Do Credit Market Shocks Affect the Real Economy? Quasi-Experimental Evidence from the Great Recession and "Normal" Economic Times

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Online Appendix

Appendix A: Assumptions Underlying Modified Instrument

Our estimating equation of interest is of the form:

$$\Delta\ln(Y_i) = \gamma X_i + \beta\ln(Q_i) + \varepsilon_i,$$

where *i* indicates a county and Y_i is a county-level outcome variable. The outcome is a function of covariates, X_i, and loan originations in county *i*, $\ln(Q_i)$.

A standard formulation of the Bartik instrument is:

$$(A1)\ Z_i = \sum_j (ms_{ij} * (\Delta\ln(Q_j) - \Delta\ln(Q)),$$

where county *i*'s value of the instrument is the product of (i) the beginning of period market shares of banks in its county and (ii) the difference between each bank's national change in lending and the economy-wide change in lending, summed over all banks in the county.

Consider a simple model of credit demand and supply where credit supply of a bank to a county is perfectly elastic and there is county heterogeneity in the elasticity of credit demand. The change in the log "price" of credit for bank *j* in county *i* can be written as

$$\Delta\ln(p_{ij}) = -\varepsilon_{ij}^S,$$

where ε_{ij}^S is a bank/county specific supply shock. We rewrite $\Delta\ln(Q_j)$ as:

$$\Delta\ln(Q_j) = \sum_i (ms^{ij}\varepsilon_i^D - \beta_i ms^{ij}\Delta\ln(p_{ij}))$$

$$= \sum_i (ms^{ij}\varepsilon_i^D + \beta_i ms^{ij}\varepsilon_{ij}^S)$$

$$= \sum_i ms^{ij}D_i + S_j,$$

where $\beta_i > 0$ is the county-specific demand elasticity for credit and ms^{ij} is the share of bank *j's* lending in county *i*. Note that we assume there are county-specific demand shocks but not bank-specific demand shocks. The implications of bank-specific shocks are discussed below. Given this model, the Bartik instrument can be written as

$$Z_i = \sum_j ms_{ij}(\sum_i(ms^{ij}\varepsilon_i^D + \beta_i ms^{ij}\varepsilon_{ij}^S) - \Delta\ln(Q)),$$

$$= \sum_j ms_{ij}\sum_i ms^{ij}\,\varepsilon_i^D + \sum_j ms_{ij}\,S_j - \Delta\ln(Q),$$

The first term is the average exposure of banks in county *i* to demand shocks in places where the banks operate. The second term is the average supply shocks across all banks in county *i*. When employing the Bartik instrument it is necessary to assume that both of these terms are uncorrelated with ε_i. However, it is immediately evident that Z_i is a function of ε_i^D so local demand shocks enter directly and are a possible threat to validity.

We instead employ a shift-share approach that is purged of local demand shocks for lending as a partial solution to this problem. Specifically, we estimate an equation that decomposes the contribution of the change in equilibrium credit to county and bank components:

$$\Delta\ln(Q_{ij}) = d_i + s_j + e_{ij},$$

where the outcome variable is the log change in small business lending by bank *j* in county *i*. The vector d_i is a full set of county fixed effects and the parameters of interest are those associated with the vector of bank fixed effects, s_j. They are estimates of change in bank credit purged of banks' differential geographic exposure to small lending shocks. We complement the standard shift-share (Bartik) approach by replacing the change in aggregate bank lending, $\Delta\ln(Q_j)$, in the construction of Z_i in Equation A1 with these estimated bank-specific supply shocks.

To see what we are identifying in estimating this equation with respect to the simple supply and demand model specified above, note that:

$$\hat{s}_j = \frac{1}{I}\sum_{i=1}^{I}(\Delta\ln(Q_{ij}) - \Delta\ln(Q_{i\sim}))$$

$$= \frac{1}{I}\sum_{i=1}^{I}(\varepsilon_i^D + \beta_i\varepsilon_{ij}^S - \frac{1}{J}\sum_{j=1}^{J}(\varepsilon_i^D + \beta_i\varepsilon_{ij}^S))$$

$$= \frac{1}{I}\sum_{i=1}^{I}\beta_i(_i\,\varepsilon_{ij}^S - \frac{1}{J}\sum_{j=1}^{J}\varepsilon_{ij}^S)$$

The estimated bank effect identifies the average supply response for bank *j* relative to the average supply response of banks in counties where *j* operates, weighted by the (possibly heterogeneous) demand elasticity.

The resulting instrument is:

$$Z_i = \sum_{j=1}^{J} ms_{ij}(\frac{1}{I}\sum_{i=1}^{I}\beta_i(_i\,\varepsilon_{ij}^{S} - \frac{1}{J}\sum_{j=1}^{J}\varepsilon_{ij}^{S})).$$

Under this approach, the required assumption is now weaker than when using the unadjusted approach, requiring that counties exposed to banks with above- or below-average supply shocks relative to county averages (weighted by demand elasticities) not have systematically above- or below-average shocks to outcomes. If demand elasticities are heterogeneous, we also require that the magnitude of the elasticity not be systematically related to outcomes.

We made the assumption that county demand shocks have no bank specific component. Suppose that credit demand is instead:

$$\Delta \ln\big(Q_{ij}\big) = \varepsilon_i^D + \varepsilon_j^D - \beta_i \Delta \ln(p_{ij}) = \varepsilon_i^D + \varepsilon_j^D + \beta_i \varepsilon_{ij}^S,$$

meaning that there is a bank specific demand shock that cannot be separately identified from the supply shock. This case would entail an added assumption for the validity of the instrument that banks that have a bigger demand shock are not more likely to be located in hard-hit areas. An example of how this might fail is if banks specialize in lending to certain industries, and if these industries decline relative to others, that will represent a national demand shock to the bank that might be correlated to county outcomes.

Appendix B: Measures of the Federal Policy Response to the Recession

We use county-level data on expenditures related to the American Recovery and Reinvestment Act of 2009 (ARRA) computed by Propublica. These county-level sums are available on their website (https://projects.propublica.org/recovery/), and derive from data scraped from the recovery.gov website which listed all ARRA contracts.

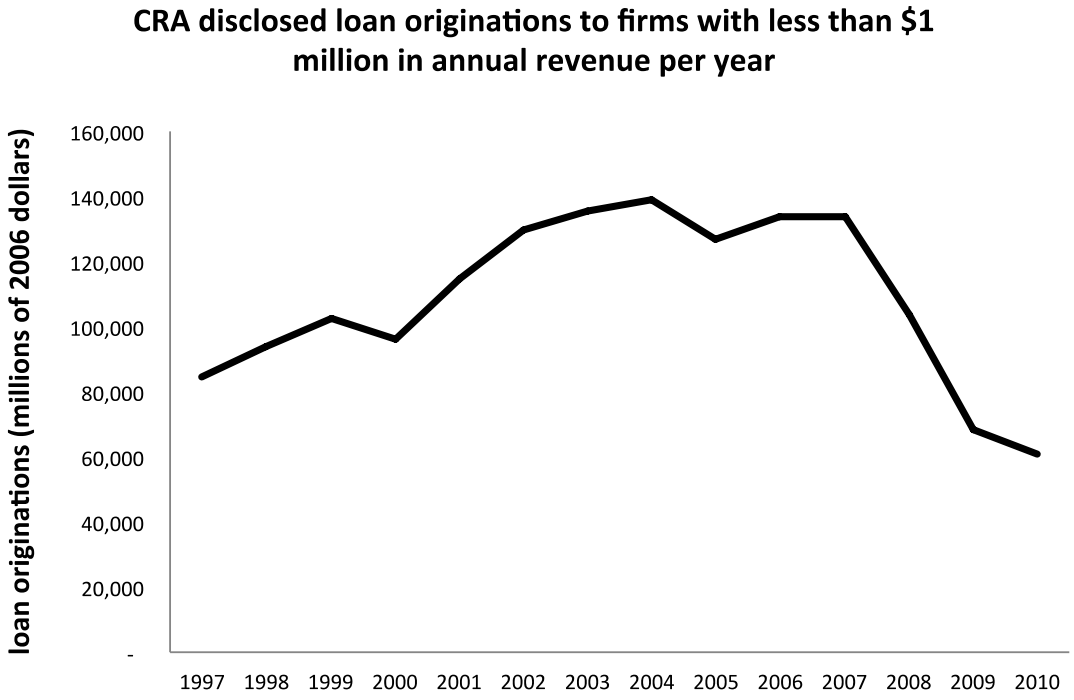
County-level transfer payments are from the BEA's Regional Economics Information System (REIS) and are pulled from "Table CA35: Personal Current Transfer Receipts" under "Local Area Personal Income accounts".

The merge between the REIS and ARRA data is not one-to-one as there are observations in the REIS data with multiple counties grouped together. This is the case for 53 counties (2 in Hawaii, 51 in Virginia) in the universe of 3,164 counties overall. To address this, if counties X and Y are grouped together in the REIS data and not in the ARRA data, we create an observation in the recovery data called $X+Y$, which sums the total stimulus spending for each county.

Likewise, it is also the case that some observations in the recovery data span multiple counties in the transfer payments data. For these, we sum the transfer payments for those counties in order to facilitate the merge with the recovery data.

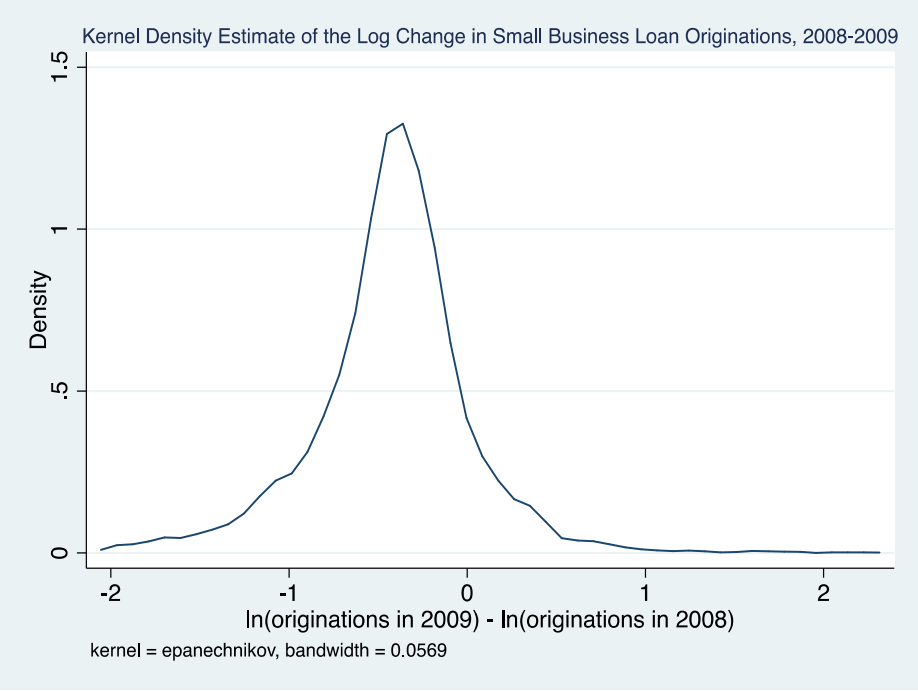
Our resulting merged dataset is at the county-level, with 24 observations with grouped counties.

Appendix Figure 1



Source: Authors' calculation from FFIEC Community Reinvestment Act disclosure data.

Appendix Figure 2



Appendix Table 1: Main effects of the predicted lending shocks

	(1)	(2)	(3)
	Panel A: ln(loan originations)		
2008 shock	-0.3033	0.2754	0.2724
	(0.0753)	(0.0180)	(0.0199)
2009 shock	-0.1044	0.0128	0.0066
	(0.0612)	(0.0171)	(0.0185)
	Panel B: Small standalone firms (LBD)		
	Employment growth		
2008 shock	-0.0038	-0.0010	-0.0007
	(0.0012)	(0.0010)	(0.0010)
2009 shock	-0.0011	-0.0010	-0.0009
	(0.0008)	(0.0007)	(0.0008)
	Establishment growth		
2008 shock	-0.0094	0.0027	0.0049
	(0.0052)	(0.0047)	(0.0052)
2009 shock	-0.0082	-0.0069	-0.0068
	(0.0045)	(0.0042)	(0.0045)
	Panel C: County-level aggregates		
	Employment growth		
2008 shock	-0.0004	0.0005	0.0005
	(0.0006)	(0.0005)	(0.0006)
2009 shock	-0.0002	-0.0007	-0.0007
	(0.0005)	(0.0005)	(0.0005)
	Establishment growth		
2008 shock	-0.0010	0.0001	0.0001
	(0.0005)	(0.0005)	(0.0005)
2009 shock	-0.0006	-0.0007	-0.0007
	(0.0005)	(0.0004)	(0.0004)
State-by-year fixed effects	X	X	X
Baseline controls		X	X
Debt-to-income ratio			X

Notes: Entries are based on estimation of Equation (7). The dependent variables are, respectively, log small business loan originations, small standalone firm employment and establishment growth rates, and county-level aggregate employment and establishment growth rates. Standard errors clustered on county in parentheses. An observation is a county-by-year cell. Shocks refer to predicted loan originations as specified in Equation (4). Baseline controls are 2006 log density, log population, construction share, manufacturing share, and log per capita income. All controls are interacted with year dummies. All main effects are included. Specifications are weighted by 2006 county-level employment. See the text for further details.

Appendix Table 2: Relationship between predicted lending shock and ln(loan originations) for non-CRA banks

	ln(loan originations)
2009 shock * 2009	0.026
	(0.026)
2008 shock * 2009	-0.024
	(0.030)
2008 shock * 2008	-0.055
	(0.031)
Observations	29284

Notes: This table tests whether areas with larger credit shocks experienced increased lending from banks not covered by the CRA. The unit of analysis is commercial banks that are below the CRA asset threshold. The dependent variable is small loan balances from FDIC Call Reports. Standard errors clustered on county in parentheses. Specifications are weighted by 2006 county-level employment. See text for further details.

Appendix Table 3: Effect of predicted lending shock on employment and establishment growth rates for small standalone firms

	Employment growth rate				Establishment growth rate			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2009 shock * 2010	0.0015	0.0018	0.0019	0.0010	0.0081	0.0073	0.0073	0.0018
	(0.0009)	(0.0009)	(0.0010)	(0.0012)	(0.0046)	(0.0043)	(0.0046)	(0.0026)
2009 shock * 2009	0.0011	0.0022	0.0023	0.0017	0.0073	0.0063	0.0058	0.0021
	(0.0010)	(0.0010)	(0.0012)	(0.0013)	(0.0053)	(0.0050)	(0.0055)	(0.0028)
2008 shock * 2010	-0.0003	-0.0019	-0.0018	-0.0038	0.0073	-0.0033	-0.0055	0.0037
	(0.0011)	(0.0010)	(0.0010)	(0.0018)	(0.0051)	(0.0046)	(0.0051)	(0.0025)
2008 shock * 2009	-0.0011	0.0002	-0.0004	-0.0030	0.0079	-0.0061	-0.0101	0.0031
	(0.0014)	(0.0012)	(0.0013)	(0.0022)	(0.0064)	(0.0060)	(0.0067)	(0.0028)
2008 shock * 2008	-0.0024	-0.0002	-0.0006	-0.0039	-0.0066	-0.0105	-0.0137	0.0121
	(0.0009)	(0.0009)	(0.0009)	(0.0019)	(0.0200)	(0.0202)	(0.0224)	(0.0054)
Cumulative effect of 2008 Shock	-0.0038	-0.0019	-0.0029	-0.0107	0.0086	-0.0199	-0.0292	0.0189
	(0.0028)	(0.0024)	(0.0025)	(0.0054)	(0.0265)	(0.0260)	(0.0288)	(0.0092)
Cumulative effect of 2009 Shock	0.0026	0.0040	0.0042	0.0027	0.0154	0.0136	0.0131	0.0039
	(0.0014)	(0.0015)	(0.0018)	(0.0021)	(0.0096)	(0.0088)	(0.0098)	(0.0052)
F-test of joint significance of shock interactions (p-value)	0.03	0.03	0.10	0.04	0.10	0.55	0.47	0.38
Observations	43540	42420	30842	30842	43540	42420	30842	30842
State-by-year fixed effects	X	X	X	X	X	X	X	X
Baseline controls		X	X	X		X	X	X
Debt-to-income ratio			X	X			X	X
Additional Controls				X				X

Note: Entries are based on estimation of Equation (7). The dependent variable in Columns (1)-(4) is the employment growth rate for small standalone firms calculated according to Equation (1). The dependent variable in Columns (5)-(8) is the establishment growth rate for small standalone firms calculated according to Equation (2). Small standalone firms are defined to be single-unit establishments with fewer than 20 employees. Standard errors clustered on county in parentheses. An observation is a county-by-year cell. Shocks refer to predicted loan originations as specified in Equation (4). Baseline controls are 2006 log density, log population, construction share, manufacturing share, and log per capita income. Additional controls are 2000-2006 population growth, fraction college-educated, fraction minority, female labor force participation rate, elderly share of the population, and share foreign-born. All controls are interacted with year dummies. All main effects are included. Specifications are weighted by 2006 county-level employment. See the text for further details.

Appendix Table 4: Effect of predicted lending shock on employment and establishment growth rates for small establishments, NETS data

	Employment growth rate		Establishment growth rate	
	(1)	(2)	(3)	(4)
2009 shock * 2009	0.003	0.002	-0.005	0.003
	(0.001)	(0.001)	(0.004)	(0.001)
2008 shock * 2009	0.009	0.005	0.021	0.005
	(0.002)	(0.001)	(0.004)	(0.002)
2008 shock * 2008	-0.001	0.002	-0.005	0.002
	(0.001)	(0.001)	(0.002)	(0.001)
Cumulative effect of 2008 Shock	0.008	0.007	0.016	0.007
	(0.002)	(0.002)	(0.004)	(0.002)
Cumulative effect of 2009 Shock	0.003	0.002	-0.005	0.003
	(0.001)	(0.001)	(0.004)	(0.001)
F-test of joint significance of shock interactions (p-value)	0.00	0.00	0.00	0.00
Observations	40287	28678	40287	28678
State-by-year fixed effects	X	X	X	X
Baseline controls		X		X
Debt-to-income ratio		X		X

Note: Entries are based on estimation of Equation (7) where the dependent variable is, respectively, the employment or establishment growth rate for small establishments. Small establishments are defined to be those with less than 20 employees. These estimates use the NETS data, which only extends through 2009. Standard errors clustered on county in parentheses. An observation is a county-by-year cell. Shocks refer to predicted loan originations as specified in Equation (4). Baseline controls are 2006 log density, log population, construction share, manufacturing share, and log per capita income. All controls are interacted with year dummies. All main effects are included. Specifications are weighted by 2006 county-level employment. See the text for further details.

Appendix Table 5: Effect of predicted lending shock on employment growth rates for small establishments that are part of multi-unit firms

	LBD: Establishments that are Part of Multi-Unit Firms			NETS: Establishments that are Part of Multi-State Firms		
	(1)	(2)	(3)	(4)	(5)	(6)
2009 shock * 2010	0.0023	0.0015	0.0018			
	(0.0017)	(0.0014)	(0.0016)			
2009 shock * 2009	0.0011	0.0012	0.0012	0.0038	-0.0034	-0.0028
	(0.0011)	(0.0011)	(0.0012)	(0.0050)	(0.0035)	(0.0037)
2008 shock * 2010	0.0017	-0.0029	-0.0034			
	(0.0016)	(0.0015)	(0.0016)			
2008 shock * 2009	0.0020	0.0000	-0.0003	0.0151	-0.0005	-0.0015
	(0.0014)	(0.0013)	(0.0013)	(0.0039)	(0.0033)	(0.0036)
2008 shock * 2008	-0.0003	-0.0010	-0.0009	-0.0041	-0.0100	-0.0100
	(0.0015)	(0.0014)	(0.0015)	(0.0060)	(0.0057)	(0.0060)
Cumulative effect of 2008 shock	0.0034	-0.0039	-0.0047	0.0110	-0.0105	-0.0115
	(0.0034)	(0.0030)	(0.0031)	(0.0070)	(0.0063)	(0.0067)
Cumulative effect of 2009 shock	0.0035	0.0028	0.0030	0.0038	-0.0034	-0.0028
	(0.0023)	(0.0021)	(0.0024)	(0.0050)	(0.0035)	(0.0037)
F-test of joint significance of shock interactions (p-value)	0.18	0.26	0.29	0.00	0.25	0.29
Observations	43503	42406	30842	40184	39142	28678
State-by-year fixed effects	X	X	X	X	X	X
Baseline controls		X	X		X	X
Debt-to-income ratio			X			X

Notes: Entries are based on estimation of Equation (7) where the dependent variable is the employment growth rate for small establishments that are part of multi-unit firms. Small establishments are defined to be those with less than 20 employees. Columns (1)-(3) use the LBD data, which extends through 2010. Columns (4)-(6) use the NETS data, which extends only through 2009. Standard errors clustered on county in parentheses. An observation is a county-by-year cell. Shocks refer to predicted loan originations as specified in Equation (4). Baseline controls are 2006 log density, log population, construction share, manufacturing share, and log per capita income. All controls are interacted with year dummies. All main effects are included. Specifications are weighted by 2006 county-level employment. See the text for further details.

Appendix Table 6: Effect of predicted lending shock on county aggregate outcomes

	Employment growth			Establishment growth		
	(1)	(2)	(3)	(4)	(5)	(6)
2009 shock * 2010	0.0006	0.0008	0.0007	0.0006	0.0012	0.0013
	(0.0009)	(0.0009)	(0.0010)	(0.0005)	(0.0004)	(0.0005)
2009 shock * 2009	0.0027	0.0026	0.0027	0.0007	0.0015	0.0016
	(0.0011)	(0.0011)	(0.0012)	(0.0005)	(0.0005)	(0.0006)
2008 shock * 2010	0.0017	0.0002	0.0004	-0.0012	-0.0013	-0.0015
	(0.0011)	(0.0010)	(0.0011)	(0.0007)	(0.0005)	(0.0006)
2008 shock * 2009	-0.0012	-0.0003	-0.0010	-0.0002	-0.0003	-0.0007
	(0.0014)	(0.0012)	(0.0013)	(0.0008)	(0.0007)	(0.0007)
2008 shock * 2008	-0.0002	0.0012	0.0007	-0.0002	0.0006	0.0004
	(0.0010)	(0.0009)	(0.0010)	(0.0005)	(0.0004)	(0.0005)
Cumulative effect of 2008 shock	0.0004	0.0012	0.0001	-0.0016	-0.0011	-0.0018
	(0.0028)	(0.0024)	(0.0026)	(0.0018)	(0.0014)	(0.0015)
Cumulative effect of 2009 shock	0.0033	0.0034	0.0034	0.0013	0.0027	0.0028
	(0.0017)	(0.0017)	(0.0019)	(0.0010)	(0.0009)	(0.0010)
F-test of joint significance of shock interactions (p-value)	0.017	0.176	0.313	0.111	0.001	0.010
Observations	42947	41973	30830	42947	41973	30830
State-by-year fixed effects	X	X	X	X	X	X
Baseline controls		X	X		X	X
Debt-to-income ratio			X			X

Notes: Entries are based on estimation of Equation (7) where the dependent variables are, respectively, county-level employment and establishment growth. We use the average of the growth rates from the CBP and QCEW. Standard errors clustered on county in parentheses. An observation is a county-by-year cell. Shocks refer to predicted loan originations as specified in Equation (4). Baseline controls are 2006 log density, log population, construction share, manufacturing share, and log per capita income. All controls are interacted with year dummies. All main effects are included. Specifications are weighted by 2006 county-level employment. See the text for further details.

Appendix Table 7: OLS Models of the Relationship Between Economic Activity and Small Business Loan Originations

	LBD	CBP/QCEW
	(1)	(2)
ln(loan originations) (t)	0.0007	0.0010
	(0.0010)	(0.0009)
ln(loan originations) (t-1)	-0.0026	-0.0028
	(0.0011)	(0.0008)
Observations	39359	39001

Notes: Entries show OLS estimates of the relationship between small business lending and employment. The dependent variable in Column (1) is small business employment growth. The dependent variable in Column (2) is county-level employment growth. All models include state-by-year fixed effects along with baseline controls (2006 log density, log population, construction share, manufacturing share, and log per capita income) interacted with year dummies. All main effects are included. Specifications are weighted by 2006 county-level employment. See text for further details.