Bank Credit and Productivity Growth

Fadi Hassan [1] Filippo di Mauro [2] Gianmarco Ottaviano [3]

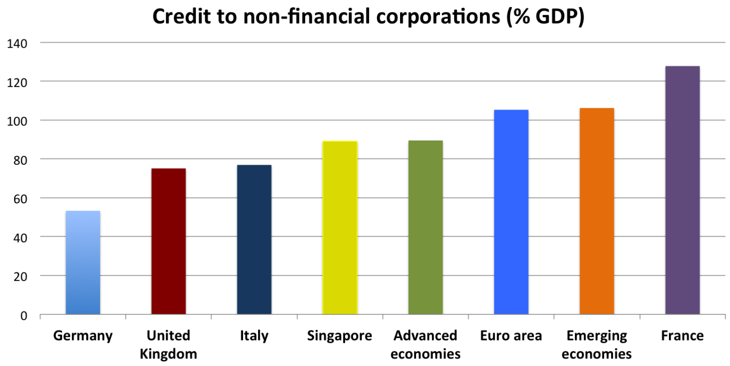
[1]Trinity College Dublin, CEP, Bank of Italy

[2]NUS and ECB

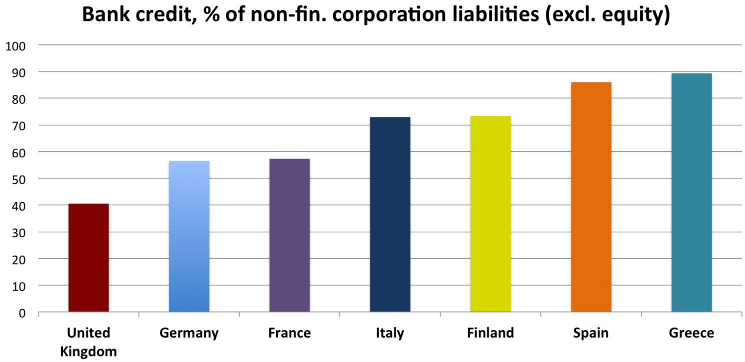
[3]LSE, CEP, and CEPR

World Finance Conference,Cagliari, 28 July 2017

Credit to non-financial corporations is a large share of GDP



Bank credit is a large share of non-financial corporations' liabilities



Efficient allocation of credit

- Standard benchmark comes from q-theory of investments
- $q \simeq \frac{MarketValue}{BookValue}$

A macroeconomic angle: productivity

- **Research question**: what is the relation between credit allocation and firm-level productivity?

A macroeconomic angle: productivity

- **Research question**: what is the relation between credit allocation and firm-level productivity?
  - How should we think about an efficient allocation of credit in terms of firms' productivity?
  - How does this relation look like in the data?

Our contribution:

- To introduce a theoretical model that provides guidance about the relation between credit and firm-level productivity, with and without binding market frictions.

Our contribution:

- To introduce a theoretical model that provides guidance about the relation between credit and firm-level productivity, with and without binding market frictions.
- To estimate the relation implied by the model using a novel dataset with firm-level information on credit and productivity across a set of eurozone countries.

Our contribution:

- To introduce a theoretical model that provides guidance about the relation between credit and firm-level productivity, with and without binding market frictions.
- To estimate the relation implied by the model using a novel dataset with firm-level information on credit and productivity across a set of eurozone countries.
- To provide a comprehensive set of measures on the relation between bank credit and productivity since the late 1990s and make normative statements about the efficiency of credit allocation across countries through the lenses of the model.

Related literature

- Effects of finance on economic growth: Arcand et al. (2015); Beck et al. (2008); Ciccone and Papaioannou (2006); Levine (2005); Guiso et al. (2004); Rajan and Zingales (1998); Levine (1997); King and Levine (1993).
- Real effects of bank credit: Cecchetti and Kharroubi (2015) Jimenez et al. (2014), Chodorow-Reich (2014), Schnabl (2012), Amiti and Weistein (2011) and Khawaja and Mian (2008).
- Literature on resource misallocation in Europe: Calligaris et al. (2016), Gopinath et al. (2015), Benigno and Fornaro (2014).

Related literature

- Effects of finance on economic growth: Arcand et al. (2015); Beck et al. (2008); Ciccone and Papaioannou (2006); Levine (2005); Guiso et al. (2004); Rajan and Zingales (1998); Levine (1997); King and Levine (1993).
- Real effects of bank credit: Cecchetti and Kharroubi (2015) Jimenez et al. (2014), Chodorow-Reich (2014), Schnabl (2012), Amiti and Weistein (2011) and Khawaja and Mian (2008).
- Literature on resource misallocation in Europe: Calligaris et al. (2016), Gopinath et al. (2015), Benigno and Fornaro (2014).
- **Role of financial sector in allocating capital efficiently**: Wurgler (2000), Hartmann et al. (2007), and Lee et al. (2016).

Discussion's outline

- Theoretical model
- Empirics: econometric specification and results
- Conclusion

Model

Main features

- Two periods model of entrepreneurs.

Main features

- Two periods model of entrepreneurs.
- Entrepreneurs are born with a stock of human capital that they transform into a combination of short- and long-term capital (as in Aghion et al. 2010).

Main features

- Two periods model of entrepreneurs.
- Entrepreneurs are born with a stock of human capital that they transform into a combination of short- and long-term capital (as in Aghion et al. 2010).
- There is a borrowing constraint and a "liquidity shock" that can hit at the end of the first period and hinder the ability to repay the loan.

Main features

- Two periods model of entrepreneurs.
- Entrepreneurs are born with a stock of human capital that they transform into a combination of short- and long-term capital (as in Aghion et al. 2010).
- There is a borrowing constraint and a "liquidity shock" that can hit at the end of the first period and hinder the ability to repay the loan.
- We look at two market set-ups: complete and incomplete credit markets.

Main features

- Two periods model of entrepreneurs.
- Entrepreneurs are born with a stock of human capital that they transform into a combination of short- and long-term capital (as in Aghion et al. 2010).
- There is a borrowing constraint and a "liquidity shock" that can hit at the end of the first period and hinder the ability to repay the loan.
- We look at two market set-ups: complete and incomplete credit markets.
- We derive the relation between bank credit and and both contemporaneous and future productivity growth, under complete and incomplete markets.

Production

- Two-periods: t (short-run) and $t+1$ (long-run)
- Entrepreneur endowed with $L_t = L_{t+1} = L$ units of labor and H_t units of human capital.
- The technology for transforming human capital is linear and share the same productivity θ:
  - $K_t = \theta H_{k,t}$ and $Z_t = \theta H_{z,t}$, with $H_{k,t} + H_{z,t} = H_t$.
- Production at t: $Y_t = A_t K_t^{\alpha} L^{1-\alpha},\ A_t \in [A_{min}, A_{max}]$
- Production at $t+1$:
  $Y_{t+1} = A_{t+1} Z_t^{\alpha} L^{1-\alpha},\ A_{t+1} \in [A_{min}, A_{max}]$

Budget and borrowing constraints

- Entrepreneur borrows at an exogenous risk-free rate R_t.
- Borrowing at t cannot exceed a multiple $\mu \geq 0$ of her contemporaneous income.
- Investment in long-term capital is subject to a liquidity shock that can hinder the ability to repay the loan.
- Budget constraint at t:

$$\Pi_t + q_t(K_t + Z_t) + S_t e_t = Y_t + B_t, \quad B_t \leq \mu Y_t$$

- Budget constraint at $t+1$:

$$\Pi_{t+1} + (1 + R_t)B_t = [Y_{t+1} + (1 + R_t)S_t]\, e_t$$

Borrowing and productivity under complete markets

- The present expected value of the flow of profits is:

$$\Pi_t + (1+R_t)^{-1} E_t[\Pi_{t+1}]$$

- The maximization problem can be written as:

$$\max_{k_t, z_t} A_t k_t^{\alpha} l_t^{1-\alpha} + (1+R_t)^{-1} E_t \left[A_{t+1} z_t^{\alpha} l_t^{1-\alpha} \right] - q_t k_t - q_t z_t$$

subject to: $k_t + z_t = \theta$

Borrowing and productivity under complete markets

- The present expected value of the flow of profits is:

$$\Pi_t + (1 + R_t)^{-1} E_t[\Pi_{t+1}]$$

- The maximization problem can be written as:

$$\max_{k_t, z_t} A_t k_t^{\alpha} l_t^{1-\alpha} + (1 + R_t)^{-1} E_t \left[A_{t+1} z_t^{\alpha} l_t^{1-\alpha} \right] - q_t k_t - q_t z_t$$

subject to: $k_t + z_t = \theta$

- The FOC implies that present expected values of the marginal product of long-term and short-term capital are equalized:

$$\left(\frac{z_t}{\theta - z_t} \right)^{1-\alpha} = (1 + R_t)^{-1} \frac{E_t \left[A_{t+1} \right]}{A_t}$$

Borrowing and productivity under incomplete markets (1)

- The maximum liquidity available to the entrepreneur at t is $(1+\mu)Y_t$
- The entrepreneur meets the liquidity shock with probability: $\Phi_t \equiv \Phi((1+\mu)(Y_t/H_t)) = \left[(1+\mu)A_t k_t^{\alpha} l_t^{1-\alpha}/s_{\mathsf{max}}\right]^{\phi}$
- The entrepreneur faces a 'failure' or 'liquidation' of her long-term investment with probability $1-\Phi_t$ ('liquidity risk').

Borrowing and productivity under incomplete markets (2)

- The entrepreneur maximization problem is:

$$\max_{k_t, z_t} A_t k_t^{\alpha} l_t^{1-\alpha} + (1+R_t)^{-1} E_t \left[\Phi_t A_{t+1} z_t^{\alpha} l_t^{1-\alpha} \right] - q_t k_t - q_t z_t$$

subject to $k_t + z_t = \theta$

Borrowing and productivity under incomplete markets (2)

- The entrepreneur maximization problem is:

$$\max_{k_t, z_t} A_t k_t^{\alpha} l_t^{1-\alpha} + (1+R_t)^{-1} E_t \left[\Phi_t A_{t+1} z_t^{\alpha} l_t^{1-\alpha} \right] - q_t k_t - q_t z_t$$

subject to $k_t + z_t = \theta$

- The FOC implies:

$$\left(\frac{z_t}{\theta - z_t} \right)^{1-\alpha} = (1-\tau_t)(1+R_t)^{-1} \frac{E_t [A_{t+1}]}{A_t}$$

with

$$\tau_t \equiv 1 - \Phi_t + \left(\frac{\partial \Phi_t}{\partial k_t} - \frac{\partial \Phi_t}{\partial z_t} \right) \frac{z_t}{\alpha}.$$

Borrowing and productivity under incomplete markets (3)

- Given the definition of Φ_t, τ can be expressed as:

$$\tau_t = 1 - \left[\frac{(1+\mu)A_t\left(\theta - z_t\right)^{\alpha} l_t^{1-\alpha}}{s_{\max}}\right]^{\phi}\left(1 - 2\phi\frac{z_t}{\theta - z_t}\right)$$

Borrowing and productivity under incomplete markets (3)

- Given the definition of Φ_t, τ can be expressed as:

$$\tau_t = 1 - \left[\frac{(1+\mu)A_t\left(\theta - z_t\right)^{\alpha} l_t^{1-\alpha}}{s_{\max}}\right]^{\phi}\left(1 - 2\phi\frac{z_t}{\theta - z_t}\right)$$

- The FOC under incomplete market can be written as:

$$\left(\frac{z_t}{\theta - z_t}\right)^{1-\alpha} = \left\{\left[\frac{(1+\mu)A_t\left(\theta - z_t\right)^{\alpha} l_t^{1-\alpha}}{s_{\max}}\right]^{\phi}\left(1 - 2\phi\frac{z_t}{\theta - z_t}\right)\right\} (1+R_t)^{-1}\frac{E_t\left[A_{t+1}\right]}{A_t}$$

Borrowing and productivity

- Under incomplete markets:

$$\left(\frac{z_t}{\theta - z_t}\right)^{1-\alpha} = \underbrace{(1-\tau_t(A_t))}_{+}(1+R_t)^{-1}\frac{E_t\left[A_{t+1}\right]}{A_t}$$

Borrowing and productivity

- Under incomplete markets:

$$\left(\frac{z_t}{\theta - z_t}\right)^{1-\alpha} = \underbrace{(1 - \tau_t(A_t))}_{+}(1 + R_t)^{-1}\frac{E_t\left[A_{t+1}\right]}{A_t}$$

- Under complete markets:

$$\left(\frac{z_t}{\theta - z_t}\right)^{1-\alpha} = (1 + R_t)^{-1}\frac{E_t\left[A_{t+1}\right]}{A_t}$$

Main predictions

- Under complete credit markets the correlation between borrowing and:
  - *future* relative productivity growth is *positive.*
  - *contemporaneous* relative productivity growth is *negative.*
  - 'opportunity cost effect'.
- Under incomplete credit markets the correlation between borrowing and:
  - *future* productivity growth is *positive* but smaller.
  - *contemporaneous* productivity growth can be *positive*.
  - 'liquidity risk effect' & 'opportunity cost effect'.

Empirics

Data set

- Novel firm-level data set based on the CompNet database of the ECB.
- Variables' definition and data are carefully homogenised across countries.
- Countries: France, Germany, and Italy (data are not pooled)
- Period: late 1990s (exact year varies by country) until 2012
- Financial variables: bank credit, leverage, return on assets
- Productivity variables: total factor productivity, marginal product of capital, labor productivity, and real value added.

Sample summary

Country	France	Germany	Italy
Data Source	Banque de France	Bundesbank	ISTAT
Years	1995-2012	1997-2012	2001-2012
Firms	93,569	42,726	393,489
Observations	589,609	184,807	1,721,881

Econometric specification

- The traditional approach since Wurgler (2000):
  - Dependent variable: growth rate of investments, as a proxy for credit (industry level).
  - Main explanatory variable: growth rate of value added, as a proxy of investment opportunity (industry level).
  - Elasticity of investment with respect to real value added was consistent with a q-theory of investment as it captures whether credit get reallocated more quickly to the most promising sectors.

Econometric specification

- The traditional approach since Wurgler (2000):
  - Dependent variable: growth rate of investments, as a proxy for credit (industry level).
  - Main explanatory variable: growth rate of value added, as a proxy of investment opportunity (industry level).
  - Elasticity of investment with respect to real value added was consistent with a q-theory of investment as it captures whether credit get reallocated more quickly to the most promising sectors.
- Our framework is close, but we bring it forward by:
  - looking directly at bank credit and take a firm-level dimension.
  - focusing explicitly on productivity.
  - disentangling the relation of bank credit with current and future productivity.

Baseline regression

$$Credit\ Growth_{it} = \beta_0 + \beta_1 Productivity\ Growth_{it+k} +$$
$$\beta_2 Demand\ Proxy_{it} + \beta_3 Leverage_{it-1} + \delta_t + \psi_i + \epsilon_{it}$$

Baseline regression

$$Credit\ Growth_{it} = \beta_0 + \beta_1 Productivity\ Growth_{it+k} + \beta_2 Demand\ Proxy_{it} + \beta_3 Leverage_{it-1} + \delta_t + \psi_i + \epsilon_{it}$$

- Main challenges:
  - Distinguishing between credit supply and demand.
  - Expected vs. future realized prductivity.
  - Endogeneity between credit/capital and TFP.

How do we measure firm-level TFP?

- As well renown, estimating TFP under a standard Cobb-Douglas is problematic because of endogeneity:

$$Y_{it} = A_{it} K_{it}^{\alpha} L_{it}^{1-\alpha}$$

- Firm-specific productivity is controlled for by a proxy of the unobserved productivity derived from a structural model (Olley and Pakes, 1996; and Levinshon and Petrin, 2003)

- This proxy is a function of capital and material inputs approximated by a third-order polynomial, as in Petrin et al. (2004), and estimated through GMM following Woolridge (2009):

$$y_{it} = \beta_0 + \beta_1 k_{it} + \beta_2 k_{i(t-1)} + \beta_3 m_{i(t-1)} + \beta_4 k_{i(t-1)}^2 + \beta_5 m_{i(t-1)}^2 + \beta_6 k_{i(t-1)}^3 + \beta_7 m_{i(t-1)}^3 +$$

$$\beta_8 k_{i(t-1)} m_{i(t-1)} + \beta_9 k_{i(t-1)} m_{i(t-1)}^2 + \beta_{10} k_{i(t-1)}^2 m_{i(t-1)} + \gamma Year_t + \omega l_{it}$$

- TFP is then retrieved as $TFP_{it} = rva_{it} - (\hat{\beta}_0 + \hat{\beta}_1 k_{it} + \hat{\gamma} Year_t + \hat{\omega} l_{it})$.

- Underlying assumption: i) productivity follows a first-order Markov process and ii) capital is assumed to be a function of past investments and not current ones. These imply that productivity shocks at time t do not depend from capital at time t,

Baseline results

Table

Elasticity of bank loans to:	**France**		**Germany**		**Italy**	
	t	t+1	t	t+1	t	t+1
TFP	-27%***	14.4%***	-8%***	6.1%***	0.8%***	2.4%***
MRPK	-51%***	7.6%***	-24%***	5.1%***	-0.3%***	0.1%***
LProd	-17%***	10.3%***	-7%***	5.7%***	4.4%***	3.4%***
RVA	17%***	22.5%***	-0.1%	8.8%***	12%***	1.2%

Baseline results: focus on $t+1$

Table

Elasticity of bank loans to:	**France**		**Germany**		**Italy**	
	t	t+1	t	t+1	t	t+1
TFP	-27%***	14.4%**	-8%***	6.1%**	0.8%***	2.4%**
MRPK	-51%***	7.6%***	-24%***	5.1%***	-0.3%***	0.1%***
LProd	-17%***	10.3%***	-7%***	5.7%***	4.4%***	3.4%***
RVA	17%***	22.5%***	-0.1%	8.8%***	12%***	1.2%

Baseline results: focus on t

Table

Elasticity of bank loans to:	**France**		**Germany**		**Italy**	
	t	t+1	t	t+1	t	t+1
TFP	$\boxed{-27\%}$**	14.4%***	$\boxed{-8\%}$**	6.1%***	$\boxed{0.8\%}$**	2.4%***
MRPK	-51%***	7.6%***	-24%***	5.1%***	-0.3%***	0.1%***
LProd	-17%***	10.3%***	-7%***	5.7%***	4.4%***	3.4%***
RVA	17%***	22.5%***	-0.1%	8.8%***	12%***	1.2%

Baseline results for real value added

Table

Elasticity of bank loans to:	France		Germany		Italy	
	t	t+1	t	t+1	t	t+1
TFP	-27%***	14.4%***	-8%***	6.1%***	0.8%***	2.4%***
MRPK	-51%***	7.6%***	-24%***	5.1%***	-0.3%***	0.1%***
LProd	-17%***	10.3%***	-7%***	5.7%***	4.4%***	3.4%***
RVA	$\boxed{17\%}$**	22.5%***	$\boxed{-0.1\%}$	8.8%***	$\boxed{12\%}$**	1.2%

Small vs. large firms: focus on t+1

Table

Elasticity of bank loans to:		France		Germany		Italy	
		t	t+1	t	t+1	t	t+1
TFP	Small	-29%***	18% **	-9%***	7.3% **	1%***	2.5% **
	Large	-22%***	9% **	-8%***	5.1% **	-1.6%***	0.6%
MRPK	Small	-59%***	10%***	-24%***	4.6%***	-0.3%***	0.1%***
	Large	-36%***	5%***	-24%***	5.2%***	-0.9%***	0.1%
Lprod	Small	-16%***	14%***	-5%***	7%***	4.6%***	0.4%
	Large	-18%***	5%***	-7%***	5%***	0.1%	4.6%**
RVA	Small	15%***	26%***	-0.3%	10.3%***	13%***	1.3%
	Large	22%***	18%***	0%	8%***	5%***	0.3%

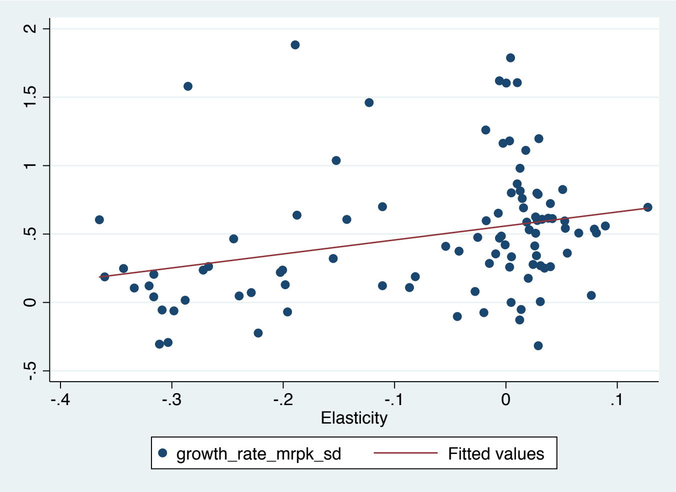
Small vs. large firms: focus on t

Table

Elasticity of bank loans to:		France		Germany		Italy	
		t	t+1	t	t+1	t	t+1
TFP	Small	$\boxed{-29\%}$ **	18%***	$\boxed{-9\%}$ **	7.3%***	$\boxed{1\%}$ **	2.5%***
	Large	$\boxed{-22\%}$ **	9%***	$\boxed{-8\%}$ **	5.1%***	$\boxed{-1.6\%}$ **	0.6%
MRPK	Small	-59%***	10%***	-24%***	4.6%***	-0.3%***	0.1%***
	Large	-36%***	5%***	-24%***	5.2%***	-0.9%***	0.1%
Lprod	Small	-16%***	14%***	-5%***	7%***	4.6%***	0.4%
	Large	-18%***	5%***	-7%***	5%***	0.1%	4.6%**
RVA	Small	15%***	26%***	-0.3%	10.3%***	13%***	1.3%
	Large	22%***	18%***	0%	8%***	5%***	0.3%

Any suggestive evidence of allocative efficiency?

Sectoral elasticities of productivity and credit (at t) and changes in MRPK dispersion



Conclusion

Conclusion

- We focus on the question of credit allocation taking a productivity angle at the firm-level.
- We propose a model to disentangle the relation between credit and current as well as future productivity.
- We look at an extensive set of measures of credit and productivity for a set of eurozone countries.
- Italy resemble our incomplete market setting, whereas Germany and France close to complete market.
- For small firms the allocation seems more 'efficient' than for large firms.

What's next

- Improving empirical identification
- Easier way: Panel GMM Arellano-Bond, Blundell-Bond.
- "Harder way": IV, Bartik-style instrument
- More evidence on the underlying mechanisms.