Capital Constraints, Lending over the Cycle and the Precautionary Motive:

A Quantitative Exploration

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1. Introduction

In the wake of the financial crisis, financial regulators have developed new tools. Among these tools are countercyclical capital buffers, which aim to decrease the procyclicality of bank lending. The idea is that capital buffers should rise in good times, to build up high levels of equity capital. Then in bad times, capital requirements can be loosened, to encourage banks to lend more during the downturn, in an attempt to stimulate the economy.

One difficulty of this is that banks may not wish to lend more during a downturn, even if their capital requirements are loosened. In particular, banks may display a precautionary motive : They might seek to build up capital stocks in a downturn, to avoid coming near their capital constraint, as this would involve costly adjustments. Hence, banks might optimally choose to reduce lending in a downturn, even if capital constraints were loosened. As a result, the countercyclical effects desired by regulators might be undermined.

The objective of this paper is to examine the lending behaviour and capital levels over the cycle of a bank which has an explicit precautionary motive. Precautionary effects are 3rd order, and so require 3rd order approximation schemes to capture them. Moreover, a capital constraint only binds occasionally, and models with occasionally binding constraints are known to be quite challenging to solve using non-linear methods.

We present a model of the bank's decision to hold capital, and to allocate assets between safe bonds and risky loans when faced with a stochastic default rate on risky loans. The bank (manager) aims to maximize the present value of dividends on behalf of the banks's risk-averse shareholders. For simplicity, we abstract from any agency problems, and assume that banks act in the shareholders' best interests.

The model is partial equilibrium, since the rates of return on both the safe asset R_S and the risky loan R_L are exogenous. Risky loans have a higher rate of return, $R_L > R_S$, but are also subject to a stochastic default rate ξ_t. Banks are faced with a capital constraint, that requires that bank equity capital be at least a fraction $\gamma > 0$ of the value of risky loans at all times. Clearly, if an unusually large share of loans defaults, then the capital constraint might be violated. In this case, the bank's manager either reduces risky lending (deleverages) or reduces dividends until the capital constraint is satisfied once again.

There are two main trade-offs in the model. First, higher dividends at date t increase current utility, but make it more likely that the capital constraint will be breached in *t+1*, triggering a costly deleveraging. Deleveraging is costly both because it reduces returns on the bank's portfolio of assets, and also because of an adjustment cost. Second, a higher share of assets allocated to risky loans at date t has the benefit of increasing the share of assets earning a higher gross return, but also increases the losses from defaults and makes it more likely that the capital constraint will be breached in *t+1*.

We show how to solve the model, which includes an occasionally binding capital constraint, necessitating the use of advanced non-linear numerical methods. We then use the model to examine the impact of the capital constraint on optimal lending behaviour. In particular, we check how lending reacts to a shock to the default rate on risky loans both with and without a capital constraint. Moreover, we are able to turn the precautionary motive in the model on and off, and examine the size and direction of the precautionary effect on bank lending and capital holdings in the model with a capital constraint. We are aiming to understand better whether countercyclical capital buffers could be an effective tool to encourage banks to increase their lending when hit by a higher than expected rate of defaults on their risky loans.

2. Model

2.1 Model setup

The objective function of the bank's management is to maximize the present value of dividends on behalf of its risk-averse shareholders. The bank is assumed to be small enough so as to not influence market interest rates. In other words, this is a partial equilibrium model of the bank's portfolio and dividend choices when it faces a capital constraint.

At the beginning of each period, bank assets A_t are known, and a new value of the stochastic default rate ξ_t on risky loans is realized. The bank then chooses how to allocate assets between safe bond paying R_S and risky lending paying $R_L > R_S$, and how much to pay out to shareholders in dividends D_t, whilst respecting the capital constraint that equity capital K_t exceed a share γ of risky assets.

The bank's new share of risky loans α_t leads to a new level of bank capital $K_t = [(1-\xi_t)\alpha_t + (1-\alpha_t)]A_t - \overline{B}$, where $\overline{B}$ are deposits, assumed to be constant. This share of risky loans must satisfy the capital constraint

$$K_t = [(1-\xi_t)\alpha_t + (1-\alpha_t)]A_t - \overline{B} \geq \gamma\alpha_t(1-\xi_t)A_t$$

The capital constraint can be conveniently expressed as a constraint on the portfolio share of risky loans α_t:

$$\alpha_t \leq \left[1 - \frac{\overline{B}}{A_t}\right]\frac{1}{\gamma + \xi_t - \gamma\xi_t}$$

If the bank's optimal choice for α_t would breach the capital constraint, then it would find itself at a corner solution, and would choose its share of risky loans so as to just satisfy the capital constraint:

$$\alpha_t = \left[1 - \frac{\overline{B}}{A_t}\right]\frac{1}{\gamma + \xi_t - \gamma\xi_t}$$

Similarly, the optimal choice of dividend must satisfy an inequality constraint, as banks cannot pay negative dividends to their shareholders. If the bank's optimal choice of dividend were to breach this lower bound, then it would be in a corner solution with $D_t = \underline{D} > 0$, where $\underline{D}$ represents some (small) inalienable and possibly non-pecuniary benefit from being a bank shareholder. In our numerical example, we set $\underline{D} = 0.01$. Effectively, lower dividends are a form of 'punishment' to shareholders when the bank's level of capital becomes so low that it is unable to lend optimally, and must recapitalise quickly.

Once (α_t, D_t) have been chosen optimally, next period's assets are calculated as

$$A_{t+1} = R_S(1-\alpha_t)A_t + R_L(1-\xi_t)\alpha_t A_t - bA_t(\alpha_t - \overline{\alpha})^2 - D_t$$

where $bA_t(\alpha_t - \overline{\alpha})^2$ are the adjustment costs to deviating from the steady-state share of loans.

2.2 Bank's optimization problem

Now we turn to the bank's optimization problem. The bank chooses the share of risky loans and dividends so as to maximize the expected discounted sum of utilities from dividends, whilst respecting the regulatory capital constraint and the lower bound on dividends:

$$V(A_0) = \max_{\{D_t, \alpha_t\}_{t=0}^{\infty},} E_0 \sum_{t=0}^{\infty} \beta^t u(D_t) \tag{1}$$

Subject to:

$$A_{t+1} = R_S(1-\alpha_t)A_t + R_L(1-\xi_t)\alpha_t A_t - bA_t(\alpha_t - \overline{\alpha})^2 - D_t \tag{2}$$

$$\alpha_t \leq \left(1 - \frac{\overline{B}}{A_t}\right)\frac{1}{\gamma + \xi_t - \gamma\xi_t} \tag{3}$$

$$D_t \geq \underline{D} > 0 \tag{4}$$

The bank's optimal portfolio and dividend choices satisfy the first order conditions:

$$\begin{aligned} &u_D(D_t) + \mu_t \\ &= \beta E_t \Bigg[[u_D(D_{t+1}) + \mu_{t+1}] \cdot \left(R_S(1-\alpha_{t+1}) + R_L(1-\xi_{t+1})\alpha_{t+1} - b(\alpha_{t+1} - \overline{\alpha})^2\right) \\ &+ \lambda_{t+1} \frac{1}{\gamma + \xi_t - \gamma\xi_t} \frac{\overline{B}}{(A_{t+1})^2} \Bigg] \end{aligned} \tag{5}$$

$$[u_D(D_t) + \mu_t][(R_L(1-\xi_t) - R_S)A_t - 2bA_t(\alpha_t - \overline{\alpha})] + \lambda_t = 0 \tag{6}$$

where λ_t and μ_t are the date t Lagrange multipliers on the capital constraint and dividend lower bound respectively. These LaGrange multipliers represent the utility cost to hitting the capital constraint or dividend lower bound, respectively.

2.2.1 Interior solution:

At an interior solution at date t, the current period Lagrange multipliers are equal to zero, and (D_t, α_t) satisfy:

$$\alpha_t = \overline{\alpha} + (R_L(1-\xi_t) - R_S)\frac{1}{2b} < \left(1 - \frac{\overline{B}}{A_t}\right)\frac{1}{\gamma + \xi_t - \gamma\xi_t} \tag{7}$$

$$u_D(D_t) = \beta E_t \Bigg[[u_D(D_{t+1}) + \mu_{t+1}] \cdot (R_S(1-\alpha_{t+1}) + R_L(1-\xi_{t+1})\alpha_{t+1} - b(\alpha_{t+1} - \overline{\alpha})^2)$$

$$+ \lambda_{t+1} \frac{1}{\gamma + \xi_t - \gamma\xi_t} \frac{\overline{B}}{(A_{t+1})^2} \Bigg] \quad (8)$$

2.2.2 Capital constraint binds

The capital constraint binds when the optimal share of risky loans exceeds the maximum value which would satisfy the capital constraint.

$$\overline{\alpha} + (R_L(1-\xi_t) - R_S)\frac{1}{2b} \geq \left(1 - \frac{\overline{B}}{A_t}\right)\frac{1}{\gamma + \xi_t - \gamma\xi_t}$$

In this case, α_t is chosen to just satisfy the capital constraint with equality:

$$\alpha_t = \left(1 - \frac{\overline{B}}{A_t}\right)\frac{1}{\gamma + \xi_t - \gamma\xi_t}$$

while dividends satisfy either (6) or (8), depending on whether the dividend lower bound binds or not.

2.3 Comparative Statics and the Precautionary Motive

The capital constraint comes down to a condition on the share of assets that can be allocated to risky lending (3).

$$\alpha_t \leq \left(1 - \frac{\overline{B}}{A_t}\right)\frac{1}{\gamma + \xi_t - \gamma\xi_t}$$

The maximum allowable share of risky loans is greater for lower default rates ξ_t, higher value of initial assets A_t in excess of deposits $\underline{B}$ and looser capital constraints (smaller γ). Hitting the capital constraint is costly, because it requires deviating from the optimal share of risky loans in the portfolio, in addition to an adjustment cost to deleveraging. It may also require a decrease in dividends paid to the bank's shareholders. The precautionary motive stems from banks' reluctance to hit the capital constraint, causing them to try to increase bank equity capital by choosing low dividends and/or deleveraging. In our model, the choice between increasing equity capital by reducing dividends and deleveraging is endogenous, allowing us to better understand bank behaviour in a downturn.

3. Solving the Model

Dynamic optimization problems with occasionally binding constraints are notoriously challenging to solve. Moreover, some of the methods which have been proposed shut down any precautionary effects and risk premia, because they linearization and/or perfect foresight. These include the linear method proposed by Eggertson and Woodford (2003), implemented by the OccBin add-on for Dynare developed by Guerrieri and Iacoviello (2014), which have been popular in the monetary economics literature on zero lower bounds on interest rates (ZLBs). The 'extended path' method proposed by Adjemian and Juillard (2011) relies on perfect foresight, which also excludes any precautionary effects. As examining the impact of the precautionary motive of banks which face a capital constraint is the main objective of this paper, methods which shut down precautionary effects are clearly inappropriate.

More promising is the approach described by Holden and Paetz (2012), which relies neither on linearization nor on perfect foresight, and hence can capture precautionary effects. We solve the model by using Holden's toolkit for occasionally binding constraints in conjunction with Dynare. Since precautionary effects show up as 3rd order approximation terms, we can turn the precautionary motive on and off by choosing either a 3rd or 2nd order approximation in Dynare, respectively. This will allow us to isolate the impact of the precautionary motive.

Applying Holden and Paetz (2012)'s method involves extend the set of optimality conditions using one auxiliary variable for each occasionally binding constraint. In our model, this involves introducing the auxiliary variables C_t and F_t defined as:

$$C_t = max\left\{0, \beta E_t[u_D(D_{t+1}) \cdot (R_S(1-\alpha_{t+1}) + R_L(1-\xi_{t+1})\alpha_{t+1} - b(\alpha_{t+1} - \overline{\alpha})^2)] - u_D\left(\underline{D}\right)\right\}$$

$$F_t = \max\left\{0, \overline{\alpha} + (R_L(1-\xi_t) - R_S)\frac{1}{2b} - \left(1 - \frac{\overline{B}}{A}\right)\frac{1}{\gamma + \xi - \gamma\xi}\right\}$$

In both cases, the auxiliary variables take the value 0 (zero) for an interior solution, and a non-zero value when the constraint binds. We then rewrite the optimality conditions as suggested by Holden and Paetz (2012):

$$u_D(D_t) = \beta E_t\left[[u_D(D_{t+1})] \cdot (R_S(1-\alpha_{t+1}) + R_L(1-\xi_{t+1})\alpha_{t+1} - b(\alpha_{t+1} - \overline{\alpha})^2)\right] - C_t$$

$$\alpha_t = \overline{\alpha} + (R_L(1-\xi_t) - R_S)\frac{1}{2b} - F_t$$

We then ask Dynare, a standard piece of software, to solve the extended system of five non-linear equations ()-() and (2) in the five endogenous variables $(A_t, D_t, \alpha_t, C_t, F_t)$.

4. Steady state and parameterization of the model

We use the non-stochastic steady state in the absence of a capital constraint to parameterize the model. There are 9 parameters to set: the discount factor β, the return on the safe asset R_S, the return on risky loans R_L, the average default rate on risky loans $\overline{\xi}$ its variance σ_ξ^2 and autoregressive parameter ρ, the parameters of the adjustment cost to portfolio choice $\overline{\alpha}$ and b, the capital constraint parameter γ and the size of deposits $\overline{B}$. Table 1 summarizes the parameter choices, while Table 2 gives the model's steady state.

First, we normalize the assets to $A = 100$. We set the discount factor $\beta = (0.96)^{1/4}$ quarterly, corresponding to an annual discount factor is 0.96. The mean quarterly default rate on risky loans is set to 0.5%, which corresponds to an annual default rate of 2.0%. The autocorrelation parameter ρ is set to 0.80, while the variance is set to $(0.25\%)^2$. We set the target portfolio share of risky loans $\overline{\alpha}$ to 0.80, and the cost of a unit of square deviation from that target portfolio share of risky loans is $bA = 0.002$. We set the 'risk premium' on risky loans (the excess return on risky loans) $R_L\left(1-\overline{\xi}\right) - R_S = 0.002$ quarterly. We use the equation for optimal interior portfolio choice, evaluated at the steady state, to obtain the steady state value for portfolio choice as:

$$\alpha = \overline{\alpha} + \left[R_L\left(1 - \overline{\xi}\right) - R_S\right]\frac{1}{2b}$$

Next, we use the optimality condition for dividends, evaluated at the steady state, to pin down the return on the safe asset as:

$$R_S = \frac{1}{\beta} - [R_L(1 - \xi) - R_S]\alpha - b(\alpha - \overline{\alpha})^2$$

This yields the value $R_S = 1.0087$ quarterly, which gives a return of 3.5% annually. Substituting this back into the risk premium definition gives a quarterly return on risky loans of $R_L = 1.0157$, which corresponds to an annual return of 6.4%. Evaluating the transition equation at the steady state pins down steady state dividends $\frac{D}{A} = \frac{1}{\beta} - 1$ at 1.03% of bank assets quarterly, or about 4.12% annually.

The capital constraint is assumed to require that the bank's equity capital, the difference between the bank's assets and its (constant) deposits $\overline{B}$ is at least $\gamma = 8\%$ of the value of its risky loans. Finally, we choose deposits $\overline{B}$ so that in the steady state, equity capital is equal to about 10% of the value of risky loans and the capital constraint does not bind in good times.

The steady state equations can help to illustrate the model's key mechanisms. Begin with the non-stochastic steady state equation for optimal portfolio choice.

$$\frac{\bar{A}}{2b}[R_L(1 - \xi) - R_S] = \alpha - \bar{\alpha}$$

Near the steady-state, a small increase in the default rate to $\xi > \bar{\xi}$ is expected to lead to a decrease in the optimal share of risky loans to below their steady state level $\alpha < \bar{\alpha}$, as returns on risky loans fall relative to safe assets.

5. Quantitative Results

We solve the model using Tom Holden's additions to Dynare, which allow us to approximate a 3rd order solution to the model of bank lending and dividend behaviour with capital constraints. This method ensures that the precautionary effects are preserved. We compare the behaviour of lending, dividends and bank capital after a one standard-deviation positive shock to the default rates on risky loans. While this shock is too small to cause the bank's capital constraint to bind, the threat of hitting it in the future increases, as the set of shocks which would lead to a corner solution increases. As a result, banks reduce dividends, and deleverage sharply. This is illustrated by the impulse-responses displayed in Figure 1. Bank lending, $\alpha_t A_t$ falls by 10% on impact, while dividends fall by 8% and the bank's equity capital falls by 14.5%. The recovery is fairly slow: It takes about 5 years for the bank to return to the steady state. This indicates that countercyclical capital buffers, which seek to reduce capital requirements after a 'bad' shock to the economy, might not be effective at mitigating the procyclicality of lending behaviour. Banks' optimal behaviour implies deep cuts in lending that are unlikely to be reversed by more lenient capital requirements.

Next, we examine whether the bank's steep cut in lending is due to precautionary motives. The idea is that in bad times, when default rates are higher, banks would seek to deleverage sharply, in order to rebuild their equity capital, staying well away from the capital constraint. We examine the importance of the precautionary motive by shutting it down. We do this by solving the model using only a 2^{nd} order approximation to the policy functions, which shuts down any precautionary effects. Indeed, in the absence of a precautionary motive, the model bank reacts quite differently to a shock to its default rate, as illustrated in Figure 2. This underlines the importance of the precautionary motive, and suggests that models of bank behaviour which abstract from it might give erroneous results.

Still, these results should be treated with some caution. Little is known about the accuracy of perturbation methods when constraints are occasionally non-binding. Using the global methods described in Christiano and Fisher (2000), while challenging, would have the advantage of a known and high accuracy level.

Conclusions

We set up and solve a dynamic model of bank lending and dividend choices when facing stochastic default rates on risky loans and a capital constraint. We use a 3rd order non-linear solution method that does not rely on perfect foresight, in order to preserve any precautionary effects. We show that in the model which allows for precautionary effects, banks deleverage sharply when default rates increase, in order to rebuild their capital stocks. The strength of the decline in lending suggests that loosening capital constraints to encourage banks to increase their lending is not likely to succeed. This conclusion should be treated with some caution, as it is based on a local, rather than a global solution method. Future work should focus on solving the model presented here using a projection method, whose accuracy is well-established.

References

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Guerrieri, L. and M. Iacoviello (2012), "OccBin: A toolkit to solve models with occasionally binding constraints easily," mimeo, Federal Reserve Board of Governors.

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Tables

Table 1: Parameterization of the Numerical Examples

Parameter	Value
$\boldsymbol{\beta}$	0.9898
$\boldsymbol{R_S}$	1.0087
$\boldsymbol{R_L}$	1.0157
$\bar{\boldsymbol{\xi}}$	0.005
$\boldsymbol{\rho}$	0.800
$\boldsymbol{\sigma_\xi}$	0.0025
$\bar{\boldsymbol{\alpha}}$	0.800
$\boldsymbol{b}$	0.002
$\bar{\boldsymbol{B}}$	90
$\boldsymbol{\gamma}$	0.08

Table 2: Steady State

Variable	Value
$\boldsymbol{A}$	100
$\boldsymbol{D}$	1.02
$\boldsymbol{\alpha}$	0.805

Figures

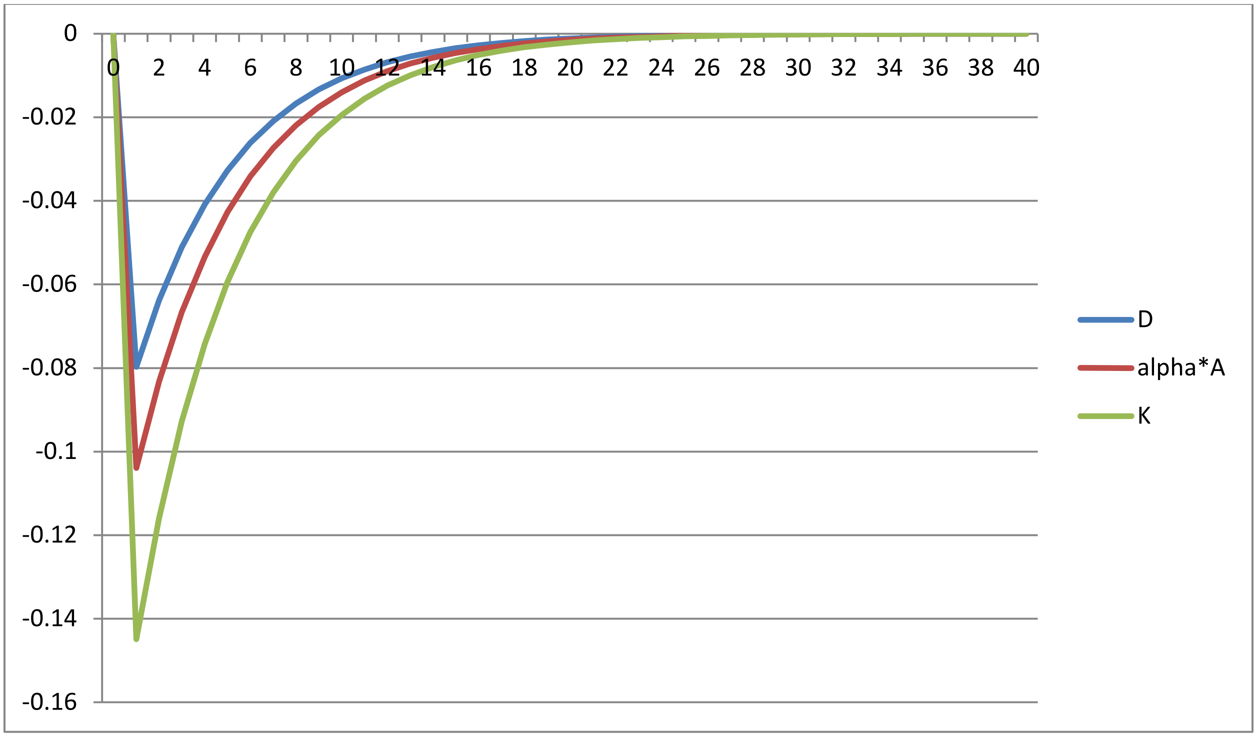

Figure 1: Impulse responses to a one standard deviation shock (increase) to the default rate on risky loans for the 3rd order approximation to the model with a capital constraint. Periods are quarters, so the bank takes about 5 years to return to its steady state lending and dividend levels.

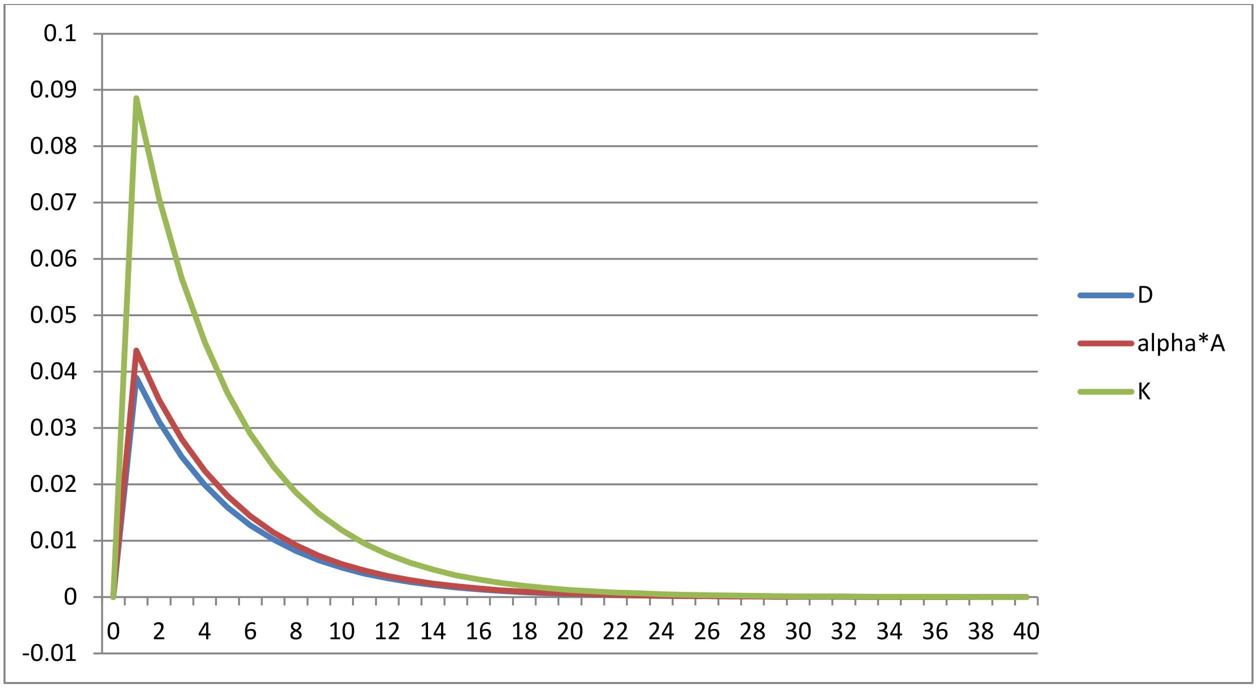

Figure 2: Impulse responses to a one standard deviation shock (increase) to the default rate on risky loans for the 2rd order approximation to the model with a capital constraint. Periods are quarters, so the bank takes about 4 years to return to its steady state lending and dividend levels.

Appendix

Characterizing the bank's optimal choices analytically

We now proceed to derive first order optimality conditions for the optimization problem with occasionally binding capital constraints described in equations (1)-(4). The corresponding Lagrangian is:

$$L = E_0 \sum_{t=0}^{\infty} \beta^t \Bigg\{ u[R_S(1-\alpha_t)A_t + R_L(1-\xi_t)\alpha_t A_t - bA_t(\alpha_t - \overline{\alpha})^2 - A_{t+1}]$$

$$+ \lambda_t \left[\left(1 - \frac{\overline{B}}{A_t}\right) \frac{1}{\gamma + \xi_t - \gamma\xi_t} - \alpha_t \right]$$

$$+ \mu_t \left[R_S(1-\alpha_t)A_t + R_L(1-\xi_t)\alpha_t A_t - bA_t(\alpha_t - \overline{\alpha})^2 - A_{t+1} - \underline{D} \right] \Bigg\}$$

The first order conditions are:

$$\frac{\partial L}{\partial A_{t+1}} = \beta^t [-u_D(D_t) - \mu_t]$$

$$+ \beta^{t+1} E_t \Bigg[[u_D(D_{t+1}) + \mu_{t+1}]$$

$$\cdot (R_S(1-\alpha_{t+1}) + R_L(1-\xi_{t+1})\alpha_{t+1} - b(\alpha_{t+1} - \overline{\alpha})^2)$$

$$+ \lambda_{t+1} \frac{1}{\gamma + \xi_t - \gamma\xi_t} \frac{\overline{B}}{(A_{t+1})^2} \Bigg] = 0$$

$$\frac{\partial L}{\partial \alpha_t} = [u_D(D_t) + \mu_t][-R_S A_t + R_L(1-\xi_t)A_t - 2bA_t(\alpha_t - \overline{\alpha})] - \lambda_t = 0$$

Which reduce to equations (5) and (6) respectively:

$$u_D(D_t) + \mu_t = \beta E_t \left[[u_D(D_{t+1}) + \mu_{t+1}] \cdot (R_S(1-\alpha_{t+1}) + R_L(1-\xi_{t+1})\alpha_{t+1} - b(\alpha_{t+1} - \overline{\alpha})^2) \right.$$

$$\left. + \lambda_{t+1} \frac{1}{\gamma + \xi_t - \gamma \xi_t} \frac{\overline{B}}{(A_{t+1})^2} \right]$$

$$[u_D(D_t) + \mu_t][(R_L(1-\xi_t) - R_S)A_t - 2bA_t(\alpha_t - \overline{\alpha})] = -\lambda_t$$

In addition, the Kuhn-Tucker conditions apply:

$$D_t - \underline{D} \geq 0$$

$$\mu_t \geq 0$$

$$\mu_t(D_t - \underline{D}) = 0$$

$$\left(1 - \frac{\overline{B}}{A_t}\right) \frac{1}{\gamma + \xi_t - \gamma \xi_t} - \alpha_t \geq 0$$

$$\lambda_t \geq 0$$

$$\lambda_t \left[\left(1 - \frac{\overline{B}}{A_t}\right) \frac{1}{\gamma + \xi_t - \gamma \xi_t} - \alpha_t \right] = 0$$

Finally, the bank's optimal choices are also characterized by the transition equation (2).

$$A_{t+1} = R_S(1-\alpha_t)A_t + R_L(1-\xi_t)\alpha_t A_t - bA_t(\alpha_t - \overline{\alpha})^2 - D_t$$

1) Maturity structure of loans. Implicitly assuming that all loans are one period, i.e. can choose the share of loans α_t to lie anywhere between 0 and the maximum that would satisfy the capital

constraint. Alternative is to assume that a share δ of loans matures each period, and the maximum decline in share of loans is to shift maturing loans to riskless asset. Latter is technically much more cumbersome.

2) Stochastic process for default rate on risky loans. To capture greater volatility during recessions, ξ_{t+1} could follow a GARCH process. This is not necessary to produce a precautionary effect – for that, a concave utility function with a positive 3rd derivative (see Kimball) would suffice. GARCH volatility that was countercyclical would, however, amplify the precautionary effect during recessions.

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Steady state:

$$\frac{1}{\beta} = (R_S(1-\alpha) + R_L(1-\xi)\alpha - b(\alpha-\overline{\alpha})^2)$$

$$\overline{\alpha} + (R_L(1-\xi) - R_S)\frac{1}{2b} = \alpha$$

$$\frac{D}{A} = R_S(1-\alpha) + R_L(1-\xi)\alpha - b(\alpha-\overline{\alpha})^2 - 1$$

Set either R_L or $\overline{\alpha}$, as well as $\beta, \overline{\xi}, R_S$.

$$R_L(1-\xi) - R_S = 0.002$$

$$\beta = (0.96)^{1/4}$$

$$\overline{\xi} = 0.005$$

$$\overline{\alpha} = 0.80$$

$$b = 0.2$$

$$\alpha - \overline{\alpha} = [R_L(1-\xi) - R_S]\frac{1}{2b}$$

$$R_S = \frac{1}{\beta} - \alpha[R_L(1-\xi) - R_S] + b(\alpha-\overline{\alpha})^2$$

$$R_L = \frac{R_S}{1-\xi} + R_L(1-\xi) - R_S$$

If set $\overline{\alpha} = 0.80$, then the implied value for the interest rate on risky loans is R_L =1.0157, while the dividend rate would be 1.01% and $R_S = 1.0087$, all quarterly.