X_t, \theta) = \Phi(\delta_{ijt})$$

Our first specification is that the transition probabilities are constant;
i.e., $\delta_{ijt} = \delta$

As per Diebold et al. (1994), we examine time-varying probabilities that are functions of financial stability indicators.

$$\Omega_t = \begin{bmatrix} \Phi(\delta_+ + \gamma_+ X_t) & 1 - \Phi(\delta_+ + \gamma_+ X_t) \\ 1 - \Phi(\delta_- + \gamma_- X_t) & \Phi(\delta_- + \gamma_- X_t) \end{bmatrix}$$

Financial stability indicators

We examine a focused subset of FSI based on previous literature.

FSI reflecting conditions in the corporate bond market and correlated with near-term economic growth:

- (1) The spread between yields on seasoned long-term Baa-rated industrial bonds and Treasuries of comparable maturities
 - As per Lopez-Salido, Stein, and Zakrajsek (2015)
- (2)(3) Spread and excess bond premium measures developed by Gilchrist and Zakrajsek (2012)

FSI reflecting conditions in the banking system: (4) Leverage Ratio

FSI by Brave & Butters (2012) reflecting conditions more broadly:

- Constructed using an unbalanced panel of 105 mixed-frequency indicators of financial activity
 - (5) The National Financial Conditions Index (NFCI)
 - (6) The NFCI adjusted for current economic conditions (ANFCI)
 - (7) NFCI Nonfinancial leverage subcomponent

Markov-switching model (cont.)

8 models are combined with Bayesian model averaging techniques.

Two states are defined according to the estimated model parameters, so they vary somewhat across specifications.

States are distinguished primarily by differences in the estimated constants and the contemporaneous coefficients on credit growth.

S+ : Average real GDP growth > 0, Minimal co-movement with credit
- estimated at +2.5% annualized growth rate
- near-zero coefficient on $\Delta \ln(C_t)$

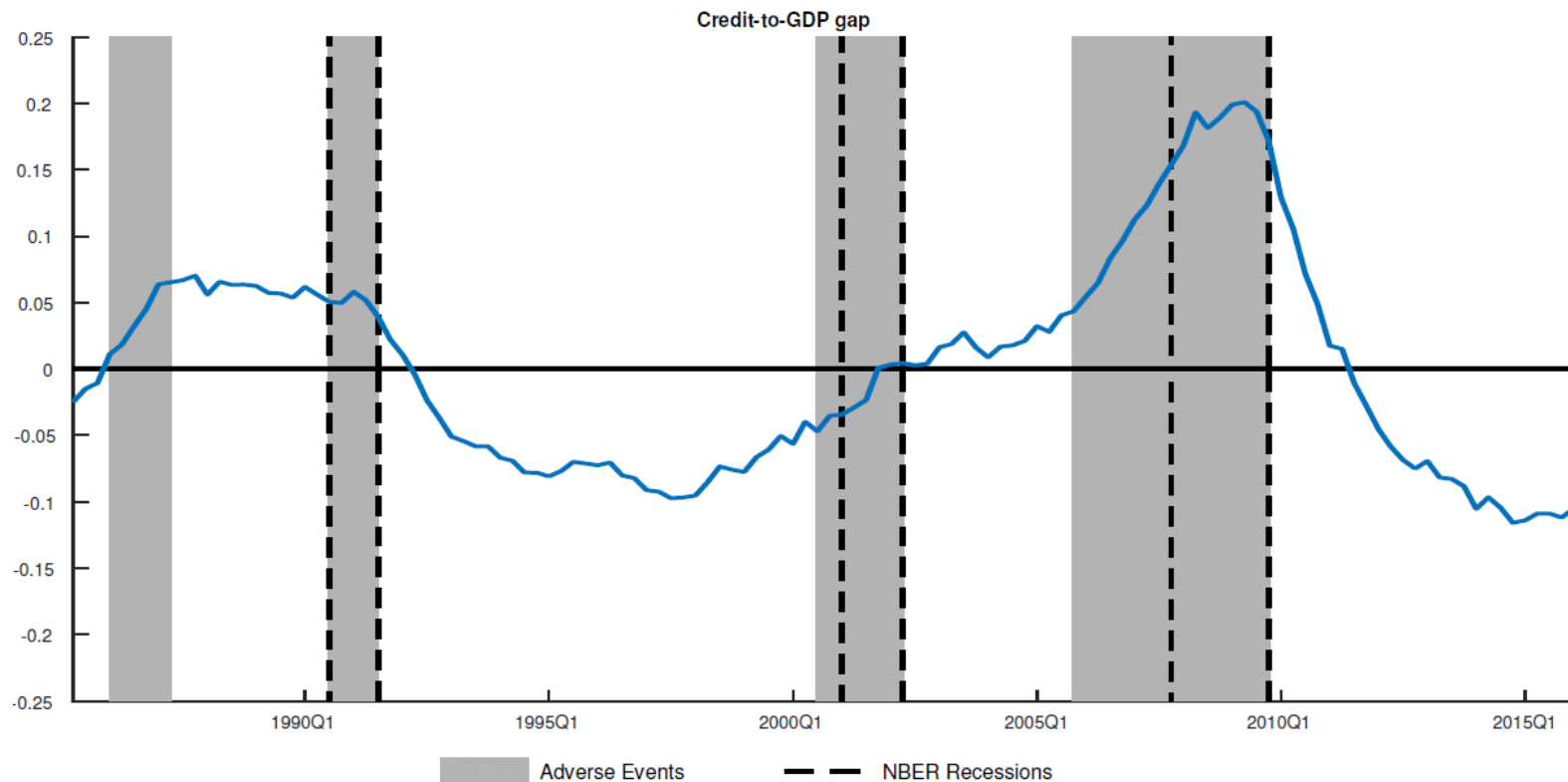
S- : Average real GDP growth < 0, Strong co-movement with credit
- estimated at -2.7% annualized growth rate
- coefficient of +0.7 on $\Delta \ln(C_t)$

Markov-switching model (cont.)

Model-implied states of financial instability:

Down states: 1986Q1-1986Q4, 1990Q3-1991Q1, 2000Q3-2001Q4, 2005Q4-2009Q2

Recessions: 1990Q3-1991Q1, 2001Q1-2001Q4, 2007Q4-2009Q2



Forecasting state probabilities

To forecast the state probabilities up to k periods ahead, define

$$E[\xi_T | S_{T-1} = +, \Omega_T] = \begin{pmatrix} \Pr(S_T = +) \\ \Pr(S_T = -) \end{pmatrix} = \begin{pmatrix} p_{+T} \\ p_{-T} \end{pmatrix}$$

and

$$P = \begin{bmatrix} p_{++} & p_{+-} \\ p_{-+} & p_{--} \end{bmatrix},$$

such that

$$E[\xi_{T+k} | \xi_T] = P^k \xi_T$$

and the hazard function for the negative state is

$$H_T(k) = E[\Pr(S_{T+k} = -) | \xi_T] = (P^k \xi_T)_{(2,1)}$$

Forecasting state probabilities (cont.)

While the hazard function of the single-quarter event of tipping into the negative state can be readily generated from the model, it is not interesting to the macroprudential policymaker.

- A single quarter of the financial instability state is likely insufficient to warrant policy action.

For the CCyB policy, the capital increase must be completed within 12 months of enactment.

- Intuition to create the macroprudential event of interest as 4 quarters in the negative state.

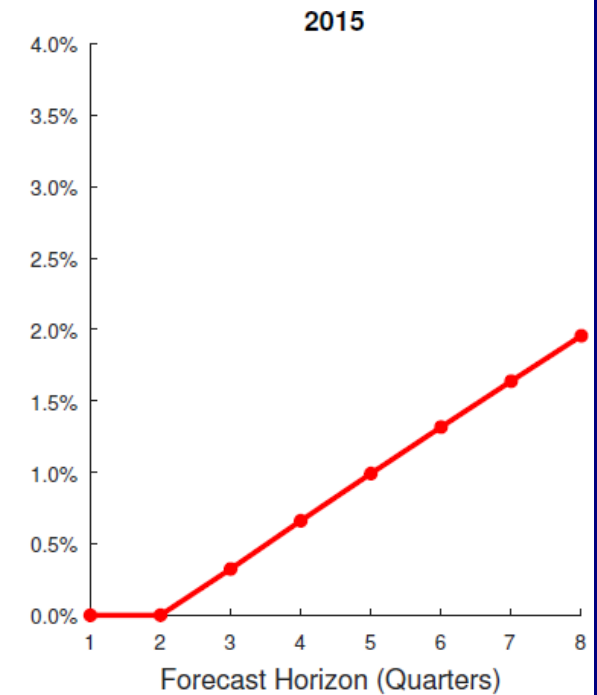
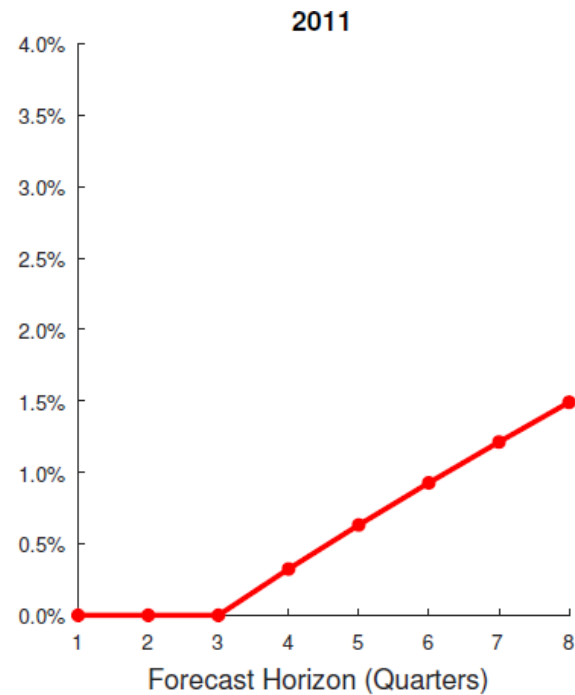
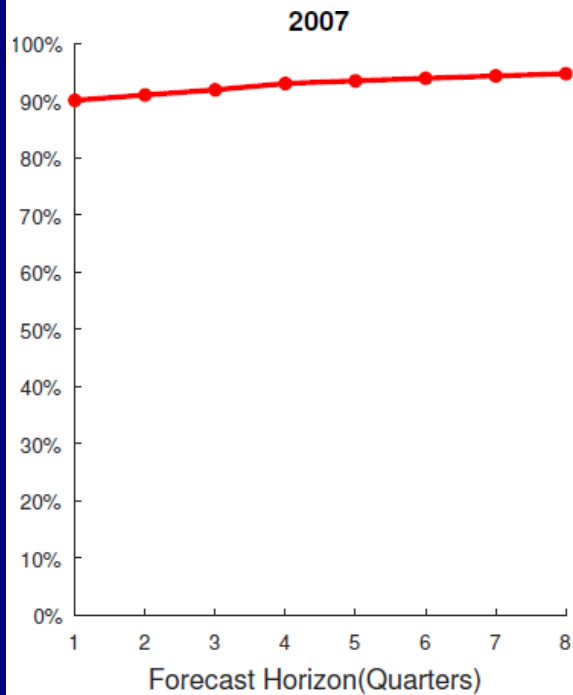
We consider this event over 8 projection quarters $T+k$, $k \in [1, 8]$.

With 3 in-sample quarters, we have 2,048(= 2^{11}) paths to consider.

- With 8(= 2^3) sets of initial conditions, we can aggregate the cumulative likelihood of the 4-quarter event across the projection quarters and weight by likelihood.

We use empirical Bayesian methods to combine the specifications.

Forecasting state probabilities (cont.)



2007.Q4 hazard function for the 4-quarter event rises from 90% (i.e., high prob. of already being 3 quarters in) to 95% by PQ8.

In contrast, 2011.Q4/2015.Q4 hazard starts at zero and rises to about 1.5%/2.0%, suggesting that we are not likely to leave S^+ .

KS policy objective function

These hazard function projections are an input into the objective function of the macroprudential policymaker, but what does that function look like?

Kahn-Stinchcombe (*AER*, 2015) present an analytical framework for decisions based on hesitating to take a costly action in order to gather more information on the current state of the situation.

- “At issue is the optimal timing of a costly...precautionary measure: an evacuation before a hurricane landfall; or a politically painful reform of a banking system before the next financial crisis.”

Closed-form first order condition for optimal time to act t^* :

$$h(t^*) = \frac{rC}{\left(\left[\theta \bar{u} + (1-\theta) \underline{u} \right] / r - C \right)}$$

Balancing the benefit of waiting in the numerator (i.e., saving from not incurring cost) and the policy cost (i.e., NPV of gains minus C)

KS policy objective function (cont.)

Define t_w as the waiting time until the defined adverse event arrives.

$f(t_w)$ is its pdf; $F(t_w)$ is its cdf; $h(t_w) = f(t_w)/(1-F(t_w))$ is its hazard

When to act balances the costs and benefits of the policy with the probabilistic arrival of the adverse event.

\bar{u} is the present utility flow, and \underline{u} is the flow after enacting the policy such that

$$\bar{u} > \underline{u} > 0$$

C is the cost of enacting the policy (current cost, but can be expanded)

The policy also affects the probability of the event occurring:

$$f_{\theta}(t_w; t_1) = \begin{cases} f(t_w) & \text{if } t_w < t_1 \\ (1-\theta)f(t_w) & \text{if } t_w \geq t_1 \end{cases}$$

KS policy objective function (cont.)

Calibration:

The discount rate r is the 2-year Treasury rate since the government policymaker is working over a two-year event horizon.

The narrow cost C of the policy is the dollar cost to the affected firms of raising the equity capital needed to meet a 0.25% CCyB increase.

Θ is calibrated as $[0, 0.25, 0.50, 0.75, 1]$.

How do we calibrate the current and adverse utility flows?

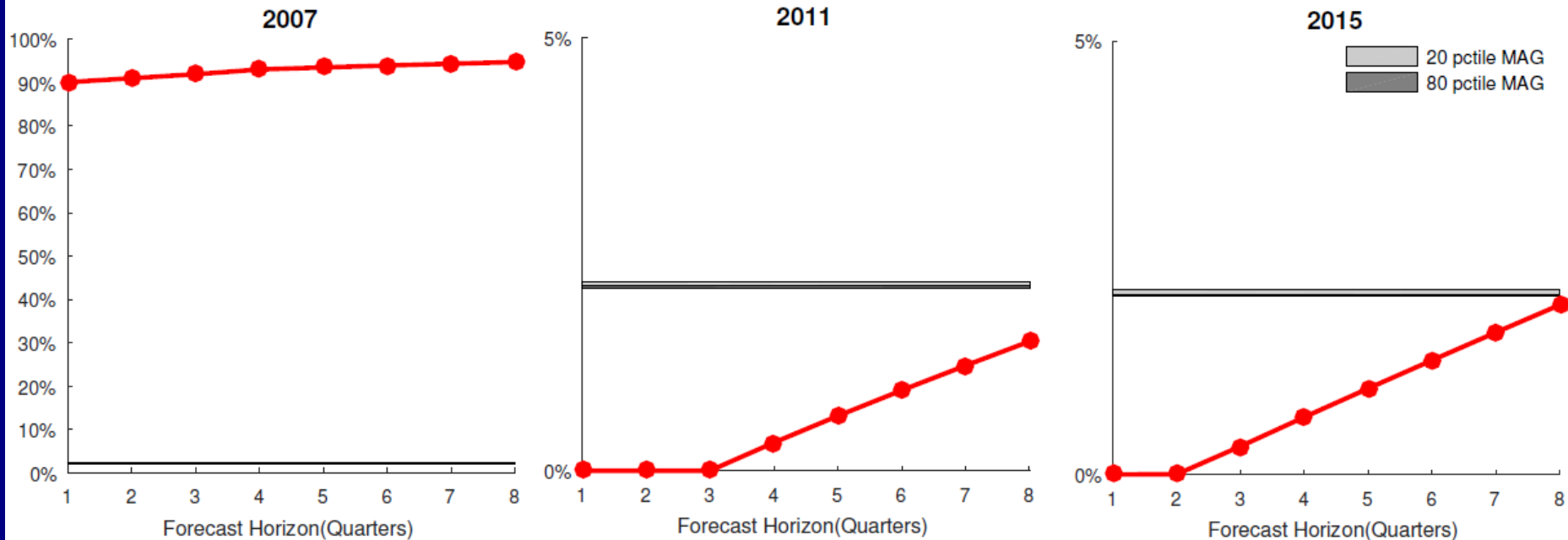
- External calibration:

- Set \bar{u} as expected GDP growth (from SPF 1-year forecast)
- Set \underline{u} as reduction based on decreased GDP growth after increase in capital requirements
- MAG (2010) study: [20%,80%] range from [-17, -4]bp

- Internal calibration:

- Set $\left[\bar{u}, \underline{u} \right]$ using estimated model parameters

External calibration results: 0.25% buffer



Small difference between $\left[\bar{u}, \underline{u} \right]$ leads to narrow KS band.

2007.Q4 policymaker is behind and should act immediately.

2011.Q4/2015.Q4 policymaker can wait since the hazard function is below the KS band that would signal the need to act.

Internal calibration

Set $[\bar{u}, \underline{u}]$ using estimated model parameters:

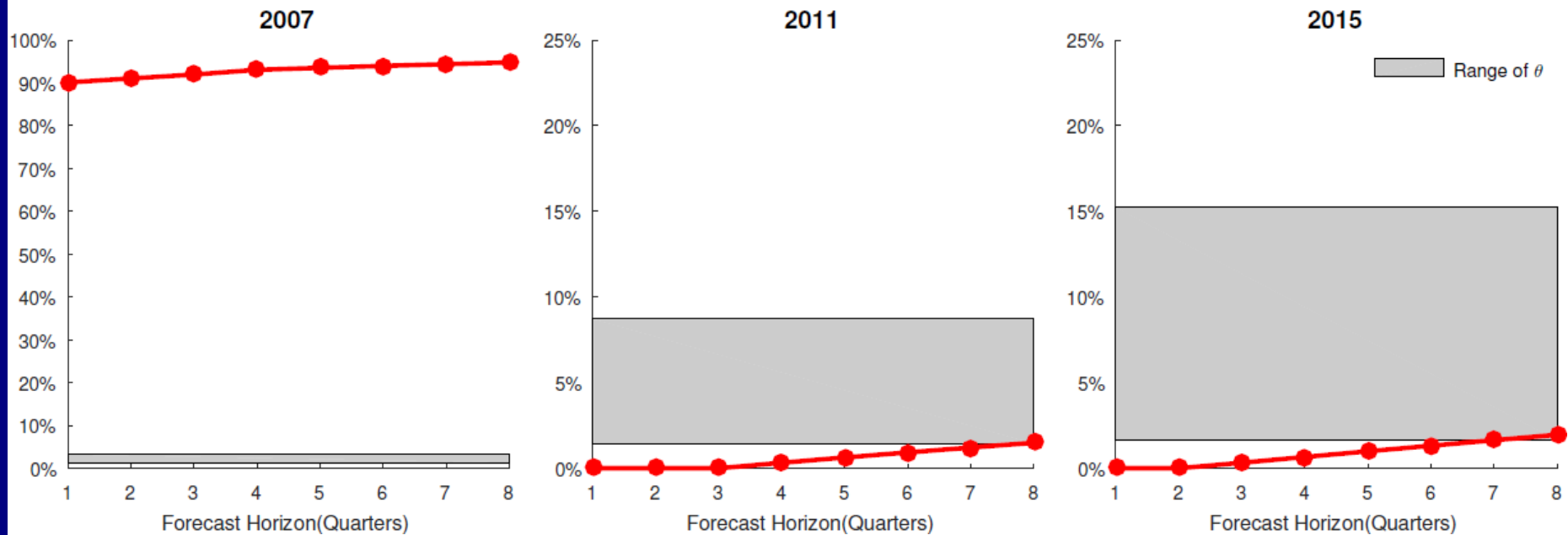
- Calculate the state-dependent expected GDP growth rate from the model, which includes expected credit growth

$$\mu_S = \frac{\beta_{S,constant} + (\beta_{S,credit} + \beta_{S,credit-1}) * E[credit]}{(1 - \beta_{S,GDP-1})}$$

	<u>2007.Q4</u>	<u>2011.Q4</u>	<u>2015.Q4</u>
μ_g	3.86(%)	3.48(%)	3.26(%)
μ_b	1.68(%)	0.62(%)	0.40(%)

- Set $\bar{u} = \mu_g$ and $\underline{u} = \mu_b$
 - The larger difference in values leads to a lower and wider KS band.

Internal calibration results: 0.25% buffer

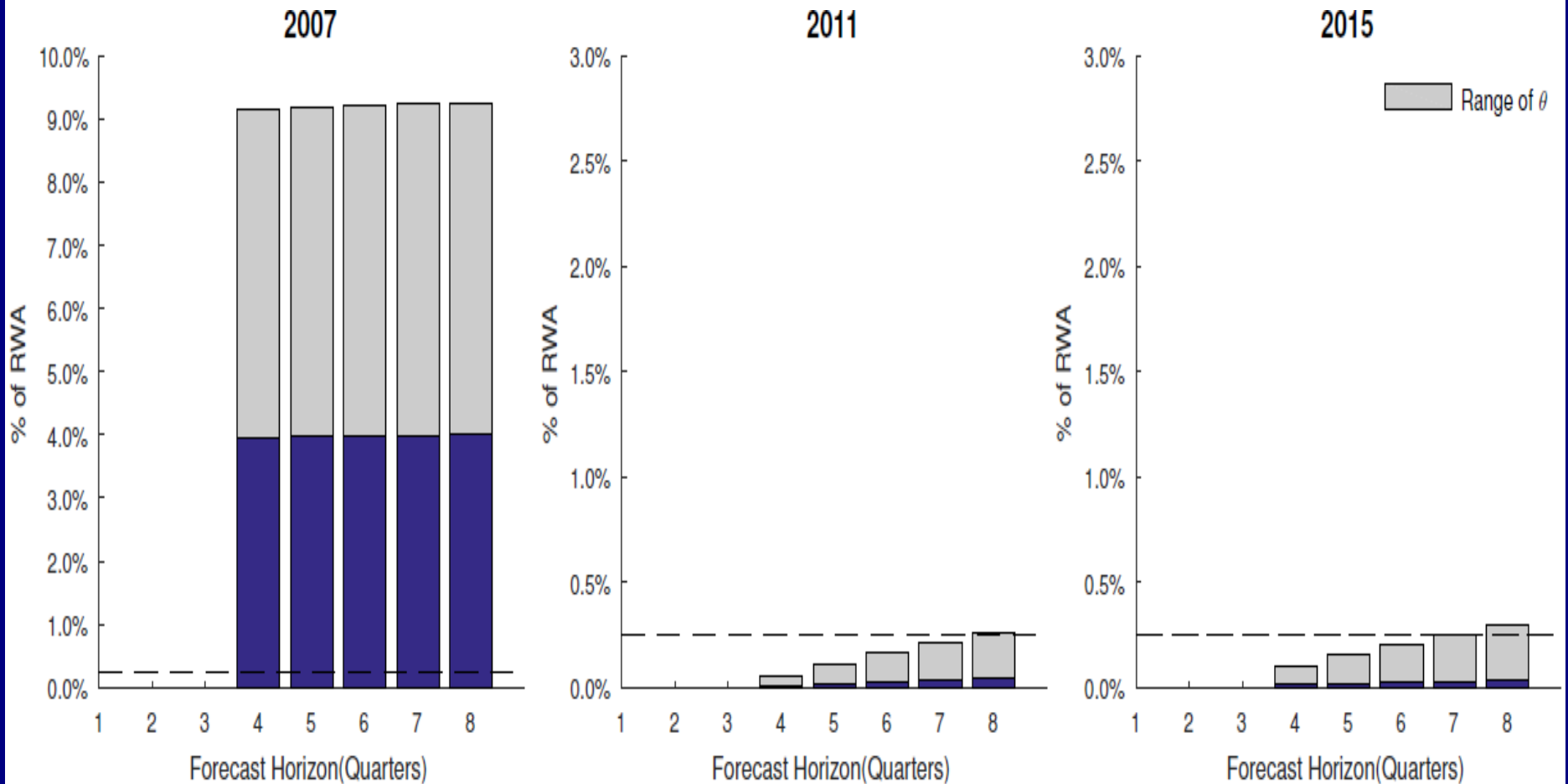


2007.Q4 policymaker is behind and should act immediately.

2011.Q4/2015.Q4 policymaker can wait until PQ8/PQ7 to act since the hazard function is just then touching the lower bound of the KS band that would signal the need to act.

Internal calibration results: optimal buffer

- Free the CCyB policy from a strict +0.25% to a range of values; i.e., for current conditions, what CCyB value is most reasonable?



Dashed line represents a 0.25% capital buffer

Conclusion

Macroprudential policy responsibilities have become important elements for maintaining financial stability.

Given a set of policy tools, policymakers need

- (1) ways to measure the degree of financial stability,
- (2) translate those measurements into policy projections, and
- (3) decide if and when to implement their policy tools.

We propose a methodology that

- (1) can incorporate a wide variety of financial stability indicators,
- (2) translates financial stability measures into probability forecasts of better or worse states of financial stability over an event horizon, and
- (3) presents a closed-form solution for when to act that can be calibrated to the cost, benefits, and effectiveness of the policy tool to be implemented.