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Abstract:

Financial institutions are key to allocate capital to its most productive uses. In order to examine the relationship between bank credit and firm-level productivity in the context of different financial markets set-ups, we introduce a model of overlapping generations of entrepreneurs under complete and incomplete credit markets. Then, we exploit firm-level data for a group of European countries to explore the relation between bank credit and productivity following the main predictions of the model. We estimate an extended set of elasticities of bank credit with respect to a series of productivity measures of firms. We focus not only on the elasticity between bank credit and productivity during the same year, but also on the elasticity between credit and future realised productivity. Our estimates show a clear Eurozone core-periphery divide, for instance the elasticities between credit and productivity estimated in France and Germany are consistent with complete markets, whereas in Italy they are consistent with incomplete markets. The implication is that in countries that are consistent with an incomplete market setting, firms turn to be constrained in their long-term investments and bank credit is allocated less efficiently than in other countries. Hence capital misallocation by banks can be a key driver of the long-standing slow productivity growth that characterises periphery countries.

Keywords: Bank Credit, Capital Allocation, Productivity, Credit Constraints. JEL Classifications: G10, G21, G31, D92, O16.

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1 Introduction

A fundamental role of the financial sector is to allocate capital efficiently. This implies that banks should invest capital in the sectors and firms that are expected to have higher returns and withdraw it from those with poor prospects. In this paper we analyze the allocative efficiency of bank credit across a group of European countries exploiting firm-level data on loans and productivity.

Our point of departure is a theoretical model, which aims at examining the relationship between productivity and bank credit in the context of different financial market set-ups. The model is a two-periods OLG model of entrepreneurs and credit under both complete and incomplete market close in spirit to the one of Aghion et al. (2010). With complete credit markets, the model predicts a negative correlation between credit and productivity at time t and a positive one at time t+1; whereas with incomplete credit markets the correlation at time t turns positive.

In our empirical analysis we estimate the elasticity of banks credit with respect to productivity, by looking at the correlation of credit growth with productivity growth at the firm-level across the countries in our sample. These estimates can be interpreted as a proxy for how quickly credit is reallocated to the firms with faster productivity growth and resemble the main derivations of the model. Data come from the ECB-CompNet database, which provides data on bank credit, from firms' balance sheet, matched with various firm-level measures of productivity.[1] We use these data by country in order to document the joint distribution of credit and productivity and to estimate the elasticities of bank credit with respect to firm-level TFP, the marginal product of capital, labor productivity and value added. Moreover, we analyse the heterogeneity of such estimates by firm-size and by focusing at pre- vs. post-Global Financial Crisis differences. Finally, we estimate the correlations between bank credit growth and productivity growth not only at time t, but also at time t+1 and t+2, so we can look the relation between credit and the realised future productivity.

[1] The countries we have access to data are: Finland, France, Germany, Italy, and Poland. We have data also for Portugal and Spain, but only after 2008.

The results show that the elasticities differ by country not only in terms of magnitude, but also sign. There is in particular a clear divide between the Eurozone core and periphery, especially Italy. Core countries (France, Germany, and Finland) show a large negative elasticity between credit and productivity at time t and a positive one at time *t+1* and *t+2*. Periphery countries show either a positive elasticity at time t (Italy) or a negative, but small one, (Portugal and Spain). Drawing from the model these findings would indicate that for the core economies credit is allocated in a more efficient fashion, closer to a complete market setting; this, in turns, generates a negative correlation at time t and a positive one at time *t+1* and *t+2*. For periphery countries, instead, and for Italy in particular, the empirical results would suggest that an incomplete market setting are prevalent, thus generating an inefficient allocation of capital.

Over and above following the model guidance, the empirical analysis offers also a number of additional results, which are very relevant for policy. First, there is a large heterogeneity of the size of credit elasticity across countries. Second, in most countries, the elasticities between credit and productivity tend to be significantly bigger for small firms with respect to large firms. Finally, we find that the above elasticities tend not to vary significantly when measured in the period before or after the Global Financial Crisis.

The contribution of our paper is to show that an OLG model of credit allocation with complete and incomplete markets provides clear guidance about the correlation we should expect between credit and productivity at different points in time. In particular, under complete markets we should expect a negative correlation between credit and productivity growth at time t and a positive one at time *t+1*, whereas with incomplete markets the correlation turns positive also at time t. As the model makes clear, this implies that the firms in a country that face this type of correlation are constrained in their long-term investments plan. The second contribution of the paper is to measure and interpret the relation between bank credit and productivity at the firm level for a sample of Eurozone countries. To our knowledge there are not studies that document these type of patterns for a considerable group of Eurozone countries. This is a critical analysis since

TFP accounts for most of the income differences across countries (Caselli (2005), resource allocation is a key determinant of TFP (Hsieh and Klenow, 2009), and - in turn - bank credit is a key determinant in the allocation of capital.

Our paper relates to the literature that analyses the effects of finance on economic growth (King and Levine, 1993; Levine, 1997; Rajan and Zingales, 1998; Guiso et al., 2004; Ciccone and Papaioannou, 2006; Beck et al., 2008); to the literature on the real effects of bank credit as Jimenez et al. (2014), Schnabl (2012), Amiti and Weistein (2011) and Khawaja and Mian (2008); and to the literature on resource misallocation in Europe like Gopinath et al. (2015). However, the paper closest in spirit to ours is Wugler (2000) which represents one of the few attempts to specifically assess the role of the financial sector in allocating capital efficiently. This study takes the sector-level elasticity of investment on value added as a measure of the allocative efficiency of capital and then rely on cross-country reduced form regressions to evaluate the impact of different financial factors on such measure.[2] Hartmann et al. (2007) extend the work of Wurgler by looking at the impact that different characteristics of the financial sector have on the volume of investments.[3]

Our paper takes a step forward in this literature by i) elaborating a theoretical model that helps connecting the empirically found elasticities between bank credit and productivity with the relative effectiveness of the underlying financial markets, and ii) by estimating such elasticities using a novel firm-level dataset across a set of core and periphery countries in the EU. In Section 2 we introduce the theoretical model that serves us as a guide to interpret and test the interaction between bank credit and productivity; Section 3 presents the empirical specifications. Section 4 discusses the main results and policy implications; and Section 5 concludes.

[2]Wugler (2000) regresses this elasticity on the level of financial development measured as the sum of stock market capitalization and private and non-financial public domestic credit.

[3]They develop 17 indicators of different aspects of the financial system that can be mainly grouped into size, innovation and completeness, transparency, corporate governance, regulation, and competition.

2 A model of Credit, Productivity and Market Failure

Our point of departure is a simple model of investment allocation in the spirit of Aghion, Angeletos, Banerjee and Manova (2010), in which an entrepreneur chooses between short- and long-term capital goods. In this framework different patterns of correlation emerge between bank credit and productivity depending on the completeness of the credit market. This is a critical input for our successive empirical analysis since the model will help us interpret the sign and the magnitute of such correlations - which we compute with our firm level data set. In particular, via the model we wil be able to draw inference on the allocative conditions prevailing in the underlying financial markets of the different countries included in our dataset.

2.1 Production, Investment and Capital Goods

Consider an entrepreneur who can be active for at most two periods, t ('short run') and $t+1$ ('long run'), and maximizes the present expected value of flow profits over the two periods.[4] The entrepreneur is endowed with $L_t = L_{t+1} = L$ units of labor in both periods, and H_t units of human capital. Human capital can be thought of as skills and other know-how that the entrepreneur decides to invest in the first period for the creation of both short-term and long-term capital.

The technologies for transforming human capital in capital goods are assumed to be linear and to share the same productivity θ_t with the supplies of the short- and long-term capital goods given by $K_t = \theta H_{k,t}$ and $Z_t = \theta H_{z,t}$ respectively, where $H_{k,t}$ and $H_{z,t}$ are the amounts of human capital used as inputs for the two goods ($H_{k,t} + H_{z,t} = H_t$, or equivalently $K_t + Z_t = \theta H_t$).

Turning to the production of the final good, in period t the entrepreneur supplies this good combining her first-period labor endowment L_t with the installed amount of the short-term capital good K_t through the Cobb-Douglas

[4] While, for realism, we could have more than two periods, two will make the logic of the argument more transparent.

technology

$$Y_t = A_t K_t^{\alpha} L^{1-\alpha},$$

where: Y_t is the final good output; $A_t \in [A_{\min}, A_{\max}]$, with $0 < A_{\min} < A_{\max} < \infty$, is TFP; and $\alpha \in (0, 1)$ is the income share of the short-term capital good. Analogously, in period $t+1$ the entrepreneur supplies the final good combining her second-period labor endowment with the installed (and tooled) long-term capital good Z_t through the Cobb-Douglas technology

$$Y_{t+1} = A_{t+1} Z_t^{\alpha} L^{1-\alpha},$$

where: Y_{t+1} is the final good output; $A_{t+1} \in [A_{\min}, A_{\max}]$ is TFP; and $\alpha \in (0, 1)$ is the income share of the long-run capital good.

2.2 Borrowing and Credit Constraint

We assume that the entrepreneur can only borrow from and lend to banks at an exogenously (risk-free) rate R_t. We distinguish two scenarios: one in which the credit market is complete so that there are no borrowing constraints; the other in which the credit market is incomplete and the entrepreneur faces an ad-hoc borrowing constraint such that her net borrowing in period t cannot exceed a multiple $\mu \geq 0$ of her contemporaneous income. In the latter case we also assume that the entrepreneur is not able to meet the maximum liquidity shock when credit markets are sufficiently tight (i.e. μ is sufficiently small).[5]

Under these assumptions, the budget and borrowing constraints (when relevant) of the entrepreneur in period t can thus be stated as

$$\Pi_t + q_t(K_t + Z_t) + S_t e_t = Y_t + B_t, \qquad B_t \leq \mu Y_t, \tag{1}$$

where: Π_t is profit in period t; q_t is the unit (shadow) price of capital goods; $q_t(K_t + Z_t)$ is expenditures on capital goods; S_t is the liquidity shock; e_t is

[5]The formal condition for this to happen is $s_{\max} > A_{\max}\theta^{\alpha} (L_t/H_t)^{1-\alpha}$. This condition states that, even after devoting (in the limit) all human capital to the production of the short-term capital good and achieving maximum productivity in the first period, the entrepreneur would not generate enough income in that period to meet the maximum possible realization of the liquidity shock.

an indicator function valued 1 if the entrepreneur covers the liquidity shock and 0 otherwise; B_t is borrowing (or lending, if negative); and Y_t is revenue (as the price of the final good is normalized to one). Differently, as in the second period the entrepreneur cannot borrow (being this her last period of activity), her budget constraint in period $t+1$ is given by

$$\Pi_{t+1} + (1 + R_t)B_t = [Y_{t+1} + (1 + R_t)S_t]\, e_t, \tag{2}$$

where $(1+R_t)B_t$ is borrowing and associated interest repayment (or lending and associated interest repayment if B_t is negative) and $(1 + R_t)S_t$ is the recovery of the tooling cost with interest.

2.3 Productivity Shocks and Borrowing Response

To understand how borrowing reacts to productivity shocks, we characterize the composition of investment that maximizes the present expected value of the entrepreneur's flow profits

$$\Pi_t + (1 + R_t)^{-1} E_t[\Pi_{t+1}] \tag{3}$$

in our two scenarios: when the credit market is complete so that credit constraints are not binding; and when it is incomplete so that credit constraints are binding.

2.3.1 Complete Credit Market

When the credit market is complete, the entrepreneur can borrow as much as she wishes in the first period of her life. She can thus meet the liquidity shock after it happens if she wants to. This is always the case as the net present value of meeting the liquidity shock is positive:

$$(1 + R_t)^{-1} [Y_{t+1} + (1 + R_t)S_t] - (1 + R_t)^{-1} S_t = (1 + R_t)^{-1} Y_{t+1} > 0.$$

The fact that it is always optimal for the entrepreneur to meet the liquidity shock implies that she always sets $e_t = 1$. With this result at hand, we can use the budget constraints (1) and (2) to substitute for Π_t and Π_{t+1} in (3) so as to write the entrepreneur's maximization problem

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

subject to

$$k_t - z_t = \theta,$$

where $l_t \equiv L_t/H_t$, $k_t \equiv K_t/H_t$ and $z_t \equiv Z_t/H_t$ denote the 'normalized' levels of L_t, K_t and Z_t while $k_t - z_t = \theta$ comes from the technology and resource constraints for capital goods production requiring $K_t + Z_t = \theta H_t$.[6]

The first order conditions of this problem with respect to k_t and z_t then imply that the marginal products of short- and long-term capital goods are equalized in present expected value

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

Rewriting this condition as

$$\left(\frac{z_t}{\theta - z_t} \right)^{1-\alpha} = (1 + R_t)^{-1} \frac{E_t \left[A_{t+1} \right]}{A_t} \tag{4}$$

reveals that, as R_t is exogenously given, larger A_t leads to smaller z_t whereas larger $E_t [A_{t+1}]$ leads to larger z_t. In other words, *when the credit market is complete the correlation between borrowing and contemporaneous productivity growth is negative whereas the correlation between borrowing and future productivity growth is positive.* This is a standard 'opportunity cost effect': if productivity increases in period t (period $t+1$) relative to period $t+1$ (period t), the entrepreneur has an incentive to increase the supply of the short-term (long-term) capital good relative to the long-term (short-term) capital good, thus decreasing (increasing) her level of borrowing.

2.3.2 Incomplete Credit Market

Consider now the case in which the credit market is incomplete. As before, if the entrepreneur has or can borrow enough funds to meet the liquidity shock the first period, she will find it optimal to do so. However, differently

[6] By assumption, the normalized level of labor $l_t \equiv L_t/H_t$ is exogenously given.

from before, the entrepreneur now faces a credit constraint as in the first period she can borrow at most a fraction μ of her contemporaneous income, and thus there is uncertainty about whether she will be able to meet the liquidity shock. This implies that the maximum liquidity available to the entrepreneur in period t equals $(1+\mu)Y_t$ and she meets the liquidity shock if and only if $S_t \leq (1+\mu)Y_t$. Accordingly, given our distributional assumption on s_t, the entrepreneur meets the liquidity shock with probability $\Phi_t \equiv \Phi((1+\mu)(Y_t/H_t)) = \left[(1+\mu)A_t k_t^{\alpha} l_t^{1-\alpha}/s_{\max}\right]^{\phi}$, and faces 'failure' or 'liquidation' of her long-term investment with probability $1-\Phi_t$ ('liquidity risk').

Using the budget constraints and borrowing (1) and (2) to substitute for Π_t and Π_{t+1} in (3), we can state the entrepreneur's problem with incomplete credit market as:[7]

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

subject to

$$k_t + z_t = \theta.$$

The first order conditions of this problem with respect to k_t and z_t now require the equalization of the marginal product of the short-term capital good with liquidity-risk-adjusted marginal product of the long-term capital goods in present expected value

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

or equivalently

$$\left(\frac{z_t}{\theta - z_t}\right)^{1-\alpha} = (1-\tau_t)(1+R_t)^{-1} \frac{E_t[A_{t+1}]}{A_t} \tag{5}$$

[7] With $e_t = 1$ and binding credit constraint $B_t = \mu Y_t$, (1) and (2) become $\Pi_t + q_t(K_t + Z_t) + \Phi_t S_t = Y_t(1+\mu)$ and $\Pi_{t+1} + (1+R_t)\mu Y_t = \Phi_t[Y_{t+1} + (1+R_t)S_t]$ respectively.

with

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

If the credit constraint were not binding, the entrepreneur would meet the liquidity shock with certainty, which implies $\Phi_t = 1$ and $\partial\Phi_t/\partial k_t = \partial\Phi_t/\partial z_t = 0$. In this case τ_t would equal one and (5) would coincide with (4): the choice between short- and long-term capital goods would only depend on the opportunity costs of production. When, instead, the credit constraint binds, whether the entrepreneur can meet the liquidity shock is uncertain and depends on the realisation of the shock. In this case, we have $\Phi_t < 1$, $\partial\Phi_t/\partial k_t > 0$ and $\partial\Phi_t/\partial z_t < 0$ so that, given the definition of Φ_t, τ_t evaluates to

$$\tau_t = 1 - \left[\frac{(1+\mu) A_t \left(\theta - z_t\right)^{\alpha} l_t^{1-\alpha}}{s_{\max}} \right]^{\phi} \left(1 - 2\phi \frac{z_t}{\theta - z_t} \right). \tag{6}$$

This shows that the incompleteness of the credit market works as a 'tax' τ_t on the return of investment in the long-term capital good due to the fact that this investment has a positive probability of failure. This probability increases with the supply of the long-term capital good as larger supply of that good drains the income from short-term production that can be used to meet the liquidity shock, both directly and indirectly as collateral for (constrained) borrowing. For given z_t, the 'tax' τ_t is higher when the credit constraint is more severe (smaller μ), when the probability of a sizeable liquidity shock is higher (larger $s_{\max}$ or larger ϕ), and when the productivity of capital goods production is lower (smaller θ).

For our purposes, however, the crucial aspect of the 'tax' in (6) is that it depends on the (expected) productivity of final good production in the two periods, both directly through A_t as well as $E_t\left[A_{t+1}\right]$ and indirectly through z_t. Accordingly, the entrepreneur's choice between short- and long-term capital good supply depends not only on the opportunity costs of production (i.e. $(1+R_t)^{-1}\left(E_t\left[A_{t+1}\right]/A_t\right)$) but also on a 'wedge' (i.e. $(1-\tau_t)$) introduced by the 'tax' between the marginal products of short- and long-term capital goods. To see what this implies, we can substitute (6) in (5) to obtain the profit-maximising implicit relation of investment, z_t, with current and expected future productivity levels, A_t and $E_t\left[A_{t+1}\right]$:

$$\left(\frac{z_t}{\theta - z_t}\right)^{1-\alpha} = \left\{\left[\frac{(1+\mu)A_t\left(\theta - z_t\right)^{\alpha} l_t^{1-\alpha}}{s_{\max}}\right]^{\phi}\left(1 - 2\phi\frac{z_t}{\theta - z_t}\right)\right\}(1+R_t)^{-1}\frac{E_t\left[A_{t+1}\right]}{A_t} \tag{7}$$

This relation is analyzed graphically in Figure 2. In the figure the left and right hand sides of (7) are plotted against investment z_t measured along the horizontal axis. In particular, the left hand side (LHS) is represented by the upward sloping curve starting from the origin while the right hand side (RHS) is represented by the downward sloping curve meeting the horizontal axis at $z_t = \theta/\left(2\phi+1\right)$. The optimal level of investment z_t^* corresponds to the crossing of the two curves. Given the slopes and the intercepts of the two curve, this level is unique.

What is the impact of higher expected productivity in period $t+1$ on borrowing in period t? Larger $E_t\left[A_{t+1}\right]$ does not affect the left hand side, whereas it rotates the right hand side clockwise to RHS'. It follows that the optimal level of investment z_t^* and thus borrowing in period t increase. As in the case of complete credit market, higher expected productivity in the second period always entails more production of the long-term capital good in the first period. Hence, *the correlation between borrowing and future productivity growth is positive also when the credit market is incomplete.*

What about the impact of higher productivity in period t on borrowing in that period? In principle, the answer depends on how larger A_t affects two opposite effects. The first is the 'opportunity cost effect' that is also present with complete credit market. It works through the fall in relative (expected) future productivity $E_t\left[A_{t+1}\right]/A_t$ and makes the entrepreneur decrease the supply of the long-term capital good. The second effect is the 'liquidity risk effect' that works through the increase in the probability of covering the liquidity shock $\Phi_t = \left[(1+\mu)A_t\left(\theta - z_t\right)^{\alpha} l_t^{1-\alpha}/s_{\max}\right]^{\phi}$: all the rest equal, larger A_t allows to meet larger shocks. Which of the two effects dominates hinges on the comparison between ϕ and 1 given that the change in Φ_t is proportionate to A_t^{ϕ} while the change in productivity ratio is proportionate to A_t^{-1}. Under our assumption $\phi > 1$, the 'liquidity risk effect' dominates. The reason why for $\phi > 1$ the increase in Φ_t associated with larger A_t is strong is that the density of the liquidity shock distribution is disproportionately concentrated close the upper bound of its support. As a result, for $\phi > 1$ the right hand side of (7) rotates clockwise to RHS' as A_t rises, leading to more investment on long-term capital goods and thus more borrowing. Accordingly, higher productivity in the first period entails more production of the long-term capital good in that period. Hence, differently from when the credit market is complete, *the correlation between borrowing and contemporaneous productivity growth is positive when the credit market is incomplete.*[8]

3 Empirical Analysis

The model presented in Section 2 provides theoretical guidance for our empirical analysis, where we focus on the elasticity of bank credit with respect to productivity at different points in time. We use a novel firm-level data set, which underlies the CompNet database of the ECB.[9] One of the main advantage of this source is that it provides comparable estimates of firm-level characteristics across a set of European countries, since variable definitions and data treatment are carefully homogenised across the participant country teams.

3.1 The dataset

Unlike in the original CompNet database, the firm-level data we are using are not pooled at the sector level, but they were separately managed by the individual national teams participating to this specific exercise. As usual in CompNet, key firm-level variables were harmonised across countries. In Table 1 we provide a summary of the specific data source and sample extension of the countries we use in this paper.

[8]Beyond our assumption, for $\phi = 1$ the 'opportunity cost effect' and the 'liquidity risk effect' exactly offset each other; while for $\phi < 1$ the 'opportunity cost effect' dominates. The reason why for $\phi < 1$ the increase in Φ_t associated with larger A_t is weak is that the density of the liquidity shock distribution is disproportionately located close the lower bound of its support. As a result, for $\phi < 1$ the right hand side of (7) would rotate counterclockwise as A_t rises, leading to less investment in the long-term capital good and thus less borrowing. Accordingly, even when the credit market is incomplete, the impact of higher productivity in the first period on the production of the long-term capital good in that period would still be negative if the entrepreneur were more likely to be exceptional than standard at solving tooling problems.

[9]See Lopez-Garcia and di Mauro (2015) for details about the CompNet dataset.

For each firm we have data on bank credit, leverage, return on assets. marginal product of capital, TFP, labor productivity, real value added. For financial data, loans corresponds to the entry 'liabilities to financial institutions' in the firms' balance sheet. Returns on assets are defined as operating profit/loss over the average of total assets at t and t-1. Finally, leverage is the ratio of total debt on total assets.

As for data on productivity, the CompNet Database computes the firm-level TFP using the approach of Wooldridge (2009), which follows the approach of Olley and Pakes (1996) and Levinshon and Petrin (2003) to deal with the problem of endogeneity between TFP and inputs (see the Appendix for details about TFP estimation). Real value added is computed using country-sector specific deflators. Labor productivity is defined as real value added per employee. Finally the marginal product of capital is defined as the ratio of real value added over the capital stock accounting for the firm level elasticity of capital in the production function.

3.2 Econometric specifications

We run a series of firm level regressions in reduced form, but that follow the main intuitions of the model derived in Section 2. The regressions are implemented separately by country. The main purpose of this empirical exercise is to uncover some relevant pattern in the data about the relation between bank credit and productivity.

Wurgler (2000) shows that according to the q-theory of investments, firms with better growth prospects should experience faster investment growth. This implies that in a country with a high elasticity of bank credit to productivity, capital can get allocated to firms with better growth prospects more quickly. Similarly, in this paper we focus on the elasticity of productivity and credit itself documenting its pattern across different countries.

We compute the elasticity of bank loans at time t with respect to various measures of productivity at time $t+1$ and $t+2$. We put bank credit on the left-hand side, because the purpose of our research is to understand the allocation of credit and analyse how this relates to firms short-term and long-term productivity. There is an extensive literature that investigate the impact that credit constraints have on firm's productivity. However we look at the problem from a different angle, as we are interested in analysing how a given allocation of credit relates to firms' productivity at different point in times in order to study the allocative efficiency of bank credit in the different countries in pur sample.

Equation 8 represents out main specification. We control for a proxy of external finance demand, financial health of a firm, year, sector, and firm fixed effects.

$$\begin{aligned} Credit\ Growth_{ist} = \beta_0 + \beta_1 Productivity\ Growth_{ist+k} + \\ \beta_2 Growth\ with\ internal\ funds_{ist} + \beta_3 Leverage_{ist-1} + \delta_t + \gamma_s + \psi_i + \epsilon_{ist} \end{aligned} \tag{8}$$

where the dependent variable is the growth rate of credit (loans and bonds) of firm i in sector s at time t; the explanatory variable of interest is productivity growth at time $t+k$, $k = 0, 1, 2$; we use different productivity measures alternatively at various points in time $t+k$; δ_t is a year dummy; γ_s is a sector dummy; ψ_i is a firm dummy, and ϵ_{ist} is the error term.

The measures of productivity enter in the regression at time t, $t+1$ and $t+2$. These are realised productivities, which are equal to expected productivities under the assumption that banks and markets have rational expectations with perfect foresight. If these assumptions are violated realised productivities are not equal to the expected ones, so we have a measurement error in the independent variable of interest. Nevertheless, this measurement error would generate an attenuation bias in our estimates, so our results would provide a lower bound of the true elasticities for each country and a lower bound of the elasticity differences across countries. It is important to stress that we do not give to our estimates causal interpretation, as they might subject to endogeneity issues. Nevertheless, they are still valid correlations, which by definition capture the elasticity of bank credit respect to productivity.

Notice, that in our dataset bank lending information des not come from the banks' balance sheets, but rather from bank borrowing activities of the firms which are included in our dataset. However, the sample of firms is large and representative, so our results can be indicative of the overall banking sector.

In order to control for firm's financial health, we use leverage. This measure enters at time $t-1$ and not t to avoid endogeneity, given that loans and bonds enter the numerator of leverage. We expect a negative coefficient on this variable as banks and markets will be less willing to provide capital to firms in worse financial conditions.

If we want to interpret the results in (8) as an elasticity of credit allocation, we need to isolate the supply effect from the demand effect. We cannot observe directly the firm's demand for credit, but we account for the external financial need of a firm. To do we rely on the maximum rate of internally financed growth following the 'percentage of sales' approach to financial planning as in Guiso et al. (2004), and Higgins (1977).[10]. This captures the fact that credit would be demanded for the growth in excess to the one that could be internally financed. We expect the coefficient β_2 to be negative and significant as firms with higher growth through internal resources will demand less credit and hence they will be negatively correlated with credit allocation.[11] Moreover, we also have firm fixed effects that control for time-invariant firm characteristics and, as Khwaja and Mian (2008) show, these firm fixed-effects capture overall firm-level credit demand due to time invariant characteristics.

In addition to the baseline specification we run (8) for firms below and above 50 employees separately, so we can compare the differences in elasticity between large and small firms. Also, we compute the elasticity both before and

[10]This will depended on return to assets. Specifically $\text{Financial demand}_{ist} = 1 - \text{Maximum rate of internally financed growth} = 1 - \frac{ROA}{1-ROA}$.

[11]We do not control for alternative sources of external finance. Data on issued shares are unavailable for most countries and involves a low number of firms. Data on bonds are used as a dependent variable in a separate regression (results available upon request) rather than as an additional control in the specification with loans. This should not bias our results given the small number of firms that issue bonds in the countries of our sample. They do not exceed the 1.5% of firms and observations in all countries, with the exception of Germany where about 25% of firms issue bonds; this might generate an omitted variable bias for the coefficients on Germany.

after the 2008 crisis introducing an interaction term between productivity growth and a temporal post-2008 dummy.

4 Empirical Results and Policy Implications

The results of our baseline regression on loans for the countries of our sample are in Tables 2 and 3. The analysis of the empirical results offers a number of information, which are critical for policy, also because they are based on granular firm level information, normally not available, particularly for the cross-country comparison. We separate the countries into two groups because for Portugal and Spain we have data only after 2008, so their results are not fully comparable with rest of the sample. The main pattern in the data is that there is a significant and negative correlations between credit and productivity at time t and a positive one at time *t+1* and *t+2*. This is fully in line with our model. Italy is a notable exception to this pattern as it has a positive correlation between credit and both TFP and labor productivity at time t, and a positive, but small one, in subsequent periods. Moreover, Spain and Portugal have a relative small negative correlation at time t, a positive but rather small at $t + 1$, and an insignificant one at time $t + 2$, which can be driven by low power because of only two years of observations per firm.

A key point is to understand whether the negative correlation between TFP and credit at time t is just a mechanical consequence that stems from the TFP estimation or if it has an economic interpretation. Our TFP measure control for the simultaneous determination of TFP and production inputs, which can be favoured by a rise in credit, so this aspect should not be of concern.[12] Finally, this negative correlation does not involve only the TFP but also alternative measures of productivity such as labor productivity and the marginal product of capital.

[12] If a firm has a positive productivity shock, then the firm is likely to invest, possibly through accessing credit, and will increase capital and labor. This would bias the estimate of TFP coming from a Cobb-Douglas production function, but i) the TFP estimates we rely on control for this simultaneity issue and ii) capital should respond to the positive productivity shock by an amount so large to push a downward bias of the estimate of TFP growth into negative territory, which is implausible given the magnitude of the increase that would be required and the fact that capital needs time to be put in place.

One important empirical result is that the size of the coefficients varies considerably across countries (Figure 1). This suggests in turn that the efficiency of capital allocation is highly heterogenous across countries. In Italy bank loans responds very little to changes in productivity, while in the other countries this is not the case, especially in France. In all countries the coefficients for $t+2$ tend to be smaller than the ones for $t+1$, but this is because the growth rate of our regressors at time $t+2$ is taken with respect to $t+1$. So, for example, if a new project financed by loans at time t increases productivity at time $t+1$, we will not see a significant correlation between loans at time t and the productivity growth at $t+2$, as it is the case for Germany.

Turning to an interpretation of our empirical results with the model predictions, it would seem that in Italy, credit markets would be "incomplete". In particular, the positive correlation between bank credit and productivity at time t would suggest that banks would be affected by some sort of 'short-termism', whereby funds are preferably allocated to projects to immediate short term returns, rather than initiatives, possibly more risky, but that would imply - if chosen correctly - higher future returns and thus higher firm productivity in the following period. In other words, the pattern of correlations we observe in the data suggests that *access to credit for long-term investment is more of an issue in Italy than in the other countries in our sample*. This obviously result in a misallocation of entrepreneurial resources and is consistent with the findings on misallocation of Calligaris et al. (2016).

This result implies that during the last fifteen years bank credit in Italy may have constrained the long-term investments of firms, as banks focused mostly on short-term investments associated with low firm productivity going forward. This can be one of the explanations behind the high level of non-performing loans that is currently characterising the country. The policy recommendation that stems from these findings is that Italy would need to strive to improve substantially the capacity of its banking system to assess appropriately long term investment opportunities worth to be financed, and then to support such investments with adequate provision of capital.

Our results relates also to the extent in which firm size matters as regards the credit-productivity elasticity. Tables 4 and 5 show that it does. In most cases, the elasticity of loans to productivity is inversely correlated with firm size.[13] With the exception of Poland and Portugal, smaller firms experience the highest elasticity. Several interpretation are possible. First, banks may tend to be particularly careful in the borrowing firms selection, thus allocating credit solely to particularly promising one, as opposed to larger firms where relational banking can matter more, as large firms are cross-selling clients for whom loans represent only one of the financial services they may ask. Second, it could well be that larger firms are less dependent from bank loans (and related conditions applied by the banks), given their larger access to capital markets, typically unavailable for smaller firms. Third, it could also be that the average commitment and complexity of loans to larger firms is bigger; hence, it might be more complicated to reallocate credit across large firms than small firms. Finally, for larger firms, the result would be consistent also with an explanation based on relational banking.

Large firms represent a big share of employment and value added in an economy. This implies that the allocation of credit towards the more productive firms among large firms is particularly important for the long-term prosperity and productivity growth. Therefore, policy makers should pay particular attention to the degree of credit reallocation among large firms, as our empirical findings suggest that the elasticities are lower than what they could be in comparison with small firms. Possible policy recommendations include exploring the possibility to reduce the concentration limits of banks for loans on specific firms. This might provide incentives for firms to increase the number of lenders for large projects, hence reducing the commitments that a single bank face and easing a relocation of credit towards other firms. Moreover, the regulator could consider demanding a higher weight of specific productivity measures in the risk assessment models that banks use for lending. This would provide an incentive for banks to lend to more productive firms reducing the level of credit misallocation. Such requirement could also be confined to large firms only, for which the information needed to compute productivity measures such TFP could be retrieved more easily.

[13]The threshold between small and large firms is 50 employees.

Our set of results explores also whether the loan productivity elasticity tends to be constant over time. To test this, in Table 6 we compare the regression parameters estimated before and after the Global financial crisis. For Germany and France we are able to do so both at time t and t+1, whereas for the other countries we have results only for time t.[14]

Overall the results are not overwhelmingly robust and there is not a clear pattern emerging. In relation to TFP, the elasticity coefficient becomes slightly smaller after the crisis. This may reflect either a lower ability of banks to distinguish performance across firms during a crisis or the inability of banks to finance longer term productive projects. Germany is a notable exception to this pattern, as the magnitude of the elasticity of bank credit to TFP increases both at time t and $t+1$ hinting to a more careful selection of projects to finance by German banks. Among the countries in our sample, Italy is the one that seems to have the strongest worsening of credit allocation with the elasticity respect to labor productivity at time t switching sign from negative into positive, the elasticity respect to the marginal product of capital approaching zero and a strong increase in real value added, which signal a stronger focus on firms' short term sales to grant credit rather than longer term productivity prospects.

5 Conclusions

In this paper we analyze the relationship between bank credit and productivity at the firm level for a group of EU countries. To study this issue we propose a model of overlapping generations of entrepreneurs, which invest in capital building in the context of two opposite financial markets set-ups, one complete and the other incomplete. The model suggests that the sign of the correlation between bank loans and productivity varies in accordance with the relvant market set-up which prevails. In the empirical analysis we

[14]The regression we run is $Credit\ Growth_{ist} = \beta_0 + \beta_1 Productivity\ Growth_{ist+k} + \beta_2 Productivity\ Growth_{ist+k} * Post\ Crisis_t + \beta_3 Post\ Crisis_t + \beta_3 Growth\ with\ internal\ funds_{ist} + \beta_4 Leverage_{ist-1} + \gamma_s + \psi_i + \epsilon_{ist}$. Please notice that this does not include year dummy variables, so the coefficients cannot be compared to those in Table **??**.

put this hypothesis at a test, using a novel firm level data set for a number of EU countries. To do so, we estimate the elasticity of bank credit with respect to various measures of productivity at different points in time, as we look at the contemporaneous elasticity between credit and productivity as well as between credit and realised future productivity.

The general pattern of the data is such that there is a strong negative elasticity between contemporaneous bank credit and productivity and a positive one between bank credit and realised productivity. Italy is a notably exception to this pattern as it shows a positive elasticity also between contemporaneous credit and productivity; whereas, Spain and Portugal, even if they show a negative coefficient, they have a smaller elasticity compared to the other countries and their sample is restricted to the post-crisis period only. Reading these results with the eye of the theoretical model would suggest that overall - for most of European countries considered - financial markets appear to be approaching the "complete" state as defined by the model, although with different degrees of "completeness" across countries. On the other hand, for Italy, the empirical results would suggest that incomplete markets are more likely to be prevalent. This implies that during the last fifteen years bank credit in Italy may have constrained the long-term investments of firms, with bank focussing merely on short-term investments, unlikely to have substantial future returns and associated with low firm productivity going forward. This can be one of the explanations behind the high level of non-performing loans that is currently characterising the country.

Second, our results show that in most countries credit is more elastic to productivity for small rather than large firms. This means that for the same amount of credit provided, smaller firms would have a larger productivity outcome than the one experienced by larger ones. This is a relevant result because large firms represent a big share of employment and value added in an economy. Therefore, making sure that capital gets allocated to its most productive uses is particularly important across large firms.

The implications that stems from our findings are that Italy would need to strive to improve substantially the capacity of its banking system to assess appropriately long term investment opportunities worth to be financed and that a stronger focus on credit allocation across large firms is warranted. In order to overcome these issues policy makers could explore the possibility of changing the concentration limits of banks for loans on specific firms for large projects. This can be tricky to regulate, but it can lead to a lower commitments by banks on specific projects they have to finance for relational purposes and freeing capital to be allocated to more productive firms. Moreover, policy maker should reconsider the role of productivity in the models of risk assessment that banks use to to determine lending. Putting a higher weight on productivity and asking for productivity measures such as TFP would provide an incentive for banks to lend to more productive firms. This should be feasible especially for large firms that can provide all the information needed at a lower cost than small firms. This would improve the allocation of bank credit from a macroeconomic perspective and ensure a higher productivity growth for the economy.

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Appendix: estimation of firm-level TFP

The starting point of the estimation of firm-level TFP is a standard Cobb-Douglas production function:

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

where Y_{it} is real value added of firm i at time t, K is the real book value of net capital, L is total employment, and A is the object of interest TFP.

As it is well renown, estimating TFP using a standard Cobb-Douglas setting is subject to endogeneity problems between the input levels and the unobserved firm-specific productivity. Therefore, following the approach of Olley and Pakes (1996) and Levinshon and Petrin (2003) the unobserved firm-specific productivity is controlled for by a proxy of the unobserved productivity derived from a structural model. This proxy is a function of capital and material inputs that is approximated by a third-order polynomial, as in Petrin et al. (2004). Therefore, the following regression is then estimated on a 2-digit industry level using GMM, with the moments restrictions specified as in Woolridge (2009):

$$\mathrm{y}_{it} = \beta_0 + \beta_1 k_{it} + \beta_2 k_{i(t-1)} + \beta_3 m_{i(t-1)} + \beta_4 k_{i(t-1)}^2 + \beta_5 m_{i(t-1)}^2 + \beta_6 k_{i(t-1)}^3 + \beta_7 m_{i(t-1)}^3 + \beta_8 k_{i(t-1)} m_{i(t-1)} + \beta_9 k_{i(t-1)} m_{i(t-1)}^2 + \beta_{10} k_{i(t-1)}^2 m_{i(t-1)} + \gamma Year_t + \omega l_{it}$$

All variables are in logs, y_{it} is the real value added of firm i at time t, k is the real book value of net capital, m is material inputs, and l is total employment. While capital takes time to build, labor and TFP are simultaneously determined, so labor is instrumented by its first lag.

TFP is then retrieved as $TFP_{it} = rva_{it} - (\hat{\beta}_0 + \hat{\beta}_1 k_{it} + \hat{\gamma} Year_t + \hat{\omega} l_{it})$.
Two key assumptions of this methodology are that 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, but on past productivity realizations and that an increase in bank credit at time t, even if used for

investment, does not affect capital at time t as capital needs time to build up.

Tables

Table 1: Sample summary

Country	Finland	France	Germany	Italy	Poland	Portugal	Spain
Data Source	Tilastokeskus	Banque de France	Bundesbank	ISTAT	Narodowy Bank Polski	Banco de Portugal	Banco de Espana
Years	1999-2012	1995-2012	1997-2012	2001-2012	2005-2012	2008-2012	2008-2012
Firms	79,922	93,569	42,726	393,489	20,749	136,771	198,528
Observations	377,830	589,609	184,807	1,721,881	65,577	347,587	422,978

Table 2: Baseline results on loans A

Elasticity of bank loans to:	Finland			France			Germany			Italy			Poland		
	t	t+1	t+2	t	t+1	t+2	t	t+1	t+2	t	t+1	t+2	t	t+1	t+2
TFP	-10%***	11%***	1.7%***	-27%***	14.4%***	4.4%***	-8%***	6.1%***	1%	0.8%***	2.4%***	0.1%	-14%***	11.6%***	2.24%***
MRPK	-15%***	5.8%***	1.3%***	-51%***	7.6%***	2%***	-24%***	5.1%***	3.8%***	-0.3%***	0.1%***	-0.005%***	-22%***	5.1%***	3.5%***
LProd	-5%***	6.7%***	1.2%***	-17%***	10.3%***	3.5%***	-7%***	5.7%***	1%	4.4%***	3.4%***	0%	-9%***	10%***	1.8%
RVA	3.5%***	8.9%***	1.1%***	17%***	22.5%***	6.4%***	-0.1%	8.8%***	1.3%	12%***	1.2%	0%	0.4%	12.1%***	2%*

***, **, * Significant at the 1%, 5% and 10% level. The elasticities at time $t+1$ and $t+2$ are computed separately. The regressors enter each specification independently and they are the marginal product of capital, total factor productivity, labor productivity, and real value added. All specifications include time and sector dummies.

Table 3: Baseline results on loans B (sample after 2008 only)

Elasticity of bank loans to:	**Potugal**			**Spain**		
	t	t+1	t+2	t	t+1	t+2
TFP	-4.9%***	3.7%***	-9.5%	-1.5%**	3.5%***	-2.0%
MRPK	-7.4%***	1.6%***	-3.9%	-2.2%***	3.0%***	-0.006%
LProd	-3.1%***	3.0%***	-11-2%**	-0.03%	2.7%***	-2.6%**
RVA	0.03%	3.7%***	-5.7%	4.3%***	1.7%**	-1.9%

***, **, * Significant at the 1%, 5% and 10% level. The elasticities at time $t+1$ and $t+2$ are computed separately. The regressors enter each specification independently and they are the marginal product of capital, total factor productivity, labor productivity, and real value added. All specifications include time and sector dummies.

Table 4: Baseline results by firm size

Elasticity of bank loans to:		Finland			France			Germany			Italy			Poland		
		t	t+1	t+2	t	t+1	t+2	t	t+1	t+2	t	t+1	t+2	t	t+1	t+2
TFP	Small	-10%***	11.4%***	1.7%***	-29%***	18%***	3.7%***	-9%***	7.3%***	0.1%	1%***	2.5%***	0.1%	-12%***	9%***	1.1%
	Large	-15%***	9.4%***	5.0%*	-22%***	9%***	5.6%***	-8%***	5.1%***	1.1%	-1.6%***	0.6%	-1%	-16%***	15%***	3.3%*
MRPK	Small	-15%***	6%***	0.6%***	-59%***	10%***	1.7%***	-24%***	4.6%***	3.9%***	-0.3%***	0.1%***	-0%***	-18%***	2%***	0.4%***
	Large	-15%***	3.8%***	0.6%	-36%***	5%***	3.3%**	-24%***	5.2%***	3.8%***	-0.9%***	0.1%	-0.2%**	-26%***	6%***	2.8%*
Lprod	Small	-5%***	6.8%***	1.2%***	-16%***	14%***	2.32%**	-5%***	7%***	0.7%	4.6%***	0.4%	- 0.03%	-6%***	7%***	1.5%
	Large	-11%***	4.6%**	4%*	-18%***	5%***	5.2%***	-7%***	5%***	1.2%	0.1%	4.6%**	-1.2%*	-12%***	13%***	2.1%
RVA	Small	4%***	9.1%***	1.1%***	15%***	26%***	5.7%***	-0.3%	10.3%***	2.7%**	13%***	1.3%	0%	0%	8%***	3%**
	Large	3%	4.8%***	4.4%**	22%***	18%***	7.4%***	0%	8%***	0.1%	5%***	0.3%	-0.1%	-0.7%	16%***	0.8%

***, **, * Significant at the 1%, 5% and 10% level. The elasticities at time $t+1$ and $t+2$ are computed separately. The regressors enter each specification independently and they are the marginal product of capital, total factor productivity, labor productivity, and real value added. All specifications include time and sector dummies.

Table 5: Baseline results by firm size B (sample after 2008 only)

Elasticity of bank loans to:		**Portugal**			**Spain**		
		t	t+1	t+2	t	t+1	t+2
TFP	Small	-4.8%***	3.7%***	0.1%	-1.5%**	3.4%***	-2.1%
	Large	-11.8%***	3.4%	2.4%	-2.9%	0.00%	-4.3%
MRPK	Small	-7.3%***	1.6%***	1.7%***	-2.3%***	3.1%***	-0.7%
	Large	-13.9%***	4.0%**	1.6%	4.6%	3.0%	-12.5%
Lprod	Small	-3.0%***	3.0%***	2.1%	-0.3%	2.7%***	-2.7%**
	Large	-9.2%***	4.3%	1.1%	-1%	-0.1%	-1.8%
RVA	Small	0.3%	3.6%***	-1.2%*	4.2%***	1.7%**	-2.4%**
	Large	2.0%	4.4%*	0.1%	14.5%**	2.9%	-15.4%

***, **, * Significant at the 1%, 5% and 10% level. The elasticities at time $t+1$ and $t+2$ are computed separately. The regressors enter each specification independently and they are the marginal product of capital, total factor productivity, labor productivity, and real value added. All specifications include time and sector dummies.

Table 6: Baseline results pre- and post-crisis

Elasticity of bank loans to:		Finland		France		Germany		Italy		Poland	
		Pre-crisis	Post-crisis	Pre-crisis	Post-crisis	Pre-crisis	Post-crisis	Pre-crisis	Post-crisis	Pre-crisis	Post-crisis
TFP	t	-10.2%***	-9.7%***	-30%***	-22%***	-7%***	-11%***	-4-7%***	-3.8%***	-18%***	-14%***
	t+1	-	-	16%***	11.4%***	5.8%***	9.2%***	-	-	-	-
MRPK	t	-15.6%***	-14.6%***	-52%***	-44%	-22%***	-29%***	-1.5%***	-0.2***	-31%***	-17%***
	t+1	-	-	8.4%***	1.3%	4.6%***	3.5%***	-	-	-	-
LProd	t	-4.6%**	-5.3%***	-20%***	-11%***	-6%***	-8%***	-2.4%***	16.4%***	-8%***	-6.6%***
	t+1	-	-	11%***	2%	5.2%***	3.3%***	-	-	-	-
RVA	t	3.7%***	3.3%***	19%***	16%***	0.2%	-1%	3.5%***	12%***	4%***	2.4%***
	t+1	-	-	25.5%***	11.1%***	8.6%***	5.7%***	-	-	-	-

***, **, * Significant at the 1%, 5% and 10% level. The regressors enter each specification independently and they are the marginal product of capital, total factor productivity, labor productivity, and real value added. All specifications include sector dummies.

Figures

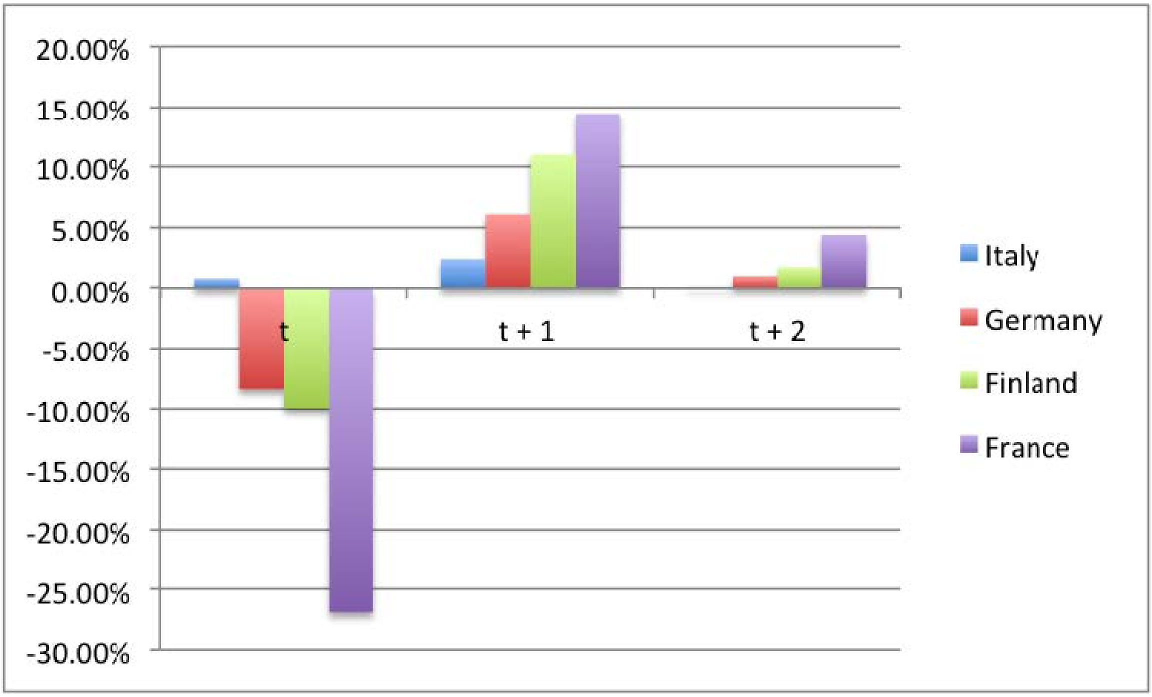

Figure 1A: Elasticity of Loans with Respect to the Total Factor Productivity

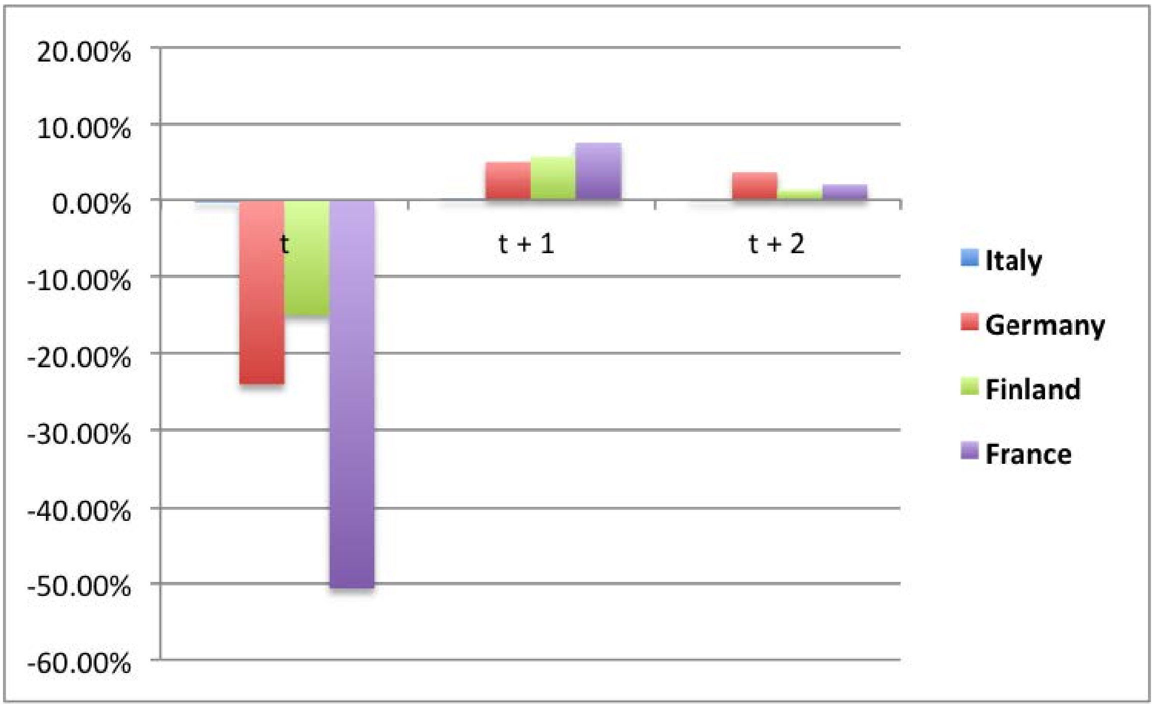

Figure 1B: Elasticity of Loans with Respect to the Marginal Product of Capital

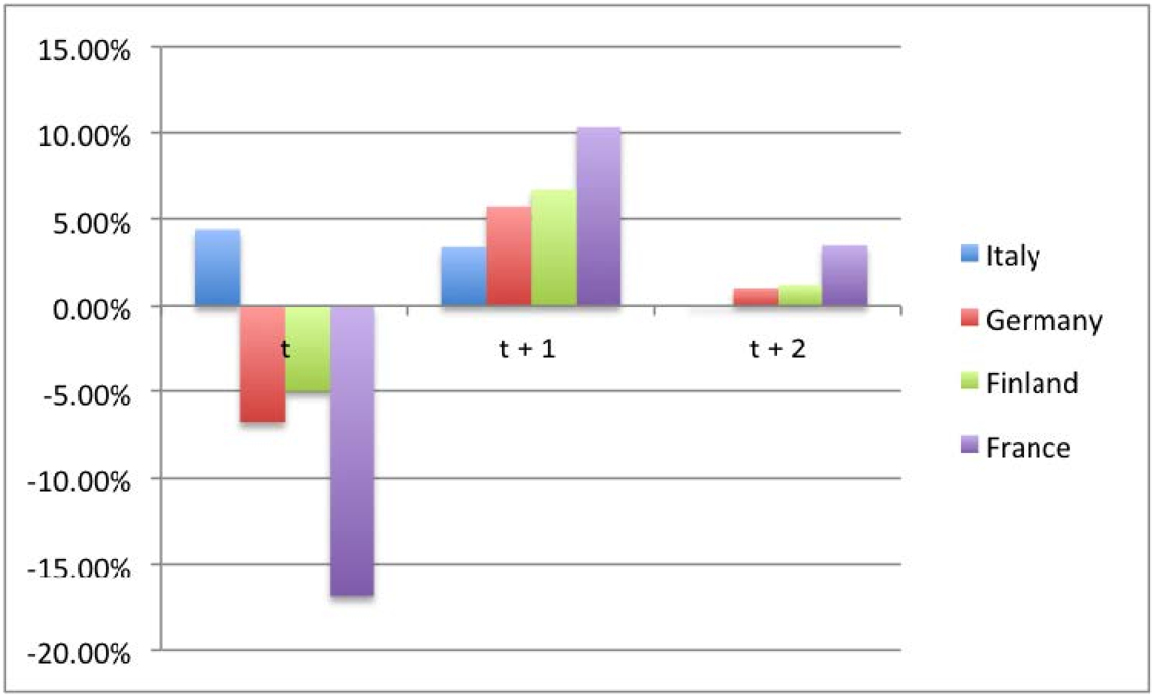

Figure 1C: Elasticity of Loans with Respect to the Labor Productivity

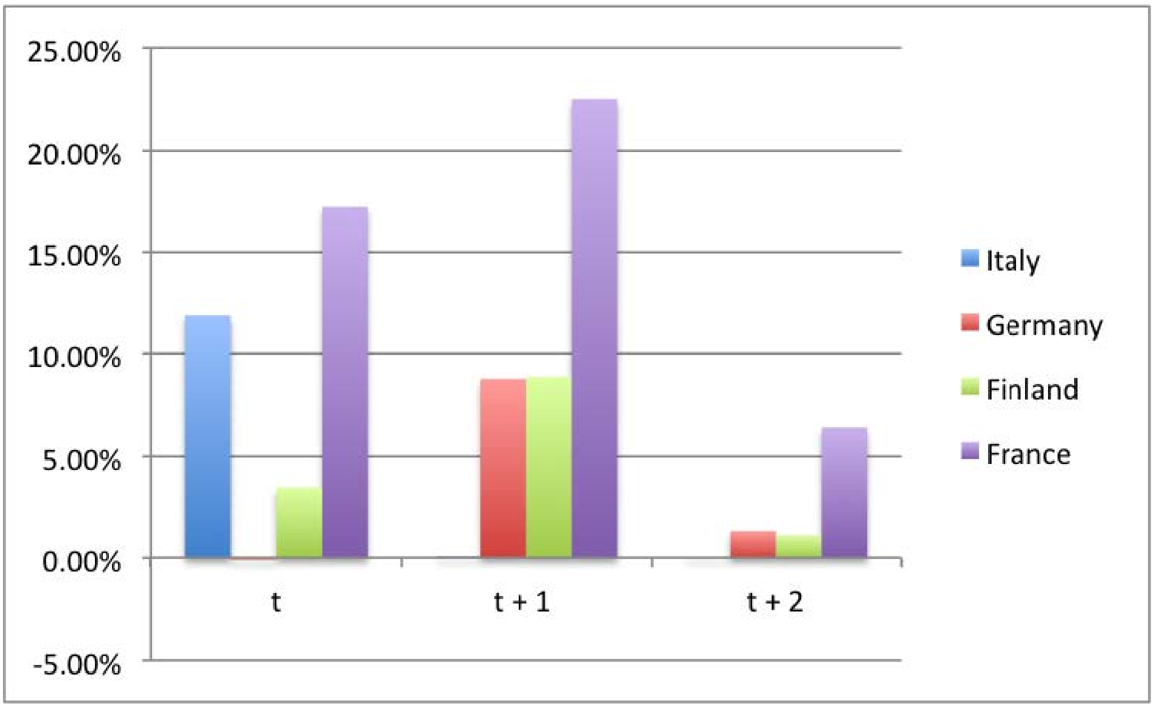

Figure 1D: Elasticity of Loans with Respect to the Real Value Added

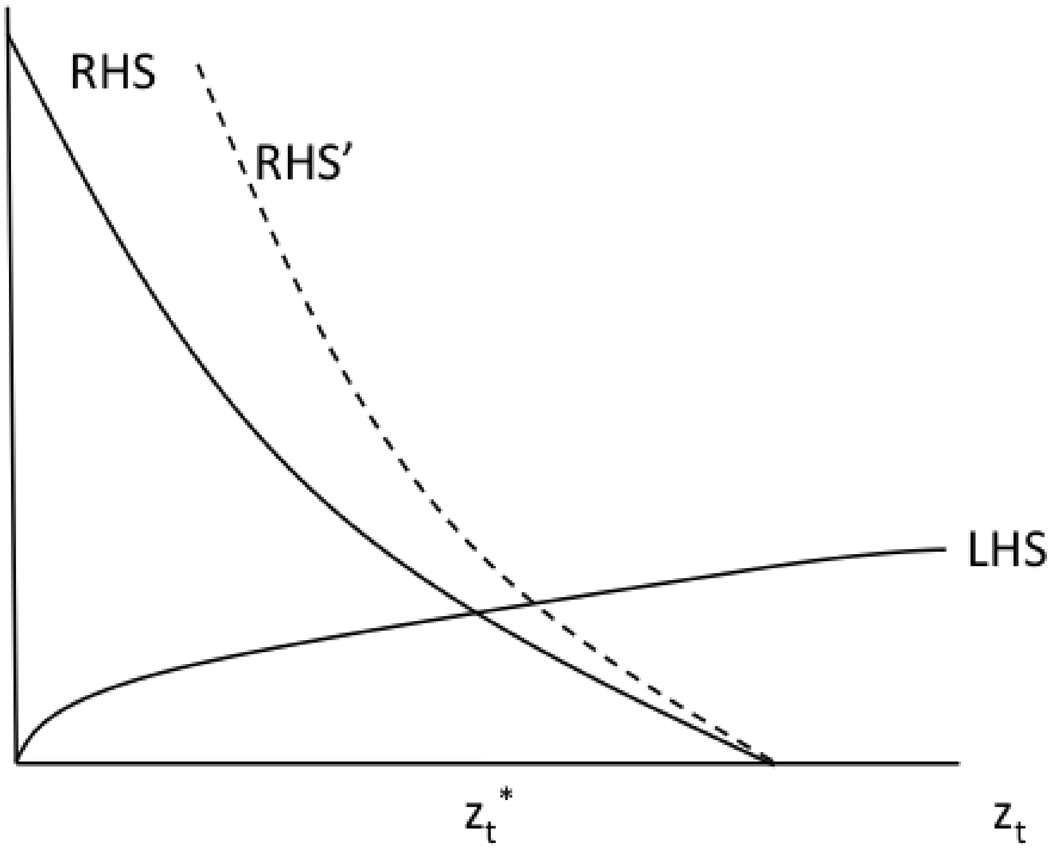

Figure 2: Productivity shock and borrowing under incomplete markets

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