

Online Appendix

Fiscal Policy and Credit Supply in a Crisis

Diana Bonfim* Miguel A. Ferreira[†] Francisco Queiró[‡]
Sujiao (Emma) Zhao[§]

December 4, 2024

A Proofs

A.1 Derivation of aggregate credit and output

Household optimization implies that labor supply satisfies:

$$L = w^{\frac{1}{\phi}} \quad (1)$$

$$l_i = L \left(\frac{w_i}{w} \right)^{\alpha}. \quad (2)$$

Using the expression for l_i , product demand $y_i = Y p_i^{-\sigma}$ and the production function $y_i = z_i l_i$, firm profits can be expressed as:

$$\Pi_i = \max_{l_i} (z_i l_i)^{\frac{\sigma-1}{\sigma}} Y^{\frac{1}{\sigma}} - R_i w L^{-\frac{1}{\alpha}} l_i^{\frac{\alpha+1}{\alpha}}. \quad (3)$$

*Banco de Portugal, ECB, Católica Lisbon and CEPR. Email: dbonfim@bportugal.pt.

[†]Nova School of Business and Economics, ECGI and CEPR. Email: miguel.ferreira@novasbe.pt.

[‡]Nova School of Business and Economics. Email: francisco.queiro@novasbe.pt.

[§]Banco de Portugal, Católica Lisbon and Cef.Up. Email: szhao@bportugal.pt.

The FOC for l_i gives:

$$l_i = \left(\frac{\sigma}{\sigma - 1} \right)^{-\sigma \frac{\alpha}{\alpha + \sigma}} (Y w^{-\sigma})^{\frac{\alpha}{\alpha + \sigma}} z_i^{(\sigma - 1) \frac{\alpha}{\alpha + \sigma}} L^{\frac{\sigma}{\alpha + \sigma}} R_i^{-\sigma \frac{\alpha}{\alpha + \sigma}}. \quad (4)$$

Elevating to $\frac{\alpha + 1}{\alpha}$, integrating over firms, elevating to $\frac{\alpha}{\alpha + 1}$ and re-arranging gives:

$$L = \left(\frac{\sigma}{\sigma - 1} \right)^{-\sigma} Y w^{-\sigma} \left(\int_0^1 z_i^{\frac{(\alpha + 1)(\sigma - 1)}{\alpha + \sigma}} di \right)^{\frac{\alpha + \sigma}{\alpha + 1}} \left(\int_0^1 R_i^{-\sigma \frac{\alpha + 1}{\alpha + \sigma}} di \right)^{\frac{\alpha + \sigma}{\alpha + 1}}. \quad (5)$$

Using equation (5) to plug in for $Y w^{-\sigma}$ in equation (4) yields:

$$l_i = L z_i^{(\sigma - 1) \frac{\alpha}{\alpha + \sigma}} R_i^{-\sigma \frac{\alpha + 1}{\alpha + \sigma}} \left(\int_0^1 z_i^{\frac{(\alpha + 1)(\sigma - 1)}{\alpha + \sigma}} di \right)^{-\frac{\alpha}{\alpha + 1}} \left(\int_0^1 R_i^{-\sigma \frac{\alpha + 1}{\alpha + \sigma}} di \right)^{-\frac{\alpha}{\alpha + 1}}. \quad (6)$$

Multiplying equation (6) by z_i gives an expression for y_i . Elevating that expression to $\frac{\sigma - 1}{\sigma}$, integrating over firms, elevating to $\frac{\sigma}{\sigma - 1}$ and re-arranging gives:

$$Y = LZ \left(\int_0^1 R_i^{-\sigma \frac{\sigma - 1}{\alpha + \sigma}} di \right)^{\frac{\sigma}{\sigma - 1}} \left(\int_0^1 R_i^{-\sigma \frac{\alpha + 1}{\alpha + \sigma}} di \right)^{-\frac{\alpha}{\alpha + 1}}, \quad (7)$$

where $Z \equiv \left(\int_0^1 z_i^{\frac{(\alpha + 1)(\sigma - 1)}{\alpha + \sigma}} di \right)^{\frac{\alpha + \sigma}{(\alpha + 1)(\sigma - 1)}}$.

Aggregate credit must equal the aggregate wage bill:

$$Q = Lw = L^{1 + \phi}, \quad (8)$$

where the second equality follows from equation (1). Using equations (1) and (7) to plug in for w and Y into equation (5) and combining it with equation (8) leads to:

$$Q = \left(\frac{\sigma - 1}{\sigma} \frac{Z}{R} \right)^{\frac{1}{\phi} + 1}, \quad (9)$$

where $R \equiv \left(\int_0^1 R_i^{-\alpha \frac{\sigma-1}{\alpha+\sigma}} di \right)^{-\frac{1}{\sigma-1}} \left(\int_0^1 R_i^{-\sigma \frac{\alpha+1}{\alpha+\sigma}} di \right)^{-\frac{1}{\alpha+1}}$ is the composite aggregate lending rate.

The remaining step is to solve for R . The definition of R_i in equation (12) and the loan pricing rule in equation (13) imply that $R_i = \frac{\theta}{\theta-1} v_i^{\frac{1}{\eta}}$, where $v_i \equiv \left(\int_0^1 \omega_{ib} v_b^{\frac{1-\theta}{\eta}} db \right)^{\frac{\eta}{1-\theta}}$. Multiplying the expression for l_i in equation (6) by w_i gives an expression for firm-level credit demand q_i . Using equations (1), (2) and (8) to plug in for w , w_i and L in the resulting expression, q_i can be expressed as:

$$q_i = Q \left(\frac{z_i}{Z} \right)^{\frac{(\alpha+1)(\sigma-1)}{\alpha+\sigma}} \frac{v_i^{-\frac{\sigma}{\eta} \frac{\alpha+1}{\alpha+\sigma}}}{\int_0^1 v_i^{-\frac{\sigma}{\eta} \frac{\alpha+1}{\alpha+\sigma}} di}. \quad (10)$$

Plugging for q_i into equation (11), integrating over firms and using equations (13) and (14) gives:

$$v_b e_b = Q \frac{\int_0^1 v_i^{-\frac{\sigma}{\eta} \frac{\alpha+1}{\alpha+\sigma} - \theta} di}{\int_0^1 v_i^{-\frac{\sigma}{\eta} \frac{\alpha+1}{\alpha+\sigma}} di} v_b^{-\frac{\theta}{\eta}}. \quad (11)$$

Solving equation (11) for v_b and plugging into v_i yields:

$$v_i = \left[\int_0^1 \omega_{ib} \left(Q \frac{\int_0^1 v_i^{-\frac{\sigma}{\eta} \frac{\alpha+1}{\alpha+\sigma} - \theta} di}{\int_0^1 v_i^{-\frac{\sigma}{\eta} \frac{\alpha+1}{\alpha+\sigma}} di} e_b \right)^{\frac{1-\theta}{\eta+\theta}} db \right]^{\frac{\eta}{1-\theta}}. \quad (12)$$

Raising both sides to $-\frac{\sigma(\alpha+1)}{\alpha+\sigma}$, integrating over firms, and solving for $\int_0^1 v_i^{-\frac{\sigma}{\eta} \frac{\alpha+1}{\alpha+\sigma}} di$:

$$\int_0^1 v_i^{-\frac{\sigma}{\eta} \frac{\alpha+1}{\alpha+\sigma}} di = \left[\left(Q \int_0^1 v_i^{-\frac{\sigma}{\eta} \frac{\alpha+1}{\alpha+\sigma} - \theta} di \right)^{-\frac{\sigma(\alpha+1)}{(1+\frac{\theta}{\eta})(\alpha+\sigma)}} \int_0^1 e_i^{\frac{\sigma(\alpha+1)}{(1+\frac{\theta}{\eta})(\alpha+\sigma)}} di \right]^{\frac{(1+\frac{\theta}{\eta})(\alpha+\sigma)}{(1+\frac{\theta}{\eta})(\alpha+\sigma) - \sigma(\alpha+1)}} \quad (13)$$

where:

$$e_i \equiv \left(\int_0^1 \omega_{ib} e_b^{-\frac{1-\theta}{\eta+\theta}} db \right)^{-\frac{\eta+\theta}{1-\theta}}. \quad (14)$$

Plugging into equation (12), raising both sides to $-\frac{\sigma \frac{\alpha+1}{\alpha+\sigma} - \theta}{\eta}$, integrating over firms, and solving for $\int_0^1 v_i^{-\frac{\sigma \frac{\alpha+1}{\alpha+\sigma} - \theta}{\eta}} di$:

$$\int_0^1 v_i^{-\frac{\sigma \frac{\alpha+1}{\alpha+\sigma} - \theta}{\eta}} di = \left(\frac{Q}{\int_0^1 e_i^{\frac{\sigma(\alpha+1)}{(1+\frac{\theta}{\eta})(\alpha+\sigma)}} di} \right)^{\frac{\frac{\theta}{\eta}(\alpha+\sigma) - \sigma(\alpha+1)}{\alpha+\sigma}} \left(\int_0^1 e_i^{-\frac{\frac{\theta}{\eta}(\alpha+\sigma) - \sigma(\alpha+1)}{(1+\frac{\theta}{\eta})(\alpha+\sigma)}} di \right)^{\frac{(1+\frac{\theta}{\eta})(\alpha+\sigma) - \sigma(\alpha+1)}{\alpha+\sigma}}. \quad (15)$$

Using equations (12), (13) and (15), v_i can be expressed as:

$$v_i = \frac{Q}{\int_0^1 e_i^{\frac{\sigma(\alpha+1)}{(\eta+\theta)(\alpha+\sigma)}} di} \frac{\int_0^1 e_i^{-\frac{\theta(\alpha+\sigma) - \sigma(\alpha+1)}{(\eta+\theta)(\alpha+\sigma)}} di}{e_i^{\frac{\eta}{\eta+\theta}}}, \quad (16)$$

which implies that:

$$R_i = \frac{\theta}{\theta - 1} \left(\frac{Q}{\int_0^1 e_i^{\frac{\sigma(\alpha+1)}{(\eta+\theta)(\alpha+\sigma)}} di} \frac{\int_0^1 e_i^{-\frac{\theta(\alpha+\sigma) - \sigma(\alpha+1)}{(\eta+\theta)(\alpha+\sigma)}} di}{e_i^{\frac{\eta}{\eta+\theta}}} \right)^{\frac{1}{\eta}}. \quad (17)$$

Using equation (17) to plug in for R_i leads to an expression for R as a function of aggregate leverage:

$$R = \frac{\theta}{\theta - 1} \left(\frac{Q}{E} \right)^{\frac{1}{\eta}}, \quad (18)$$

where

$$E \equiv \frac{\left(\int_0^1 e_i^{\frac{\sigma(\alpha+1)}{(\eta+\theta)(\alpha+\sigma)}} di \right)^{\frac{\eta}{\sigma-1}} \left(\int_0^1 e_i^{\frac{\sigma(\alpha+1)}{(\eta+\theta)(\alpha+\sigma)}} di \right)^{\frac{\eta+\alpha+1}{\alpha+1}}}{\int_0^1 e_i^{-\frac{\theta(\alpha+\sigma) - \sigma(\alpha+1)}{(\eta+\theta)(\alpha+\sigma)}} di}. \quad (19)$$

Using equation (18) to plug in for R in equation (9) gives the final expression for ag-

gregate credit:

$$Q = \left[\frac{(\sigma - 1)(\theta - 1)}{\sigma\theta} Z E^{\frac{1}{\eta}} \right]^{\frac{\eta(\frac{1}{\phi} + 1)}{\eta + \frac{1}{\phi} + 1}}. \quad (20)$$

Using equations (8) and (17) to plug in for L and R_i in equation (7) gives the final expression for aggregate output:

$$Y = Q^{\frac{1}{\phi+1}} Z \left(\int_0^1 e_i^{\frac{\alpha(\sigma-1)}{(\eta+\theta)(\alpha+\sigma)}} di \right)^{\frac{\sigma}{\sigma-1}} \left(\int_0^1 e_i^{\frac{\sigma(\alpha+1)}{(\eta+\theta)(\alpha+\sigma)}} di \right)^{-\frac{\alpha}{\alpha+1}}. \quad (21)$$

A.2 Proof of Proposition 1

Using equation (16) to plug in for v_i in equation (11) and solving for v_b gives:

$$v_b = \frac{Q}{\int_0^1 e_i^{\frac{\sigma(\alpha+1)}{(\eta+\theta)(\alpha+\sigma)}} di} \frac{\int_0^1 e_i^{-\frac{\theta(\alpha+\sigma)-\sigma(\alpha+1)}{(\eta+\theta)(\alpha+\sigma)}} di}{e_b^{\frac{\eta}{\eta+\theta}}}. \quad (22)$$

Using equation (10) to plug in for q_i in equation (11), and the expressions for v_i and v_b from equations (16) and (22), bank-firm level credit demand can be expressed as:

$$q_{ib} = Q \left(\frac{z_i}{Z} \right)^{\frac{(\alpha+1)(\sigma-1)}{\alpha+\sigma}} \frac{e_i^{\frac{\sigma(\alpha+1)}{(\eta+\theta)(\alpha+\sigma)}}}{\int_0^1 e_i^{\frac{\sigma(\alpha+1)}{(\eta+\theta)(\alpha+\sigma)}} di} \omega_{ib} \left(\frac{e_b}{e_i} \right)^{\frac{\theta}{\theta+\eta}}, \quad (23)$$

Let $\hat{x} = \frac{dx}{x}$. The model analog of our bank-firm credit regression is then:

$$\hat{q}_{ib} = \hat{Q} - \hat{\Theta} + \frac{\sigma(\alpha+1) - \theta(\alpha+\sigma)}{(\eta+\theta)(\alpha+\sigma)} \hat{e}_i + \frac{\theta}{\theta+\eta} \hat{e}_b, \quad (24)$$

where $\Theta \equiv \int_0^1 e_i^{\frac{\sigma(\alpha+1)}{(\eta+\theta)(\alpha+\sigma)}} di$ and $\hat{z}_i = \hat{T}_{ib} = 0$ by assumption. Using equation (15) and

evaluating at the initial point where $e_b = \bar{e}$, we get:

$$\hat{q}_{ib} = \hat{Q} - \hat{\Theta} + \frac{\sigma(\alpha + 1) - \theta(\alpha + \sigma)}{(\eta + \theta)(\alpha + \sigma)} \hat{e}_i + \beta u_b, \quad (25)$$

where

$$\beta = -\rho \bar{v} \frac{\theta}{\theta + \eta}. \quad (26)$$

A.3 Proof of Proposition 2

Taking the log of Q in equation (20) and differentiating with respect to u gives:

$$\frac{d \log Q}{du} = \frac{\frac{1}{\phi} + 1}{\eta + \frac{1}{\phi} + 1} \frac{d \log E}{du}, \quad (27)$$

Using equation (19) to evaluate $\frac{d \log E}{du}$, we get:

$$\frac{d \log E}{du} = \frac{\eta}{\sigma - 1} x_1 \frac{\int_0^1 e_i^{x_1-1} \frac{de_i}{du} di}{\int_0^1 e_i^{x_1} di} + \frac{\eta + \alpha + 1}{\alpha + 1} x_2 \frac{\int_0^1 e_i^{x_2-1} \frac{de_i}{du} di}{\int_0^1 e_i^{x_2} di} - x_3 \frac{\int_0^1 e_i^{x_3-1} \frac{de_i}{du} di}{\int_0^1 e_i^{x_3} di}, \quad (28)$$

where $x_1 \equiv \frac{\alpha(\sigma-1)}{(\eta+\theta)(\alpha+\sigma)}$, $x_2 \equiv \frac{\sigma(\alpha+1)}{(\eta+\theta)(\alpha+\sigma)}$ and $x_3 \equiv -\frac{\theta(\alpha+\sigma)-\sigma(\alpha+1)}{(\eta+\theta)(\alpha+\sigma)}$.

Differentiating equation (14) yields:

$$\frac{de_i}{du} = e_i \frac{\int_0^1 \omega_{ib} e_b^{-\frac{1-\theta}{\eta+\theta}-1} \frac{de_b}{du} db}{\int_0^1 \omega_{ib} e_b^{-\frac{1-\theta}{\eta+\theta}} db}. \quad (29)$$

Equation (15) implies:

$$\frac{de_b}{du} = -e_b \rho v_b \int_0^1 \frac{q_{ib}}{q_b} (1 - \tau_i) di. \quad (30)$$

Combining the last three equations and evaluating at the initial point where $e_b = \bar{e}$, all equity terms cancel, and we get:

$$\frac{d \log E}{du} = -\rho \bar{v} \int_0^1 \int_0^1 \omega_{ib} \int_0^1 \frac{q_{ib}}{\bar{q}_b} (1 - \tau_i) di db di \quad (31)$$

$$= -\rho \bar{v} \int_0^1 \int_0^1 \omega_{ib} \int_0^1 \omega_{ib} (1 - \tau_i) di db di \quad (32)$$

$$= -\rho \bar{v}, \quad (33)$$

where the second line follows from evaluating equation (23) at the initial point, and using the fact that z_i and ω_{ib} are independent.

Let $\psi \equiv -\frac{d \log Q}{d \log R} = \frac{1}{\phi} + 1$, which follows from equation (9). Using this and equation (33) to plug into equation (27) gives:

$$\frac{d \log Q}{du} = -\frac{\psi}{\psi + \eta} \rho \bar{v} \quad (34)$$

$$= -\frac{\psi}{\theta} \frac{\theta + \eta}{\psi + \eta} \beta, \quad (35)$$

where the second line uses equation (26).

A.4 Proof of Proposition 3

Differentiating the log of equation (21), using equations (29) and (30) and evaluating at the initial point gives:

$$\frac{d \log Y}{du} = \frac{1}{1 + \phi} \frac{d \log Q}{du}. \quad (36)$$

A.5 Coefficient on exposure at the firm level

Combining equations (10) and (16), firm-level credit can be expressed as:

$$q_i = Q \left(\frac{z_i}{Z} \right)^{\frac{(\alpha+1)(\sigma-1)}{\alpha+\sigma}} \frac{e_i^{\frac{\sigma}{\eta+\theta} \frac{\alpha+1}{\alpha+\sigma}}}{\int_0^1 e_i^{\frac{\sigma}{\eta+\theta} \frac{\alpha+1}{\alpha+\sigma}} di}. \quad (37)$$

Letting $\hat{x} = \frac{dx}{\bar{x}}$, the model counterpart of our firm-level credit regression is:

$$\hat{Q}_i = \hat{Q} - \hat{\Theta} + \frac{\sigma}{\eta + \theta} \frac{\alpha + 1}{\alpha + \sigma} \hat{e}_i, \quad (38)$$

where $\Theta \equiv \int_0^1 e_i^{\frac{\sigma(\alpha+1)}{(\eta+\theta)(\alpha+\sigma)}} di$ and $\hat{z}_i = 0$ by assumption. Using equations (29) and (30) and evaluating at the initial point where $e_b = \bar{e}$, we get:

$$\hat{Q}_i = \hat{Q} - \hat{\Theta} + \beta_{firm} u_i, \quad (39)$$

where $u_i \equiv \int_0^1 \omega_{ib} \int_0^1 \frac{q_{ib}}{\bar{q}_b} (1 - \tau_i) di db$ is the model counterpart of our empirical measure of firm-level procurement exposure, and β_{firm} is given by:

$$\beta_{firm} = -\frac{\sigma}{\eta + \theta} \frac{\alpha + 1}{\alpha + \sigma} \rho \bar{v}. \quad (40)$$

Using equation (26), θ can then be expressed as:

$$\theta = \frac{\beta}{\beta_{firm}} \sigma \frac{\alpha + 1}{\alpha + \sigma}. \quad (41)$$

B Appendix Tables

Table B.1: Summary statistics for public procurement contracts

	Mean	P10	Median	P90	% of contracts	% of value
Total	132,217	523	12,132	95,950	100.00	100.00
By Procedure						
Open	821,491	8,695	128,565	1,299,385	6.40	39.74
Outright Award	37,051	471	10,910	67,146	92.75	25.99
Restricted	5,308,300	83,240	1,215,998	15061965	0.61	24.50
Negotiated	5,233,682	34,991	163,698	2,352,789	0.25	9.77
By Buyer						
Central	216,312	340	9,600	109,270	41.38	67.69
Local	72,883	2,100	14,985	99,966	58.62	32.31
By Product						
Construction work	452,950	2,900	25,000	391,849	16.18	55.42
Health and social work	1,248,029	222	7,400	52,800	0.97	9.20
Energy	615,271	3,491	26,659	717,725	1.18	5.48
Sewage, refuse and cleaning	133,581	2,800	18,350	146,376	3.31	3.35
Architecture and engineering	57,543	1,878	19,468	127,411	7.07	3.08
Business services	47,040	3,000	15,300	71,320	8.32	2.96
Medical equipment, pharmaceuticals	45,480	190	5,325	78,795	6.78	2.33
Repair and maintenance	51,366	177	6,030	49,500	5.25	2.04
IT services	59,091	5,665	22,605	114,453	3.53	1.58
Office and computing equipment	35,808	153	5,494	38,481	5.38	1.46
Transport equipment	49,038	204	11,997	75,580	3.33	1.23
Hotel, restaurant and retail trade	79,822	1,000	11,108	117,000	1.61	0.97
Construction materials	41,419	345	11,282	62,000	3.00	0.94
Other community services	32,586	402	11,500	52,549	3.77	0.93
Industrial machinery	103,514	608	10,451	51,332	1.12	0.88
Transport services	51,906	268	10,388	64,134	1.92	0.75
Furniture and domestic products	26,467	1,375	10,883	57,960	3.26	0.65
Software	45,130	3,875	16,330	76,781	1.60	0.55
Printed matter	47,886	218	8,194	41,450	1.47	0.53
Agriculture, forestry and fisheries	104,254	1,900	11,200	52,800	0.66	0.52
Other	33,540	395	9,172	54,000	20.29	5.15

This table reports summary statistics for public procurement contracts in 2010. Products are based on two-digit Common Procurement Vocabulary (CPV) codes.

Table B.2: Large procurement cuts in the OECD (1995-2018)

Episode	% cut	Cut as a % of GDP	Composition of procurement cut (%)			Banking crisis	IMF/EU bailout	Sovereign default or restructuring
			Gross fixed capital formation	Inter- mediate cons.	Social transfers in kind			
Greece, 2009-2013	46.37	7.19	42.38	42.22	15.39	1.00	1.00	1.00
Portugal, 2010-2014	32.37	4.32	78.69	12.36	8.94	1.00	1.00	1.00
Spain, 2009-2014	28.99	4.02	77.80	12.97	9.23	1.00	1.00	0.00
Ireland, 2008-2013	28.50	3.61	91.04	21.75	-12.79	1.00	1.00	1.00
Slovak Republic, 1997-1999	24.49	3.98	59.74	45.67	-5.41	1.00	0.00	0.00
Lithuania, 2008-2009	18.92	2.40	67.54	31.24	1.22	0.00	0.00	0.00
Iceland, 2008-2010	17.60	2.90	62.19	36.27	1.54	1.00	1.00	0.00
Estonia, 2008-2010	17.19	2.43	80.94	19.14	-0.07	0.00	0.00	0.00
Czech Republic, 2009-2013	15.67	2.58	85.22	25.54	-10.76	0.00	0.00	0.00
Luxembourg, 2005-2006	14.92	1.87	85.50	8.85	5.65	0.00	0.00	0.00
Italy, 2009-2014	14.33	1.74	80.07	6.94	12.99	1.00	0.00	0.00
Norway, 1998-2000	11.52	1.50	68.32	26.01	5.67	0.00	0.00	0.00
Greece, 2004-2005	10.52	1.51	82.38	29.60	-11.98	0.00	0.00	0.00
United States, 2010-2014	10.51	1.22	44.19	55.81	-0.00	1.00	0.00	0.00
Slovenia, 2015-2016	10.32	1.41	107.72	-3.09	-4.63	0.00	0.00	0.00
Latvia, 2015-2016	10.30	1.31	89.00	24.04	-13.04	0.00	0.00	0.00
Average	19.53	2.75	75.17	24.71	0.12	0.50	0.31	0.19

This table characterizes the 16 episodes of cuts to real procurement spending of at least 10% we identify among OECD countries between 1995 and 2018. When cuts happen in consecutive years, we consider them to be part of the same episode. We drop cases where procurement increased by 10% or more in the year prior to the cuts, to exclude the effect of transitory spending fluctuations. Data on banking crises are from Laeven and Valencia (2020), data on IMF bailouts are from IMF (2022) (we add the 2012 EU bailout of Spain, in which the IMF did not participate) and data on sovereign defaults and restructurings are from Beers et al. (2021).

Table B.3: Summary statistics for government contractors

	Procurement/sales for contractors				Contractors/all firms			
	Mean	P10	Median	P90	Firms	Value added	Empl.	Credit
Total	0.18	0.00	0.06	0.57	0.05	0.33	0.26	0.19
By Sector								
Agriculture and farming	0.24	0.01	0.13	0.77	0.01	0.03	0.04	0.02
Mining and quarrying	0.11	0.01	0.03	0.25	0.10	0.17	0.30	0.28
Manufacturing	0.08	0.00	0.02	0.21	0.05	0.25	0.15	0.22
Electricity, gas, steam, water, air	0.07	0.00	0.01	0.10	0.02	0.30	0.44	0.10
Water and waste management	0.12	0.00	0.03	0.41	0.12	0.18	0.26	0.14
Construction	0.22	0.01	0.12	0.59	0.07	0.49	0.39	0.21
Wholesale and retail trade	0.07	0.00	0.02	0.19	0.05	0.34	0.28	0.25
Transportation and storage	0.18	0.00	0.07	0.50	0.02	0.18	0.13	0.24
Accommodation and food service	0.09	0.00	0.03	0.21	0.01	0.22	0.16	0.26
Information and communication	0.22	0.01	0.10	0.63	0.11	0.74	0.53	0.51
Real estate	0.31	0.00	0.18	1.00	0.00	0.02	0.02	0.01
Consulting	0.32	0.02	0.19	0.94	0.07	0.33	0.27	0.19
Administrative services	0.21	0.01	0.08	0.64	0.09	0.52	0.57	0.44
Education	0.31	0.01	0.17	1.00	0.04	0.24	0.19	0.26
Human health and social work	0.20	0.00	0.09	0.58	0.01	0.12	0.10	0.16
Arts, entertainment, sports	0.34	0.03	0.25	0.91	0.08	0.38	0.26	0.23
Other service	0.20	0.01	0.08	0.64	0.01	0.09	0.04	0.04

This table reports mean, 10th-percentile (P10), median and 90th-percentile (P90) for the share of public procurement contracts in sales for the sample of firms with procurement contracts in 2009-2010. The table also reports the share of these firms in the universe of non-financial firms in Portugal in terms of number of firms, value added, employment and corporate credit in 2010.

Table B.4: Direct effect of procurement cuts on government contractors

	Value added (1)	NPL ratio (2)
Contract Cut	-1.046 (0.058)	0.142 (0.015)
Observations	13,402	13,402
Adjusted R^2	0.070	0.088

This table presents estimates of the direct effect of procurement cuts on government contractors. Column 1 presents estimates of a regression of log of cumulative value added growth between 2010 and 2015, defined analogously to cumulative credit growth in equation (3), on the firm's procurement cut as a fraction of sales. Procurement cuts are defined in equation (2) and sales are the 2009-2010 average. Column 2 presents estimates of a regression of the average change in the firm's NPL ratio between 2010Q4 and each quarter between 2011Q1 and 2015Q4 on the firm's procurement cut as a fraction of sales. The sample is restricted to government contractors with credit outstanding in 2010Q4. Both regressions control for log total assets, return on assets, leverage, and the current ratio. Robust standard errors are reported in parentheses.

Table B.5: Additional robustness tests: bank-firm level credit

Panel A. Alternative exposure measures				
	NPL growth (1)	Procurement/ sales (2)	Include procurement increases (3)	Winsorize exposure (4)
Procurement Exposure	-3.169 (0.536)	-1.822 (0.575)	-2.444 (0.792)	-2.463 (0.682)
BM degrees of freedom	3.4	3.4	3.7	3.3
Observations	76,289	76,289	76,289	76,289
Adjusted R^2	0.070	0.066	0.067	0.067

Panel B. Alternative samples				
	Single relationship firms (1)	Drop high procurement sectors (2)	Contractor sample (3)	Weighted (4)
Procurement Exposure	-2.719 (0.530)	-2.541 (0.598)	-2.928 (0.891)	-2.444 (0.678)
BM degrees of freedom	3.9	3.2	3.2	3.3
Observations	16,820	41,034	16,843	76,289
Adjusted R^2	0.058	0.059	0.086	0.068

This table presents robustness checks for the bank-firm results. The dependent variable is the log cumulative growth in credit between 2010Q4 and 2015Q4. Procurement exposure is the fraction of credit to government contractors in the bank's loan portfolio in 2010Q1, weighted by the share of contract cuts in firm sales. All regressions control for precrisis sovereign debt exposure, total assets, and the equity-to-assets ratio at the bank level, as well as for precrisis log total assets, return on assets, leverage, and the current ratio at the firm level. Panel A uses alternative definitions of procurement exposure. Column 1 replaces procurement cuts with the national growth of NPLs by product (eight-digit CPV). When a firm supplies more than one product, we take the average NPL growth weighted by firm-level contract amounts in 2010. Column 2 replaces procurement cuts with precrisis procurement levels. Column 3 accounts for procurement increases (negative cuts). Column 4 winsorizes procurement exposure at the 2.5th and 97.5th percentiles. Panel B employs alternative samples. Column 1 restricts the sample to firms with a single credit relationship in 2010Q4. Column 2 drops firms in sectors with above median procurement cuts. Column 3 estimates the effect on the sample of government contractors. Column 4 weights observations by log credit. The sample consists of banks with at least 1% of the corporate credit market, firms without public procurement contracts (non-contractors) in 2009-2010, and lending relationships above €25,000 in 2010Q4 that existed in 2009 and 2010. Standard errors in parentheses are clustered at the bank level using the "LZ2" bias-reduction modification of Imbens and Kolesár (2016). The BM degrees of freedom row reports the degrees of freedom suggested by Bell and McCaffrey (2002) to compute t -distribution confidence intervals for the coefficient on procurement exposure.

Table B.6: Robustness: firm-level credit

Panel A. Controls for other shocks to credit supply			
	Construction exposure (1)	Predicted growth in other NPLs (2)	Recapitalization (3)
Procurement Exposure	-1.405 (0.303)	-1.456 (0.294)	-1.343 (0.266)
BM degrees of freedom	4.5	4.3	4.1
Observations	50,346	50,346	50,346
Adjusted R^2	0.087	0.087	0.087

Panel B. Controls for predicted growth in other credit				
	Financing type (1)	Collateral type (2)	Sector (3)	Location (4)
Procurement Exposure	-1.428 (0.310)	-1.415 (0.286)	-1.363 (0.311)	-1.362 (0.308)
BM degrees of freedom	4.2	4.3	4.4	4.8
Observations	50,346	50,346	50,346	50,346
Adjusted R^2	0.087	0.087	0.087	0.087

This table presents robustness checks for the firm-level credit results. The dependent variable is the log cumulative growth in credit between 2010Q4 and 2015Q4. Procurement exposure is the fraction of credit to government contractors in the bank's loan portfolio in 2010Q1, weighted by the share of contract cuts in firm sales. All regressions control for precrisis sovereign debt exposure, total assets, and the equity-to-assets ratio at the bank level, as well as for precrisis log total assets, return on assets, leverage, and the current ratio at the firm level. Panel A presents estimates including controls for other shocks to credit supply. Column 1 adds the share of credit to the construction sector in 2010Q1 to the set of bank controls. Column 2 adds a shift-share predictor of NPL growth for non-contractors during the crisis, in which the shares are bank exposures by sector in 2010Q1 and the shifters are the leave-one-out national changes in NPLs as a share of precrisis credit in each sector between 2010Q1 and 2015Q4. Column 3 adds an indicator for whether a bank was recapitalized. Panel B presents estimates including controls for predicted growth in other credit. Column 1 adds a shift-share predictor of credit growth for non-contractors during the crisis, where the shares are bank exposures by financing type in 2010Q1 and the shifters are the leave-one-out national credit growth rates for each financing type between 2010Q1 and 2015Q4. Columns 2, 3 and 4 add analogous predictors of credit growth based on precrisis exposures to credit collateral types, sectors and municipalities respectively. The sample consists of banks with at least 1% of the corporate credit market, and firms without public procurement contracts (non-contractors) in 2009-2010. Standard errors in parentheses are clustered at the level of the main bank by loan size, using the "LZ2" bias-reduction modification of Imbens and Kolesár (2016). The BM degrees of freedom row reports the degrees of freedom suggested by Bell and McCaffrey (2002) to compute t -distribution confidence intervals for the coefficient on procurement exposure.

Table B.7: Additional robustness tests: firm-level credit

Panel A. Alternative exposure measures				
	NPL growth (1)	Procurement/ sales (2)	Include procurement increases (3)	Winsorize exposure (4)
Procurement Exposure	-1.487 (0.355)	-1.029 (0.265)	-1.477 (0.273)	-1.593 (0.273)
BM degrees of freedom	4.7	4.5	4.7	4.7
Observations	50,346	50,346	50,346	50,346
Adjusted R^2	0.087	0.086	0.087	0.087

Panel B. Alternative samples				
	Single relationship firms (1)	Drop high procurement sectors (2)	Contractor sample (3)	Weighted (4)
Procurement Exposure	-2.050 (0.460)	-1.279 (0.236)	-1.743 (0.440)	-1.347 (0.282)
BM degrees of freedom	4.1	4.2	4.8	4.4
Observations	16,820	27,551	8,306	50,346
Adjusted R^2	0.070	0.082	0.046	0.087

This table presents additional robustness checks for the firm-level credit results. The dependent variable is the log cumulative growth in credit between 2010Q4 and 2015Q4. Procurement exposure is the fraction of credit to government contractors in the bank's loan portfolio in 2010Q1, weighted by the share of contract cuts in firm sales. All regressions control for precrisis sovereign debt exposure, total assets, and the equity-to-assets ratio at the bank level, as well as for precrisis log total assets, return on assets, leverage, and the current ratio at the firm level. Panel A uses alternative definitions of procurement exposure. Column 1 of Panel A replaces procurement cuts with the national growth of NPLs by product (eight-digit CPV). When a firm supplies more than one product, we take the average NPL growth weighted by firm-level contract amounts in 2010. Column 2 replaces procurement cuts with precrisis procurement levels. Column 3 accounts for procurement increases (negative cuts). Column 4 winsorizes procurement exposure at the 2.5th and 97.5th percentiles. Panel B employs alternative samples. Column 1 restricts the sample to firms with a single credit relationship in 2010Q4. Column 2 drops firms in sectors with above median procurement cuts. Column 3 estimates the effect on the sample of government contractors. Column 4 weights observations by log credit. The sample consists of banks with at least 1% of the corporate credit market, and firms without public procurement contracts (non-contractors) in 2009-2010. Standard errors in parentheses are clustered at the level of the main bank by loan size, using the "LZ2" bias-reduction modification of Imbens and Kolesár (2016). The BM degrees of freedom row reports the degrees of freedom suggested by Bell and McCaffrey (2002) to compute t -distribution confidence intervals for the coefficient on procurement exposure.

Table B.8: Robustness: value added

Panel A. Controls for other shocks to credit supply			
	Construction exposure (1)	Predicted growth in other NPLs (2)	Recapitalization (3)
Procurement Exposure	-0.579 (0.201)	-0.558 (0.160)	-0.618 (0.250)
BM degrees of freedom	4.5	4.3	4.1
Observations	50,346	50,346	50,346
Adjusted R^2	0.277	0.277	0.277

Panel B. Controls for predicted growth in other credit				
	Financing type (1)	Collateral type (2)	Sector (3)	Location (4)
Procurement Exposure	-0.563 (0.152)	-0.563 (0.148)	-0.583 (0.139)	-0.570 (0.197)
BM degrees of freedom	4.2	4.3	4.4	4.8
Observations	50,346	50,346	50,346	50,346
Adjusted R^2	0.277	0.277	0.277	0.277

This table presents robustness checks for the firm-level value added results. The dependent variable is the log cumulative growth in value added between 2010 and 2015. Procurement exposure is the fraction of credit to government contractors in the bank's loan portfolio in 2010Q1, weighted by the share of contract cuts in firm sales. All regressions control for precrisis sovereign debt exposure, total assets, and the equity-to-assets ratio at the bank level, as well as for precrisis log total assets, return on assets, leverage, and the current ratio at the firm level. Panel A presents estimates including controls for other shocks to credit supply. Column 1 adds the share of credit to the construction sector in 2010Q1 to the set of bank controls. Column 2 adds a shift-share predictor of NPL growth for non-contractors during the crisis, in which the shares are bank exposures by sector in 2010Q1 and the shifters are the leave-one-out national changes in NPLs as a share of precrisis credit in each sector between 2010Q1 and 2015Q4. Column 3 adds an indicator for whether a bank was recapitalized. Panel B presents estimates including controls for predicted growth in other credit. Column 1 adds a shift-share predictor of credit growth for non-contractors during the crisis, where the shares are bank exposures by financing type in 2010Q1 and the shifters are the leave-one-out national credit growth rates for each financing type between 2010Q1 and 2015Q4. Columns 2, 3 and 4 add analogous predictors of credit growth based on precrisis exposures to credit collateral types, sectors and municipalities respectively. The sample consists of banks with at least 1% of the corporate credit market, and firms without public procurement contracts (non-contractors) in 2009-2010. Standard errors in parentheses are clustered at the level of the main bank by loan size, using the "LZ2" bias-reduction modification of Imbens and Kolesár (2016). The BM degrees of freedom row reports the degrees of freedom suggested by Bell and McCaffrey (2002) to compute t -distribution confidence intervals for the coefficient on procurement exposure.

Table B.9: Additional robustness tests: value added

Panel A. Alternative exposure measures				
	NPL growth (1)	Procurement/ sales (2)	Include procurement increases (3)	Winsorize exposure (4)
Procurement Exposure	-0.434 (0.129)	-0.430 (0.110)	-0.558 (0.156)	-0.651 (0.163)
BM degrees of freedom	4.7	4.5	4.7	4.7
Observations	50,346	50,346	50,346	50,346
Adjusted R^2	0.277	0.277	0.277	0.277

Panel B. Alternative samples				
	Single relationship firms (1)	Drop high procurement sectors (2)	Contractor sample (3)	Weighted (4)
Procurement Exposure	-0.348 (0.279)	-0.622 (0.141)	-0.606 (0.732)	-0.560 (0.160)
BM degrees of freedom	4.1	4.2	4.8	4.3
Observations	16,820	27,551	8,306	50,345
Adjusted R^2	0.252	0.269	0.286	0.285

This table presents additional robustness checks for firm-level value added results. The dependent variable is the log cumulative growth in value added between 2010 and 2015. All regressions control for pre-crisis sovereign debt exposure, total assets, and the equity-to-assets ratio at the bank level, as well as for precrisis log total assets, return on assets, leverage, and the current ratio at the firm level. Panel A uses alternative definitions of procurement exposure. Column 1 of Panel A replaces procurement cuts with the national growth of NPLs by product (eight-digit CPV). When a firm supplies more than one product, we take the average NPL growth weighted by firm-level contract amounts in 2010. Column 2 replaces procurement cuts with precrisis procurement levels. Column 3 accounts for procurement increases (negative cuts). Column 4 winsorizes procurement exposure at the 2.5th and 97.5th percentiles. Panel B employs alternative samples. Column 1 restricts the sample to firms with a single credit relationship in 2010Q4. Column 2 drops firms in sectors with above median procurement cuts. Column 3 estimates the effect on the sample of government contractors. Column 4 weights observations by log value added. The sample consists of banks with at least 1% of the corporate credit market, and firms without public procurement contracts (non-contractors) in 2009-2010. Standard errors in parentheses are clustered at the level of the main bank by loan size, using the “LZ2” bias-reduction modification of Imbens and Kolesár (2016). The BM degrees of freedom row reports the degrees of freedom suggested by Bell and McCaffrey (2002) to compute t -distribution confidence intervals for the coefficient on procurement exposure.

Table B.10: Elasticity of substitution across banks

	(1)	(2)	(3)	(4)
Interest Rate	-6.598 (0.071)	-4.490 (0.080)	-4.537 (0.078)	-4.550 (0.079)
Observations	1,205,360	1,203,176	1,203,046	1,202,865
Adjusted R^2	0.720	0.777	0.786	0.793

This table presents estimates from regressions of log credit on log gross interest rates for new loans in the 2013-2015 period. All columns include bank-year fixed effects and bank-firm fixed effects. Column 2 includes firm-year fixed effects. Column 1 includes firm-year fixed effects. Column 2 includes firm-year-maturity fixed effects, using ten loan maturity bins. Column 3 includes firm-year-maturity-fixed rate fixed effects, where fixed rate is a dummy for whether the loan has a fixed interest rate. Column 4 includes firm-year-maturity-fixed rate-collateral fixed effects, where collateral is a dummy for whether the loan is collateralized. The sample consists of loans issued by banks with at least 1% of the corporate credit market in 2010Q1.

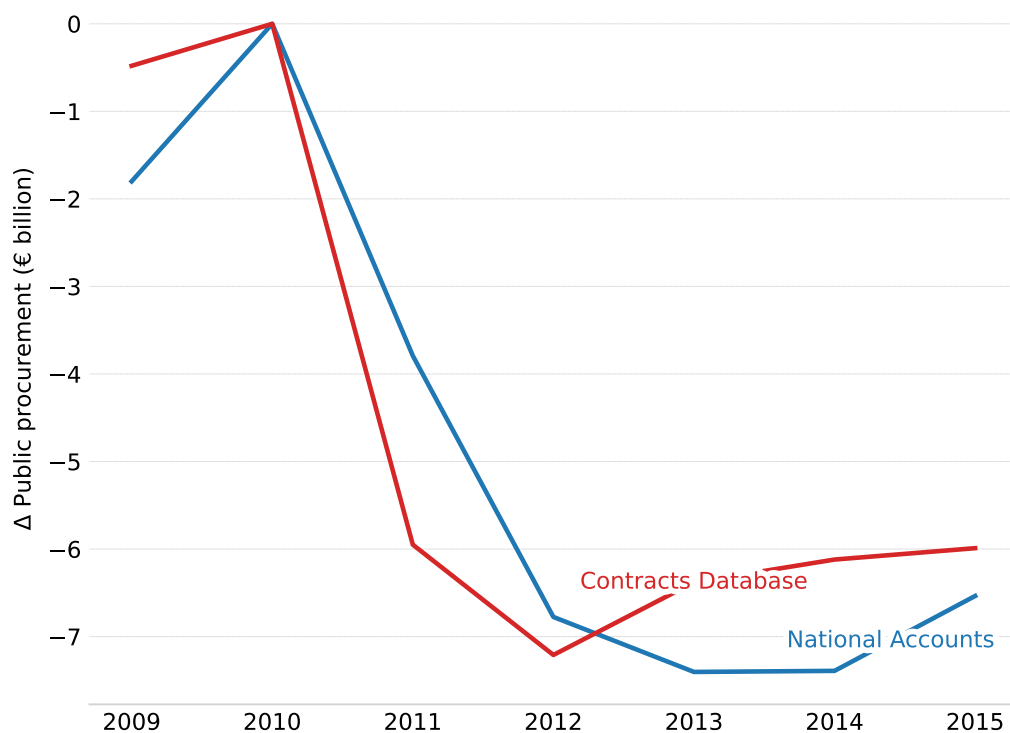
Table B.11: Elasticity of credit supply with respect to bank equity

	First Stage (1)	Second Stage (2)
Procurement Exposure	-2.561 (1.353)	
Equity Growth		0.902 (0.312)
BM degrees of freedom	3.0	2.9
Observations	72,648	72,648
Adjusted R^2	0.363	0.068

This table presents estimates of a 2SLS regression of log cumulative growth in credit at the bank-firm level between 2010Q4 and 2015Q4 on log cumulative growth in bank equity over the same period. Equity growth is instrumented with procurement exposure, defined as the fraction of credit to government contractors in the bank's loan portfolio in 2010Q1, weighted by the share of contract cuts in firm sales. Column 1 shows the first-stage estimates, and column 2 the second-stage estimates. Both regressions control for sovereign debt exposure, total assets, and the equity-to-assets ratio at the bank level, as well as for log total assets, return on assets, leverage, and the current ratio at the firm level. The sample consists of banks with at least 1% of the corporate credit market, firms without public procurement contracts (non-contractors) in 2009-2010, and lending relationships above €25,000 in 2010Q4 that existed in 2009 and 2010. Foreign branches are excluded from the sample. Standard errors in parentheses are clustered at the bank level using the "LZ2" bias-reduction modification of Imbens and Kolesár (2016). The BM degrees of freedom row reports the degrees of freedom suggested by Bell and McCaffrey (2002) to compute t -distribution confidence intervals for the coefficient on procurement exposure. Robust standard errors are presented in parentheses.

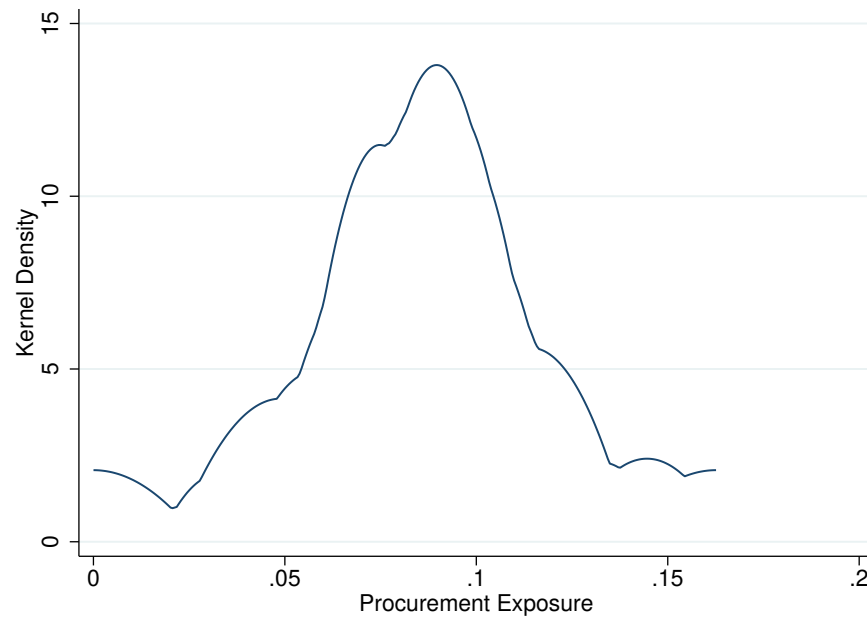
C Appendix Figures

Figure C.1: Procurement cuts: National Accounts vs contract data



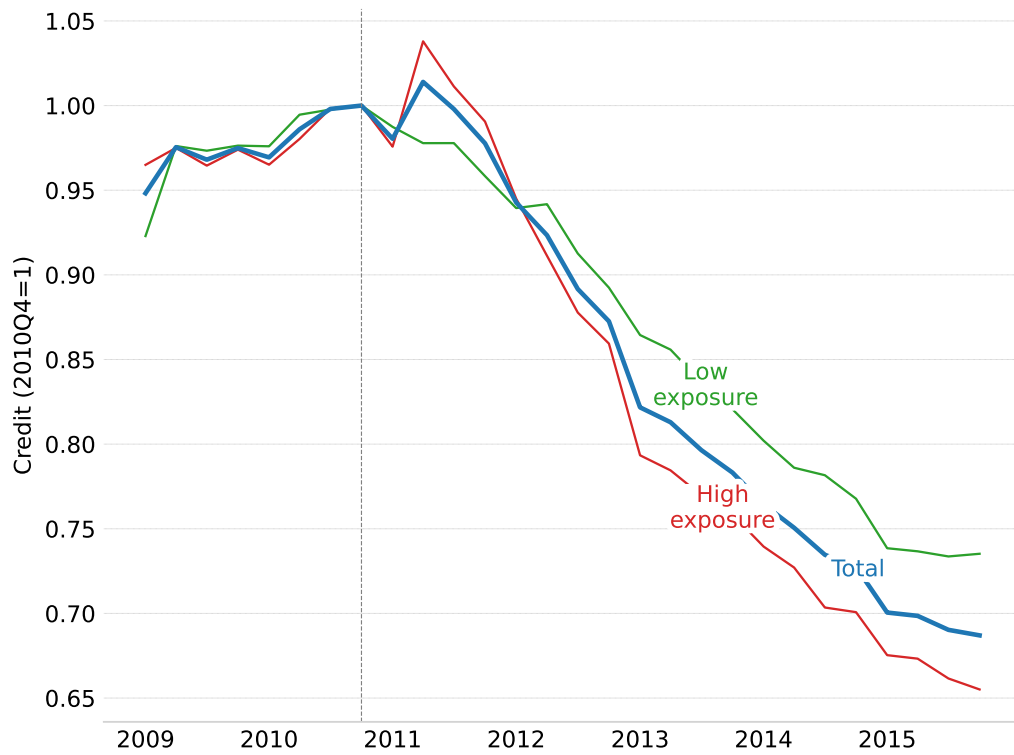
This figure compares the change in public procurement spending in Portugal in the postcrisis period calculated using System of National Accounts (SNA) data from the OECD and using our data on public procurement contracts. In SNA data, public procurement is defined as the sum of gross fixed capital formation, intermediate consumption and social transfers in kind via market producers for the general government sector.

Figure C.2: Distribution of procurement exposure across banks



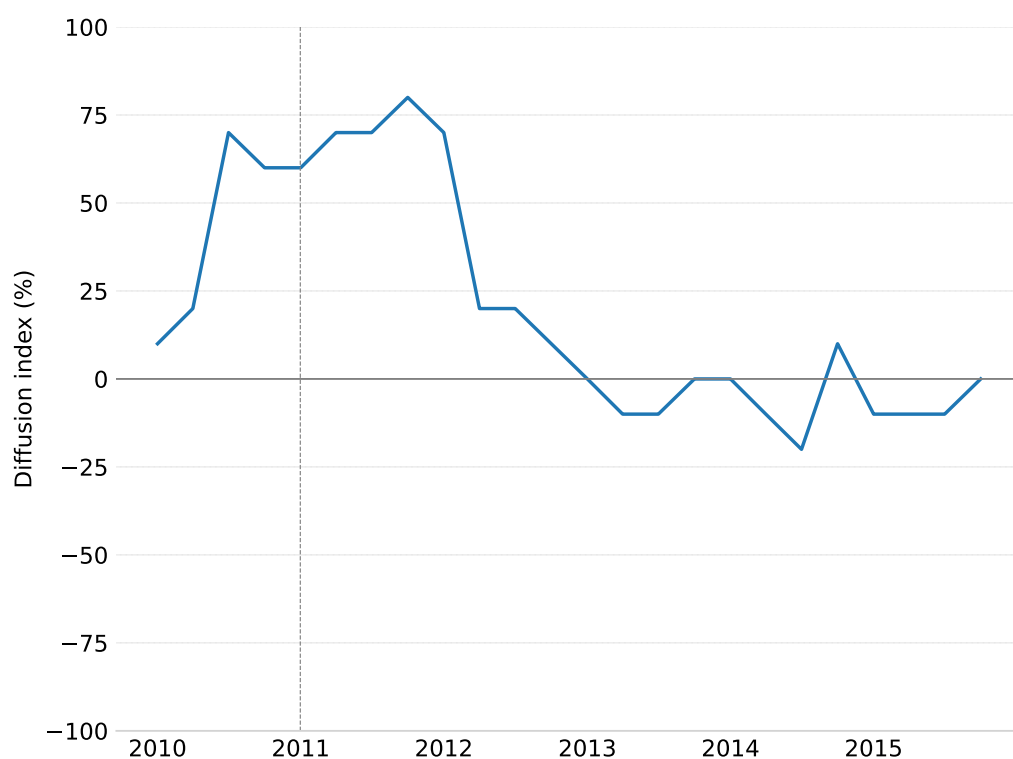
This figure shows kernel density estimates of the precrisis (2010Q1) distribution of bank exposure to firms with public procurement contracts in 2010.

Figure C.3: Credit from high and low exposure banks



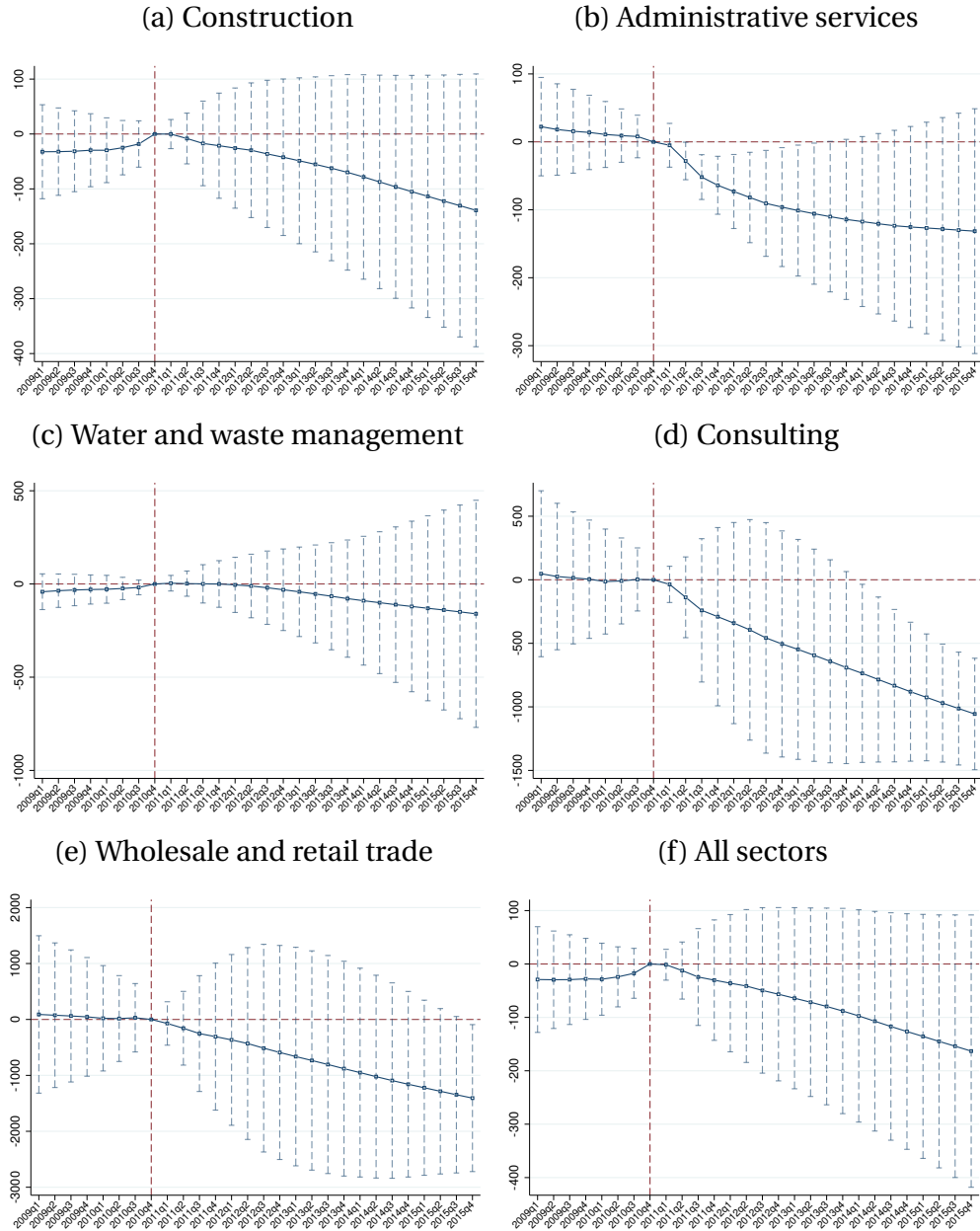
This figure plots the evolution of credit for during the sample period for all banks in the sample (blue line), and for banks with above and below-median procurement exposure (red and green lines).

Figure C.4: Change in bank lending standards versus previous quarter



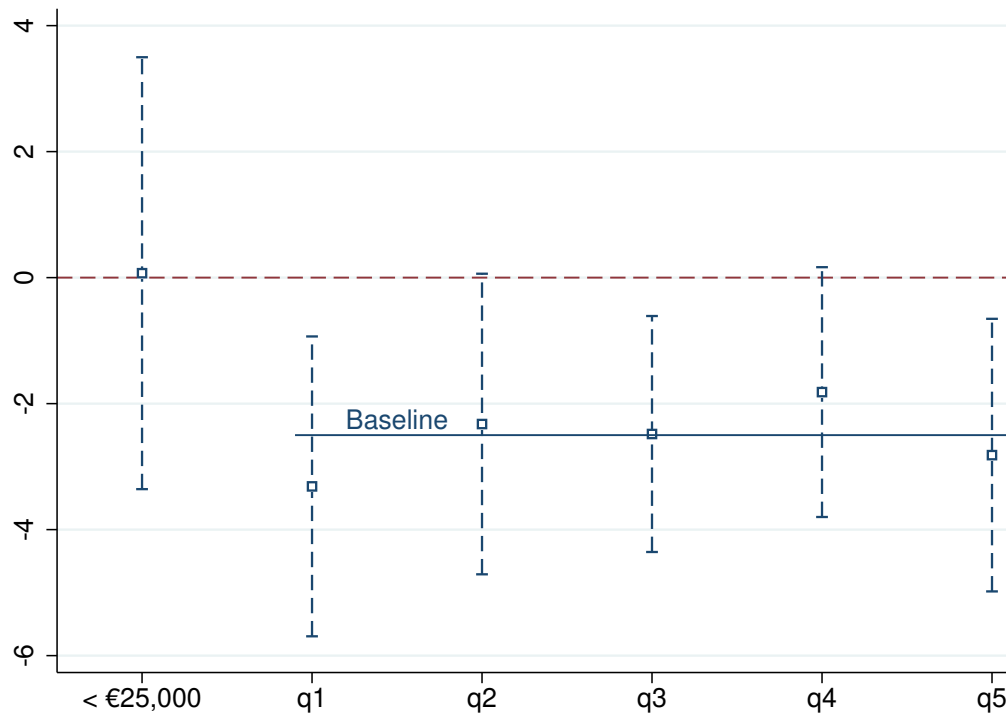
This figure plots data from the Euro Area Bank Lending Survey (ECB, 2024) for Portugal. Banks are asked the following question: “Over the past three months, how have your bank’s credit standards as applied to the approval of loans or credit lines to enterprises changed?” The diffusion index aggregates answers from all banks and varies between -100 and 100. Values above zero correspond to a tightening of credit standards, and values below zero to a loosening of those standards.

Figure C.5: Credit at the bank-firm level weighted average contractor credit shares



This figure plots point estimates and 95% confidence intervals from estimating regression equation (4) replacing procurement exposure with $\hat{\alpha}_i$ -weighted average contractor credit shares by sector, where $\hat{\alpha}_i$ are the Rotemberg weights (Goldsmith-Pinkham, Sorkin and Swift, 2020). Standard errors are clustered at the bank level using the “LZ2” bias-reduction modification of Imbens and Kolesár (2016), and confidence intervals are calculated using a t -distribution with the degrees of freedom suggested by Bell and McCaffrey (2002).

Figure C.6: Effect of procurement exposure on credit by relationship size



This figure shows point estimates and 95% confidence intervals for the effect of procurement exposure on credit supply at the bank-firm level as a function of loan size. The left-most point uses lending relationships under €25,000, which are excluded from our sample. The remaining points are obtained by splitting our regression sample by relationship size quintiles. The blue horizontal line corresponds to our baseline estimate, reported in column 1 of Table 3 in the paper. Standard errors are clustered at the bank level using the “LZ2” bias-reduction modification of Imbens and Kolesár (2016), and confidence intervals are calculated using a t -distribution with the degrees of freedom suggested by Bell and McCaffrey (2002).

References

- Beers, David, Elliot Jones, Zacharie Quiviger, and John Walsh.** 2021. “BoC–BoE Sovereign Default Database.” <https://doi.org/10.34989/san-2021-15> (accessed 07/13/2022).
- Bell, Robert, and Daniel McCaffrey.** 2002. “Bias Reduction in Standard Errors for Linear Regression with Multi-stage Samples.” *Survey Methodology*, 28(2): 169–182.
- ECB.** 2024. “Euro Area Bank Lending Survey.” European Central Bank. https://www.bportugal.pt/sites/default/files/documents/2024-01/bls_en.xlsx (accessed 07/19/2024).
- Goldsmith-Pinkham, Paul, Isaac Sorkin, and Henry Swift.** 2020. “Bartik Instruments: What, When, Why, and How.” *American Economic Review*, 110(8): 2586–2624.
- Imbens, Guido, and Michal Kolesár.** 2016. “Robust Standard Errors in Small Samples: Some Practical Advice.” *Review of Economics and Statistics*, 98(4): 701–712.
- IMF.** 2022. “Monitoring of Fund Arrangements (MONA).” International Monetary Fund. <https://www.imf.org/external/np/pdr/mona/index.aspx> (accessed 07/03/2022).
- Laeven, Luc, and Fabian Valencia.** 2020. “Systemic Banking Crises Database II.” *IMF Economic Review*, 68(2): 307–361.