Online Appendix
Does credit crunch investment down?

New evidence on the real effects of the bank-lending channel

February 2016

Contents

A1 Additional Results

This section contains results from additional robustness checks which are mentioned in the paper. In what follows, we will refer to the reduced-form impact of Firm Exposure on investment as ITT ("Intention to Treat", or model (3)); to our core between-firm credit growth regression as FS ("First Stage" or model (5)); and to the estimated impact of credit on real outcomes as IV (equation (4)). The Within-firm credit growth regression corresponds to model (1). All models are described in Section 3 of the main text.

Table A1: Alternative measurement of credit growth: Δ-log vs. percent change.

	(1)	(2)	(3)	(4)
	FS	FS	IV	IV
Dep var is:	Credit growth		Investment Rate	
Credit Growth as:	Pct Change	Δ-Log	Pct Change	Δ-Log
Indep var is:				
Firm Exposure	-0.787***	-0.734***		
	(0.193)	(0.136)		
Credit Growth			0.263***	0.314***
			(0.054)	(0.086)
Sector FE	Y	Y	Y	Y
Province FE	Y	Y	Y	Y
Controls	Y	Y	Y	Y
No. of Observations	31047	28112	31047	28112

Notes: The table reports estimates from the first stage regression (FS or model (5)) and the IV regression (model (6)) using two alternative definitions of credit growth. Label total outstanding credit (committed credit) in a bank-firm relationship as $Cr_{ij,t}$. In columns 1 and 3 the growth of credit for each firm i is computed (as in the main text) aggregating the percent change of credit in each underlying bank relationship $\hat{C}_{ij} = \frac{C_{ij,2010}}{C_{ij,2006}} - 1$; in columns 2 and 4 it is obtained aggregating the log-difference approximation ($(\hat{C}_{ij} \approx \log C_{ij,2010} - \log C_{ij,2006}$. Firm-level aggregates are obtained using bank-firm growth rates are aggregated using the share of total outstanding credit by each lender to the firm in 2006. Firm Exposure is the firm-level average of Bank Exposure weighted by the share of total credit granted to the firm by each bank in 2006. Credit data are from the Italian Credit Register. Firm balance-sheet data are from CADS. Controls include a set of firm characteristics measured in 2006 (2^{nd} order polynomial in assets, sales/assets ratio, cash-holdings/assets ratio, investment rate in 2006, ROA, leverage, drawn/granted credit ratio); the firm fixed effect estimated in model (1). Heteroskedasticity robust standard errors clustered at the main bank and sector levels in parentheses with *** p<0.01, ** p<0.05, * p<0.1.

Table A2: The Effect of Firm Exposure on Cumulative Gross Investment (CAPEX) Rate

	(1) ITT	(2) ITT	(3) IV	(4) IV
Indep var is:				
Firm Exposure	-0.171**	-0.204***		
	(0.0666)	(0.0562)		
Credit growth			0.190***	0.239***
			(0.0645)	(0.0579)
Sector FE	Y	Y	Y	Y
Province FE	Y	Y	Y	Y
Controls	N	Y	N	Y
No. of Observations	31047	31047	31047	31047

Notes: The dependent variable is the cumulative gross investment between 2007 and 2010 on total assets in 2006. Firm Exposure is the average ratio of interbank funding to total assets at the bank-level (weighted by each bank credit share in 2006). Credit growth is the percent change of total outstanding credit (committed credit) granted to a firm between 2006 and 2010. Controls in columns 2 and 4 are measured in 2006, and include a second-order polynomial in total assets, credit demand (estimated firm fixed-effect in a Khwaja-Mian regression), sales/assets, cash-holdings/assets, investment rate (investment in 2006 on total assets in 2005), leverage, and the ratio between drawn and granted credit. Credit data are from the Italian Credit Register. Heteroskedasticity robust standard errors clustered at the main bank and sector levels in parentheses with *** p<0.01, ** p<0.05, * p<0.1.

Table A3: The Effect of Banks' Exposure to the Interbank Market on Credit Growth Before and During the Crisis - Within-Firm Estimates

Dep. Var.: Credit growth between 2006 and:								
	2002	2003	2004	2005	2007	2008	2009	2010
Bank Exposure in 2006 (bank level)	-0.130	-0.127	-0.056	0.055	-0.308*	-0.799***	-0.296*	-0.740***
	(0.240)	(0.219)	(0.182)	(0.089)	(0.173)	(0.225)	(0.167)	(0.211)
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y
No. of Obs.	149972	161892	173500	187570	171313	166469	151467	151690

Notes: The table reports results from estimating the within-firm credit growth regression (model (1) in Section 3). The dependent variable is credit growth within a bank-firm pair between the year indicated in the column head and 2006. Credit growth is measured as the percentage change in total credit granted (i.e. credit commitments) within the pair. Bank Exposure is the ratio of interbank funding to total assets at the bank-level, measured in 2006. Credit data are from the Italian Credit Register. Heteroskedasticity robust standard errors clustered at the bank level in parentheses with *** p<0.01, ** p<0.05, * p<0.1.

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Table A4: Correlation between the estimated credit demand and the expected investment rate in SISF

	(1)	(2)
Exp. Investment Rate	1.171***	1.128***
	(0.088)	(0.277)
Controls	N	Y
Sector FE	Y	Y
Province FE	Y	Y
No. of Obs	1,433	1,412

Notes: The dependent variable is firm-specific credit demand, as proxied by the firm fixed-effects estimated using model (1) in the paper. "Exp. Investment rate" is the expected investment rate as reported by firms in the April 2007 issue of the Bank of Italy's Survey of Industrial and Service Firms (SISF) described in section 6.3 (for more details, see https://www.bancaditalia.it/pubblicazioni/indagine-imprese/index.html). The other controls, measured in 2006, include a second-order polynomial in total assets, credit demand (the estimated firm fixed-effect in model (1) as described in Section 3), sales/assets, cash-holdings/assets, investment rate (investment in 2006 on total assets in 2005), leverage, and the ratio between drawn and granted credit. Heteroskedasticity robust standard errors clustered at the main bank and sector levels in parentheses with *** p<0.01, ** p<0.05, * p<0.1.

Table A5: The Effects of Firm Exposure and of Credit Growth on Investment: Robustness Checks

	(1) Sector-Province FE	(2) Main Bank FE	(3) Long term Relationships	(4) Winsorizing at 2.5%	(5) Winsorizing at 1%	(6) Trimming at 5%
Panel A: ITT						
Firm Exposure	-0.232***	-0.122*	-0.251***	-0.286***	-0.290***	-0.242***
	(0.051)	(0.063)	(0.060)	(0.048)	(0.053)	(0.046)
Panel B: IV						
Credit Growth	0.271***	0.155**	0.309***	0.335***	0.340***	0.279***
	(0.057)	(0.071)	(0.066)	(0.077)	(0.080)	(0.074)
Sector FE	N	Y	Y	Y	Y	Y
Province FE	N	Y	Y	Y	Y	Y
Sector-Province FE	Y	N	N	N	N	N
Controls	Y	Y	Y	Y	Y	Y
No. of Observations	30336	30962	17529	31047	31047	29497

Notes: The dependent variable is the cumulative (2007-2010) firm-level investment rate. Panel A reports OLS estimates, Panel B reports IV estimates. Firm Exposure measures the average exposure of firms to the interbank market shock. For each firm, it is obtained as the weighted average of Bank Exposure (the ratio of interbank funding to the bank total assets, measured in 2006) of all banks lending to the firm, using each bank share of total credit to the firm as weights. Credit Growth is the percentage change in total credit granted (credit commitments) to each firm between 2006 and 2010. In Panel B, Credit Growth is instrumented with Firm Exposure. Data are from the Italian Credit Register, from Supervisory Reports, and from the Company Accounts Data System. Controls include assets, squared assets, ROA, credit demand (the estimated firm fixed-effect in model (1) as described in Section 3), cash-holdings over assets, sales over assets, investment rate, leverage, and drawn-to-granted credit ratio, all measured in 2006. Heteroskedasticity robust standard errors clustered at the main bank and sector levels in parentheses with *** p<0.01, ** p<0.05, * p<0.1.

Table A6: The Effect of Firm Exposure to the Interbank Market on credit and investment - Differences-in-differences Estimates

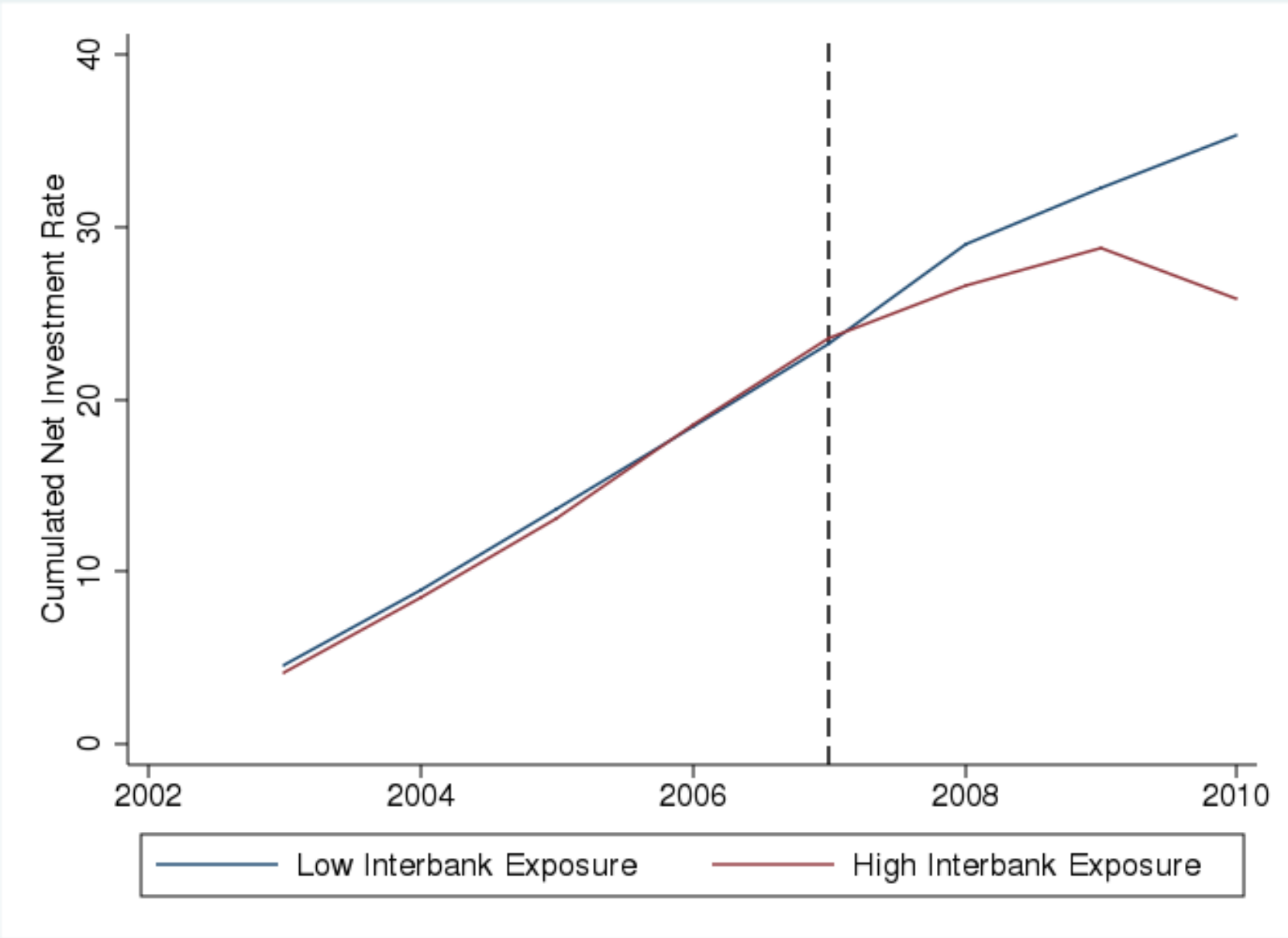
	(1)	(2)	(3)	(4)
Dep. var. is:	*Investment rate*		*Credit Growth*	
Difference-in-differences Model				
Firm exposure in 2006	-0.188***	-0.178***	-1.043***	-0.938***
	(0.0534)	(0.0568)	(0.344)	(0.178)
Δ Credit Demand		0.0810***		0.843***
		(0.0043)		(0.0088)
Observations	22897	22897	22897	22897
Cross-Sectional Model				
Firm exposure in 2006	-0.203***	-0.197***	-0.804***	-0.756***
	(0.0561)	(0.0493)	(0.195)	(0.205)
Credit Demand		0.0386***		0.327***
		(0.0022)		(0.0112)
Observations	22897	22897	22897	22897

Notes: The DiD estimate are based on the following model:

$$\Delta Y_{it} = \beta \times \bar{B}_i + \varepsilon_{it} \quad \text{(i)}$$

where $\bar{B}_i$ is Firm Exposure in 2006. In column 1 and 2, the dependent variable (Y_{it}) is the difference in the investment rate between the pre-crisis period (2002-2006) and the crisis period (2007-2010). The former is normalized by firm assets as of 2001, the latter is normalized by firm assets as of 2006. In column 3 and 4 the dependent variable is the difference in the rate of growth of credit between the pre-crisis and the crisis period. Credit data are from the Italian Credit Register. Firm balance-sheet data are from CADS. Heteroskedasticity-robust standard errors clustered at the main bank and sector levels in parentheses with *** p<0.01, ** p<0.05, * p<0.1.

Figure A1: Cumulative investment rate of firms borrowing from high and low exposure banks.



A2 Propensity Score Estimates

We assess the relevance of biases associated with differences in observed covariates combining regression analysis with weighting based on the propensity score, as suggested by Imbens and Wooldridge (2009). This two-step procedure requires to (i) estimate the propensity score, that is the probability of high exposure to the shock (i.e. of treatment) conditional on covariates; (ii) use the inverse of the propensity score to weight units in the regression(s) of interest (e.g., the estimated impact of exposure on investment - the ITT).

Because there is no univocal way to distinguish treated and control firms starting from our continuous measure of exposure, we performed two distinct analyses using alternative definitions of the binary variable. In the first one, the treatment group is composed by firms that have higher-than-*median* Firm Exposure (those having lower-than-median Firm Exposure represent the control group). In the second one, treated firms are those belonging to the *top quartile* of the Firm Exposure distribution, and control-group firms as those belonging to the bottom quartile. Hence, this second exercise compares firms that are ex-ante very different in terms of exposure to the bank shock.

In both cases, we estimate the propensity score with a Probit model conditioning on all the covariates reported in Table 8, thus including the bank-level characteristics that proved less balanced across quartiles of exposure. The algorithm pairs treated firms with the closest firms in the control group based on nearest-neighbor matching. Observations that are used repeatedly are given higher weight. In particular, observations in the treated group are used once, while observations in the control group may be used in several matches. This weighting balances the covariates distributions in the sample (Rubin 1979, Imbens 2014).

Table A7 assesses the extent to which this matching procedure is able to create a balanced sample of treated and control observations when identified on the basis of median exposure (Table A8 shows this is also true of the more demanding matching between firms at the top vs. bottom quartile for Firm Exposure). For each covariate, the table presents the sample means in the treated (col. 1) and matched control (col. 2) sub-samples (the averages computed accounting for the weights produced by the propensity score procedure). As in the case of Table 8 in the main text, the normalized difference is reported as a test of the difference between the two figures. The normalized difference, proposed by Imbens and Wooldridge (2009), is the difference in averages by treatment status, normalized by the square root of the sum of the variances.[1]

Column 3 reports the normalized difference computed in the matched sample. For comparison purposes, column 4 reports the normalized difference in the full (rather than the matched) sample. Imbens and Wooldridge (2009) suggest as a rule of thumb that differences in covariates should become a concern with a value of Δ_{tc} exceeding

[1]The reason for focusing on the normalized difference rather than on the t-statistic for the null hypothesis of equal means is that the first does not respond to changes in sample size while the second increases with the sample (see Imbens and Wooldridge, 2009).

0.25. Based on this rule, the table shows that once conditioning on the propensity score treatment and control firms looks homogeneous across observable characteristics. Importantly, column 4 confirms that (as in the case of the quartile partitioning presented in Table 8) some bank variables (in particular, bank size and profitability) are not well balanced in the full sample. Finally, column 5 shows the standard deviation of the variable indicated in the row.

Next, we computed the weighting (Horvitz-Thompson) estimator in the case of our ITT (model 3) and IV (model 4-5) specifications. This uses the inverse of the estimated propensity score to weight the units (firms) in order to eliminate biases associated with observable characteristics (see, among others, Imbens 2000).[2] Panel A of Table A9 shows the estimated impact of exposure on investment (the ITT), for alternative specifications of the control set (the same set is used here and in the corresponding propensity score estimation). Column 1 focuses on firm-level characteristics used throughout the main text while the remaining columns add the bank-level variables, including those that proved imbalanced in the full sample (see Table 8 and Table A7 above. Panel B shows the estimated sensitivity of investment to credit (the IV), using the same control sets. The estimated coefficients are similar to the corresponding baseline estimates reported in Section 5.2 (see, respectively Table 3, column 5 and Table 4, column 2). Table A10 shows that similar conclusions are reached estimating the same set of coefficients using firms in the top and bottom quartile of the Firm Exposure distribution as treatment and control groups, respectively.

[2]Intuitively, weighting creates a synthetic sample in which the distribution of covariates is independent of treatment assignment.

Table A7: Propensity Score: Test of the Balancing Hypothesis - Treated: Upper 50% of Firm Exposure Distribution; Control: Lower 50%

	μ Treated	μ Control	normalized diff. after pscore	normalized diff. before pscore
Sector-Level Inv.Rate	4.021	4.041	-0.011	0.012
Province-Level Inv.Rate	3.977	3.972	0.005	-0.072
Credit Demand	13.281	12.358	0.014	0.015
Inv.Rate in 2006	3.947	4.119	-0.015	-0.011
Assets	43.906	51.714	-0.005	0.027
Cash Holdings/Assets	0.067	0.071	-0.03	0.016
Sales/Assets	1.509	1.517	-0.006	-0.071
Roa	6.444	6.427	0.002	0.034
Leverage	8.676	8.399	0.016	-0.095
Z-Score	4.439	4.529	-0.036	-0.074
Drawn/Granted	47.864	47.564	0.008	-0.018
Average Bank Capital	7.272	7.271	0.001	-0.124
Average Bank Size	12.776	12.704	0.103	0.566
Average Bank Roa	1.009	0.995	0.062	0.366
Average Bank Loan Charge-Offs	0.578	0.574	0.026	0.072

Notes: The treated group consists of firms with higher-than-median Firm Exposure, firms in the control group have lower-than-median Firm Exposure. Averages computed on the matched sample. The normalized difference (Imbens and Wooldridge 2009) is defined as the difference between the means of the treated and of the control group, normalized by the square root of the sum of the variances.

Table A8: Propensity Score: Test of the Balancing Hypothesis- Treated: Upper 25% of Firm Exposure Distribution; Control: Lower 25%

	μ treated	μ control	normalized diff. after pscore	normalized diff. before pscore
Sector-level Inv.Rate	4.033	4.113	-0.044	0.017
Province-level Inv.Rate	3.988	4.035	-0.053	-0.117
Credit Demand	12.977	10.916	0.03	0.022
Inv. Rate in 2006	4.09	4.665	-0.046	-0.001
Assets	56.692	34.661	0.014	0.029
Cash Holdings/Assets	0.073	0.087	-0.091	0.037
Sales/Assets	1.521	1.493	0.02	-0.115
Roa	6.689	6.332	0.032	0.047
Leverage	8.33	8.774	-0.026	-0.143
Z-Score	4.291	4.524	-0.09	-0.112
Drawn/Granted	46.218	47.36	-0.029	-0.04
Average Bank Capital	7.569	7.574	-0.002	-0.2
Average Bank Size	12.73	12.535	0.265	0.817
Average Bank Roa	1.001	0.958	0.183	0.449
Average Bank Loan Charge-offs	0.561	0.543	0.103	0.094

The treated group consists of firms belonging to the top quartile of the distribution of Firm Exposure, firms in the control group belong to the first quartile of it. Quartile averages computed on the matched sample. The normalized difference (Imbens and Wooldridge 2009) is defined as the difference between the means of the treated and of the control group, normalized by the square root of the sum of the variances.

Table A9: Regressions weighted by the propensity score. Firms above and below median exposure.

	(1) Base	(2) Bank capital	(3) Bank assets	(4) Bank ROA	(5) Average charge-offs	(6) All-in
			Panel A: ITT			
Exposure	-0.239***	-0.221***	-0.194***	-0.222***	-0.228***	-0.208***
	(0.052)	(0.045)	(0.065)	(0.053)	(0.054)	(0.054)
Firm-level controls	Y	Y	Y	Y	Y	Y
Bank-Level Controls	N	Y	Y	Y	Y	Y
N	31047	31047	31047	31047	31047	31047
			Panel B: IV			
Credit Growth	0.286***	0.265***	0.264***	0.268***	0.269***	0.281***
	(0.061)	(0.060)	(0.080)	(0.064)	(0.063)	(0.080)
Firm-level controls	Y	Y	Y	Y	Y	Y
Bank-Level Controls	N	Y	Y	Y	Y	Y
N	31047	31047	31047	31047	31047	31047

Notes: The table shows results of ITT and IV estimates, performed on the matched sample of treated and control groups, where the treated group includes firms with above median exposure and the control firms with below median exposure. Observations are weighted by the propensity-score. Controls, measured in 2006, include a second-order polynomial in total assets, credit demand (the estimated firm fixed-effect in model (1) as described in Section 3), sales/assets, cash-holdings/assets, investment rate (investment in 2006 on total assets in 2005), leverage, and the ratio between drawn and granted credit. Columns 2 to 6 also include the average tier 1 capital ratio of the banks lending to the firm (column 2), average logarithm of banks' assets (column 3), average bank roa (column 4), average loan charge-offs (column 5), and all together in column 6. Firm and bank level controls are measured as of 2006. Heteroskedasticity robust standard errors clustered at the main bank and sector levels in parentheses, with *** p<0.01, ** p<0.05, * p<0.1.

Table A10: Regressions weighted by the propensity score. Firms in the bottom and top quartiles of exposure.

	(1) Base	(2) Bank capital	(3) Bank assets	(4) Bank ROA	(5) Average charge-offs	(6) All-in
			Panel A: ITT			
Exposure	-0.244***	-0.219***	-0.206***	-0.226***	-0.241***	-0.196***
	(0.055)	(0.050)	(0.072)	(0.055)	(0.062)	(0.057)
Firm-level controls	Y	Y	Y	Y	Y	Y
Bank-Level Controls	N	Y	Y	Y	Y	Y
N	31047	31047	31047	31047	31047	31047
			Panel B: IV			
Credit Growth	0.295***	0.272***	0.272***	0.285***	0.287***	0.251***
	(0.069)	(0.070)	(0.094)	(0.074)	(0.076)	(0.078)
Firm-level controls	Y	Y	Y	Y	Y	Y
Bank-Level Controls	N	Y	Y	Y	Y	Y
N	31047	31047	31047	31047	31047	31047

Notes: The table shows results of ITT and IV estimates, performed on the matched sample of treated and control groups, where the treated group includes firms with exposure in the top quartile and the control firms with exposure in the bottom quartile of exposure. Observations are weighted by the propensity-score. Controls, measured in 2006, include a second-order polynomial in total assets, credit demand (the estimated firm fixed-effect in model (1) as described in Section 3), sales/assets, cash-holdings/assets, investment rate (investment in 2006 on total assets in 2005), leverage, and the ratio between drawn and granted credit. Columns 2 to 6 also include the average tier 1 capital ratio of the banks lending to the firm (column 2), average logarithm of banks' assets (column 3), average bank roa (column 4), average loan charge-offs (column 5), and all together in column 6. Firm and bank level controls are measured as of 2006. Heteroskedasticity robust standard errors clustered at the main bank and sector levels in parentheses, with *** p<0.01, ** p<0.05, * p<0.1.

A3 Correcting the bias in between-firm credit growth regressions

This section contains a formal derivation of the bias correction method of Jimenez et al. (2010) and shows its equivalence with the approach of Bonaccorsi and Sette (2012) used in the paper.

Recall that the within firm model used both in this paper and in Jimenez et al. (2010) is:

$$c_{ij} = \alpha + \beta B_j + d_i + \varepsilon_{ij} \tag{ii}$$

where c_{ij} is the growth rate of credit granted to firm i by bank j after the shock, B_j is bank-specific shock (in our case, exposure to the interbank market), and d_i is firm fixed-effect. The difference between fixed-effect and OLS estimates can be written as

$$\hat{\beta}_{OLS} - \hat{\beta}_{FE} = \frac{E(c_{ij}d_i)}{V(d_i)} * \frac{E(B_j d_i)}{V(B_j)} \tag{iii}$$

The between-firm equation in Jimenez et al. (2010) is

$$c_i = \bar{\alpha} + \bar{\beta}\bar{B}_j + \bar{\varepsilon}_i \tag{iv}$$

where c_i is credit growth for firm i across all banks (that is, also including loans from new banks) and B_i is Firm Exposure, the average of Bank Exposure (B_j) for banks lending to firm i at the beginning of the period.
OLS estimates of $\bar{\beta}$ would yield

$$\hat{\bar{\beta}} = \bar{\beta} + \frac{E(\bar{B}_i d_i)}{V(B_i)} * \frac{E(c_i d_i)}{V(d_j)} \tag{v}$$

where the second term on the RHS represents the bias due to not controlling for credit demand d_i. The Jimenez et al. (2010) method exploits the estimated bias on the RHS of (ii) to correct the OLS cross-sectional estimate in (iv). This requires two ingredients:

- a consideration: namely that $E(B_j d_i) = E(\bar{B}_i d_i)$. This stems from the fact that $\bar{B}_i$ is the average of B_j lending to firm i (see note 7 in Jimenez 2010);
- an assumption: $E(c_{ij}d_i) = E(c_i d_i)$. This is an assumption because c_i is not simply the average of c_{ij}, as it may include also new bank relationships. For this equality to hold it suffices that firm demand is not bank-specific, an assumption made also in equation (1) for existing firm-bank relationships, and underlying the approach of Khwaja and Mian (2008).

We apply the same logic and assumption when estimating equation 2 in the paper:

$$c_i = \bar{\tilde{\alpha}} + \bar{\tilde{\beta}}\bar{B}_i + \gamma\hat{d}_i + \bar{\varepsilon}_i \tag{vi}$$

where, as in Bonaccorsi and Sette (2012), $\hat{d}_i$ is the estimated FE from equation (ii).

Indeed, note that $\bar{\tilde{\beta}} = E(\bar{B}_i c_i)/V(\bar{B}_i)$, where $\bar{B}_i$ is such that $E(\bar{B}_i \hat{d}_i) = 0$. Thus, we are partialling out the potential correlation between Firm Exposure and firm demand estimated in equation (ii): here, as in Jimenez et al. (2010), it is where the assumption that firm demand is not bank specific plays a role. Without this assumption, conditioning on $\hat{d}_i$ would not be enough to retrieve an unbiased estimate of $\bar{\beta}$.

Not surprisingly, the formal equivalence of the two approaches is confirmed also empirically. Table A11 shows the results of the coefficient $\bar{\beta}$ using the direct bias correction of Jimenez et al. and the fixed-effects correction of Bonaccorsi and Sette, used in our paper.

Table A11: Effect of Firm Exposure on credit growth

	Direct bias correction Jimenez et al. (2010)	Bias correction via Bonaccorsi and Sette (2012)
Firm Exposure	-0.857	-0.857
		(0.103)
Firm FE	N	Y
Province FE	Y	Y
Sector FE	Y	Y
No. of Firms	31047	31047

A4 Evidence of credit substitution

To what extent are high-exposure firms able to "migrate" towards less exposed banks, thus attenuating the impact of the interbank market shock on credit flows? In Section 5.1 we already noted that such credit substitution is unlikely to have been effective.[3] Here we provide more direct, though preliminary, evidence on this issue exploiting our detailed bank-firm data. In particular, we are interested in understanding whether credit substitution is more likely in the case of high growth potential, high-exposure firms. Evidence that this is the case would imply that the impact of the bank shock on credit and investment might be significantly underestimated in our framework.

We start by estimating a simple linear model for the probability where the dependent variable is a dummy equal to one if firm i, active in province p and sector s, has at least a new relationship opened after 2006 and in place in 2010 (i.e., in 2010 the firm borrows from a bank which was not among its lenders in 2006):

$$Pr(NewRelationship = 1)_{ips} = \alpha + \beta B_{ips} + \theta(B_{ips}G_{ips} + \pi G_{ips}) + X_{ips}\delta + \lambda_p + \gamma_s + \epsilon_{ips} \quad \text{(vii)}$$

where B is firm exposure (measured in 2006), and G is a measure of growth potential all measured in 2006 (to avoid endogeneity of the variable); X is the vector of baseline controls. In this specification, β measures whether high exposure firms are more likely to seek for credit substitution. The coefficient on the interaction term ($B_{ips} * G_{ips}$) indicates whether this occurs, in particular, in the case of high growth firms. The corresponding results are shown in Panel A of Table A12.

The first column focuses on a restricted version of the regression, excluding the interaction term. As expected, high exposure firms were more likely to open new relationships with other banks after the interbank market collapse. However, the estimated effect is very small: a 10 percentage point increase in Firm Exposure (corresponding to 3 standard deviations) would increase the probability of a new relationships by 3 percentage points. For reference, the average probability of opening at least one new relationship between 2006 and 2010 was 57%. The remaining columns report the results obtained further interacting Firm Exposure (B_{ips}) with three alternative proxies for firms' growth opportunities: the sales to assets ratio, the ROA, and the pre-crisis investment rate. As shown in columns (2), (3), and (4), respectively, all these interactions attract a negligible and highly non-significant coefficient. Hence, we do not find evidence that credit substitution concerned in particular high exposure firms with a high growth potential.

Panel B show results from a Poisson model where the dependent variable is the number of new relationship opened in 2010 relative to 2006, and the control variables are written as in the above regression. They confirm that high exposure firms *did* try to respond to the credit shock by opening new relationships (Column (1)). Yet, the estimated coefficient is economically very small: a 10 percentage point increase in Firm

[3] If ex-post migration of firms across banks with different exposure was a relevant phenomenon, then the between estimates (obtained looking at the total growth of credit across firms, irrespective of the lender) would be significantly lower than the within coefficient However, the coefficients estimated in the within and the between firm regressions are very similar in magnitude (see Table 2 in the paper).

Exposure would result in 0.1 new firm-bank relationships (against an average number of new relationships of 1.2). As in the previous case, results in columns 2 to 4 rule out that this migration is significantly correlated with our proxies for growth potential.

Table A12: The Effect of Firm Exposure on New Bank Relationships

Panel A - Dep. Var: Probability of Having a New Relationship				
	(1)	(2)	(3)	(4)
Growth Opportunities measured by:		Sales/Asset	ROA	Inv Rate
Firm Exposure	0.003***	0.003**	0.004***	0.003***
	(0.001)	(0.002)	(0.001)	(0.001)
Firm Exposure × Growth Opp		0.000	-0.000	0.000
		(0.001)	(0.000)	(0.000)
Growth Opp		-0.000	0.002	0.002***
		(0.009)	(0.001)	(0.001)
Sector FE	Y	Y	Y	Y
Province FE	Y	Y	Y	Y
Controls	Y	Y	Y	Y
No. of Observations	31047	31047	31047	31047
Panel B - Dep. Var: Number of New Relationships				
	(1)	(2)	(3)	(4)
Firm Exposure	0.010***	0.012***	0.011***	0.010***
	(0.002)	(0.003)	(0.002)	(0.002)
Firm Exposure × Growth Opp		-0.002	-0.000	-0.000
		(0.001)	(0.000)	(0.000)
Growth Opp		-0.004	0.004*	0.008***
		(0.024)	(0.002)	(0.001)
Sector FE	Y	Y	Y	Y
Province FE	Y	Y	Y	Y
Controls	Y	Y	Y	Y
No. of Observations	31047	31047	31047	31047

Notes: Panel A reports results of a linear probability model in which the dependent variable is a dummy equal to one if firm i, active in province p and sector s, has at least a new relationship opened after 2006 and in place in 2010. Panel B reports results of a Poisson model in which dependent variable is the number of new relationships opened after 2006 and in place in 2010. Firm Exposure is the average ratio of interbank funding to total assets at the bank-level (weighted by each bank credit share in 2006). The indicators of firm growth opportunities used in cols 2 to 4 are indicated in the column headings. Controls, measured in 2006, include a second-order polynomial in total assets, sales/assets, cash-holdings/assets, investment rate (investment in 2006 on total assets in 2005), leverage, the ratio between drawn and granted credit and the measure of firm credit demand (the estimated firm FE in model (1) as described in Section 3). Heteroskedasticity robust standard errors clustered at the main bank and sector levels in parentheses with *** p<0.01, ** p<0.05, * p<0.1.

A5 Data sources and data construction

A5.1 Datasets

We build our dataset by matching data from three sources. First we obtain balance sheet information for Italian companies, mostly privately held, from the Company Accounts Data System (CADS). This is a proprietary database, kept by a consortium of Italian banks for credit risk evaluation. The CADS collects detailed balance-sheet information on a large sample of non-financial incorporated firms since 1982. It is used by banks for credit decisions and, hence, the data are carefully controlled. In 2006, firms in CADS accounted for more than 75% of total net revenues of Italian incorporated firms. The sample, however, is not randomly drawn, since a firm is observed only if it has ever borrowed from at least one bank.

From CADS we select balance-sheet data from 2006 to 2010 to obtain the main variables we use in our baseline regression (investment, assets, return on assets (ROA), sales, leverage, and cash-holdings), and other balance-sheet variables that we use in the heterogeneity analysis and for the extensions.

The second source of data is the Italian Credit Register (CR). This database, owned by the Bank of Italy, collects from all intermediaries operating in Italy (banks, other financial intermediaries providing credit, special purpose vehicles) individual data on borrowers with exposures above 75,000 euros towards a single intermediary. Exposures include both debt and guarantees. A borrower with debt of, say, 20,000 euros towards a bank appears in the CR if she also provides guarantees worth at least 55,000 euros to another individual borrowing from the same bank. The 75,000 euros threshold has been lowered to 30,000 euros since January 2009. In our analysis, we exclude loan exposures of less than 75,000 even after 2009, to ease comparability with previous years. The CR contains data on the outstanding bank debt of each borrower, distinguished into loans backed by account receivables, term loans, and revolving credit lines. The CR also contains information about the granting institution and the unique tax identification number of the borrower. Banks routinely use the CR as a tool to monitor borrowers, which ensures a high quality of the data. We select all credit relationships between banks and firms in each year from 2006 to 2010. We also select data back to 2002 to run the placebo regressions. For the DID analysis, we select firms reporting complete balance sheet information in every year between 2001 and 2010. In this case, variables are deflated using the deflator of investment (for manufacturing, services, and construction) from the National Accounts by the Italian National Statistics (ISTAT). Our data include only existing firms. While the sample is representative of the Italian economy, it does not account for the entry/exit of firms.

The third source of data is the Supervisory Reports submitted by banks to the Bank of Italy. These contain balance-sheet data of all banks operating in Italy, including banks that are not listed on the stock market. From these data we select interbank borrowing by each bank and total bank assets at December 2006 (at December 2005 for the placebo regression), to construct the interbank to assets ratio, on which we base our instrument for credit growth. We use data consolidated at the bank holding company level. This is

crucial in our case: in unconsolidated bank balance-sheets, interbank transactions may include also transfers among banks belonging to the same group.

In Section 6.3 we also exploit information investment expectations reported in the Bank of Italy Survey of Industrial and Service Firms (SISF). SISF is a panel representative survey administered to approximately 3,000 Italian firms (with at least 20 employees) in April of each year. It is designed to obtain detailed information on investment and employment decisions in the two years preceding the interview and on plans for the following years. These include a set of questions that directly elicit expectations on future investment and demand (Guiso et al. 1999).

A5.2 Sample selection

First, we match data on each bank-firm relationship from the CR with data on banks' interbank to asset ratio from the Supervisory Reports using the unique bank identification number ('ABI code'). Then, we aggregate data on all loans to each firm from the CR and we match them with firm balance sheet data using firms' unique tax identification number.

We exclude branches of foreign banks since they fund their activity almost exclusively through interbank transactions from their country of domicile, and we cannot distinguish true external interbank funding from internal transfer of funds. According to Credit Register data, branches of foreign banks (mostly from other European countries) grant only a small share of total loans to Italian firms (about 6 percent).

This procedure yields a sample of 38,797 firms in 2006. We exclude firms that borrowed from one single bank (3,200), because in their case the firm fixed-effect in model (1) of the paper would not be identified. We also exclude firms that did not provide continuous data on CADS over the period 2007-2010 (1,567). The inclusion of all firm-level controls additionally excludes 2,983 firms from the sample, as they did not report complete balance sheet data in CADS. Overall, the baseline sample includes 31,047 firms.

The 2007-2010 investment rate is equal to the cumulative investments over the 4 years normalized by the value of firm assets in 2006. We winsorize the top 5% observations, as the book value of assets and investment are extremely noisy, and we want to avoid our results to be driven by outliers. We test the robustness of all results to different winsorizing thresholds, and to trimming the data. Data indicate that total gross investment over 4 years are, for the median firm, equal to 9.3% of its initial assets. This corresponds to an yearly investment rate of about 25 percent, in line with the evidence from the US and Japan.[4]

Credit growth is the cumulative growth rate of credit granted (commitments) from December 2006 to December 2010. In computing the growth rate of credit, we keep track of existing credit relationships over time even after a bank disappears from the sample due to a merger or an acquisition. In this case, we assume the firm had a relationship

[4]The investment to asset (book capital) ratio of large Japanese firms in Gan (2007b) is on average 31 percent; that of US Compustat firms used in Almeida and Campello (2007) is around 25-30 percent.

with the new bank from the beginning. The credit growth is winsorized at the top 5 per cent. On average, credit granted grew over the period, although almost half of the firms experienced a contraction in credit granted.

Other dependent variables, for which the sensitivity to bank credit is estimated in Section 7.3 of the paper, include the growth rates of value added (defined as production + change in inventories - intermediate goods and services), number of employees, total labor cost, expenditure on intermediate goods and services, trade credits and debits. All variables are winsorized at the top 5 per cent.

Independent variables are measured in 2006 (end of year data), with the exception of Credit demand that is retrieved from estimating model (ii). They include Firm Exposure (interbank funding to bank assets ratio), and standard controls in investment equations (see, for example Gan 2007b): sales over total fixed assets and Return on Equity to control for investment opportunities, total assets (a quadratic polynomial) to control for size effects. We also include cash holdings, normalized by fixed assets, to measure the availability of internal funds prior to the crisis. Finally, we include the investment rate before the crisis, to control for past investment opportunities. Additional measures of reliance on financial position of firms include leverage and the share of drawn credit to total credit granted.

A6 Data on interest rates

The credit Register contains a special section ("Taxia"), which collects information on interest rates from a representative subset of the banks operating in Italy (around 100 banks accounting for more than 80% of total bank lending) for all the borrowers that are recorded in the Credit Register. The data are structured as follows: at the end of every quarter, for each borrower with an outstanding exposure above 75,000 Euros, banks report the amount of money paid as interest rates during the quarter, the fees and commissions (when these are paid annually banks have to report the pro-quota amount for the quarter), and the "products", i.e. the product between each loan amount outstanding in a period and the number of days in which that loan has been outstanding, based on the credit actually drawndown. For example, if a firm was drawing down 100 euros for 60 days and 50 euros for 30 days, the products are: 100*60+50*30. Dividing the amount of money paid as interest by the products yields the "unit" interest rate. This information is available with a breakdown by loan type: term loans, overdraft facilities (revolving credit lines), and loans backed by account receivables.

Taxia also includes information on the average percentage rate charged on the new term loans initiated in each period. In this case it is possible to observe directly the level of the interest rate.

While these data are very informative, they have a few important drawbacks. In particular, the information on the maturity of the loan is very coarse. For this reason, we focus on overdraft facilities (revolving credit lines), which do not have a predetermined maturity. We also show results aggregating interest rates across loan types, as a further supportive test.