Econometrica Supplementary Material

SUPPLEMENT TO "CAPITAL BUFFERS IN A QUANTITATIVE MODEL OF BANKING INDUSTRY DYNAMICS"

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APPENDIX

A.1. *Data Appendix*

WE COMPILE a large panel of banks from 1984 to 2016 using data for the last quarter of each year.[1] The source for the data is the Consolidated Report of Condition and Income (known as Call Reports) that banks submit to the Federal Reserve each quarter.[2] Report of Condition and Income data are available for all banks regulated by the Federal Reserve System, Federal Deposit Insurance Corporation (FDIC), and the Comptroller of the Currency. All financial data are on an individual bank basis.

We consolidate individual commercial banks to the bank holding company level and retain those bank holding companies and commercial banks (if there is no top holder)

TABLE A.I

DEFINITION MODEL MOMENTS.

Aggregate bank loan supply	$L^{s,c}(z,\mu) = \ell'_b + L^s_f(z,\mu,\ell'_b,r^n)$
Output	$\mathcal{H}y + \sum_{j=c,n} L^{s,j}(z,\mu)\{p(R^j,z')(1+z'R^j) + (1 - p(R^j,z'))(1-\lambda)\} + \int_0^{\overline{\omega}} \mathbf{1}_{\{\omega' > \mathbf{\Pi}_E(\mathbf{r},z)\}} \omega' \, d\Omega(\omega')$
Entry rate	$\sum_\theta M'_{e,\theta} / \sum_\theta \int d\mu_\theta(k_\theta,\delta_\theta)$
Default frequency	$1 - p(R^j,z')$
Borrower return	$p(R^j,z')(z'R^j)$
Loan return	$p(R^j,z')r^L(z,\mu) - (1-p(R^j,z'))\lambda$
Loan charge-off rate	$(1-p(R^j,z'))\lambda$
Bank interest margin	$r^c(z,\mu) - r^D$
Loan market share fringe banks	$L^s_f(z,\mu,\ell'_b,r^n)/L^{s,c}(z,\mu)$
Deposit market share fringe banks	$\int d'_f d\mu_f(n_f,\delta_f)/[\sum_\theta \int d'_\theta d\mu_\theta(n_\theta,\delta_\theta)]$
Bank net cash low	$\pi'_\theta = \{p(R^c,z')r^L - (1-p(R^c,z'))\lambda\}\ell'_\theta + r^A A'_\theta - r^D d'_\theta$
Risk-weighted capital ratio	$k'_\theta/\ell'_\theta = (\ell'_\theta + A'_\theta + \pi'_\theta - d'_\theta)/\ell'_\theta$
Loans to asset ratio	$\ell'_\theta/(\ell'_\theta + \max\{A'_\theta + \pi'_\theta, 0\})$
Equity to asset ratio	$(\ell'_\theta + A'_\theta + \pi'_\theta - d'_\theta)/(\ell'_\theta + \max\{A'_\theta + \pi'_\theta, 0\})$
Securities to assets ratio	$\max\{A'_\theta + \pi'_\theta, 0\}/(\ell'_\theta + \max\{A'_\theta + \pi'_\theta, 0\})$
Markup	$[p(R^j,z')r^j(\mu,z)]/[r^D + c'_\theta(\ell'_\theta,z)] - 1$
Lerner index	$1 - [r^D + c'_\theta(\ell'_\theta,z)]/[p(R^j,z')r^j(\mu,z)]$

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[1]There was a major overhaul to the Call Report format in 1984. Since 1984 banks are, in general, required to provide more detailed data concerning assets and liabilities. Due to changes in definitions and the creation of new variables after 1984, some of the variables are only available after this date.

[2]Balance Sheet and Income Statements items can be found at https://cdr.ffiec.gov/public/.

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for which the share of assets allocated to commercial banking (including depository trust companies, credit card companies with commercial bank charters, private banks, development banks, limited charter banks, and foreign banks) is higher than 25%. We follow Kashyap and Stein (2000) and den Haan, Sumner, and Yamashiro (2007) in constructing consistent time series for our variables of interest. Finally, we only include banks located within the 50 states and the District of Columbia ($0 < \text{RSSD9210} < 57$). In addition to information from the Call Reports, we identify bank failures using public data from the FDIC.[3] We also identify mergers and acquisitions using the transformation table in the Call Reports.

To deflate balance sheet and income statement variables, we use the CPI index. To compute business cycle correlations, variables are detrended using the HP filter with parameter 6.25. When we report weighted aggregate time series, we use the asset market share as weight. To control for the effect of a small number of outliers, when constructing the loan returns, cost of funds, charge-off rates, and related series we eliminate observations in the top and bottom 1% of the distribution of each variable. We also control for the effects of bank entry, exit, and mergers by not considering the initial period, the final period, or the merger period (if relevant) of any given bank.

Tables A.IIa, A.IIb, and A.III present the balance sheet variables, income statement variables, and the derived variables used, respectively.

A.1.1. *Appendix Parameterization*

The discrete grid for aggregate shocks is

$$\{z_C, z_B, z_M, z_G\} = \{0.97376, 0.98685, 1.00000, 1.01321\}.$$

The transition matrix for aggregate shocks is (rows correspond to z and columns correspond to z')

$$F(z, z') = \begin{bmatrix} 0.11795 & 0.43509 & 0.37248 & 0.07448 \\ 0.05682 & 0.33929 & 0.45621 & 0.14767 \\ 0.02422 & 0.23204 & 0.48749 & 0.25625 \\ 0.00901 & 0.13866 & 0.45621 & 0.39611 \end{bmatrix}.$$

A.1.2. *Estimating Bank Cost Structure*

We estimate the marginal cost of producing a loan and the fixed cost following the empirical literature on banking (see, for example, Berger, Klapper, and Turk-Ariss (2008)).[4] The marginal cost is derived from an estimate of marginal net expenses that is defined to be marginal non-interest expenses net of marginal non-interest income. Marginal non-interest expenses are derived from the trans-log cost function

$$\begin{aligned} \log(\text{NIE}_t^i) = {} & g_1 \log(W_t^i) + \varsigma_1 \log(\ell_t^i) + g_2 \log(q_t^i) + g_3 \log(W_t^i)^2 \\ & + \varsigma_2 [\log(\ell_t^i)]^2 + g_4 \log(q_t^i)^2 + \varsigma_3 \log(\ell_t^i) \log(q_t^i) + \varsigma_4 \log(\ell_t^i) \log(W_t^i) \\ & + g_5 \log(q_t^i) \log(W_t^i) + \sum_{j=1,2} g_6^j t^j + g_{8,t} + g_9^i + \epsilon_t^i, \end{aligned} \tag{A.1}$$

[3]Data are available at https://www.fdic.gov/bank/individual/failed/banklist.html.

[4]The marginal cost estimated is also used to compute our measure of markups and the Lerner index.

TABLE A.IIa

Variable mapping to call report data (balance sheet).

Variable Name	Code	Number	Year Start	Year End
Balance Sheet				
Total assets	RCFD	2170	1984	2016
Loans	RCFD	1400	1984	2016
Deposits	RCFD	2200	1984	2016
Federal funds purchased	RCFD	2800	1984	2001
	RCFD	B993 + B995	2002	2016
Loans non-accrual	RCFD	1403	1984	2016
Loans past due 90 days	RCFD	1407	1984	2016
Tier 1 capital	RCFD	8274	1996	2013
	RCFA	8274	2014	2016
Risk-weighted assets	RCFD	A223	1996	2013
	RCFA	A223	2014	2016
Other borrowings	RCFD	2835	1984	2000
	RCFD	3190	2001	2016
Cash	RCFD	0010	1984	2016
Federal funds sold	RCFD	1350	1984	2001
	RCFD	B987 + B989	2002	2016
U.S. Treasury securities	RCFD	0400	1984	1993
	RCFD	0211 + 1287	1994	2016
U.S. agency obligations	RCFD	0600	1984	1993
	RCFD	1289 + 1294 + 1293 + 1298 + 1698 + 1702 + 1703 + 1707 + 1714 + 1717 + 1718 + 1732	1994	2008
		1289 + 1294 + 1293 + 1298 + G300 + G303 + G304 + G307 + G312 + G315 + G316 + G319 + G324 + G327	2009	2010
		1289 + 1294 + 1293 + 1298 + G300 + G303 + G304 + G307 + G312 + G + 15 + G316 + G319 + K142 + K145	2011	2016

TABLE A.IIb

Variable mapping to call report data (income statement).

Income Statement				
Interest income loans	RIAD	4010 + 4065	1984	2016
Interest expense deposits	RIAD	4170	1984	2016
Interest expense Fed funds	RIAD	4180	1984	2016
Charge-off loans	RIAD	4635	1984	2016
Recovery loans	RIAD	4605	1984	2016
Total expenses	RIAD	4130	1984	2016
Expenses on premises and fixed assets	RIAD	4217	1984	2016
Labor expenses	RIAD	4135	1984	2016
Total non-interest income	RIAD	4079	1984	2016
Interest income safe securities	RIAD	4027	1984	2000
		B488	2001	2016
Equity issuance	RIAD	4346 + B510	1984	2000
	RIAD	B509 + B510	2001	2016
Dividends	RIAD	4470 + 4460	1984	2016

Note: Source: Call and Thrift Financial Reports.

TABLE A.III

DERIVED VARIABLES.

Variable Name	
Loans (risk-weighted assets) to assets	Risk-weighted assets/total assets
Cash & securities to assets	1−risk-weighted assets/total assets
Capital ratio (risk-weighted)	Tier 1 capital/risk-weighted assets
Equity to assets	Tier 1 capital/total assets
Deposits to assets	1−equity/assets
Interest return on loans	Int. income loans/loans
Interest cost deposits	Int. expense deposits/deposits
Loan interest margin	Int. return on loans−int. cost deposits
Cost Fed funds	Int. expense Fed funds/Fed funds purchased
Charge-off rate loans	(Charge-off loans−recovery loans)/loans
Delinquency rate loans	(Loans non-accrual + loans past due 90 days)/loans
Safe securities	U.S. Treasury securities + U.S. agency obligations
Cost of funds	(Int. exp. dep. + int. exp. Fed funds)/(dep. + Fed funds)
Interest return on safe assets	Int. inc. safe securities/safe securities
Return safe securities	Int. return on safe asets−mg. non-int. exp. on safe securities
Return on loans	Interest return on loans−charge-off rate loans
Mg. Net Exp.	Mg. non-int. expense−mg. non-int. inc.
Markup	Int. return on loans/(cost of funds + mg. net exp.)−1
Lerner Index	1−(cost of funds + mg. net exp.)/int. return on loans

Note: The term "int." denotes interest, "exp." denotes expenses, "dep." denotes deposits, "mg." denotes marginal, and "inc." denotesw income. Source: Call and Thrift Financial Reports.

where $\text{NIE}^i_{\theta,t}$ is non-interest expenses (calculated as total expenses minus the interest expense on deposits, the interest expense on federal funds purchased, and expenses on premises and fixed assets), g^i_9 is a bank fixed effect, W^i_t corresponds to input prices (labor expenses over assets), ℓ^i_t corresponds to real loans (one of the two bank i's outputs), q^i_t represents safe securities (the second bank output), the t regressor refers to a time trend, and $g_{8,t}$ refers to time fixed effects. We estimate this equation by panel fixed effects with robust standard errors clustered by bank.[5] Non-interest marginal expenses are then computed as

$$\begin{aligned}\text{mg. non-int. exp.} &\equiv \frac{\partial NIE^i_t}{\partial \ell^i_t} \\ &= \frac{NIE^i_t}{\ell^i_t}\big[\varsigma_1 + 2\varsigma_2 \log(\ell^i_t) + \varsigma_3 \log(q_{it}) + h_4 \log(W^i_t)\big]. \qquad \text{(A.2)}\end{aligned}$$

The estimated (asset-weighted) average of marginal non-interest expenses is reported in the second column of Table A.IV. Marginal non-interest income (mg. non-int. inc.) is estimated using an equation similar to (A.1) (without input prices), where the left-hand side corresponds to log total non-interest income. The estimated (asset-weighted) average of marginal non-interest income is reported in the first column of Table A.IV. Net marginal expenses (mg. net exp.) are computed as the difference between marginal non-interest expenses and marginal non-interest income. The estimated (asset-weighted) average of

[5]We eliminate bank–year observations in which the bank organization is involved in a merger or the bank is flagged as being an entrant or a failing bank. We only use banks with three or more observations in the sample.

TABLE A.IV

BANKS' COST STRUCTURE.

Moment (%)	Mg. Non-Int. Inc.	Mg. Non-Int. Exp.	Mg. Net Exp. $c_\theta(\ell'_\theta, z)$	Fixed Cost $\kappa_\theta/\ell'_\theta$	Avg. Cost
Top 10 banks	$4.48^\dagger$	$4.89^\dagger$	$0.41^\dagger$	0.84	$1.25^\dagger$
Fringe banks	2.09	3.61	1.52	0.73	2.26
All banks	2.95	4.08	1.13	0.77	1.91

Note: Top 10 banks refers to top 10 banks when sorted by assets. Fringe banks refers to all banks outside the top 10. The dagger ($\dagger$) denotes statistically significant difference between the top 10 and the rest. Mg. non-int. inc. refers to marginal non-interest income; mg. non-int. exp. refetrs to marginal non-interest expenses; mg. net exp. corresponds to net marginal expense and it is calculated as marginal non-interest expense minus marginal non-interest income. Fixed cost κ_θ is scaled by loans. Data correspond to commercial banks in the United States. Source: Consolidated Reports of Condition and Income.

net marginal non-interest expenses is reported in the third column of Table A.IV. The fixed cost κ_θ is estimated as the total cost on expenses of premises and fixed assets. The estimated (asset-weighted) average fixed cost (scaled by loans) is reported in the fourth column of Table A.IV. The final column of Table A.IV presents our estimate of average costs for big and small banks. We find a statistically significant lower average cost for big banks than small banks. This is consistent with increasing returns as in the delegated monitoring model of Diamond (1984) and with empirical evidence on increasing returns as in, among others, Berger and Mester (1997).

A.1.3. *Estimating Loan Markups and Measures of Imperfect Competition*

This appendix describes how loan markups, their decomposition, and the Rosse–Panzar index are computed. With the estimates of banks' cost structure (i.e., r^D and marginal net expenses), we can compute the bank loan markup (that was discussed in Section 2). In particular, the markup is defined as

$$m_t^i = \frac{\text{price}_t^i}{\text{mc}_t^i} - 1, \tag{A.3}$$

where price_t^i denotes a measure of price and mc_t^i denotes the marginal cost in period t for bank i. We estimate price_t^i as the ratio of interest income from loans to total loans and estimate mc_t^i as the ratio of interest expenses from deposits and Fed funds over deposits (r^D) and Fed funds plus marginal net non-interest expenses (as reported in column 3 of Table A.IV). As we discussed in Section 2, we find that average markups have been rising over time and the rise has been fueled by the upper tail of the distribution. Table A.V presents moments from the distribution of markups. Similarly, the Lerner index is computed as $\text{Lerner}_t^i = 1 - \frac{\text{mc}_t^i}{\text{price}_t^i}$.

As in De Loecker, Eeckhout, and Unger (2019), we decompose the growth of asset-weighted average markup into the increase derived from an increase in average markups ("within"), the increase derived from "reallocation" (i.e., the increase derived from growing asset shares of banks with high markups keeping markups fixed), and a final term coming from changes in markups derived from entry and exit. More specifically, the change

TABLE A.V
DISTRIBUTION OF MARKUPS.

	Sample	
Moment	1984–2007	1984–2016
Average	72.65	90.02
Median	70.66	86.40
Standard deviation	28.00	39.59
Top 1%	139.18	192.62
Top 10%	110.72	140.58
Top 25%	90.51	116.24
Bottom 25%	53.51	63.01
Bottom 10%	38.88	43.63
Bottom 1%	13.20	13.65

Note: Moments from the distribution of markups. The years 1984–2007 correspond to our calibration period. Source: Consolidated Report of Condition and Income.

in markups Δm_t can be decomposed as

$$\Delta m_t = \underbrace{\sum_i s_{it-1}\Delta m_{it}}_{\Delta\text{within}} + \underbrace{\sum_i (m_{it-1} - m_{t-1})\Delta s_{it} + \sum_i \Delta s_{it}\Delta m_{it}}_{\Delta\text{reallocation}} + \underbrace{\sum_{i\in\text{Entry}} (m_{it} - m_{t-1})s_{it} + \sum_{i\in\text{Exit}} (m_{it-1} - m_{t-1})s_{it-1}}_{\text{net entry}}. \tag{A.4}$$

Panel (iii) in Figure 2 presents the time series of markups by bank size (top 10 and median in the asset distribution). We study this relationship in more depth by regressing log markups ($\log(m_t^i)$) on log(real assets$_t^i$), controlling for bank and year fixed effects. Table A.VI shows that the elasticity of markups with respect to bank size is positive and ranges between 4 and 35% (always statistically significant).

TABLE A.VI
MARKUPS AND BANK SIZE (PANEL REGRESSION).

	log markups ($\log(m_t^i)$)					
log(real assets$_{it}$)	0.3559	0.2641	0.0572	0.0408	0.02379	0.0280883
s.e.	0.00255	0.00227	0.00229	0.00204	0.00100	0.00089
Time trend	–	–	–	–	0.0365	0.0494
s.e.	–	–	–	–	0.00038	0.00029
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	No	No	Yes	Yes	Yes	Yes
Sample	1984–2007	1984–2016	1984–2007	1984–2016	1984–2007	1984–2016
Observations	180,352	228,605	180,352	228,605	180,352	228,605

Note: The abbreviation s.e. denotes standard errors. All coefficients are statistically significant at 1%. The years 1984–2007 correspond to our calibration period. Source: Consolidated Report of Condition and Income.

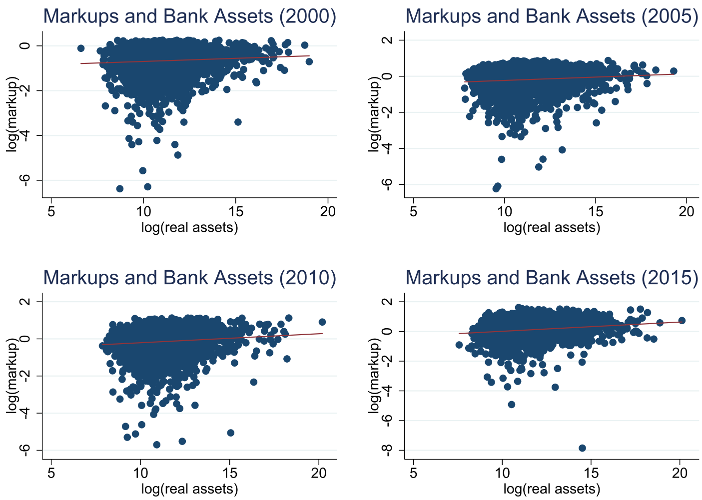

FIGURE A.1.—Cross-section markups and bank size. Note: Scatter plot of log real assets and log markups. Source: Consolidated Report of Condition and Income.

Figure A.1 shows the cross-sectional relationship between assets and markups. The figure shows the scatter plot of $\log(m_t^i)$ and $\log(\text{real assets}_t^i)$ for selected years in our sample.

The Rosse–Panzar H index is given by a log-linear regression in which the dependent variable is the natural logarithm of total revenue ($\ln(TR_{it})$ measured as interest income and non-interest income from loans), and the explanatory variables include the logarithms of input prices ($w_{1_{it}}$ funds, $w_{2_{it}}$ labor, and $w_{3_{it}}$ fixed assets) and other bank specific factors:

$$\ln(TR_{it}) = \alpha + \sum_{k=1}^{3} \beta_k \ln(w_{k_{it}}) + \text{bank specific factors}_{it} + u_{it}.$$

The Rosse–Panzar H equals the simple sum of coefficients on the respective log input price terms, $\beta_1 + \beta_2 + \beta_3$. The log-linear form typically improves the regression's goodness of fit and may reduce simultaneity bias. Bank specific factors are additional explanatory variables which reflect differences in risk, cost, and size structures of banks and include the value of loans, cash, equity and securities scaled by assets. This equation is estimated by ordinary least squares (OLS) with robust standard errors year by year.

A.1.4. *Estimating Deposit Process*

We estimate the autoregressive process for log deposits for bank i of type θ,

$$\log(\delta_\theta^{i\prime}) = (1 - \rho_\theta^d) v_\theta^0 + \rho_\theta^d \log(\delta_\theta^i) + u_\theta^{i\prime}, \tag{A.5}$$

where δ_θ^i is the sum of deposits and other borrowings in the current period for bank i, and $u_\theta^{i\prime}$ is i.i.d. and distributed $N(0, \sigma_{d,\theta}^u)$. Since this is a dynamic model, we use the method proposed by Arellano and Bond (1991). Since we work with a normalization in the model (i.e., $z_M = 1$), the mean v_θ^0 in (A.5) is not directly relevant. Instead, we include the mean of the finite state Markov process that depends on the aggregate state, parameterized as $\mu_\theta^d(z) = \overline{\mu}_\theta^d z^2$, as one of the parameters to be estimated via SMM. To keep

TABLE A.VIIA

DEPOSIT PROCESS PARAMETERS: δ^i_θ INCLUDES DEPOSITS AND OTHER BORROWINGS.

	ρ^d_θ	$\sigma^u_{d,\theta}$	$\sigma_{d,\theta}$
Top 10 banks	0.704	0.131	0.184
Fringe banks	0.881	0.173	0.365
All banks	0.882	0.173	0.366

the state space workable, we apply the method proposed by Tauchen (1986) to obtain a finite state Markov representation $G^\theta_{z'}(\delta', \delta)$ to the autoregressive process in (A.5) with state-dependent mean $\mu^d_\theta(z)$. We assume a three state Markov process for big banks and a five state Markov process for fringe banks. To apply Tauchen's method, we use the estimated values of (A.5) that we present in Table A.VIIa. From these estimates, we can construct the stationary variance of deposits by bank size (i.e., $\sigma_{d,\theta} = \sigma^u_{d,\theta}(1 - (\rho^d_\theta)^2)^{-1/2}$) that we present in the last column of Table A.VIIa. Thus, consistent with big banks having a geographically diversified pool of funding (see Liang and Rhoades (1988) and Aguirregabiria, Clark, and Wang (2016)), big banks have less volatile funding inflows, which is one important factor explaining why they hold a smaller capital buffer in our model. As a robustness check, Table A.VIIb presents estimates of the same process when δ^i_θ only includes deposits. Changes in parameters are minor.

A.2. *Funding Deposit Insurance and Servicing Securities*

The government collects lump-sum taxes (or pays transfers if negative) denoted τ that cover the cost of deposit insurance τ^D and the net proceeds of issuing securities τ^A.

Across all states (z, μ, z'), τ^D must cover deposit insurance in the event of bank failure. Let post-liquidation net transfers be given by

$$\Delta'_\theta(k_\theta, \delta_\theta, z, \mu, r^n, z') = (1 + r^D)d'_\theta - \{p(R^c, z')(1 + r^c) + (1 - p(R^c, z'))(1 - \lambda) - \xi_\theta\}\ell'_\theta - (1 + r^A)A'_\theta,$$

where $\xi_\theta \le 1$ is the post-liquidation value of the bank's loan portfolio. Then aggregate taxes are given by

$$\tau^{D'}(z, \mu, r^n, z') = \sum_\theta \left[\int \sum_{\delta_\theta} x'_\theta \max\{0, \Delta'_\theta(k_\theta, \delta_\theta, z, \mu, r^n, z')\}\, d\mu_\theta(k_\theta, \delta_\theta)\right]. \quad \text{(A.6)}$$

TABLE A.VIIB

DEPOSIT PROCESS PARAMETERS: δ^i_θ INCLUDES ONLY DEPOSITS.

	ρ^d_θ	$\sigma^u_{d,\theta}$	$\sigma_{d,\theta}$
Top 10 banks	0.741	0.129	0.193
Fringe banks	0.878	0.166	0.346
All banks	0.878	0.166	0.347

Note: Top 10 refers to top 10 banks when sorted by assets. Fringe banks refers to all banks outside the top 10. Source: Consolidated Reports of Condition and Income.

Let $\mathcal{A}'$ denote the aggregate demand of securities given by

$$\mathcal{A}'(z, \mu, r^n) = \sum_{\theta} \left[\int \sum_{\delta_\theta} A'(k_\theta, \delta_\theta; z, \mu, r^n)\, d\mu_\theta(k_\theta, \delta_\theta) \right].$$

Then, assuming that the government supplies all the securities that the banking sector demands at price r^A (i.e., the supply of domestic securities is perfectly elastic), the tax (transfers if negative) necessary to cover the net proceeds of issuing government securities is given by

$$\tau^{A'}(z, \mu, r^n, z') = \mathcal{A}'(1 + r^A) - \mathcal{A}''(z', \mu'(z, \mu, r^n, z', M'_e(z, \mu, r^n, z')), r^{n'}). \quad \text{(A.7)}$$

As a result, the per capita taxes are

$$\tau'(z, \mu, r^n, z') = \tau^{D'}(z, \mu, r^n, z') + \tau^{A'}(z, \mu, r^n, z'). \quad \text{(A.8)}$$

A.3. *Computational Algorithm*

We solve the model using a variant of Krusell and Smith (1998) and Ifrach and Weintraub (2017). The main difficulty arises in approximating the distribution of fringe banks and computing the loan reaction function from the fringe sector to clear the loan market.

We approximate the (infinite dimensional) cross-sectional distribution of fringe banks μ_f using a finite set of moments:

- The mass of incumbent fringe banks (denoted $\mathcal{M}$):

$$\mathcal{M} = \int \sum_{\delta_f} \mu_f(k_f, \delta_f). \quad \text{(A.9)}$$

  This moment is relevant since the model features endogenous entry and exit, and the mass of incumbent banks fluctuates with the business cycle.
- The cross-sectional average fringe bank net worth plus deposits (denoted by $\mathcal{K}$):

$$\mathcal{K} = \frac{\int \sum_{\delta_f} (k_f + \delta_f)\, d\mu_f(k_f, \delta_f)}{\mathcal{M}}. \quad \text{(A.10)}$$

  This moment is relevant since it determines feasible loan and asset choices at the beginning of the period.

In order to predict the evolution of the mass of fringe banks $\mathcal{M}'$, we use the solution to the problem of the fringe entrant (which provides $M'_{e,f}$) and use a log-linear function to predict the mass of fringe survivors after exit (denoted by $\mathcal{M}'_x$). The mass of fringe entrants $M'_{e,f}$, survivors $\mathcal{M}'_x$, and future incumbents $\mathcal{M}'$ are linked since the distribution evolves according to

$$\begin{aligned} \mu'_f(k'_f, \delta'_f) = {} & \int \sum_{\delta_f} (1 - x'_f(k_f, \delta_f; z, \mu, \cdot, z', r^n)) \\ & \times \mathbf{1}_{\{k'_f = k'_f(n_f, \delta_f, z, \mu, \cdot, z', r^n))\}} G_f(\delta'_f, \delta_f)\, d\mu_f(k_f, \delta_f) \\ & + M'_{e,f} \mathbf{1}_{\{k'_f = k'_{e,f}(z, \mu, z', M'_{e,f})\}} G_{e,f}(\delta'_f) \end{aligned} \quad \text{(A.11)}$$

and

$$\mathcal{M}'_x = \int \sum_{\delta_f} \big(1 - x'_f\big(k_f, \delta_f; z, \mu, \cdot, z', r^n\big)\big)\, d\mu_f(k_f, \delta_f). \tag{A.12}$$

Then $\mathcal{M}' = \mathcal{M}'_x + M'_{e,f}$. The function, specifically regression (the coefficients of which we present in Table A.IX), we use to approximate the law of motion for $\mathcal{M}'_x$ is denoted $F^{\mathcal{M}_x}(z, k_b, \delta_b, \mathcal{K}, \mathcal{M}, z')$. Similarly, the evolution of $\mathcal{K}'$ is approximated using a regression $F^{\mathcal{K}}(z, k_b, \delta_b, \mathcal{K}, \mathcal{M}, z')$ with coefficients presented in Table A.VIII. While (A.11) and (A.12) depend on r^n, our approximate transition functions $F^{\mathcal{M}_x}$ and $F^{\mathcal{K}}$ do not depend on r^n. The non-bank first order condition for loan supply (39) pins down the non-bank interest rate r^n only as a function of z. Since z is already part of the state space when estimating $F^{\mathcal{M}_x}$ and $F^{\mathcal{K}}$, we drop r^n from the regressions.

To compute the reaction function (loan supply $L^s_f(z, \mu, \ell'_b, r^n)$) of the fringe sector, we approximate the components of the loan market clearing condition

$$\ell'_b\big(k_b, \delta_b, z, \mu, r^n\big) + \underbrace{\int \sum_{\delta_f} \ell'_f\big(k_f, \delta_f, z, \mu, \ell'_b, r^n\big)\, d\mu_f(k_f, \delta_f)}_{=L^s_f(z,\mu,\ell'_b,r^n)} = L^{d,c}(\mathbf{r}, z) \tag{A.13}$$

with $\ell'_b(k_b, \delta_b, z, \mathcal{K}, \mathcal{M}, r^n)$ and $L^s_f(z, k_b, \delta_b, \mathcal{K}, \mathcal{M}, \ell'_b, r^n)$. As part of the solution algorithm, we iterate on these functions until we find a fixed point. Note that since the big bank is a dominant player in a Stackelberg game, its individual state variables $\{k_b, \delta_b\}$ are part of the state space of fringe banks. This allows fringe banks to incorporate in full the equilibrium big bank's loan decision when making their own loan decisions. That is, when solving for an equilibrium, the loan supply of fringe banks is approximated with $L^s_f(z, k_b, \delta_b, \mathcal{K}, \mathcal{M}, \ell_b(k_b, \delta_b, z, \mathcal{K}, \mathcal{M}, r^n), r^n)$. As we described above, r^n is a function of z and, since z is already part of the state space, we drop r^n when approximating the fringe bank reaction function $L^s_f = F^{\mathcal{L}}(z, k_b, \delta_b, \mathcal{K}, \mathcal{M})$ via a linear regression.

Specifically, to find an equilibrium we perform the following steps.

Step 1. Iterate on *aggregate functions*. Starting with aggregate functions for any iteration j (with an initial guess if $j = 0$),

$$L^s_f = F^{\mathcal{L}}_k(z, k_b, \delta_b, \mathcal{K}, \mathcal{M}),$$
$$\mathcal{K}' = F^{\mathcal{K}}_k\big(z, k_b, \delta_b, \mathcal{K}, \mathcal{M}, z'\big),$$
$$\mathcal{M}'_x = F^{\mathcal{M}_x}_k\big(z, k_b, \delta_b, \mathcal{K}, \mathcal{M}, z'\big).$$

Step 2. Solve the *dominant bank* problem to obtain the big bank value function and decision rules.

Step 3. Solve the problem of *fringe banks* to obtain the fringe bank value functions and decision rules.

Step 4. Solve the *entry problem* of the big and fringe banks, which gives us the measure of fringe entrants $M'_{e,f}$ as a function of the state space.

Step 5. *Simulate* the exogenous process z_t and obtain a sequence of variables $\{\delta_{b,t}, k_{b,t}, \mathcal{K}_t, \mathcal{M}_{x,t}, \mathcal{M}_{e,t}\}_{t=1}^{T}$, where $T = 10{,}000$. Dropping the first 2000 observations, evaluate the prediction errors using the criterion

$$\text{dist}^{\mathcal{K}} = \big\|\big\{\big|\mathcal{K}_{t+1} - F_j^{\mathcal{K}}(z_t, k_{b,t}, \delta_{b,t}, \mathcal{K}_t, \mathcal{M}_t, z_{t+1})\big|\big\}\big\|, \tag{A.14}$$

$$\text{dist}^{\mathcal{M}_x} = \big\|\big\{\big|\mathcal{M}_{x,t+1} - F_j^{\mathcal{M}_x}(z_t, k_{b,t}, \delta_{b,t}, \mathcal{K}_t, \mathcal{M}_t, z_{t+1})\big|\big\}\big\|, \tag{A.15}$$

$$\text{dist}^{L_f^s} = \big\|\big\{\big|L_{f,t}^s - F_j^{\mathcal{L}}(z_t, k_{b,t}, \delta_{b,t}, \mathcal{K}_t, \mathcal{M}_t)\big|\big\}\big\|, \tag{A.16}$$

$$\text{dist} = \max\big\{\text{dist}^{\mathcal{K}}, \text{dist}^{\mathcal{M}_x}, \text{dist}^{L_f^s}\big\}, \tag{A.17}$$

where $\|\cdot\|$ can denote the sup-norm or the average norm.

Step 6. If tolerance is achieved (i.e., dist < tol), stop. Otherwise, run linear regressions of L_{ft}^s on $(z_t, k_{b,t}, \delta_{b,t}, \mathcal{K}_t, \mathcal{M}_t)$ and $(\mathcal{K}_{t+1}, \mathcal{M}_{x,t+1})$ on $(z_t, k_{b,t}, \delta_{b,t}, \mathcal{K}_t, \mathcal{M}_t, z_{t+1})$ to obtain new coefficients for $(H_{j+1}^{\mathcal{L}}, F_{j+1}^{\mathcal{K}}, H_{j+1}^{\mathcal{M}})$ and return to Step 1 with the updated coefficients.

We find that adding a small amount of exogenous exit helps with the computation, especially when estimating the parameters of the model, since simulations with no exit and positive entry induce nonstationary dynamics that lead to inaccurate approximations of the equilibrium aggregate functions. We denote by ρ_x the exogenous exit parameter and set $\rho_x = 0.005$ or smaller.

A.3.1. *Equilibrium Aggregate Functions*

We use linear equations to estimate the evolution of aggregate variables. Table A.VIII presents the estimated coefficients for the function $H^{\mathcal{K}}(z, n_b, \delta_b, \mathcal{N}, \mathcal{M}, z')$. Each column presents the coefficients for each corresponding z'.

Table A.IX presents the estimated coefficients for the function $F^{\mathcal{M}_x}(z, k_b, \delta_b, \mathcal{K}, \mathcal{M}, z')$.

TABLE A.VIII

$\mathcal{K}' = F^{\mathcal{K}}(z, k_b, \delta_b, \mathcal{K}, \mathcal{M}, z')$.

	Dependent Variable $\mathcal{K}$			
	z_C	z_B	z_M	z_G
Constant	−0.1186	−0.1382	−0.1653	−0.1616
se	0.0055	0.0026	0.0021	0.0055
k_b	−0.0096	−0.0090	−0.0225	−0.0356
se	0.0152	0.0072	0.0051	0.0072
δ_b	−0.0007	0.0012	0.0008	0.0001
se	0.0005	0.0002	0.0002	0.0003
$\mathcal{K}$	0.6412	0.6632	0.7734	0.7668
se	0.0217	0.0127	0.0098	0.0178
$\mathcal{M}$	−0.0003	0.0001	0.0003	−0.0005
se	0.0001	0.0001	0.0001	0.0004
z'	0.1882	0.2002	0.2055	0.2088
se	0.0036	0.0015	0.0012	0.0019
N obs.	45,144	377,352	709,776	379,728
R^2	0.9375	0.9286	0.9285	0.9068

TABLE A.IX

$\mathcal{M}'_x = F^{\mathcal{M}_x}(z, k_b, \delta_b, \mathcal{K}, \mathcal{M}, z')$.

	Dependent Variable $\mathcal{M}'_x$			
	z_C	z_B	z_M	z_G
Constant	−0.7323	−1.1257	0.0152	−1.7094
se	0.1701	0.0541	0.2842	0.6330
k_b	−0.7910	−1.5000	−0.0164	0.2743
se	0.4683	0.1487	0.6847	0.8287
δ_b	0.0076	−0.0512	−0.0603	−0.0181
se	0.0156	0.0045	0.0215	0.0340
$\mathcal{K}$	3.6078	5.9375	−1.0331	2.8781
se	0.6702	0.2626	1.3097	2.0602
$\mathcal{M}$	0.9923	0.9901	0.9396	0.9945
se	0.0028	0.0017	0.0105	0.0427
z'	0.0762	0.1258	0.5452	1.1555
se	0.1107	0.0309	0.1592	0.2182
N obs.	45,144	377,352	709,776	379,728
R^2	0.9986	0.9961	0.9217	0.9313

Table A.X presents the estimated coefficients for the function $F^{\mathcal{L}}(z, k_b, \delta_b, \mathcal{K}, \mathcal{M})$.

A.3.2. *Computing Policy Counterfactuals*

We present short- and long-run results of the policy changes. To perform these experiments, we proceed as follows. First, we compute the long-run equilibrium with the baseline policy parameters (pre-reform) and the long-run equilibrium with policy parameters after the reform (post-reform). The moments from these two long-run equilibria are the basis for the long-run effects. This step provides a set of bank value functions $\mathcal{V}_{\theta,\text{pre}}$ and $\mathcal{V}_{\theta,\text{post}}$ for pre- and post-reform, respectively, with the corresponding decision rules $\{\ell'_{\theta,\text{pre}}, A'_{\theta,\text{pre}}, d'_{\theta,\text{pre}}, \mathcal{D}_{\theta,\text{pre}}, e_{\theta,\text{pre}}, x'_{\theta,\text{pre}}\}$ and $\{\ell'_{\theta,\text{post}}, A'_{\theta,\text{post}}, d'_{\theta,\text{post}}, \mathcal{D}_{\theta,\text{post}}, e_{\theta,\text{post}}, x'_{\theta,\text{post}}\}$, ag-

TABLE A.X

$L^s_f = F^{\mathcal{L}}(z, k_b, \delta_b, \mathcal{K}, \mathcal{M})$.

	Dependent Variable L^s_f			
	z_C	z_B	z_M	z_G
Constant	−0.8570	−1.9105	−0.5846	−0.4361
se	0.0651	0.0586	0.0307	0.0448
k_b	0.3598	1.2785	0.0711	−0.6181
se	0.2691	0.1947	0.0909	0.0628
δ_b	−0.0609	−0.1357	−0.0323	−0.0201
se	0.0089	0.0059	0.0029	0.0026
$\mathcal{K}$	5.1675	12.3447	3.8852	2.7325
se	0.3802	0.3439	0.1739	0.1561
$\mathcal{M}$	0.1222	0.0899	0.1205	0.1305
se	0.0016	0.0022	0.0014	0.0032
N obs.	45,144	377,352	709,776	379,728
R^2	0.9734	0.96246	0.97155	0.9932

gregate functions $F^{\mathcal{L}}_{\text{pre}}$, $F^{\mathcal{K}}_{\text{pre}}$, and $F^{\mathcal{M}_x}_{\text{pre}}$ for the pre-reform equilibrium, and $F^{\mathcal{L}}_{\text{post}}$, $H^{\mathcal{K}}_{\text{post}}$, and $H^{\mathcal{M}_x}_{\text{post}}$.

In order to compute the short-run effects, we assume the unanticipated policy change is announced and put into effect immediately. We approximate the response of the economy during the transition between the two long-run equilibria by computing the solution of bank, entrepreneur, and household problems under the new policy parameters, assuming that beliefs about the future moments of the cross-sectional distribution $\mathcal{M}'_x$ and $\mathcal{K}'$ as well as big bank beliefs about the fringe bank reaction function L^s_f during the transition are a convex combination of $F^{\mathcal{L}}_{\text{pre}}$, $F^{\mathcal{K}}_{\text{pre}}$, and $F^{\mathcal{M}_x}_{\text{pre}}$, and $F^{\mathcal{L}}_{\text{post}}$, $F^{\mathcal{K}}_{\text{post}}$, and $F^{\mathcal{M}_x}_{\text{post}}$:

$$F^{\mathcal{L}}_{q,\text{trans}}(z, k_b, \delta_b, \mathcal{K}, \mathcal{M}) = (1 - q_{\text{trans}})F^{\mathcal{L}}_{\text{pre}}(\cdot) + q_{\text{trans}}F^{\mathcal{L}}_{\text{post}}(\cdot), \tag{A.18}$$

$$F^{\mathcal{K}}_{q,\text{trans}}(z, k_b, \delta_b, \mathcal{K}, \mathcal{M}) = (1 - q_{\text{trans}})F^{\mathcal{K}}_{\text{pre}}(\cdot) + q_{\text{trans}}F^{\mathcal{K}}_{\text{post}}(\cdot), \tag{A.19}$$

$$F^{\mathcal{M}_x}_{q,\text{trans}}(z, k_b, \delta_b, \mathcal{K}, \mathcal{M}) = (1 - q_{\text{trans}})F^{\mathcal{M}_x}_{\text{pre}}(\cdot) + q_{\text{trans}}F^{\mathcal{M}_x}_{\text{post}}(\cdot). \tag{A.20}$$

The weight on the post-reform functions, q_{trans}, is meant to simply approximate a learning process with a slow adjustment of beliefs along the path to the new long-run equilibrium where the economy switches permanently to $F^{\mathcal{L}}_{\text{post}}$, $F^{\mathcal{K}}_{\text{post}}$, and $F^{\mathcal{M}_x}_{\text{post}}$. We choose the parameter q_{trans} to minimize the prediction errors from the difference between the aggregate functions $F^{\mathcal{L}}_{q,\text{trans}}$, $F^{\mathcal{K}}_{q,\text{trans}}$, and $F^{\mathcal{M}_x}_{q,\text{trans}}$ evaluated at $\{z_t, \delta_{b,t}, k_{b,t}, \mathcal{K}_t, \mathcal{M}_{x,t}, \mathcal{M}_{e,t}\}_{t=1}^T$ consistent with optimal behavior along the transition path and $(L^s_{ft}, \mathcal{K}_{t+1}, \mathcal{M}_{x,t+1})$. This belief approximation method yields optimal decision rules that take into account the changes in policy parameters and the adjustment of the aggregate functions as the economy moves between the two long-run equilibria.

Specifically, the value function of the bank during the transition $\mathcal{V}_{\theta,q,\text{trans}}$ and the corresponding decision rules $\{\ell'_{\theta,q,\text{trans}}, A'_{\theta,q,\text{trans}}, d'_{\theta,q,\text{trans}}, \mathcal{D}_{\theta,q,\text{trans}}, e_{\theta,q,\text{trans}}, x'_{\theta,q,\text{trans}}\}$ solve

$$\begin{aligned}
&\mathcal{V}_{\theta,q,\text{trans}}\big(k_\theta, \delta_\theta; z, k_b, \delta_b, \mathcal{K}, \mathcal{M}, \chi, r^n\big) \\
&\quad = \max_{\{\ell'_\theta, A'_\theta, \mathcal{D}_\theta, e_\theta\}\geq 0, d'_\theta \in [0,\delta_\theta]} \Big\{\mathcal{D}_\theta - e_\theta \\
&\qquad + \gamma\beta E_{z'|z}\Big[\max_{x'_\theta\in\{0,1\}}\big\{\big(1 - x'_\theta\big)\big[(1 - q_{\text{trans}})E_{\delta'_\theta|\delta_\theta}\mathcal{V}_{\theta,q,\text{trans}}\big(k'_\theta, \delta'_\theta; z', k'_b, \delta'_b, \mathcal{K}', \mathcal{M}', \chi, r^{s'}\big) \\
&\qquad + q_{\text{trans}}E_{\delta'_\theta|\delta_\theta}\mathcal{V}_{\theta,\text{post}}\big(k'_\theta, \delta'_\theta; z', k'_b, \delta'_b, \mathcal{K}', \mathcal{M}', \chi, r^{s'}\big)\big] + x'_\theta V^x_{\theta,q}\big(k'_\theta, \ell'_\theta\big)\big\}\Big]\Big\}
\end{aligned} \tag{A.21}$$

subject to

$$k_\theta + d'_\theta + e_\theta \geq \ell'_\theta + A'_\theta + \mathcal{D}_\theta + \zeta_\theta(e_\theta, z) + \big[\kappa_\theta + c_\theta\big(\ell'_\theta\big)\big], \tag{A.22}$$

$$k'_\theta = \pi'_\theta + \ell'_\theta + A'_\theta - d'_\theta, \tag{A.23}$$

$$k'_\theta \geq \varphi_{\theta,z,\text{post}}\big(w^\ell_\theta \ell'_\theta + w^A_{\theta,z}\big(A'_\theta + \pi'_\theta\big(z' = \underline{z}\big)\big)\big), \tag{A.24}$$

$$\varrho_{\theta,z,\text{post}} d'_\theta \leq A'_\theta + \pi'_\theta\big(z' = \underline{z}\big), \tag{A.25}$$

$$L^{d,c}(\mathbf{r}, z) = \ell'_b + L^s_f(z, k_b, \delta_b, \mathcal{K}, \mathcal{M}), \tag{A.26}$$

$$L^s_f = F^{\mathcal{L}}_{q,\text{trans}}(z, k_b, \delta_b, \mathcal{K}, \mathcal{M}), \tag{A.27}$$

$$\mathcal{K}' = F^{\mathcal{K}}_{q,\text{trans}}\big(z, k_b, \delta_b, \mathcal{K}, \mathcal{M}, z'\big), \tag{A.28}$$

$$\mathcal{M}'_x = F^{\mathcal{M}_x}_{q,\mathrm{trans}}(z, k_b, \delta_b, \mathcal{K}, \mathcal{M}, z'), \tag{A.29}$$

where $\mathcal{V}_{\theta,\mathrm{post}}$ is the continuation value associated with the post-reform long-run equilibrium once the aggregate functions change permanently. Once the economy switches to the post-reform aggregate functions, decisions rules are those from the post-reform long-run equilibrium. However, during the transition, decision rules are optimal given the belief approximation. While the value of q_{trans} is chosen to minimize the prediction errors of the aggregate functions (i.e., the same criteria that we use to compute a long-run equilibrium), unlike the prior minimization problem, it does not re-estimate the aggregate functions along the transition.

Specifically, we perform the following steps.

Step 1. Set a grid for $q_{\mathrm{trans}} \in \{q^1_{\mathrm{trans}}, \dots, q^Q_{\mathrm{trans}}\}$ with $q^1_{\mathrm{trans}} > 0$ and $q^Q_{\mathrm{trans}} \leq 1$.

Step 2. Use q_{trans} as well as aggregate functions $F^{\mathcal{L}}_{\mathrm{pre}}$, $F^{\mathcal{K}}_{\mathrm{pre}}$, $F^{\mathcal{M}_x}_{\mathrm{pre}}$, and $F^{\mathcal{L}}_{\mathrm{post}}$, $F^{\mathcal{K}}_{\mathrm{post}}$, and $F^{\mathcal{M}_x}_{\mathrm{post}}$ to construct $F^{\mathcal{L}}_{q,\mathrm{trans}}$, $F^{\mathcal{K}}_{q,\mathrm{trans}}$, and $F^{\mathcal{M}_x}_{q,\mathrm{trans}}$.

Step 3. Using $F^{\mathcal{L}}_{q,\mathrm{trans}}$, $F^{\mathcal{K}}_{q,\mathrm{trans}}$, and $F^{\mathcal{M}_x}_{q,\mathrm{trans}}$, solve the dominant bank problem and the fringe bank problems in (A.21).

Step 4. For a given set of initial conditions, simulate the exogenous process z_t, a random variable q_t which determines whether the aggregate beliefs are defined as in (A.18)–(A.20) or transit to the post-reform economy with probability q_{trans}, and obtain a sequence of variables $\{\delta_{b,t}, k_{b,t}, \mathcal{K}_t, \mathcal{M}_{x,t}, \mathcal{M}_{e,t}\}_{t=1}^T$, where $T = 10{,}000$. Dropping the first 2000 observations, evaluate the prediction errors during the transition period using

$$\mathrm{dist}^{\mathcal{K}}_{\mathrm{trans}} = \big\|\big\{\big|\mathcal{K}_{t+1} - F^{\mathcal{K}}_{q,\mathrm{trans}}(k_b, \delta_b, z, \mathcal{K}, \mathcal{M})\big|\big\}\big\|, \tag{A.30}$$

$$\mathrm{dist}^{\mathcal{M}_x}_{\mathrm{trans}} = \big\|\big\{\big|\mathcal{M}_{x,t+1} - F^{\mathcal{M}_x}_{q,\mathrm{trans}}(k_b, \delta_b, z, \mathcal{K}, \mathcal{M})\big|\big\}\big\|, \tag{A.31}$$

$$\mathrm{dist}^{L^s_f}_{\mathrm{trans}} = \big\|\big\{\big|L^s_{f,t} - F^{\mathcal{L}}_{q,\mathrm{trans}}(k_b, \delta_b, z, \mathcal{K}, \mathcal{M})\big|\big\}\big\|, \tag{A.32}$$

and evaluate the prediction errors using $F^{\mathcal{L}}_{\mathrm{post}}$, $F^{\mathcal{K}}_{\mathrm{post}}$, and $F^{\mathcal{M}_x}_{\mathrm{post}}$ once beliefs transit to the post-reform state. Let $\mathrm{dist}_{\mathrm{trans}} = \max\{\mathrm{dist}^{\mathcal{K}}_{\mathrm{trans}}, \mathrm{dist}^{\mathcal{M}_x}_{\mathrm{trans}}, \mathrm{dist}^{L^s_f}_{\mathrm{trans}}\}$.

Step 5. Select the value of q_{trans} that minimizes the prediction errors (i.e., the value of $q_{\mathrm{trans}} \in \{q^1_{\mathrm{trans}}, \dots, q^Q_{\mathrm{trans}}\}$ that minimizes $\mathrm{dist}_{\mathrm{trans}}$).

Initial conditions are set using the average long-run distribution of the pre-reform economy, $\bar{\mu}(n, \delta)$, that is obtained during the simulation of the model pre-reform. That is, $\bar{\mu}(k, \delta) = \sum_{t=1}^T \frac{\mu_{\theta,t}(k,\delta)}{T}$, where $T = 8000$ is the number of periods used to compute the moments as we simulate the economy for 10,000 periods and discard the initial 2000 periods. Using $\bar{\mu}(k, \delta)$ (that implies a value for k_b, δ_b, $\mathcal{M}$, and $\mathcal{K}$) and $z = 1$ as a starting point, the policy change is announced and put into effect immediately. With $\{\ell'_{\theta,q,\mathrm{trans}}, A'_{\theta,q,\mathrm{trans}}, d'_{\theta,q,\mathrm{trans}}, \mathcal{D}_{\theta,q,\mathrm{trans}}, e_{\theta,q,\mathrm{trans}}, x'_{\theta,q,\mathrm{trans}}\}$ for the selected q_{trans} at hand, we simulate the economy forward. We find that for our main experiment, the optimal weight (i.e., the one that minimizes the forecast errors along the transition) is 0.975. The moments reported as the short-run effects correspond to the moments that arise five periods after the policy change.

A.4. *Additional Results*

A.4.1. *Business Cycle Correlations and Additional Moments*

For the parameter values in Tables 5.a and 5.b, we find an equilibrium where, for example, when aggregate variables are evaluated at their observed mean, exit occurs along the equilibrium path by fringe banks (i) with the lowest deposit holdings ($\delta_f = \delta_L = 0.064$, which is 59% lower than the deposits of an average fringe bank) and low net worth levels ($k_f \leq 0.0045$, that represents on average a risk-weighted equity ratio of 3.25%), and (ii) with up to average deposit holdings ($\delta_f \leq \delta_M = 0.0621$) but even smaller net worth levels ($k_f \leq 0.002$, only 1.7% of average loans) if the economy heads into crisis or bad times (i.e., $z = z_M$ and $z' \in \{z_C, z_B\}$). Note that this includes banks with negative net worth ex post (i.e., after the realization of z' but before having the option to recapitalize the bank). Dominant-bank exit is not observed along the equilibrium path. On the equilibrium path, fringe banks that survive the arrival of a bad aggregate shock accumulate securities in order to avoid future exit. The loan supply of big banks increases with net worth, deposits δ_b, and the aggregate shock, and results in a procyclical big bank loan supply along the equilibrium path. The loan supply of fringe banks is also positively related to their net worth and deposit level, but as they respond to changes in the loan supply of big banks, the relationship of their loan supply and the aggregate shock is significantly weaker than that of the big bank.

We present business cycle correlations as a qualitative test of the model. Table 7 provides the correlation between key aggregate variables with output. This appendix presents the graphical representation of those correlations and the estimated coefficient of a linear regression between the corresponding variable and output.[6] Figure A.2 plots a set of scatter plots of each variable included in Table 7 and output for the model with imperfect competition. Figure A.3 presents the same correlations for the model with perfect competition.

We observe that, as in the data, the model with imperfect competition generates countercyclical exit rates, default frequencies, charge-off rates, interest margins, and markups. Moreover, the model generates procyclical entry rates as well as aggregate loans and deposits. The model with perfect competition misses on many of these correlations. Of particular importance is the negative correlation between entry rates and output as well as the positive correlation between interest margins and markups with output.

Table A.XI provides additional nontargeted moments from the model. Table A.XI shows that the model captures relatively well all of the moments in the balance sheets of banks of different sizes. Note that the securities to asset ratio is implied by the loan to asset ratio (since loans and securities are the only two assets in the model). Similarly, the deposit to asset ratio and the equity to asset ratio are implied by the loan to asset ratio and the risk-weighted capital ratio (effectively equal to equity to loans in the model). The model underpredicts the frequency of dividend payments (mostly for fringe banks), and the frequency of equity issuance for big banks (even though costs are substantially low) and for fringe banks. The model generates a level of markups and Lerner index that is

[6]We use the following dating conventions in calculating correlations. We compute correlations to resemble how correlations are computed in the data and consistent with the timing of the model. Since some variables depend on z and μ (e.g., loan interest rates $r^L(z, \mu)$) and some other variables depend on z, μ, and z', (e.g., default frequency $1 - p(R(r^L(z, \mu)), z')$), Table 7 displays contemporaneous correlations (i.e., correlations between any two variables observed during the same period) $corr(output(z, \mu, z'), x(z', \mu'))$ and $corr(output(z, \mu, z'), y(z, \mu, z'))$, where $x(z', \mu')$ is any variable x that depends on (z', μ') and $y(z, \mu, z')$ is any variable y that depends on (z, μ, z').

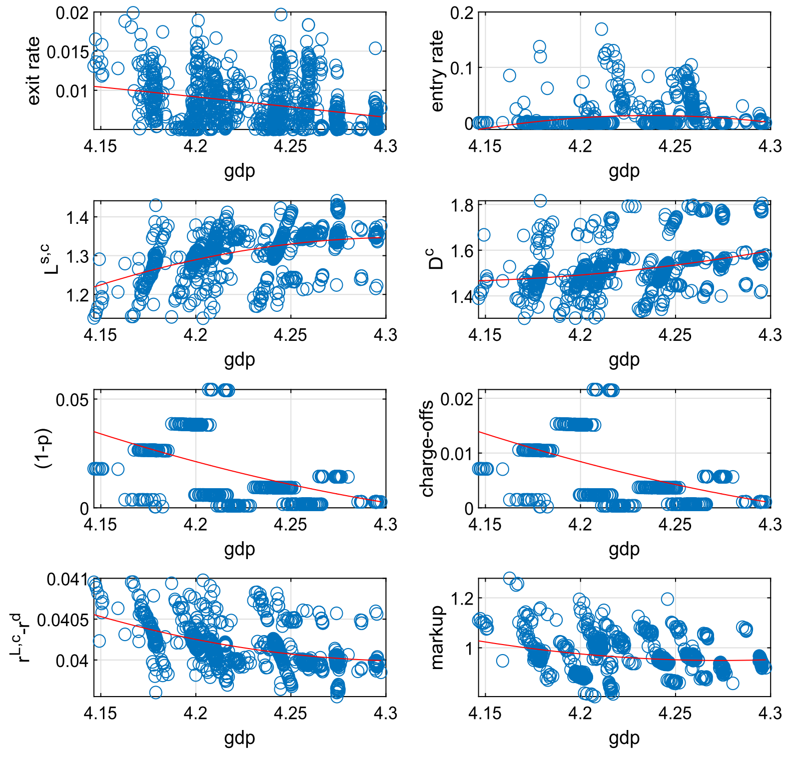

FIGURE A.2.—Business cycle correlations with imperfect competition.

slightly higher than in the data in Table A.XI. The loan return is aligned with the values observed in the data.

Figure A.4 presents the evolution of the mass of fringe banks and the loan market share of fringe banks as well as entry and exit rates over the business cycle for the model with imperfect competition. When the economy enters into a recession, a larger fraction of fringe banks exit. The reduction in the number of banks is compensated by the entry of new banks. However, in some instances entry is gradual and the level of competition

TABLE A.XI

ADDITIONAL MODEL AND DATA MOMENTS.

Long-Run Averages 1984–2007	Imperfect Competition		Perfect Competition	
Moment (%)	Data	Model	Data	Model
Securities to asset ratio (b, f)	(21.55, 26.16)	(6.13, 25.29)	(·, 24.15)	(·, 29.33)
Dep./asset ratio (b, f)	(93.36, 91.06)	(90.11, 91.80)	(·, 92.10)	(·, 91.93)
Equity to asset ratio (b, f)	(6.64, 8.94)	(9.89, 8.20)	(·, 7.90)	(·, 8.07)
Frequency of equity issuance (b, f)	(10.73, 9.55)	(0.00, 1.37)	(·, 9.71)	(·, 4.80)
Frequency of div. payment (b, f)	(94.59, 81.31)	(97.22, 15.46)	(·, 86.53)	(·, 49.85)
Avg. markup	72.65	95.24	72.65	84.72
Avg. Lerner index	42.08	48.78	42.08	45.86
Avg. loan return	4.48	4.06	4.48	3.98
Bank entry rate	1.65	0.85	1.65	1.50

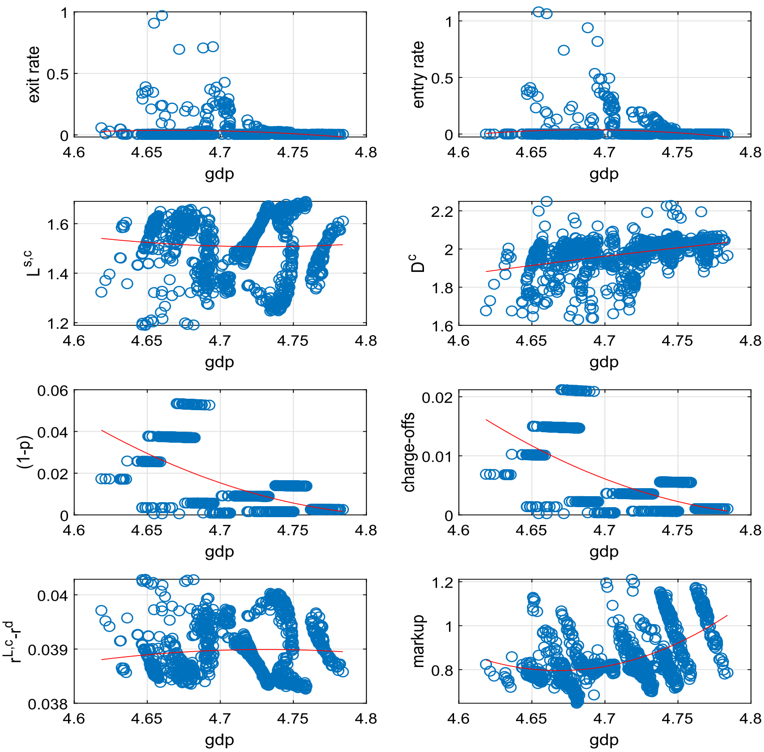

FIGURE A.3.—Business cycle correlations with perfect competition.

is not restored immediately. This is an important amplification mechanism that derives from endogenous changes in competition in our model. Downturns that lead to a more concentrated industry are amplified. This figure also makes clear that the model can generate endogenous cycles in bank level competition. While in the model these cycles tend to be short-lived, they are largely consistent with the evidence we presented on banking industry dynamics.

A.4.2. *Volatility in Benchmark versus Perfect Competition*

Figure 5 (in the main text) makes clear that big bank lending ℓ'_b and fringe bank aggregate lending L^s_f (which depends on both intensive and extensive margins) move in opposite directions.[7] Table A.XII illustrates the implications of this strategic interaction in the loan market for volatility of the other variables in our economy with imperfect competition and compares it to a model with no strategic interaction (our perfectly competitive case). Since averages may be somewhat different across the imperfect and perfect competition models, Table A.XII presents coefficients of variation. We see that all the main lending variables as well as associated rates and markups are an order of magnitude larger with perfect competition than imperfect competition. Two of the variables

[7]In particular, $\text{Var}(L^{s,c}) = 0.0018233$, $\text{Var}(\ell'_b) = 0.001797$, $\text{Var}(L^s_f) = 0.000529$, and $\text{Cov}(\ell'_b, L^s_f) = -0.000252$. The small covariance term arises because of the gentle slope of the aggregate reaction function in Figure 5.

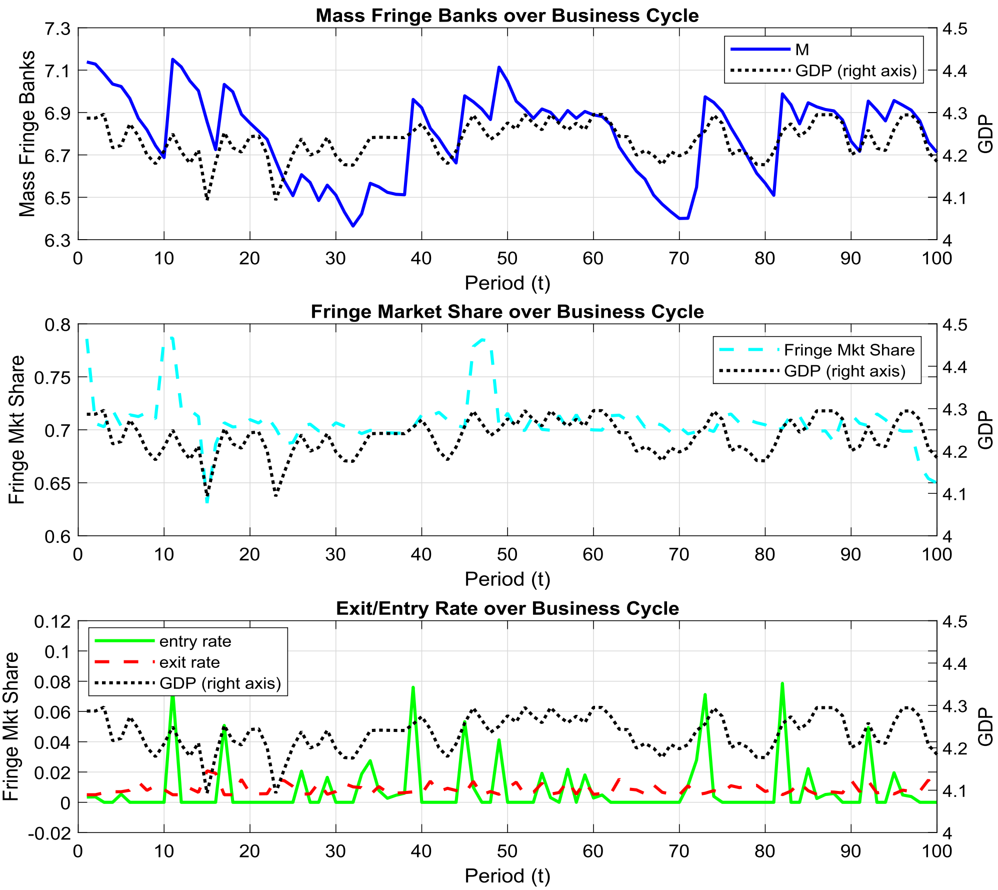

FIGURE A.4.—Competition over the business cycle.

for which volatility does not change significantly are total credit and output. This comes about since any lending induced volatility from banks is compensated for by non-bank lending.[8]

A.4.3. *The Bank Lending Channel*

In Section 6.4, we described that the model with imperfect competition is able to capture the lending channel. To understand the mechanism at play, Table A.XIII presents the aggregate and industry effects of the unexpected policy change. We present the effects of the policy change in the short run (after five periods) and in the long run. Increasing the cost of bank finance decreases the value of both types of banks in the short run as well as small banks in the long run. This leads to high exit rates for small banks in the short run and a subsequent drop in the number (measure) of small banks in the long run. Their loan and deposit market share declines considerably in the short and long run. The tightening

[8]This follows again by an application of Var(total credit) $= \text{Var}(L^{s,c}) + \text{Var}(L^{s,n}) + 2\text{Cov}(L^{s,c}, L^{s,n})$ with $\text{Cov}(L^{s,c}, L^{s,n}) < 0$. Specifically, in the model with imperfect competition, $\text{Var}(L^{s}) = 0.00045$, $\text{Var}(L^{s,c}) = 0.0018$, $\text{Var}(L^{s,n}) = 0.0014$, and $\text{Cov}(L^{s,c}, L^{s,n}) = -0.00137$. In the model with perfect competition, $\text{Var}(L^{s}) = 0.00039$, $\text{Var}(L^{s,c}) = 0.0013$, $\text{Var}(L^{s,n}) = 0.0016$, and $\text{Cov}(L^{s,c}, L^{s,n}) = -0.014$.

TABLE A.XII

VOLATILITY IN BENCHMARK VERSUS PERFECT COMPETITION.

Coefficient of Variation	Imperfect Comp.	Perfect Comp.
Loan supply fringe bank	0.025	0.076
Loan supply big bank	0.110	–
Total bank loan supply	0.032	0.076
Non-bank loan supply	0.032	0.092
Total credit	0.009	0.007
Loan interest rate	0.004	0.010
Markups	0.056	0.146
Output	0.0081	0.0076

of monetary policy and the subsequent increase in deposit finance costs of 25 basis points leads to an increase in loan rates in the short run and long run (3.5% and 6.9%, respectively). Despite the rise in loan rates, net interest margins fall by 2.2% in the short run and increase by 1.8% in the long run. Further, there is a decline in markups that is much more pronounced in the short run. In summary, the model exhibits incomplete pass-through of contractionary monetary policy which is consistent with models of imperfect competition such as Drechsler, Savov, and Schnabl (2017) (p. 1854), who find that deposit spread betas (with respect to changes in the Fed funds rate) are less than 1, and Wang et al. (2020), who find that lending spreads decline in the short run after a contractionary monetary policy shock.

TABLE A.XIII

AGGREGATE AND INDUSTRY EFFECTS OF CONTRACTIONARY MONETARY POLICY.

Moment (%)	Benchmark ($r^s = 0.0065$)	Monetary Policy ($r^s = 0.0094$)	
		Short Run	Long Run
Moment	(%)	Δ (%)	Δ (%)
Capital ratio (b, f)	(10.24, 10.89)	(3.53, 1.21)	(3.89, 0.20)
Exit rate	0.87	37.13	−25.07
Entry rate	0.90	−100.00	−23.85
Loan mkt. share fringe	70.81	−15.42	−40.45
Dep. mkt. share fringe	75.61	−12.98	−37.48
Loan interest rate	4.67	3.47	6.89
Net interest margin	3.99	−2.21	1.81
Avg. markup	95.71	−12.94	−0.32
Additional Moments			
Measure banks fringe		−39.26	−71.02
Bank loan supply		−25.86	−48.41
Output		−0.27	−0.88
Column	(2)	(3)	(4)

A.5. *Appendix Policy Counterfactuals*

A.5.1. *Higher Capital Requirements*

TABLE A.XIV

BENCHMARK MODEL VERSUS PERFECTLY COMPETITIVE MODEL.

	Baseline		High Capital Requirements			
(φ_f, φ_b)	(0.04, 0.04)		(0.085, 0.085)		$(\cdot, 0.085)$	
	Imperfect Comp.	Perfect Comp.	Imperfect Comp.		Perfect Comp.	
Moment	(%)	(%)	Short Run Δ (%)	Long Run Δ (%)	Short Run Δ (%)	Long Run Δ (%)
Capital ratio (b, f)	(10.24, 10.89)	$(\cdot, 11.56)$	(37.56, 35.80)	(44.24, 53.65)	$(\cdot, 33.81)$	$(\cdot, 36.66)$
Exit rate	0.87	2.24	37.09	−20.20	−76.08	−0.34
Entry rate	0.90	2.27	−96.32	−20.32	−100.00	1.19
Prob. of crisis	0.14	1.10	–	−20.00	–	12.73
Loan mkt. share f	70.81	100.00	−4.85	−6.07	0.00	0.00
Dep. mkt. share f	75.61	100.00	−0.82	−4.38	0.00	0.00
Loan int. rate r^c	4.67	4.58	0.95	1.17	0.50	1.41
Borrower return	14.46	14.99	0.43	0.00	0.18	0.00
Default freq.	1.66	1.62	−12.59	0.63	−0.50	0.69
Int. margin	3.99	3.90	1.11	1.37	0.59	1.66
Avg. markup	95.71	84.92	12.59	1.37	0.49	0.00
Loans/assets (b, f)	(94.06, 74.57)	$(\cdot, 71.42)$	(−0.77, −12.47)	(−0.25, −2.64)	$(\cdot, -5.47)$	$(\cdot, -2.49)$
Sec./assets (b, f)	(5.93, 25.42)	$(\cdot, 28.58)$	(12.31, 36.63)	(4.09, 7.79)	$(\cdot, 13.68)$	$(\cdot, 6.22)$
E.I./assets (b, f)	(0.00, 0.06)	$(\cdot, 0.14)$	(22812.50, 279.81)	(0.00, −48.81)	$(\cdot, -67.96)$	$(\cdot, 0.69)$
Div./assets (b, f)	(2.14, 0.51)	$(\cdot, 1.01)$	(−27.56, −54.43)	(2.93, 12.33)	$(\cdot, -12.80)$	$(\cdot, 7.20)$
$L^{s,c}$/total credit	53.40	52.67	−7.11	−8.66	−3.74	−10.27
$L^{s,c}$/output	31.03	32.16	−7.19	−8.73	−3.89	−10.33
Bank dep./output	35.96	41.87	−2.45	−11.83	−2.44	−11.07
Additional Moments						
Measure f banks			−3.92	−15.19	−4.34	−12.18
Bank loan supply			−7.19	−8.90	−3.77	−10.52
Total loan supply			−0.08	−0.27	−0.05	−0.29
Output			0.00	−0.19	0.12	−0.22
Taxes/output			−30.02	−68.50	−92.64	−32.74
Borrower Project (R)			0.056	0.007	0.027	0.008
Loans (b, f)			(3.65, −7.98)	(4.45, 0.73)	$(\cdot, 0.85)$	$(\cdot, 1.73)$
Net cash flow (b, f)			(8.77, −0.44)	(7.21, 4.50)	$(\cdot, 4.15)$	$(\cdot, 5.25)$
Column	(2)	(3)	(4)	(5)	(6)	(7)

Note: The term E.I. denotes equity issuance; Δ (%) refers to the percentage change relative to the baseline model with capital requirements at $\varphi_\theta = 0.04$ (columns 2 and 3) for the corresponding model with imperfect competition or with perfect competition. The baseline columns in this table differ slightly from those of Table 6 due to the inclusion of the crisis state.

A.5.2. *Size-Dependent Capital Requirements With Liquidity Requirements*

TABLE A.XV

SIZE-DEPENDENT EXPERIMENTS.

	Baseline	Size-Dep. Cap Req. and Liq. Req.		Count. Cap. Req. and Liq. Req.	
(φ_f, φ_b)	(0.04, 0.04)	(0.085, 0.11)		(0.085, [0.11, 0.135])	
(ϱ_f, ϱ_b)	(0.0, 0.0)	(0.0, 0.08)		(0.0, 0.08)	
Moment	(%)	Short Run Δ (%)	Long Run Δ (%)	Short Run Δ (%)	Long Run Δ (%)
Capital ratio (b, f)	(10.24, 10.89)	(63.58, 35.19)	(70.38, 52.71)	(83.46, 35.26)	(95.92, 52.71)
Exit rate	0.87	37.39	−20.00	36.56	−19.47
Entry rate	0.90	−94.66	−20.21	−95.00	−19.58
Prob. of crisis	0.14		20.00		30.00
Loan mkt. sh. fringe	70.81	−2.80	−3.24	−3.17	−4.36
Dep. mkt. sh. fringe	75.61	−0.83	−3.84	−0.80	−4.09
Loan interest rate	4.67	1.22	1.26	1.14	1.23
Borrower return	14.46	0.42	0.00	0.42	0.00
Default frequency	1.66	−12.46	0.67	−12.50	0.66
Net interest margin	3.99	1.43	1.48	1.33	1.45
Avg. markup	95.71	16.22	3.87	15.30	2.88
Loans/assets (b, f)	(94.06, 74.57)	(−8.85, −12.45)	(−8.32, −2.44)	(−9.38, −12.32)	(−8.27, −2.41)
Sec./assets (b, f)	(5.93, 25.42)	(140.52, 36.55)	(132.16, 7.20)	(148.94, 36.17)	(131.38, 7.10)
E.I./assets (b, f)	(0.00, 0.06)	(58,187.50, 258.35)	(−75.00, −48.81)	(98,400.00, 279.81)	(500.00, −46.58)
Div./assets (b, f)	(2.14, 0.51)	(−29.90, −52.63)	(0.91, 12.58)	(−35.61, −53.14)	(1.19, 12.84)
$L^{s,c}$/total credit	53.40	−9.12	−9.30	−8.50	−9.11
$L^{s,c}$/output	31.03	−9.21	−9.38	−8.59	−9.19
Bank dep./output	35.96	−2.42	−10.48	−2.36	−11.10
Additional Moments					
Measure banks fringe		−3.90	−13.40	−3.84	−14.25
Bank loan supply		−9.25	−9.57	−8.61	−9.38
Total loan supply		−0.14	−0.29	−0.12	−0.28
Output		−0.04	−0.20	−0.03	−0.20
Taxes/output		−25.82	−66.53	−28.21	−66.65
Borrower project (R)		0.06	0.08	0.06	0.01
loans (b, f)		(−3.17, −8.10)	(−2.49, 0.89)	(−1.70, −7.86)	(0.15, 0.94)
Net cash flow (b, f)		(5.41, −0.26)	(3.78, 4.66)	(7.32, −0.18)	(7.09, 4.66)
Column	(2)	(3)	(4)	(5)	(6)

Note: The term Δ (%) refers to the percentage change relative to the baseline model with capital requirements at $\varphi_\theta = 0.04$ (columns 2 and 3). The baseline columns in this table differ slightly from those of Table 6 due to the inclusion of the crisis state. The minimum capital requirement for the big banks in columns 5 and 6 is $\varphi_{b,z} = \{0.1100, 0.1183, 0.1266, 0.1350\}$.

A.5.3. *Volatility Implications of Policy Counterfactuals*

The banking crisis indicator takes value equal to 1 in periods whenever (i) the loan default frequency and the exit rate are higher than 2 standard deviations from their mean, (ii) deposit insurance outlays as a fraction of GDP are higher than 2%, or (iii) large dominant banks are liquidated. We let the indicator $I_{\{(1-p)\}}$ take value 1 when the default frequency is higher than 2 standard deviations from its mean. Similarly, we let the indicator $I_{\{xr\}}$ take value 1 when the exit rate is higher than 2 standard deviations from its mean.

TABLE A.XVI

VOLATILITY AND POLICY COUNTERFACTUALS WITH IMPERFECT COMPETITION.

	Baseline	High Capital Req.	Size Dep. Cap. Req. and Liq. Req.	Count. Cap. Req. and Liq. Req.
(φ_f, φ_b)	(0.04, 0.04)	(0.085, 0.085)	(0.085, 0.11)	(0.085, [0.11, 0.135])
(ϱ_f, ϱ_b)	(0.0, 0.0)	(0.0, 0.0)	(0.0, 0.08)	(0.0, 0.08)
Std. Dev. (%)				
Loan supply fringe	2.30	3.53	3.68	3.61
Loan supply big	4.24	4.15	4.28	4.07
Bank loan supply	4.27	5.01	5.03	4.95
Output	4.39	4.35	4.33	4.33
Default frequency	2.05	2.06	2.0810	2.0807
Exit rate	1.16	0.48	0.51	0.51
Pr (%)				
Pr(τ/output > 2%)	0.04	0.00	0.00	0.00
Pr($I_{\{xr\}} = 1$)	0.143	0.182	2.13	1.70
Pr($I_{\{(1-p)\}} = 1$)	2.990	2.99	2.99	2.99
Pr($I_{\{xr\}} = 1$ & $I_{\{(1-p)\}} = 0$)	0.00	1.70	1.96	1.52
Pr($I_{\{xr\}} = 0$ & $I_{\{(1-p)\}} = 1$)	2.85	2.88	2.82	2.80
Pr($I_{\{xr\}} = 1$ & $I_{\{(1-p)\}} = 1$)	0.143	0.114	0.172	0.186
Pr(crisis)	0.143	0.114	0.172	0.186

Note: The term $I_{\{xr\}} = 1$ if the exit rate greater is than 2 standard deviations from its mean and $I_{\{(1-p)\}} = 1$ if the default frequency is greater than 2 standard deviations from its mean. The minimum capital requirement for the big bank in columns 5 and 6 is $\varphi_{b,z} = \{0.1100, 0.1183, 0.1266, 0.1350\}$.

Condition (i) in the definition of a banking crisis is true whenever $I_{\{(1-p)\}} = I_{\{xr\}} = 1$. Table A.XVI presents some relevant volatility measures across experiments as well as the probability of occurrence for the indicators that are used for the construction of the crisis probability. In particular, $\Pr(I_{\{(1-p)\}} = 1)$ denotes the probability that $I_{\{(1-p)\}} = 1$, $\Pr(I_{\{xr\}} = 1)$ denotes the probability that $I_{\{xr\}} = 1$, and $\Pr(I_{\{xr\}} = 1\ \&\ I_{\{(1-p)\}} = 1)$ denotes the probability that $I_{\{(1-p)\}} = 1$ and $I_{\{xr\}} = 1$ (i.e., the probability that condition (i) is satisfied). We also show the probability that $I_{\{xr\}} = 1$ and $I_{\{(1-p)\}} = 0$ ($\Pr(I_{\{xr\}} = 1\ \&\ I_{\{(1-p)\}} = 0)$), and the probability that $I_{\{xr\}} = 0$ and $I_{\{(1-p)\}} = 1$ ($\Pr(I_{\{xr\}} = 0\ \&\ I_{\{(1-p)\}} = 1)$). Finally, Table A.XVI also shows the probability that deposit insurance outlays as a fraction of GDP are higher than 2% (i.e., the probability that condition (ii)) is satisfied ($\Pr(\tau/\text{output} > 2\%)$).

A.5.4. *Policy Interaction Effects*

In order to understand the contribution of each of the capital and liquidity regulations implemented by the Dodd-Frank Act, Table A.XVII presents a decomposition of the size dependent experiments. This table shows that most of the effect on exit and entry rates comes from the increase in capital requirements (size dependent or countercyclical buffer), since the increase in liquidity regulation alone reduces exit and entry rates by roughly one-half of the combined effect. On the other hand, liquidity requirements alone can lead to qualitatively different responses in market shares (i.e. a rise in fringe bank market share with liquidity requirements as opposed to a fall in the case of capital requirements alone).

TABLE A.XVII

POLICY INTERACTION.

(φ_f, φ_b)	Baseline (0.04, 0.04)	Size Dep. Cap. Req. (0.085, 0.11)		Count. Cap. Req. (0.085, [0.085, 0.11])		Liq. Req. (0.04, 0.04)	
(ϱ_f, ϱ_b)	(0.0, 0.0)	(0.0, 0.0)		(0.0, 0.0)		(0.0, 0.08)	
Moment	(%)	Short Run Δ (%)	Long Run Δ (%)	Short Run Δ (%)	Long Run Δ (%)	Short Run Δ (%)	Long Run Δ (%)
Capital ratio (b, f)	(10.24, 10.89)	(63.17, 35.14)	(68.62, 53.39)	(55.08, 36.38)	(62.59, 53.49)	(2.28, 2.33)	(2.65, 0.29)
Exit rate	0.87	36.36	−19.38	36.75	−19.82	−21.48	−12.80
Entry rate	0.90	−96.43	−19.55	−87.81	−20.00	72.30	−12.87
Prob. of crisis	0.14		10.00		−10.00		30.00
Loan mkt. sh. fringe	70.81	−5.52	−6.89	−5.09	−6.44	3.36	3.68
Dep. mkt. sh. fringe	75.61	−0.80	−4.54	−0.81	−4.49	0.63	0.85
Loan interest rate	4.67	0.90	1.15	0.92	1.17	0.01	−0.05
Borrower return	14.46	0.42	0.00	0.43	0.00	0.43	0.00
Default frequency	1.66	−12.58	0.61	−12.61	0.62	−13.08	−0.03
Net interest margin	3.99	1.06	1.35	1.07	1.37	0.01	−0.06
Avg. markup	95.71	12.93	0.59	12.10	0.96	−100.00	2.42
Loans/assets (b, f)	(94.06, 74.57)	(−3.13, −12.65)	(−0.91, −2.67)	(−1.55, −12.55)	(−1.20, −2.57)	(−7.62, 0.48)	(−8.22, 0.41)
Sec./assets (b, f)	(5.93, 25.42)	(49.84, 37.16)	(14.62, 7.87)	(24.73, 36.86)	(19.27, 7.57)	(120.98, −1.36)	(130.50, −1.17)
E.I./assets (b, f)	(0.00, 0.06)	(58187.50, 238.63)	(−75.00, −46.90)	(66200.00, 290.30)	(0.00, −48.33)	(175.00, −4.61)	(625.00, 7.63)
Div./assets (b, f)	(2.14, 0.51)	(−39.45, −54.02)	(3.11, 12.43)	(−28.33, −54.56)	(2.89, 12.43)	(−74.72, 343.21)	(−2.77, −0.72)
$L^{s,c}$/total credit	53.40	−6.76	−8.47	−6.86	−8.61	−0.16	0.40
$L^{s,c}$/output	31.03	−6.83	−8.55	−6.94	−8.68	−0.19	0.40
Bank dep./output	35.96	−2.38	−12.21	−2.40	−12.09	1.93	2.74
Additional Moments							
Measure banks fringe		−3.87	−15.72	−3.83	−15.55	2.91	4.26
Bank loan supply		−6.84	−8.72	−6.94	−8.86	−0.02	0.40
Total loan supply		−0.07	−0.26	−0.08	−0.27	0.14	0.01
Output		0.00	−0.19	0.01	−0.19	0.17	0.01
Taxes/output		−37.95	−68.14	−25.71	−68.48	−1.05	5.78
Borrower project (R)		0.06	0.01	0.06	0.01	0.05	0.00
Loans (b, f)		(5.53, −8.31)	(6.46, 0.71)	(4.45, −8.06)	(5.32, 0.82)	(−8.18, 0.24)	(−8.51, −0.28)
Net cash flow (b, f)		(10.30, −0.62)	(10.16, 4.46)	(10.48, −0.50)	(8.88, 4.54)	(−3.13, 3.24)	(−5.52, −0.30)
Column	(2)	(3)	(4)	(5)	(6)	(7)	(8)

Note: The term Δ (%) refers to the percentage change relative to the baseline model with capital requirements at $\varphi_\theta = 0.04$ (columns 2 and 3). The baseline columns in this table differ slightly from those of Table 6 due to the inclusion of the crisis state. The minimum capital requirement for the big banks in columns 5 and 6 is $\varphi_{b,z} = \{0.0850, 0.0933, 0.1016, 0.1100\}$.

A.5.5. *Zero Capital Requirements*

TABLE A.XVIII

ZERO CAPITAL REQUIREMENTS.

	Baseline		Zero Capital Requirements			
(φ_f, φ_b)	(0.04, 0.04)		(0.0, 0.0)		$(\cdot, 0.0)$	
	Imperfect Comp.	Perfect Comp.	Imperfect Competition		Perfect Competition	
			Short Run	Long Run	Short Run	Long Run
Moment	(%)	(%)	Δ (%)	Δ (%)	Δ (%)	Δ (%)
Capital ratio (b, f)	(10.24, 10.89)	$(\cdot, 11.56)$	(−14.00, −34.79)	(−38.40, −56.46)	$(\cdot, -30.38)$	$(\cdot, -37.19)$
Exit rate	0.87	2.24	−7.36	211.52	−77.72	5.40
Entry rate	0.90	2.27	704.93	225.74	−52.90	5.75
Prob. of crisis	0.14	1.10		949.98		145.32
Loan mkt. share f	70.81	100.00	6.05	6.45	0.00	0.00
Dep. mkt. share f	75.61	100.00	5.38	6.58	0.00	0.00
Loan int. rate r^c	4.67	4.58	−2.05	−2.05	−0.89	−1.11
Borrower return	14.46	14.99	0.43	0.01	0.19	0.00
Default freq.	1.66	1.62	−13.86	−1.07	−1.17	−0.54
Int. margin	3.99	3.90	−2.40	−2.40	−1.04	−1.30
Avg. markup	95.71	84.92	−1.58	−0.56	−3.76	−3.61
Loans/assets (b, f)	(94.06, 74.57)	$(\cdot, 71.42)$	(−0.36, 0.69)	(0.79, −4.64)	$(\cdot, 0.01)$	$(\cdot, 0.83)$
Sec./assets (b, f)	(5.93, 25.42)	$(\cdot, 28.58)$	(5.95, −1.98)	(−12.30, 13.66)	$(\cdot, -0.03)$	$(\cdot, -2.08)$
E.I./assets (b, f)	(0.00, 0.06)	$(\cdot, 0.14)$	(−12.50, −46.26)	(125.00, 0.48)	$(\cdot, -59.64)$	$(\cdot, 48.47)$
Div./assets (b, f)	(2.14, 0.51)	$(\cdot, 1.01)$	(21.03, 121.77)	(−4.67, −5.23)	$(\cdot, 15.09)$	$(\cdot, 0.28)$
$L^{s,c}$/total credit	53.40	52.67	14.57	14.71	6.43	8.03
$L^{s,c}$/output	31.03	32.16	14.79	14.89	6.34	8.10
Bank dep./output	35.96	41.87	20.22	25.56	8.82	10.09
Additional Moments						
Measure f banks			28.05	28.70	6.60	7.83
Bank loan supply			15.39	15.36	6.75	8.31
Total loan supply			0.68	0.54	0.26	0.25
Output			0.48	0.38	0.35	0.18
Taxes/output			131.54	840.01	−83.69	37.35
Borrower project (R)			0.039	−73.839	0.020	−0.009
Loans (b, f)			(−1.90, −4.45)	(−2.95, −4.16)	$(\cdot, 0.44)$	$(\cdot, 0.30)$
Net cash flow (b, f)			(−1.01, −2.66)	(−6.40, −5.32)	$(\cdot, -0.62)$	$(\cdot, -2.04)$
Column	(2)	(3)	(4)	(5)	(6)	(7)

Note: The term Δ (%) refers to the percentage change relative to the baseline model with capital requirements at $\varphi_\theta = 0.04$ (columns 2 and 3) for the corresponding model with imperfect competition or with perfect competition. The baseline columns in this table differ slightly from those of Table 6 due to the inclusion of the crisis state.

A.5.6. *Policy Implications for Allocative Efficiency*

We present here the effects of introducing size-dependent capital and liquidity regulations for allocative efficiency. We observe that all policies result in an increase in allocative efficiency as measured by both a decline in $\text{cov}(c_\theta(\ell'_\theta, z), \omega(\ell'_\theta))$ and an increase in $\text{cov}(\delta_\theta, \omega(\ell'_\theta))$. After the introduction of liquidity requirements, allocative efficiency increases monotonically with the market share of the big banks even as size-dependent policies affect big banks disproportionately more than fringe banks. The increase in allocative efficiency is reflected in a reduction in loan-weighted costs and an increase in loan-weighted deposits.

TABLE A.XIX

ALLOCATIVE EFFICIENCY OF CAPITAL AND LIQUIDITY REQUIREMENTS.

	Baseline		High Cap. Req.		Size Dep. Cap. Req. & Liq. Req.	Count Cap. Req. & Liq. Req.
(φ_f, φ_b)	(0.04, 0.04)		(0.085, 0.085)		(0.085, 0.11)	(0.085, [0.11, 0.135])
(ϱ_f, ϱ_b)	(0.0, 0.0)		(0.0, 0.0)		(0.0, 0.08)	(0.0, 0.08)
Moment (%)	Imperfect Comp.	Perfect Comp.	Imperfect Comp.	Perfect Comp.	Imperfect Comp.	Imperfect Comp.
Avg. (loan-weighted) cost $\hat{c}$	1.718	1.802	1.719	1.824	1.673	1.711
Avg. cost $\overline{c}$	1.7591	1.7593	1.807	1.791	1.762	1.805
$\text{cov}(c, \omega)$	−0.0414	0.043	−0.0885	0.033	−0.0889	−0.0944
Avg. (loan-weighted) deposit $\hat{\delta}$	0.229	0.2714	0.241	0.2709	0.237	0.238
Avg. deposit $\overline{\delta}$	0.2017	0.2610	0.1982	0.2637	0.1976	0.1979
$\text{cov}(\delta, \omega)$	0.0270	0.0104	0.0426	0.0072	0.0393	0.0406
Fringe loan market share	70.81	100.00	66.51	100.00	68.52	67.73

Note: Moments presented correspond to time series averages over z.

A.5.7. *Welfare Implications of Capital and Liquidity Requirements*

Table A.XX presents the welfare effects of size-dependent policies. Columns 6–9 show that size-dependent capital and liquidity requirements result in average positive welfare gains in the short and long run. Columns 6–9 show that size-dependent capital and liquidity requirements result in average positive welfare gains in the short and long run. As

TABLE A.XX

WELFARE CONSEQUENCES OF CAPITAL AND LIQUIDITY REQUIREMENTS.

	High Cap. Req.				Size-Dep. Cap. Req. & Liq. Req.		Count. Cap. Req. & Liq. Req.	
(φ_f, φ_b)	(0.085, 0.085)				(0.085, 0.11)		(0.085, [0.11, 0.135])	
(ϱ_f, ϱ_b)	(0.0, 0.0)				(0.0, 0.08)		(0.0, 0.08)	
	Imperfect Comp.		Perfect Comp.		Imperfect Comp.		Imperfect Comp.	
Moment (%)	Short Run	Long Run	Short Run	Long Run	Short Run	Long Run	Short Run	Long Run
α_H	−0.004	0.114	0.030	0.024	−0.044	0.066	−0.040	0.086
ΔCV_{C_H}	–	−1.822	–	6.736	–	−2.213	–	−2.222
α_E	−0.280	−0.268	0.015	−0.325	−0.336	−0.296	−0.322	−0.280
ΔCV_{C_E}	–	−0.673	–	1.425	–	−0.658	–	−0.658
$\overline{\alpha}$	−0.034	0.100	0.028	0.005	−0.076	0.047	−0.071	0.067
Avg. ΔCV_C	–	−1.627	–	5.833	–	−1.948	–	−1.956
Column	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)

Note: The terms α_H and α_E are defined in (44). Positive values correspond to a welfare gain from the reform and negative values correspond to a welfare loss. The terms ΔCV_{C_H} and ΔCV_{C_E} refer to the change in the coefficient of variation of long-run consumption for households and entrepreneurs, respectively. All values are reported in percentage terms.

in columns 2 and 3, the increase in household welfare derives from lower taxes due to the decline in bank failure and better capitalized failing banks (that reduce deadweight losses associated with bank failure). As liquidity requirements induce big banks to hold more securities, the increase in loan markups has a smaller impact on household welfare. Entrepreneur losses, which in this case arise even in the short run, derive from the increase in bank loan interest rates (a project default) and the decline in total credit. The reduction in average consumption volatility also suggests that these estimates can be taken as a lower bound of the effects of size-dependent capital and liquidity requirements.

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