Bank Capital and Risk Taking: A Loan Level Analysis

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Research Question

Does high leverage incentivize banks to hold riskier assets?

Motivation

- Bank investment decisions influence the whole economy, for good or ill.
- Is there evidence for an asset substitution problem in bank investing?
- Prudential regulation: is bank capital more than just a loss absorbing buffer?

Theoretical Considerations

- Potential asset substitution problem (Jensen and Meckling, 1976)
- Particularly strong for banks given insurance (Merton, 1977)
- Particularly strong for large banks due to TBTF (Kelly et al., 2016; Gandhi and Lustig, 2015)
- Also strong for banks given high leverage (Admati et al., 2017)
- Bank investments have real consequences (Mian and Sufi, 2014)

Needs for Suitable Data Source

1. Matches specific assets to the bank that holds them
2. Identifies when asset is acquired and outcome (default, profit/loss, etc.)
3. Ensures that assets are held on portfolio and not sold
4. (ideally) available for those outside of gov't to license.

Past Sources of Data on Risk of Bank Assets

Call Reports

- Gorton and Rosen (1995), Gan (2004)

Stock Returns

- Beltratti and Stulz (2012) , Haldane (2012), and Demirguc-Kunt et al. (2013)

Data Sources

Small Business Loans

- 600,000 loans (originated 2003 - 2013)
- Made via SBA's 7a Lending Program
- Obtained via FOIA

Home Mortgage Loans

- 1.2 million loans (originated 2003 - 2012)
- Merge of Deed records with HMDA

Approach

- 1.8 million small business and home mortgage loans
- Each linked to the bank that originated them
- Observe loan outcome (default / not)
- Predict outcome based on capital level at time of origination
- Bank and time fixed effects
- IV for capital (Granja et al., 2017)

Results Preview

- 1 point increase in Tier 1 capital decreases probability of mortgage foreclosure by 4% (from 2.5% to 2.4%)
- For large banks, 1 point increase in Tier 1 capital decreases probability of small business default by 9% (from 18.5% to 16.8%)
- For US counties, 1 point increase in average Tier 1 capital of banks from 2003 - 2006 is associated with 4.4% decrease in foreclosures from 2007-2012.

Identification Challenges

Artificially **Inflate** Relation b/w High Leverage and High Risk

- Bank managers may have risk preference/strategy that drives both capital and loan risk (Becker and Ivashina, 2015; Bernile et al., 2017)
- When regulators require higher capital, they might also more carefully scrutinize other aspects of bank safety

Identification Challenges

Artificially **Deflate** Relation b/w High Leverage and High Risk

- Banks that make riskier loans may do more to inflate capital ratios (Behn et al., 2016)
- Regulators may view capital and prudential regulation as substitutes

Responses to Identification Challenges

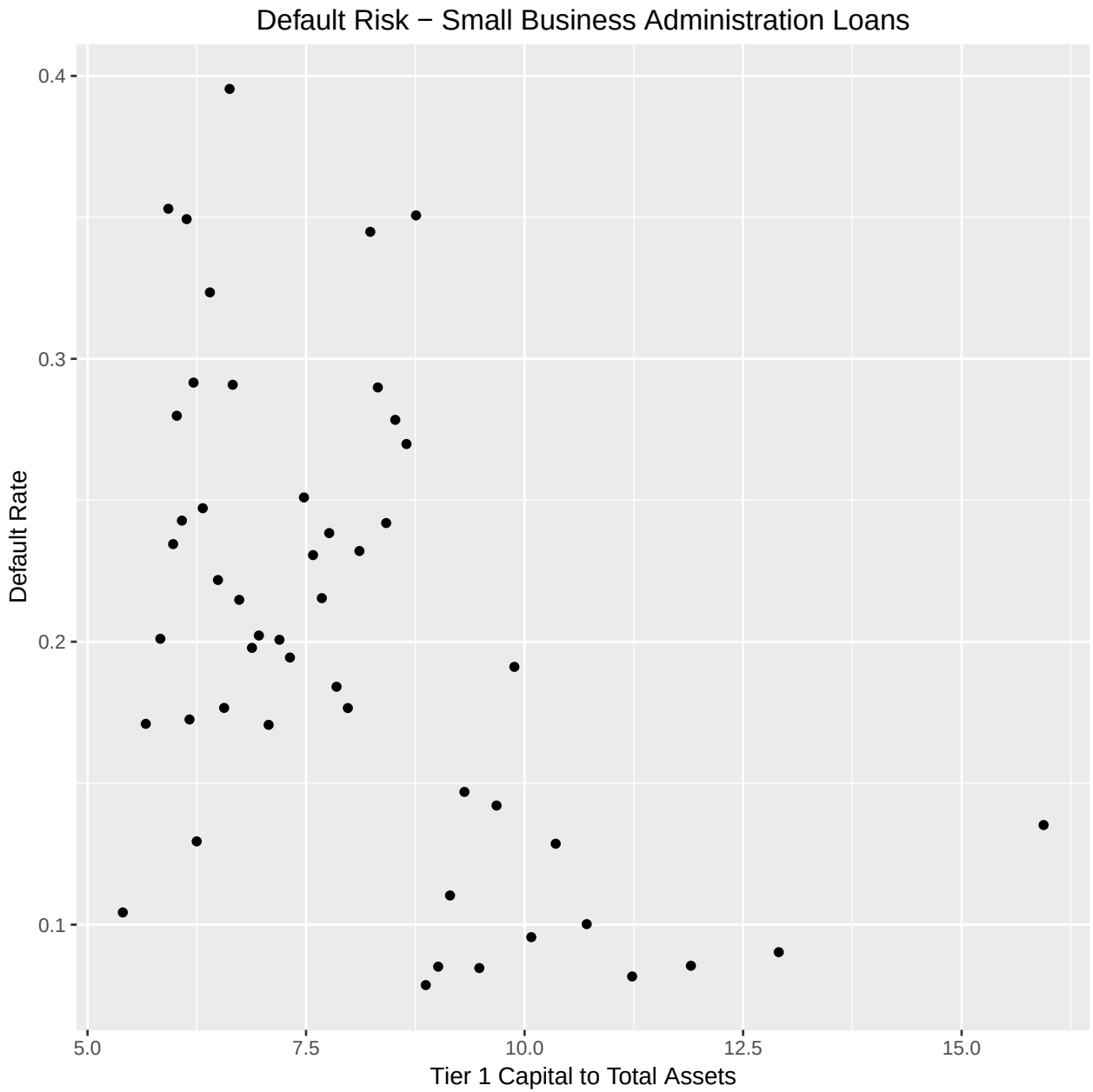
- Bank fixed effects - control for relatively stable aspects of manager strategy / distortions of capital ratios.
- Time fixed effects - control for changes in regulatory conditions, market conditions.
- Fit models over different time periods within the study - enhance bank FE effectiveness
- Fit models over different types of banks (small, medium, large) - enhance time FE
- Bartik IV for Capital (Granja et al., 2017)

Model

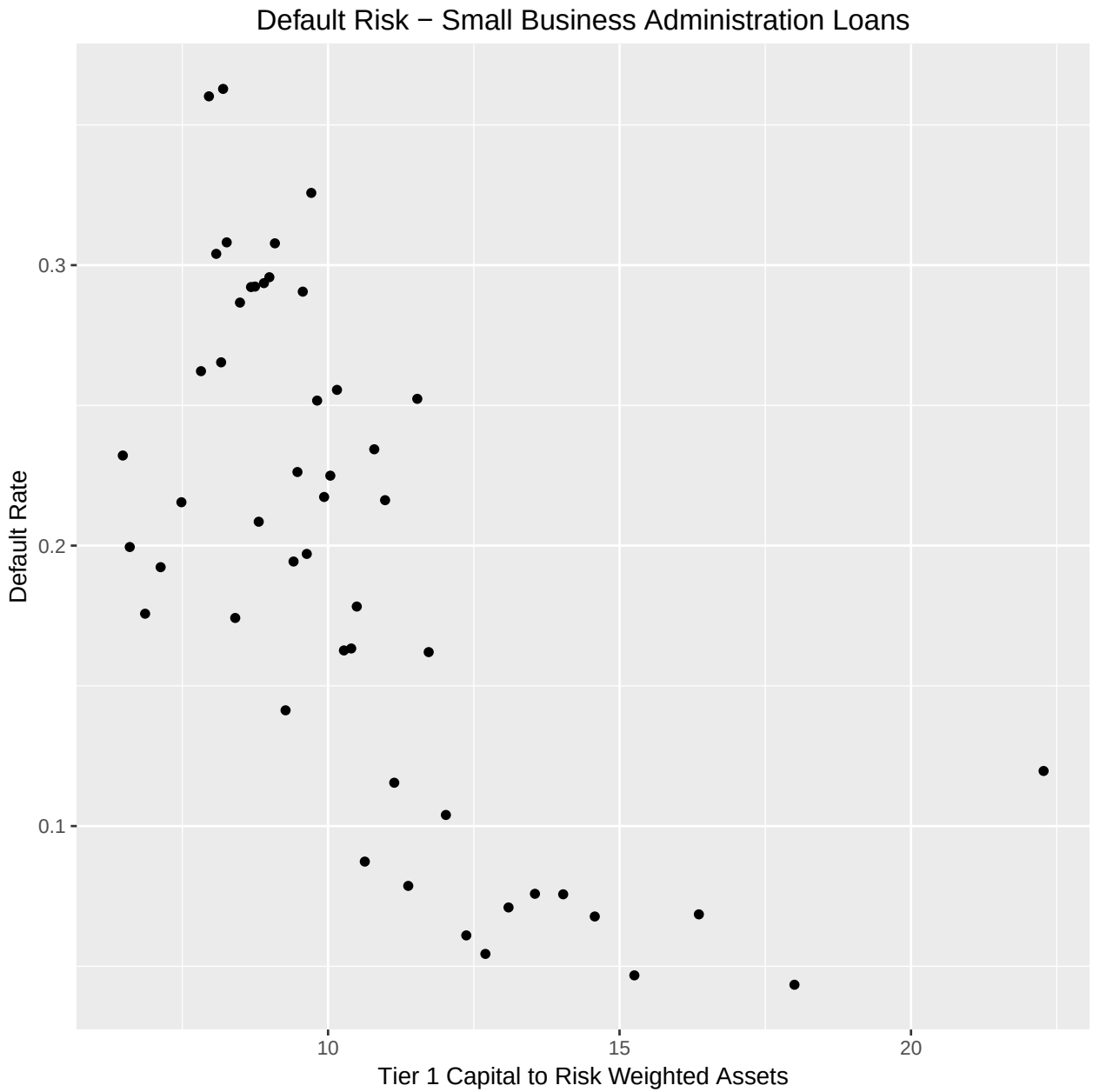
$$\mathbf{P}\left[\text{Default}_{ijt}\right] = \Lambda\left(\beta\,\text{Capital}_{jt} + \mu_j + \eta_t + \Gamma X_t + \delta B_{jt} + \varepsilon_{ijt}\right)$$

- μ_j - Bank Fixed Effect
- η_t - Time Fixed Effect
- X_t vector of macroeconomic controls (unemployment, stock returns, interest rates)
- B_{jt} Bank controls (loans/deposits, log assets, deposits/liabilities, officer loans / total loans)

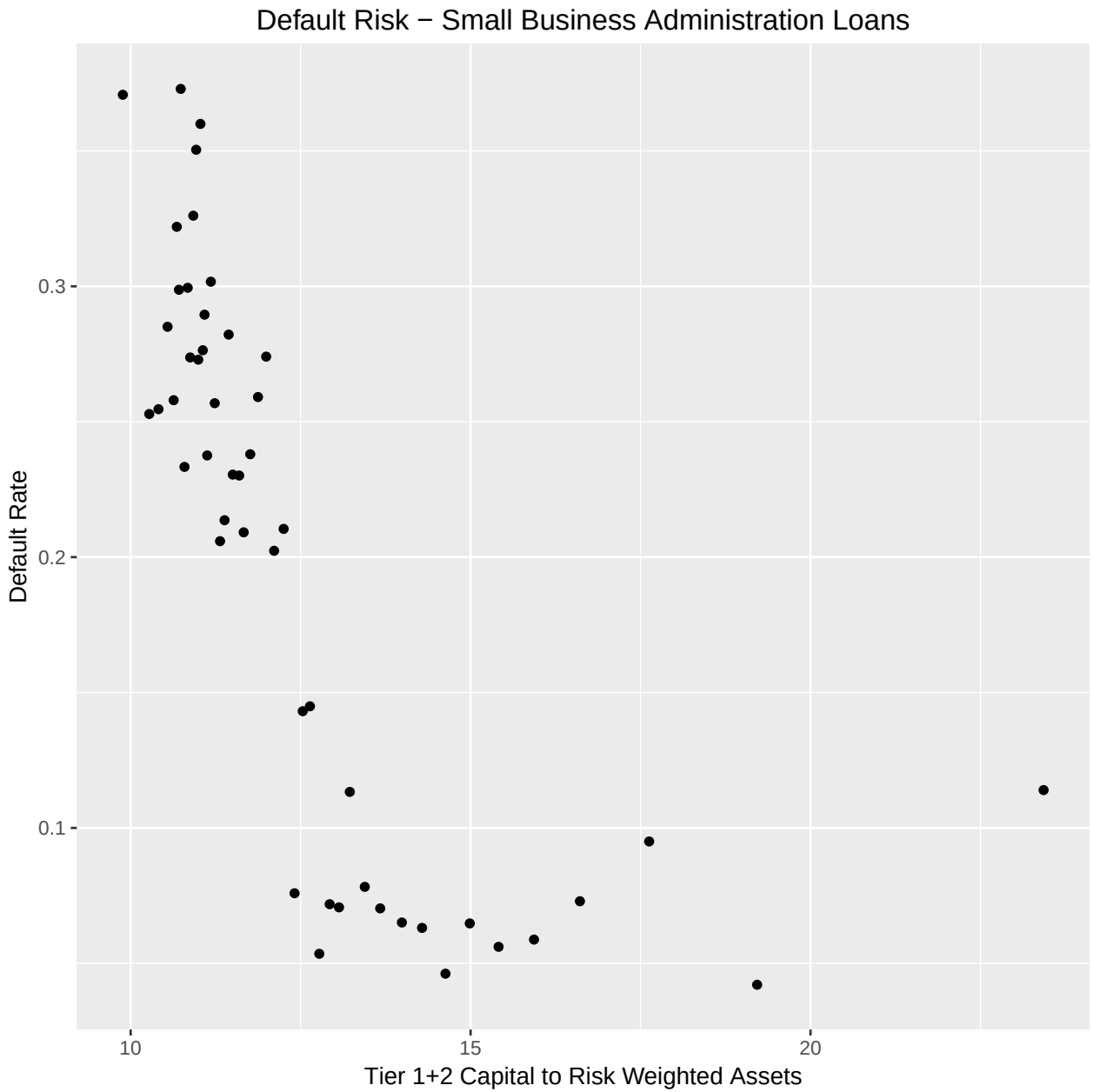
Tier 1 Capital to Total Assets



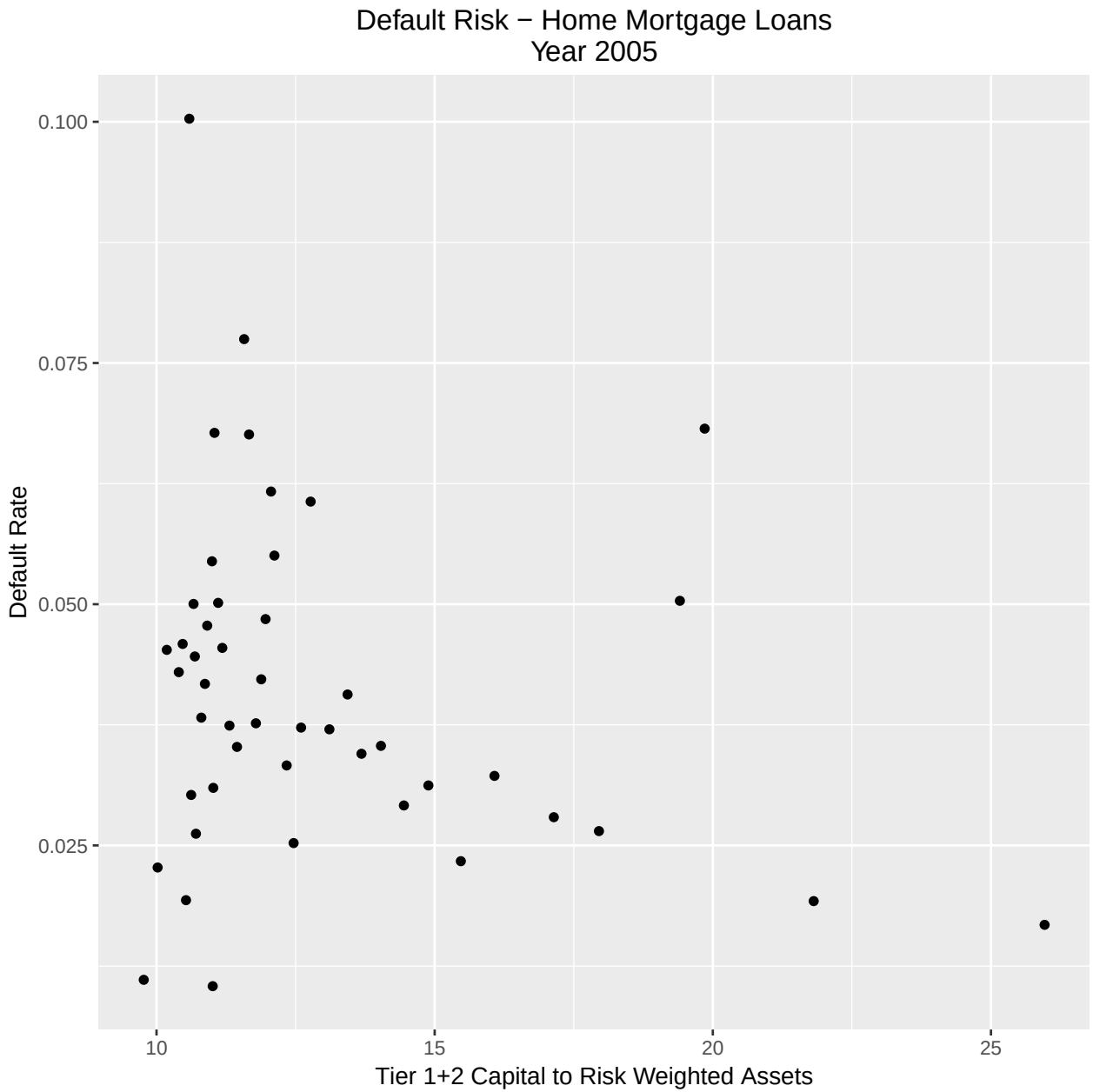
Tier 1 Capital to Risk Weighted Assets



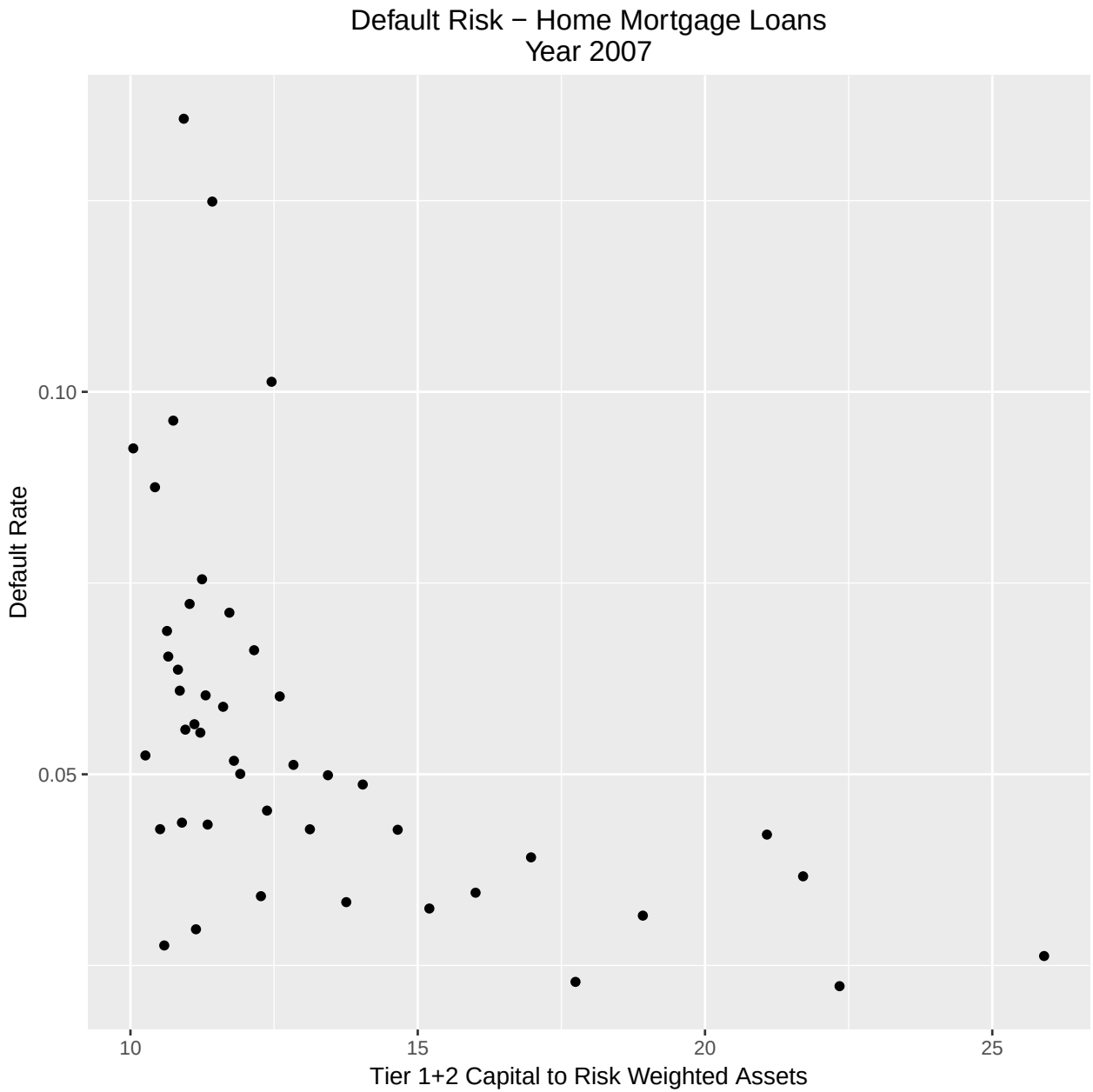
Tier 1 + Tier 2 Capital to Risk Weighted Assets



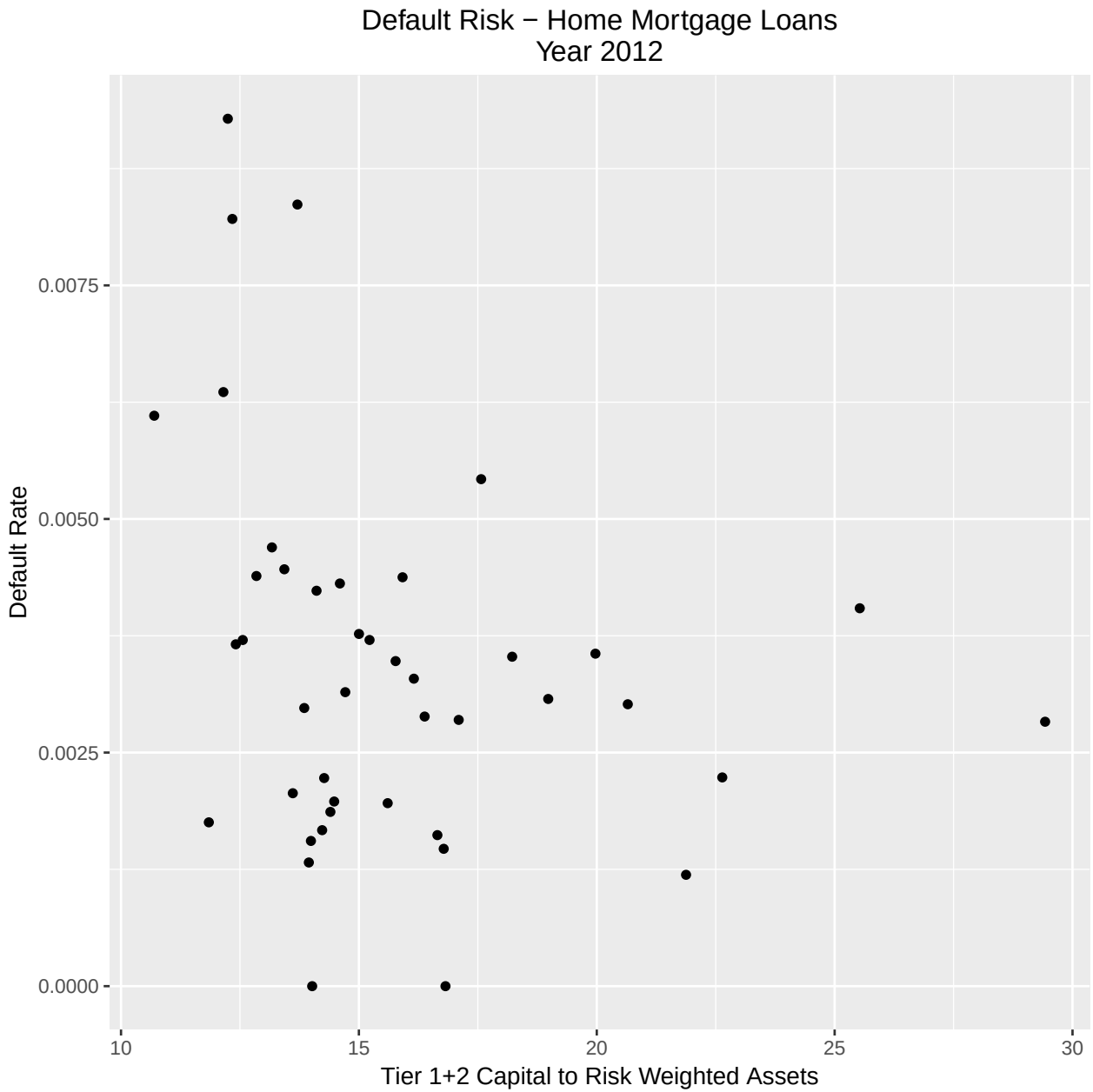
Total Capital Ratio - 2005 - Home Mortgage Loans



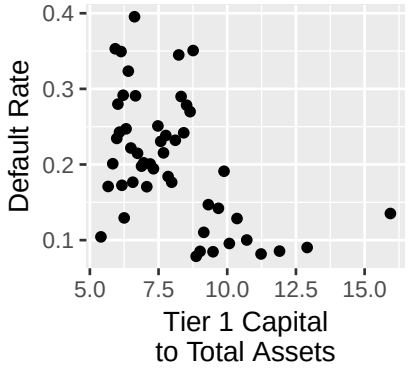
Total Capital Ratio - 2007 - Home Mortgage Loans

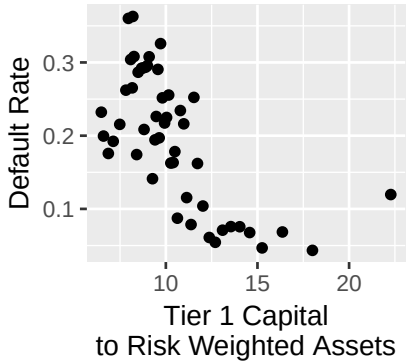


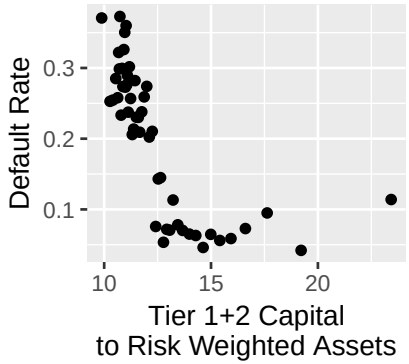
Total Capital Ratio - 2012 - Home Mortgage Loans

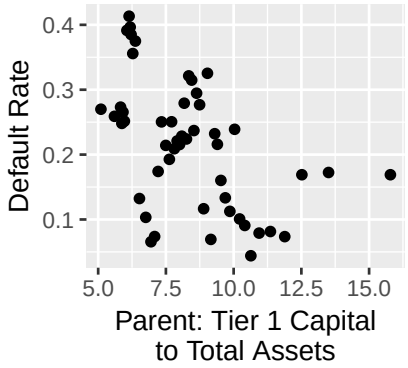


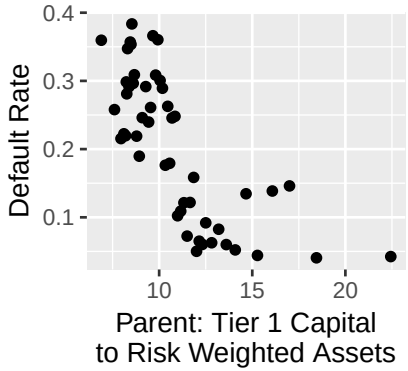
Capital to Loan Risk - Summary

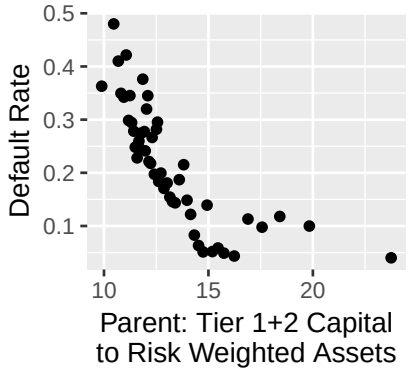


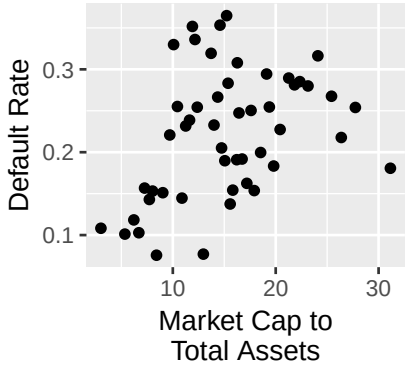


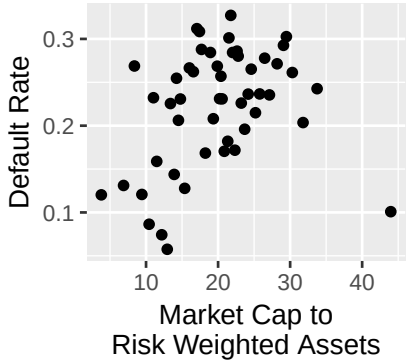












Results - Small Business Loan Risk

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A						
Tier 1 Capital to Risk Weighted Assets	-0.15 ***	-0.051 ***	-0.251 ***	-0.089 ***	-0.037 **	-0.014
	(0.023)	(0.015)	(0.0437)	(0.012)	(0.0154)	(0.0142)
S&P 500 Five-Year Return		0.166 **		0.253 ***		0.155 ***
		(0.0816)		(0.0583)		(0.0392)
5 Year Treasury Rate		0.233 ***		0.217 ***		0.037 **
		(0.0378)		(0.0284)		(0.0175)
Unemployment Rate		-0.277 ***		-0.186 ***		-0.217 ***
		(0.0364)		(0.032)		(0.0239)
Observations	571685	571685	571685	571685	571685	580326
AUC	0.624	0.718	0.736	0.77	0.722	0.774
Panel B						
Market Cap to Risk Weighted Assets	0.012	-0.019 ***	0.02	-0.024 ***	-0.014 ***	-0.006 ***
	(0.0074)	(0.0053)	(0.014)	(0.0025)	(0.0052)	(0.0022)
S&P 500 Five-Year Return		0.084		0.072		0.149 ***
		(0.0775)		(0.1112)		(0.049)
5 Year Treasury Rate		0.208 ***		0.215 ***		0.044 **
		(0.0424)		(0.031)		(0.0182)
Unemployment Rate		-0.353 ***		-0.288 ***		-0.232 ***
		(0.0458)		(0.0384)		(0.0307)
Observations	382225	382225	382225	382225	382225	389174
AUC	0.545	0.707	0.695	0.752	0.711	0.756
Banks FEs	no	no	yes	yes	no	yes
Year FEs	no	no	no	no	yes	yes
Macro Controls	no	yes	no	yes	no	yes

Cluster robust standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Results - Home Mortgage Loan Risk

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A						
Tier 1 Capital to Risk Weighted Assets	-0.107 ***	-0.048 ***	-0.165 ***	-0.083 ***	-0.043 ***	-0.055 ***
	(0.024)	(0.0131)	(0.0385)	(0.0141)	(0.0124)	(0.013)
S&P 500 Five-Year Return		-0.279 *		-0.175 *		-0.198
		(0.1606)		(0.0987)		(0.1777)
5 Year Treasury Rate		0.512 ***		0.423 ***		0.004
		(0.0368)		(0.0384)		(0.0376)
Unemployment Rate		-0.018		0.003		-0.092 *
		(0.0279)		(0.029)		(0.0515)
Observations	1161967	1161967	1161967	1161967	1161967	1161967
AUC	0.596	0.704	0.782	0.8	0.714	0.803
Panel B						
Market Cap to Risk Weighted Assets	0.027 ***	-0.034 ***	0.05 ***	0.006	-0.035 ***	0.013
	(0.0098)	(0.0089)	(0.0125)	(0.0089)	(0.0095)	(0.0093)
S&P 500 Five-Year Return		-0.725 ***		-0.335 *		-0.093
		(0.248)		(0.1946)		(0.2966)
5 Year Treasury Rate		0.558 ***		0.499 ***		0.047
		(0.0647)		(0.069)		(0.0585)
Unemployment Rate		-0.131 **		-0.012		-0.205 **
		(0.0587)		(0.0593)		(0.0836)
Observations	600272	600272	600272	600272	600272	600272
AUC	0.591	0.734	0.76	0.783	0.738	0.789
Banks FEs	no	no	yes	yes	no	yes
Year FEs	no	no	no	no	yes	yes
Macro Controls	no	yes	no	yes	no	yes

Cluster robust standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

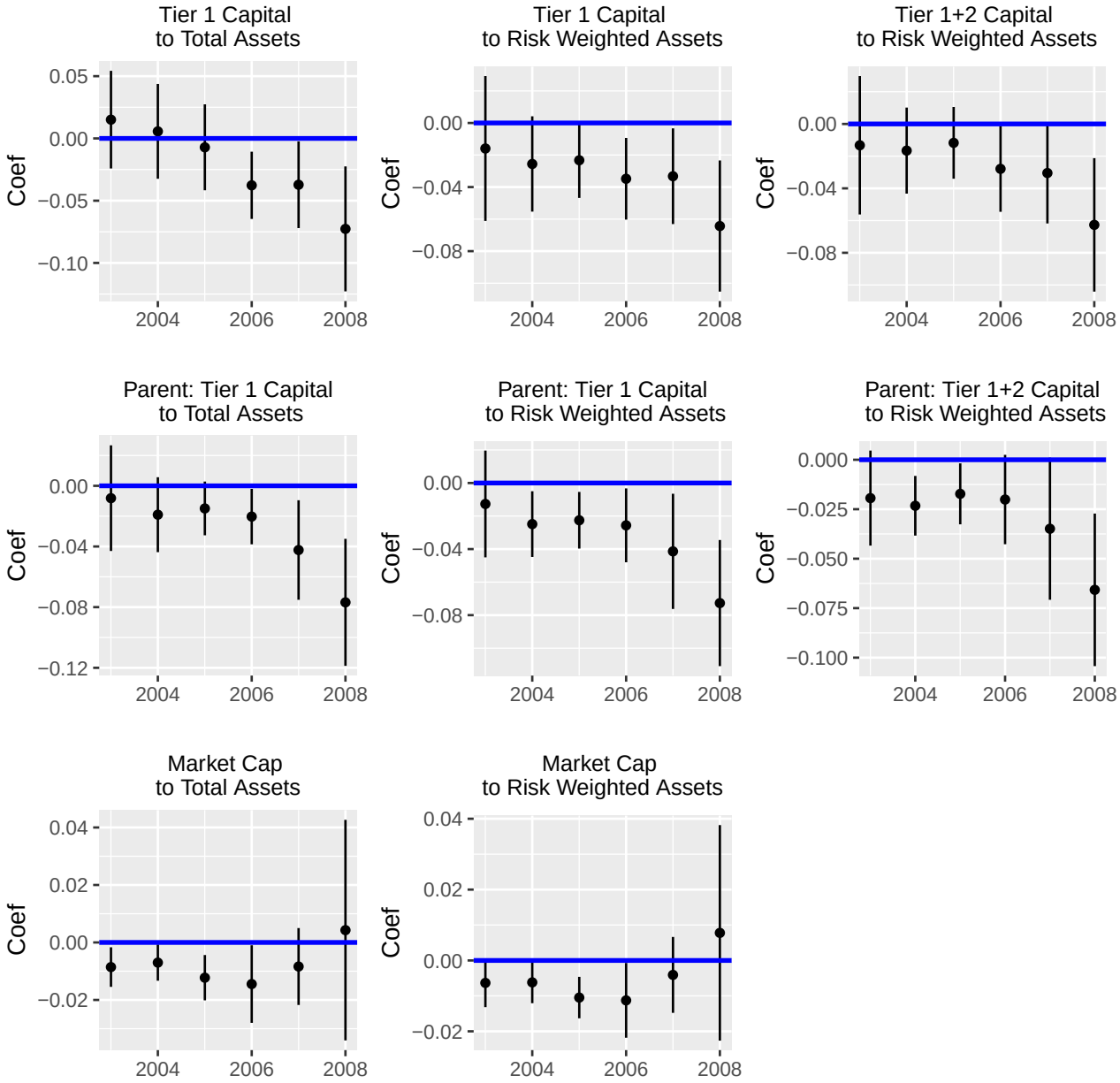
Bank Size - Small Business Loans

	(Small)	(Medium)	(Large)
Panel A			
Tier 1 Capital to Total Assets	-0.018	-0.019	-0.119 ***
	(0.0154)	(0.0256)	(0.0369)
Observations	154369	143910	122381
Panel B			
Tier 1 Capital to Risk Weighted Assets	0.003	-0.056 ***	-0.132 ***
	(0.0206)	(0.0212)	(0.0299)
Observations	154369	143910	122381
Panel C			
Parent: Tier 1 Capital to Risk Weighted Assets	0.012	-0.015 **	-0.092 *
	(0.0213)	(0.0063)	(0.0547)
Observations	154369	143910	122381
Panel D			
Parent: Tier 1+2 Capital to Risk Weighted Assets	0.017	-0.014 **	-0.061 *
	(0.0216)	(0.0056)	(0.0358)
Observations	154369	143910	122381
Banks FEs	yes	yes	yes
Time FEs	yes	yes	yes
Macro Controls	yes	yes	yes

Cluster robust standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Stability of Relationships Over Time



IV Design - Overview

- Goal: Predict capital levels of a bank making loans in a particular CBSA
- Concept: Capital levels of banks will be impacted by the local economic conditions of the communities in which they operate.
- This will be true regardless of what other manager risk preferences, investment strategies, and other difficult-to-observe factors there are about a bank.

IV Design - Overview

- Local economic conditions will also be relevant to determining whether a loan defaults.
- Therefore, only consider banks with operations in multiple CBSAs.
- Use economic conditions in CBSAs other than where a loan is made to predict the capital of the bank making the loan in that region.
- This IV first used by: Granja et al. (2017)

IV Design - Details

- Consider bank i with branches in CBSAs Ω_i
- Denote the house price index (HPI) in CBSA j at time t p_{jt}
- Bank i: deposits d_{ij} in CBSA j as of Q1 2006
- Construct a weighted index of changes in HPI (compared to Q1 2006) in regions outside of j where bank i has branches.

$$\Delta p_{ijt} = \sum_{n \in \Omega_i - j} (p_{nt}/p_{n2006} - 1) \frac{d_{in}}{\sum_{m \in \Omega_i - j} d_{im}}$$

IV Design - Details

- Bank i, with branch in region j, has Tier 1 Capital Ratio at time t of $Capital_{ijt}$

$$\Delta \text{Capital}_{ijt} := \text{Capital}_{ijt} - \text{Capital}_{ij2006}$$

- Predict:

$$\Delta \text{Capital}_{ijt} = \alpha + \beta \Delta p_{ijt} + \mu_i + \gamma_t + \eta X_t + \varepsilon_{ijt}$$

- Strong Instrument:
  - F-stat ($36 > 10$)
  - 1 SD move of instrument $\Rightarrow$ 0.58 move in Tier 1 Capital Ratio (compared to mean 2.17 move over IV period).

IV Results - Small Business Loans

$$\text{Default}_{ijt} = \alpha + \beta \widehat{\text{Capital}}_{jt} + \Gamma X_t + \mu_j + \eta_t + \varepsilon_i$$

	(Naive)	(IV)
Panel A		
Tier 1 Capital to Total Assets	-0.006	-0.04 **
	(0.0054)	(0.0201)
Observations	64194	64194
Panel B		
Tier 1 Capital to Risk Weighted Assets	-0.004	-0.039 **
	(0.0033)	(0.0163)
Observations	64194	64194
Panel C		
Tier 1+2 Capital to Risk Weighted Assets	-0.002	-0.067 *
	(0.0031)	(0.0365)
Observations	64194	64194
Banks FEs	yes	yes
Year FEs	yes	yes
Macro Controls	yes	yes

Cluster robust standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Macroeconomic Impact

$$\log(\text{Foreclosures}_i^{2007-2012}) = \alpha + \beta \text{Mean Capital}_i^{2003-2006} + \Gamma X_i + \varepsilon_i$$

	(Leverage Ratio)	(Tier 1 Ratio)	(Total Ratio)
Tier 1 Capital to Total Assets	-0.0		
	(0.0148)		
Tier 1 Capital to Risk Weighted Assets		-0.044 ***	
		(0.0106)	
Tier 1+2 Capital to Risk Weighted Assets			-0.04 ***
			(0.011)
log(Open Mortgages, 2006)	1.403 ***	1.38 ***	1.388 ***
	(0.0982)	(0.0939)	(0.0955)
Mean FICO, 2000	0.026 ***	0.026 ***	0.026 ***
	(0.0095)	(0.0094)	(0.0094)
House Price, 2000	0.002 **	0.001 **	0.001 **
	(0.0007)	(0.0007)	(0.0007)
% Change House Price, 2000-2009	-0.939 ***	-0.924 ***	-0.936 ***
	(0.0854)	(0.0854)	(0.0867)
Median Household Income, 2000	-0.072	-0.039	-0.047
	(0.0746)	(0.0744)	(0.0748)
Observations	869	869	869
Adjusted R^2	0.966	0.967	0.966

Robust standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Is there evidence for an asset substitution problem?

- Nothing here conclusively proves asset substitution
- But, absent asset substitution, most theory would predict higher capital banks would make riskier loans:
  - Rollover costs of debt. (Chen et al., 2017)
  - High capital $\Rightarrow$ better positioned to absorb losses
  - Other parts of the economy, high risk investment $\Leftrightarrow$ high capital (e.g. VC firms)
- If higher risk mortgage loans (that high capital banks don't make) were profitable, then you'd anticipate non-bank lenders to have stepped in to make them in the areas with high capital banks.

Loss Given Default (LGD)

$$\log(1 + \text{LGD}_{it}) = \alpha + \beta \text{Capital}_{jt} + \Gamma X_t + \delta L_{it} + \mu_j + \eta_t + \varepsilon_i$$

(L_{it} := All available loan/borrower/geographic predictors)

	(1)	(2)
Panel A		
Quantile: Market Cap to Risk Weighted Assets	-0.001 ***	-0.001 ***
	(0.0004)	(0.0004)
Observations	93173	93173
Adjusted R^2	0.076	0.162
Panel B		
Quantile: Market Cap to Total Assets	-0.001 **	-0.001 **
	(0.0004)	(0.0005)
Observations	93173	93173
Adjusted R^2	0.075	0.161
Banks FEs	yes	yes
Time FEs	yes	yes
Macro Controls	yes	yes
Borrower and Geographic Controls	no	yes

Cluster robust standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Default Insurance Purchases

$$\text{Pct Insured}_{it} = \alpha + \beta \text{Capital}_{jt} + \Gamma X_t + \delta L_{it} + \mu_j + \eta_t + \varepsilon_i$$

(L_{it} := All available loan/borrower/geographic predictors)

	(Naive)	(IV)
Panel A		
Tier 1 Capital to Total Assets	0.001	0.017 ***
	(0.0018)	(0.0052)
Observations	64194	64194
Adjusted R^2	0.524	0.516
Panel B		
Tier 1 Capital to Risk Weighted Assets	0.0	0.016 ***
	(0.0013)	(0.0047)
Observations	64194	64194
Adjusted R^2	0.524	0.512
Panel C		
Tier 1+2 Capital to Risk Weighted Assets	-0.001	0.027 *
	(0.001)	(0.0143)
Observations	64194	64194
Adjusted R^2	0.524	0.49
Banks FEs	yes	yes
Time FEs	yes	yes
Macro Controls	yes	yes
Borrower and Geographic Controls	yes	yes

Cluster robust standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Supervisory Response

$$\text{N Actions}_{it} = \alpha + \beta \Delta(\text{Default Rate}_{it}) + \eta_t + \varepsilon_{it}$$

$$\Delta(\text{Bank Capital}_{it}) = \alpha + \beta \Delta(\text{Default Rate}_{it}) + \eta_t + \varepsilon_{it}$$

	Enforcement Actions	Change in Capital		
	(Enforcement Actions)	Δ(Leverage Ratio)	Δ(Tier 1 Ratio)	Δ(Total Ratio)
Δ(Bank Default Rate)	0.005	-0.007	-0.02 *	-0.013
	(0.0036)	(0.0072)	(0.0115)	(0.0101)
Observations	519	519	519	519
Adjusted R^2	0.026	0.115	0.241	0.244

Cluster robust standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Conclusions

- Strong, persistent relationship: Banks with lower capital make riskier loans
- Extra risk-taking by low capital banks pre-crisis associated with substantial increase in foreclosures during financial crisis
- Effects particularly strong for largest banks
- Suggestive evidence of asset substitution problem, but no hard proof

Remaining Questions

- If not asset substitution problem, what else could account for seemingly counterintuitive association between low capital and high risk?
- Is there more direct evidence for lower capital banks making lower NPV loans?
- Expand analysis to more dimensions of bank investing, and to non-bank lenders