Discussion of “Large Banks, Loan Rate Markup, and Monetary Policy”*

Dean Corbae
University of Wisconsin–Madison and NBER

1. Introduction

Cuciniello and Signoretti (this issue, hereafter CS) provide a New Keynesian dynamic stochastic general equilibrium (NKDSGE) model with imperfect competition in the banking industry and collateral-constrained borrowers to address some important questions. How much does banking industry market structure amplify business cycles? How does strategic interaction between big banks and the central bank affect aggregate outcomes? The idea that bank market structure and real economic outcomes are connected is important, and I think the authors make a nice contribution to the literature.

CS establish some interesting results. First, strategic interaction among a small number (n) of banks generates countercyclical loan markups which depend on (i) the elasticity of substitution between loan types (ϵ^b), firm leverage, and how the central bank responds to inflation (ϕ_π) in its policy rule. Second, countercyclical markups amplify the transmission of monetary and technology shocks on the real economy, which is absent in the perfectly competitive case (i.e., constant markups when $n \to \infty$). Third, the level of the spread is positively related to firm leverage (using the accounting measure of capital assets to net worth). Fourth, amplification of financial (or technology) shocks is weaker (stronger) the more aggressive the central bank's response to inflation.

There is substantial heterogeneity in the banking sector. First, bank market structure varies substantially across countries. For instance, in 2011, the asset market share of the top three banks in

*I am grateful to Akio Ino for computational assistance on this discussion.

Table 1. Measures of Competition in Banking

Moment	Value (%)	Std. Error (%)	Corr. with GDP
Net Interest Margin	4.56	0.01	−0.31
Lerner Index	43.11	0.38	−0.21
Markup	90.13	1.42	−0.27
Rosse-Panzar H	50.15	0.87	–

Source: FDIC, Call Reports, and Thrift Financial Reports. Values correspond to the time-series average of the loan-weighted cross-sectional averages. Consistent data available from 1984 to 2010.
Notes: Data correspond to commercial banks in the United States.

the following countries varied between Portugal at 89 percent, Germany at 78 percent, the United Kingdom at 58 percent, Japan at 44 percent, and the United States at 35 percent. While this heterogeneity provides a potentially important source of variation for identification, it is not necessarily exogenous and can vary, for instance, with government policy. Second, even within countries there is substantial heterogeneity among banks. If all banks within a country are symmetric, then asset market share is $1/n$. Symmetry would then imply, for example, that U.S. top three market share should be roughly 3/7000, not 35 percent. Obviously, symmetry is a strong simplifying assumption. Again, this heterogeneity is not necessarily exogenous and can vary, for instance, with government policy and region-specific shocks.

CS cite numerous papers which document countercyclical bank markups. For instance, table 1 (taken from Corbae and D'Erasmo 2013) uses Call Report data on all U.S. commercial banks from 1984 to 2010. Several of these papers provide evidence for imperfect competition in the banking sector including high margins and imperfect pass-through of costs (as measured by the Rosse-Panzar H-statistic). Countercyclical markups in the banking sector provide a new amplification mechanism. For instance, if markups on loans are countercyclical, then loan rates rise in a downturn, choking off investment and further amplifying the downturn. This is apparent in impulse response functions (shown below) for a model with an imperfectly competitive banking sector versus the perfectly competitive case.

This discussion will be organized in the following sections. Section 2 will briefly describe essential parts of CS's model, while section 3 will present some results. Finally, section 4 will discuss questions concerning robustness of the results as well as future directions.

2. Model

2.1 Environment

There are equal masses of two types of agents: (i) households (P) who work, deposit resources in bank, and consume; and (ii) entrepreneurs (E) who produce intermediate goods, accumulate capital, and take loans from banks which must be collateralized. Households discount the future at a lower rate than entrepreneurs (i.e., $\beta_P > \beta_E$), with β_E low enough that the entrepreneurs' collateral constraint always binds.

There are three types of non-financial firms: (i) capital goods producers who operate in a perfectly competitive market at real price q_t^k subject to adjustment costs; (ii) entrepreneurs who produce intermediate goods via a constant-returns-to-scale technology with white-noise aggregate productivity shock A_t^E; and (iii) retailers who differentiate intermediate goods, sell at a markup, and face quadratic price adjustment costs (which delivers a New Keynesian Phillips curve).

There are a finite number $n \geq 2$ of identical banks which collect deposits from households and issue loans to entrepreneurs. The deposit market is assumed to be perfectly competitive, while the loan market is modeled along the lines of Gerali et al. (2010), where loans of different types are aggregated using a Dixit-Stiglitz style aggregator with each bank having a share of total loans equal to $1/n$.

Finally, the central bank sets the interbank rate R_t^{ib} to lean against inflation wind (with sensitivity ϕ_π) according to the following rule:

$$R_t^{ib} = R^{ib} \pi_t^{\phi_\pi} \exp\left(\varepsilon_t^{R^{ib}}\right),$$

where the inflation rate is given by

$$\pi_t = \log(P_t) - \log(P_{t-1})$$

and $\varepsilon_t^{R^{ib}}$ is a white-noise policy innovation.

2.2 Equilibrium

Most of the model environment is familiar from earlier NKDSGE models. The two key differences, which I will highlight here, are the entrepreneur's collateral constraint and, more importantly, the finite number of banks choosing loan rates.

Entrepreneur i chooses consumption, capital, and loans $(c_t^E(i), k_t^E(i), b_t^E(i))$ to maximize the expected present discounted value of log utility subject to a standard budget constraint and an "ex ante" collateral constraint[1]

$$b_t^E(i) \leq \frac{E_t\left[m^E q_{t+1}^k k_t^E(i)(1-\delta^k)\right]}{R_t^b}, \tag{1}$$

where m^E is the "loan-to-value" ratio.

Using sufficient conditions such that the collateral constraint (1) is always binding, the first-order condition of the entrepreneur yields the loan demand decision rule:

$$b_t^E = \frac{\beta_E \chi_t}{q_t(R_t^b - \chi_t)} nw_t^E, \tag{2}$$

where

$$\chi_t \equiv (1-\delta^k) m^E E_t\left[q_{t+1}^k\right]$$

[1]Constraint (1) is used in several DSGE models (e.g., Iacoviello 2005). Its "microfoundations" are, however, different from Kiyotaki and Moore (1997). In Kiyotaki-Moore, there is no aggregate uncertainty, so ex ante is equal to ex post and the constraint makes default sub-optimal. But the ex post condition is what is relevant for the commitment problem. In particular, in period $t+1$, if entrepreneur i does not pay back, he gains $R_t^b b_t^E(i)$ but loses his collateral $q_{t+1}^k k_t^E(i)(1-\delta^k)$. For sufficiently low realizations of q_{t+1}^k, the entrepreneur might default ex post in the current model, which is not accounted for in the ex ante analysis.

and net worth is defined as

$$nw_t^E \equiv r_t^k k_{t-1}^E - R_t^b b_{t-1}^E + q_t^k (1-\delta^k) k_{t-1}^E. \tag{3}$$

After substituting necessary conditions, leverage is given by

$$LV_t = \frac{\beta_E}{\left(1 - \frac{b_t^E}{q_t^k k_t^E}\right)},$$

which yields countercyclical leverage (since $cor\left(Y_t, \frac{b_t^E}{q_t^k k_t^E}\right) < 0$).

An alternative interpretation of CS is that loans of size $b_t^E(i)$ must be "syndicated" according to a "loan production function" whereby entrepreneur i needs loans from banks $j = 1, 2, ..., n$, which solves the following cost-minimization problem:

$$\min_{\{b_t^E(i,j)\}_j} \sum_{j=1}^{n} R_t^b(j) b_t^E(i,j) \tag{4}$$

$$\text{s.t.} \quad \left[\left(\frac{1}{n}\right)^{\frac{1}{\epsilon^b}} \sum_{j=1}^{n} b_t^E(i,j)^{\frac{\epsilon^b - 1}{\epsilon^b}}\right]^{\frac{\epsilon^b}{\epsilon^b - 1}} \geq b_t^E(i). \tag{5}$$

The solution to this problem is given by

$$b_t^E(i,j) = \left(\frac{1}{n}\right)\left(\frac{R_t^b(j)}{R_t^b}\right)^{-\epsilon^b} b_t^E(i), \tag{6}$$

where

$$R_t^b \equiv \left[\frac{1}{n}\sum_{j=1}^{n} R_t^b(j)^{1-\epsilon^b}\right]^{\frac{1}{1-\epsilon^b}}. \tag{7}$$

CS assume that each bank j solves a static profit-maximization problem, choosing loan rate $R_t^b(j)$ to maximize profits:

$$\max_{R_t^b(j)} \prod \equiv \int \left[R_t^b(j) - R_t^{ib}\right] b_t^E(i,j) di, \tag{8}$$

where the demand for syndicated loan $b_t^E(i,j)$ is given by (6). Given a finite number of banks, a bank's choice of interest rate actually affects net worth of entrepreneurs in the future, which is not being taken into account owing to the static profit-maximization assumption.

The first-order condition which solves (8) weighs the costs and benefits to bank j from raising its interest rate:

(A) Direct positive effect of raising own rate on profits:

$$\left(\frac{R_t^b(j)}{R_t^b}\right)^{-\epsilon^b} b_t^E \cdot 1$$

(B) Indirect negative effect of competition from other banks (note that the elasticity of substitution between loans ϵ^b matters directly):

$$-\epsilon^b \left[R_t^b(j) - R_t^{ib}\right] b_t^E \cdot \left(\frac{R_t^b(j)}{R_t^b}\right)^{-(\epsilon^b+1)} \left\{\frac{R_t^b - \overset{(+)}{R_t^b(j)\frac{\partial R_t^b}{\partial R_t^b(j)}}}{\left(R_t^b\right)^2}\right\}$$

(C) Indirect negative effect on overall loan demand:

$$+\left[R_t^b(j) - R_t^{ib}\right]\left(\frac{R_t^b(j)}{R_t^b}\right)^{-\epsilon^b} \cdot \overset{(-)}{\frac{\partial b_t^E}{\partial R_t^b}} \overset{(+)}{\frac{\partial R_t^b}{\partial R_t^b(j)}}$$

(D) Indirect positive effect on central bank policy choice:

$$-\overset{(-)}{\frac{\partial R_t^{ib}}{\partial R_t^b}} \overset{(+)}{\frac{\partial R_t^b}{\partial R_t^b(j)}} \left(\frac{R_t^b(j)}{R_t^b}\right)^{-\epsilon^b} b_t^E$$

Importantly, in a symmetric Nash equilibrium, the solution to the above first-order condition yields the loan markup over the interest it pays depositors (also the central bank policy rate):

$$R_t^b = \frac{\overbrace{\epsilon^b(n-1)}^{B} + \overbrace{\Xi_{b,t}}^{C} + \overbrace{\Xi_{R_t^{ib}}}^{D}}{\underbrace{\epsilon^b(n-1)}_{B} + \underbrace{\Xi_{b,t}}_{C} - \underbrace{n}_{A}} \cdot R_t^{ib} \equiv \mathcal{M}_t^b R_t^{ib}, \tag{9}$$

where

- $\Xi_{b,t}$ is the absolute value of the elasticity of aggregate loan demand to loan rates, and
- $\Xi_{R_t^{ib}}$ is the absolute value of the elasticity of central bank policy rates to loan rates (i.e., an increase in bank j's rate $R^b(j)$ increases the overall loan rate R^b, which lowers aggregate demand and inflation, which ultimately leads to a decrease in the central bank policy rate R^{ib}).

In a competitive environment where $n \to \infty$, the markup $\mathcal{M}_t^b$ in (9) simply depends on the elasticity of substitution between loans from different banks given by

$$\lim_{n\to\infty} \mathcal{M}_t^b = \frac{1}{1-\frac{1}{\epsilon^b}}$$

so that a higher degree of substitution leads to lower markups. The competitive case also implies that markups do not vary with the cycle.

With a finite number of banks, the cyclical properties of markups depend on many factors. Using the definition of markups in (9), one can compute $\frac{d\mathcal{M}_t^b}{dY}$ to determine the important factors in the cyclical properties of the markup. In particular, markups are countercyclical (i.e., $\frac{d\mathcal{M}_t^b}{dY} < 0$) if

$$\left\{ \begin{array}{c} -\left[n + \Xi_{R_t^{ib}}\right] \cdot \frac{d\Xi_{b,t}}{dY_t} \\ +\left[\epsilon^b \cdot (n-1) + \Xi_{b,t} - n\right] \cdot \frac{d\Xi_{R_t^{ib}}}{dY_t} \\ -\left[\epsilon^b + (\epsilon^b - 1)\cdot \Xi_{R_t^{ib}} - \Xi_{b,t}\right] \cdot \frac{dn_t}{dY_t} \end{array} \right\} < 0, \tag{10}$$

where $\frac{d\Xi_{b,t}}{dY_t} < 0$ since leverage is countercyclical and $\frac{d\Xi_{R_t^{ib}}}{dY_t} < 0$ by an argument similar to that in bullet 2 following (9). Note that in (10) I have also considered how markups would vary in their model if the number of banks also varied with the cycle. Since $\frac{dn_t}{dY_t} = 0$ by assumption in CS's model, markups are countercyclical if the commercial versus central bank strategic impacts (i.e., the second term in (10)) outweigh the leverage effects across the cycle (i.e., the first term in (10)), provided ϵ^b is sufficiently large (which the calibration takes below).

3. Results

There are three key (new) parameters in CS's model: (i) the elasticity of substitution across loan varieties ϵ^b; (ii) the sensitivity of the central bank policy interest rate to inflation in the policy rule ϕ_π; and (iii) the number of banks n or market share $1/n$. Table 1 in CS provides the parameter values. In particular, loan elasticity (which affects the steady-state loan spread) is set at $\epsilon^b = 161$. The parameter is calibrated so that, in the case of atomistic banks (i.e., $n = \infty$), the steady-state gross markup $\mathcal{M}^b$ equals 1.006. This value, in turn, corresponds to a net spread between the loan rate and the policy rate of around 2.5 percentage points in annual terms. The central bank policy rule takes $\phi_\pi = 1.5$. The authors vary market structure (i.e., n) between 3 and infinity (the atomistic case).

Figure 1 below reproduces the impulse response functions under these parameter values for the more standard case where there is an AR1 technology shock process with persistence equal to 0.9 instead of i.i.d. shocks as in CS's figure 4 under both the atomistic ($n = \infty$) case and the non-atomistic ($n = 3$) case. Note that in order to make comparisons between the atomistic and non-atomistic cases, CS use a subsidy which fully offsets the distortion associated with monopolistic competition in the banking sector in the steady state (see section 5 of their paper).[2]

Figure 1 with persistent technology shocks is qualitatively similar to CS's figure 4 with i.i.d. shocks. Figure 1 makes clear that the

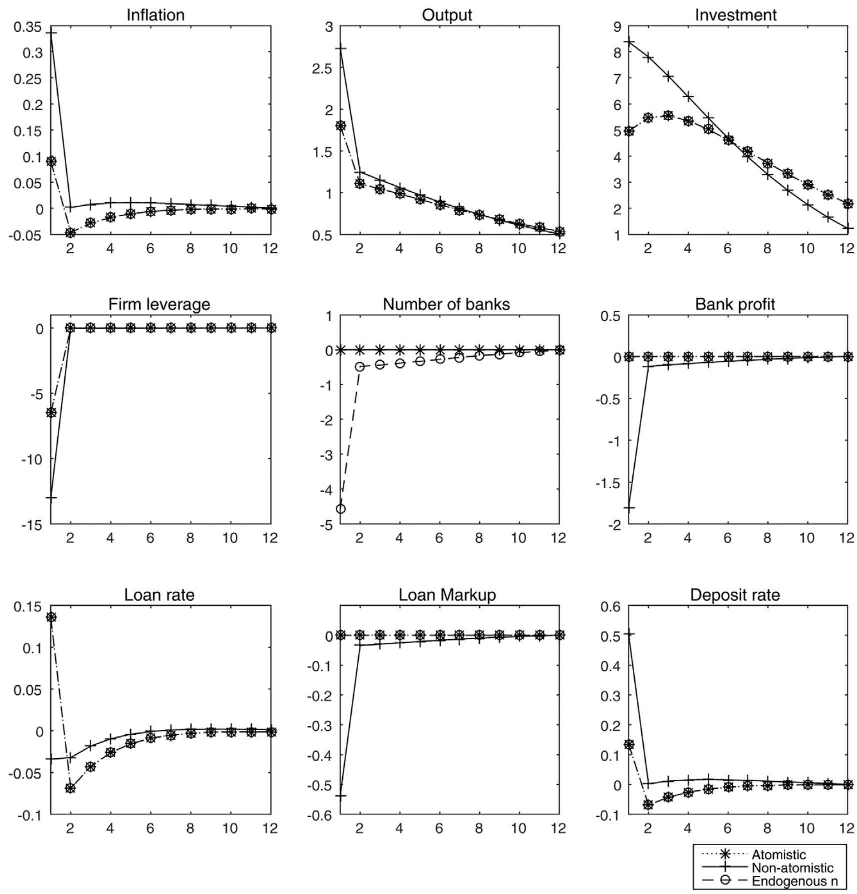
---

[2] In particular, they set Υ so that

$$\frac{\mathcal{M}^b_{ss}}{1+\Upsilon} = 1, \tag{11}$$

which means that the after-tax loan markup is 1. For the atomistic bank case, since $\mathcal{M}^b_{ss} = \frac{\epsilon^b}{\epsilon^b-1}$, they set $\Upsilon = \frac{1}{\epsilon^b-1}$. For the non-atomistic case, there is not a closed-form solution for Υ, as $\mathcal{M}^b_{ss}$ depends on Υ. So one must find a fixed point of Υ under which the after-tax markup is 1. CS set $\Upsilon = \mathcal{M}^b_{ss}(\Upsilon) - 1$.

Figure 1. Impulse Response Functions in CS Model



atomistic bank case ($n = \infty$ where loan markups do not vary with the cycle) yields less amplification in key variables than the non-atomistic case ($n = 3$ where loan markups are countercyclical). Here, however, figure 1 shows that the CS model predicts that profits with a finite number of banks are countercyclical in the short run. Empirical papers tend to find procyclical bank profits (see, for example, Albertazzi and Gambacorta 2009). Procyclical profits and countercyclical markups are consistent if loan originations are sufficiently procyclical (a property consistent with data).

4. Robustness

4.1 Exogenous Number of Banks

Obviously, in the very short run, one may want to take the number of banks n as a parameter, but surely in the long-run market share is not exogenous nor invariant to policy experiments as assumed by CS. To see the implications of exogenous market structure, one can use the same parameter values as in table 1 of CS's paper with persistent technology shocks but add a free entry condition.

As a result of the tax policy assumed in CS, steady-state bank profits are zero. Hence, to consider entry into the banking sector, we need to assume entry costs are zero. In that case, the zero-profit condition in a model with bank entry is

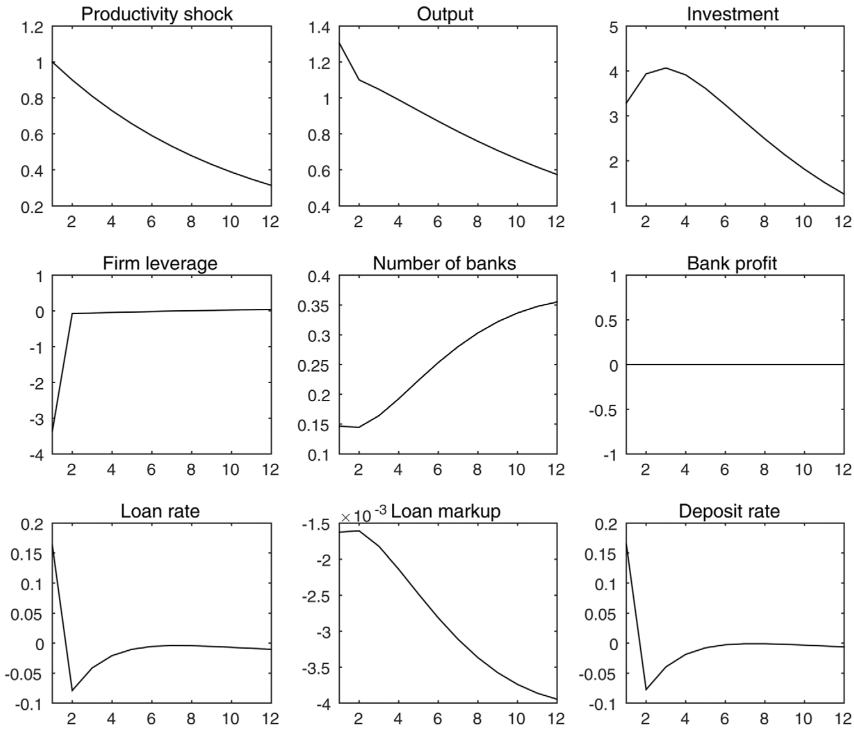
$$\left(\frac{\mathcal{M}_t^b}{1+\Upsilon}-1\right)R_t^{ib}b_t^E=0. \tag{12}$$

Since $b_t^E > 0$, this implies that in the equilibrium with zero entry cost, the after-tax markup should always be 1. Thus the equilibrium allocation is exactly the same as in the case of the atomistic bank case, but (12) pins down the number of banks endogenously (i.e., the "atomistic" and "endogenous n" lines lie on top of one another).

As one can see from our figure 1 (compared with CS's figure 4) there are some key differences between the case with free entry (i.e., "endogenous n") and the baseline model ("non-atomistic") in CS. Free entry implies that the number of banks must actually fall in order to maintain the zero-profit condition, a counterfactual prediction (countercyclical entry in the model while there is procyclical entry in the data). This is related to the countercycical profits in CS's baseline "non-atomistic" case. Ceteris paribus, negative bank profits requires exit in order to be consistent with the zero-profit condition. Countercyclical entry (i.e., $\frac{dn_t}{dY_t} < 0$) in condition (10) is why there is less amplification in the "endogenous n" impulse response functions in figure 1. Thus, the channel between the "financial acceleration markup" and propagation of shocks is not necessarily robust.

There are other ways to generate the link between the "financial acceleration markup" and propagation of shocks. It is possible to write DSGE models with countercyclical markups due to the competitive effects of procyclical entry and countercyclical exit in the

Figure 2. Impulse Response Functions in CI Model



case of a finite number of *symmetric* firms. For instance, Jaimovich and Floettoto (2008) do this in the context of non-financial firms, and it is possible to apply their ideas to the banking industry. Figure 2 graphs the impulse response functions for a case with endogenous bank entry in Corbae and Ino (2015) (hereafter CI) without New Keynesian frictions but with positive entry costs. The figure shows that procyclical bank entry in response to a favorable productivity shock can lead to countercyclical markups even with perfectly flexible prices.[3] Of course, these DSGE models cannot speak to the vast heterogeneity in the bank size distribution due to their simplifying assumption on symmetry.

[3]For this particular parameterization, however, the effects are not large in figure 2.

4.2 Static Bank Optimization

CS assume that banks are "myopic" and choose interest rates not taking into account that their choice of interest rate may in fact alter future borrowing by entrepreneurs (and hence future profits) since each "non-atomistic" bank in their model has market power. It is possible, however, to incorporate forward-looking behavior and structure layers of non-competitive and competitive forward-looking firms (be they financial or non-financial). See, for instance, Gerali et al. (2010) and the appendix in Jaimovich and Floettoto (2008). This will be important if this framework is to be used to understand bank capital and macroprudential policies.

4.3 Symmetry

Ever since Kashyap and Stein's (2000) influential empirical paper, we know the monetary transmission mechanism works differently for big and small banks, but there has been little structural work on that topic. In order to simply the analysis, CS assume that all banks are symmetric, which is obviously inconsistent with the data. It is possible to introduce bank heterogeneity into structural models with imperfect competition and dynamic bank optimization using entry/exit (like that in Jaimovich and Floettoto) to generate countercyclical markups. In a series of papers, Corbae and D'Erasmo (2013, 2014a, 2014b) also generate a "financial acceleration markup" with heterogeneous banks at the expense of computational complexity.

4.4 Binding Collateral Constraints

Not all non-financial firms are collateral constrained in the economy. It may prove useful to apply methods from occasionally binding constraints to this framework (e.g., Guerrieri and Iacoviello 2015). This is also related to the fact that the steady-state debt-to-output level is 10 in CS's model but at most 3 in the data. If one sets $m^E = 0.375$ and $n = 3$, the model produces a steady-state debt level of 3 as opposed to $m^E = 0.8$ and $n = 3$ in CS's benchmark which yields a steady-state debt level of 10. The former case, however, yields a smaller response to technology shocks. In particular, output and investment are nearly half as large in response to a technology shock when the debt-to-output level is at 3 rather than 10.

5. Conclusion

CS take an important step to bring bank market structure into the DSGE framework. Their work provides a simple framework to ask how policy interacts with an exogenous market structure to affect aggregate outcomes and welfare. A particularly interesting and novel part of their analysis is how the strategic interaction between commercial banks with market power and the central bank can amplify shocks in the economy (i.e., term D in (9)).

CS's results are complementary to other papers. For instance, Corbae and D'Erasmo (2013, 2014a, 2014b) also generate a "financial acceleration markup" with an endogenous size distribution of banks through entry and exit affecting competitive market forces. Endogenizing market structure means that policy counterfactuals can affect market structure (i.e., there are no issues with the Lucas critique) as well as market structure affecting policy. I believe this to be a very fruitful avenue of future research.

References

Albertazzi, U., and L. Gambacorta. 2009. "Bank Profitability and the Business Cycle." *Journal of Financial Stability* 5 (4): 393–409.

Corbae, D., and P. D'Erasmo. 2013. "A Quantitative Model of Banking Industry Dynamics." Mimeo.

———. 2014a. "Capital Requirements in a Quantitative Model of Banking Industry Dynamics." Mimeo.

———. 2014b. "Foreign Competition and Banking Industry Dynamics: An Application to Mexico." Mimeo.

Corbae, D., and A. Ino. 2015. "A Simple DSGE Model of Banking Industry Dynamics." Mimeo.

Gerali, A., S. Neri, L. Sessa, and F. Signoretti. 2010. "Credit and Banking in a DSGE Model of the Euro Area." *Journal of Money, Credit and Banking* 42 (s1): 107–41.

Guerrieri, L., and M. Iacoviello. 2015. "OccBin: A Toolkit for Solving Dynamic Models with Occasionally Binding Constraints Easily." *Journal of Monetary Economics* 70: 22–38.

Iacoviello, M. 2005. "House Prices, Borrowing Constraints, and Monetary Policy in the Business Cycle." *American Economic Review* 95 (3): 739–64.

Jaimovich, N., and M. Floetotto. 2008. "Firm Dynamics, Markup Variations, and the Business Cycle." *Journal of Monetary Economics* 55 (7): 1238–52.

Kashyap, A., and J. Stein. 2000. "What Do a Million Observations on Banks Say about the Transmission of Monetary Policy?" *American Economic Review* 90 (3): 407–28.

Kiyotaki, N., and J. Moore. 1997. "Credit Cycles." *Journal of Political Economy* 105 (2): 211–48.