

Technical Appendix

In order to describe how the costs and benefits of raising the CCyB are calculated, it is necessary to define some terms.

Definitions

Δc = the total reduction in the total cost of a financial crisis, if one occurs, resulting from a one percentage point increase in the CCyB, as a percent of real GDP. Future benefits are accumulated and discounted to the start of the crisis.

r = interest rate used to discount future costs and benefits

g = trend growth in real GDP

d = the cost of a one percentage point increase in bank capital requirements as a percent of GDP. That is, if the CCyB is increased by one percentage point, the level of GDP is d percent lower than it would otherwise have been in each period.

α = the annual odds of a financial crisis.

Benefit

If the banking agencies were to raise the CCyB one percentage point, the benefit would be a reduction in the cost of a financial crisis, if one occurred, equal to Δc percent of GDP.¹⁰ A crisis occurs with odds α , so the expected benefit from the first period would be

$$- \alpha \Delta c \text{ GDP}_0$$

The benefit accrues in the second period if there was no crisis in the first period, (odds $(1 - \alpha)$), but instead occurs in the second period (odds α). GDP has grown by g , and the benefit needs to be discounted at r . So the expected benefit from the second period would be

$$- \alpha \Delta c \text{ GDP}_0 \frac{(1-\alpha)(1+g)}{(1+r)}$$

Following the same logic, the benefit accruing from the possibility of a crisis in the third period is

$$- \alpha \Delta c \text{ GDP}_0 \left(\frac{(1-\alpha)(1+g)}{(1+r)} \right)^2$$

¹⁰ As discussed in the main text, consistent with the assessment of the objective of the Federal Reserve and the BIS that the CCyB would likely not help prevent asset bubbles but could help lessen the fallout when they burst, we assume that raising the CCyB only reduces the cost of a crisis, not the odds of a crisis.

Summing the benefit from each future period, the total benefit is

$$-\alpha \Delta c \text{ GDP}_0 \sum_{i=0}^{\infty} \left(\frac{(1-\alpha)(1+g)}{(1+r)} \right)^i$$

Which simplifies to

$$-\alpha \Delta c \text{ GDP}_0 \frac{1+r}{r+\alpha+\alpha g-g} \quad (1)$$

Since

$$\sum_{i=1}^{\infty} \left(\frac{(1+g)(1-\alpha)}{1+r} \right)^i = \frac{(1-\alpha)(1+g)}{(1+r) - (1-\alpha)(1+g)}$$

Thus

$$\sum_{i=0}^{\infty} \left(\frac{(1+g)(1-\alpha)}{1+r} \right)^i = 1 + \frac{(1-\alpha)(1+g)}{(1+r) - (1-\alpha)(1+g)} = \frac{1+r}{r+\alpha+\alpha g-g}$$

Cost

The cost of raising the CCyB by one percentage point is GDP that is d percent lower. The cost occurs as long as there isn't a financial crisis, so with odds $(1-\alpha)$. So in period 1, the expected cost is

$$(1-\alpha) d \text{ GDP}_0$$

In period 2, the GDP has grown by g , a crisis must not have occurred in the previous period, and the cost needs to be discounted. So the expected cost in period 2 is

$$(1-\alpha) d \text{ GDP}_0 \frac{(1-\alpha)(1+g)}{(1+r)}$$

Following the same steps as used when calculating the benefits, the total costs are

$$(1-\alpha) d \text{ GDP}_0 \frac{1+r}{r+\alpha+\alpha g-g} \quad (2)$$

Net benefit

As can be seen by comparing equations 1 and 2, the net benefit of raising the CCyB by one percentage point will be positive when

$$-\alpha \Delta c > (1-\alpha) d \quad (3)$$

That is, the benefit of higher capital in terms of the reduced cost of a crisis, should one occur, times the annual odds of a crisis would need to exceed the cost of the higher capital times the annual odds of there not being a crisis in order for raising the CCyB to be beneficial.

The BIS assessment of the probability of a crisis (α) seems to be about two percent per year.¹¹ The BCBS assesses the cost of raising capital requirements by one percentage point (d) to be 0.09 percent of GDP each year.¹² It is difficult to assess the benefit of raising the CCyB because, as the BIS points out (as noted in the text), there is no analysis that concludes the cost of financial crisis (as opposed to the probability of a financial crisis) is reduced by raising capital requirements. However, as a point of reference, the BIS study on the benefit of TLAC cited above judged that the *entire* TLAC requirement, (which requires banks to fund between six and ten percent of assets using long-term debt), would reduce the cost of a financial crisis by 5.4 percent of GDP, less than a percentage point reduction in cost for each percentage point of TLAC.¹³ We'll err in favor of the CCyB and assume that raising the CCyB by one percentage point lowers the cost of a crisis by two percent of GDP.

Using these assumptions, the left hand side of equation 3 is 0.04 percent. The right hand side of equation 3 is 0.088 percent, so more than twice as large. Increasing the CCyB would not currently be beneficial, in part because of the reduction in the odds of a financial crisis brought about by Basel III. An increase would only make sense if the odds of a crisis rose to 4.3 percent, near the levels estimated to have prevailed before the post-crisis regulatory reforms.¹⁴

To determine the dollar cost and benefit, it is necessary to calibrate the discount factor, r , and the GDP growth rate, g . We assume that r and g are 3.75 and 4 percent, respectively, the medians of the FOMC's September forecasts of the longer-run values of nominal GDP growth and the federal funds rate, respectively, as well as the current value of nominal GDP (\$18.45 trillion).¹⁵ Using those values, the benefit of raising the CCyB by one percentage point is \$420 billion (equation 1), while the cost is \$920 billion (equation 2).

¹¹ Fender, I and U. Lewrick, Calibrating the leverage ratio, December 2015, BIS Quarterly Review, p.53 http://www.bis.org/publ/qtrpdf/r_qt1512f.pdf put the odds after the post-crisis regulatory reform at 1.6 percent while the TLAC study cited above put the odds at 2.3 percent (footnote 17 on p.25).

¹² "An assessment of the long-term economic impact of strong capital and liquidity requirements," April 2010, Basel Committee on Banking Supervision, p.26. <http://www.bis.org/publ/bcbs173.pdf>.

¹³ "Assessing the economic costs and benefits of TLAC implementation," p.27

¹⁴ "An assessment of the long-term economic impact of stronger capital and liquidity requirements," p.9.

¹⁵ See "Summary of Economic Projects" at the end of the minutes of the September 2016 meeting of the Federal Open Market Committee. <http://www.federalreserve.gov/monetarypolicy/files/fomcminutes20160921.pdf>