A Real Options Explanation for Discouraged Bank Borrowers

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Abstract*

Discouraged firms are those who need credit but do not apply due to fear of rejection. Despite the high prevalence of the discouragement phenomenon the literature regarding its root causes is scant. We develop a structural financial explanation based on Real Options and derive testable implications, which we investigate using data for Eurozone SMEs. Based on a Bivariate Probit with Selection, where the Selection rule is the need for credit and the Outcome equation the discouragement, we show that Real Option effects account for the variation between discouraged and non-discouraged firms, explained by the perceived probability of application acceptance, application cost, uncertainty and irreversibility.

Keywords: Bivariate Probit with Selection, Discouraged Borrowers, Real Options, Survey Data.

JEL classification: G01, G10, G30, G32.

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1. Introduction

Small and Medium Sized Enterprises (SMEs), who account for a substantial part of job and value-added creation in modern market economies (Haltiwanger and Krizan, 1999), depend heavily on bank credit, whose availability is among the crucial determinants for their survival and growth (e.g. Berger and Udell, 1998; Beck and Demirguc-Kunt, 2006; De Mel *et al*. 2008; Banerjee and Duflo, 2014). However, although bank credit is so vital there is a sizeable portion of SMEs who choose not to apply for a bank loan, even if they need it. The relevant literature labels this group of firms as **discouraged borrowers**, which are formally defined as the firms who need bank credit but do not apply for it due to fear of rejection (Jappelli, 1990; Cox and Jappelli, 1993; Mushinski, 1999; Piga and Atzeni, 2007).[1]

Strictly speaking, discouragement is nothing more than a credit market outcome and in fact in terms of access to credit, a discouraged firm is observationally equivalent to a non-discouraged firm whose loan application has been rejected by a bank, since neither has received bank credit. The latter type of firms is typically defined as credit rationed in the Stiglitz and Weiss (1981) notion. However discouragement and the Stiglitz and Weiss (1981) type of credit rationing differ in at least two significant ways. First, discouragement is a shadow credit market outcome since discouraged in-need firms have not explicitly revealed their demand for credit, which raises the possibility that some discouraged firms, had they decided to apply for a loan, might have been successful. In other words, it is possible that the sub-population compositions of discouraged firms and *á la* Stiglitz and Weiss (1981) credit rationed firms are not identical. Second, and more important, discouraged firms are self-rationed, which means that not accessing credit is not the decision of another party (*i.e* the bank), but rather a direct result of their own choice.

The prevalence of discouragement is far from being negligible, with discouraged firms being roughly twice as many as firms whose loan application was rejected by the bank (Levenson and Willard 2000; Cole 2012; Freel *et al*., 2012). Despite this fact, the academic literature on discouragement has mainly focused on sketching the profile of the average discouraged firm (Crook, 1999; Han *et al*. 2009; Cole, 2010, 2012; Mushinski, 1999; Levenson and Willard, 2000; Kon and Storey, 2003; Piga and Atzeni, 2007; Brown *et al*.,

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1 The term 'discouraged' has originally been used in the context of labor economics to describe agents who do not apply for jobs because they fear rejection (see Finegan, 1981), and later employed by the consumer credit literature (see Jappelli, 1990).

2011; Drakos and Giannakopoulos, 2011; Freel *et al*., 2012; Sánchez-Vidal *et al*. 2012; Chakravarty and Xiang, 2013; Hain and Christensen, 2013; Ferrando and Mulier, 2014; Leon, 2014; Presbitero and Rabellotti, 2014; Xiang *et al*. 2014).

Thus, although we have a very good idea about discouraged firms' profile, we lack of an economic reasoning regarding the root causes of discouragement. In other words, the literature has established a number of characteristics that discouraged firms possess, but what is undeniably missing is a theoretical basis providing the motivation for discouragement. Hence, unless a systematized explanation for discouragement is developed, which as a byproduct would bring to the surface the discouragement drivers, empirical studies remain descriptive and the economic analysis of the discouragement phenomenon incomplete.

Kon and Storey (2003) represents the only attempt to provide a theoretical explanation for discouragement in a context of positive application costs and imperfect screening by banks. They conclude that the number of discouraged borrowers depends on loan application costs and the perceived probability that the loan will be granted. In addition, another interesting conclusion they reach is that discouragement is also related to potential borrowers' self-assessment.

With the present study we contribute to the literature by proposing a structural financial explanation for the discouragement phenomenon. We do so by exploiting the loan application decision's Real Option features that have so far passed unnoticed.[2] Let us contemplate what the features that qualify the bank loan application decision as an Option are. Clearly, a firm has the right, but not the obligation, to apply for a bank loan. In addition, the loan application decision is obviously not a 'now-or-never' proposition, since the application can, in the vast majority of cases, be delayed. Exercising, or 'killing the option', incurs at a minimum the irrevocable loan pecuniary application cost which is paid irrespectively of the application's outcome.[3] Moreover, as it is the case with every option, uncertainty is bound to crucially affect its value. In the loan application context there are two relevant sources of uncertainty. The first source relates to the stochastic nature of the loan

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2 The term 'real options' is due to Myers (1977), who refers to the 'option-like' characteristics of investments in (real) corporate assets. See Dixit and Pindyck (1994) and Trigeorgis (1996) for reviews of this literature.

3 Note that there are three more costs that are either implied or non-pecuniary: (a) a firm deciding to apply also incurs a cost in the form of the time spent in applying, and in case the application is rejected, (b) the applicant may incur a psychic cost (Kon and Storey, 2003), and (c) the rejection appears in the applicant's credit history.

application outcome, which is encapsulated in the perceived - by the applicant - probability of loan application acceptance. Essentially, as the perceived probability is lower (higher) the value of waiting should increase (decrease), and therefore discouragement would be more likely. Note that the unobserved nature of the perceived probability opens up a whole set of possible factors affecting it and pinning them down remains to a large extent an empirical issue. The second source of uncertainty relates to the economic viability and/or profitability of the venture that will be financed by the loan.

We argue that within a Real Option setup a firm needing a bank loan engages in a calculation of this (real) option value, or equivalently stated, the firm actively compares the cost and benefit of immediate loan application against the 'option value of waiting' before committing to the application process. Essentially this context allows us to shed light on which factors tend to increase (decrease) the option value of waiting and consequently decrease (increase) the likelihood of applying for a bank loan. Thus the novelty of the present study is that it opens up the possibility for an 'optimal option exercise' explanation for discouragement, which to the best of our knowledge has not been proposed before.

Furthermore, we derive a set of hypotheses from our theoretical model, which we put to the test empirically, by employing firm-level data from the **Survey of Access to Finance of Enterprises** covering European SMEs. Essentially, in our econometric analysis we explore whether the observed cross sectional variation between discouraged and non-discouraged SMEs can be accounted for by factors rendering value to the proposed underlying real option.

Our results provide empirical support for the ability of Real Option effects to explain the discouragement phenomenon. In particular, we find that factors which increase the (perceived) probability of loan application acceptance tend to decrease the likelihood of discouragement. In addition, the hypothesis that higher application costs increase the likelihood of application discouragement is also supported by the data. Empirical evidence in favor of the hypothesis that higher investment irreversibility increases the likelihood of discouragement is also uncovered. We also find that uncertainty, both firm-specific and sector-wide significantly affect discouragement.

The remaining of the paper is organized as follows: Section 2 develops a Real Options theoretical model for discouragement of in-need of bank credit borrowers. Section 3 describes the dataset as well as the variables and proxies used in our empirical investigation.

Section 4 outlines the econometric specification that is employed and presents the empirical results, while Section 5 concludes the paper.

2. Theoretical model and testable implications

In this section we develop a theoretical model in continuous-time that links discouragement of in-need borrowers to uncertainty and irreversibility. Our proposed model follows directly from the work of McDonald and Siegel (1986), Leland (1994), Kon and Storey (2003) and Sundaresan *et al*., (2015). It is essentially a one-growth-option only version of the model in Sundaresan *et al*., (2015), where the value of waiting to invest meets the trade-off model of capital structure, with loan application costs as in Kon and Storey (2003). After the model is outlined and developed, the last part of this section summarizes the testable implications of the model, with respect to the optimal timing of the loan application decision by firms, which are empirically tested using firm-level survey data.

2.1 The basic model set-up

Assume a risk-neutral firm contemplates entering a market by making an investment of a lump-sum entry cost $I > 0$.[4] We assume that the market is complete, the risk-free interest rate r is constant, and that the firm behaves in the best interests of existing equity holders/owners at each point in time, *i.e*. there are no conflicts of interest between managers and owners.

At time $t = 0$, the firm starts with no assets in place and knows it has one growth option, *i.e*. the opportunity (option) to invest, acquire assets and start production. The firm is a price-taker in the product market, in that it observes the exogenous (stochastic) price process for its output, $Y(t)$, that follows:

$$dY(t) = \mu Y(t)dt + \sigma Y(t)dW(t) \quad \textbf{(1)}$$

where $\mu < r$ is the constant growth rate, $\sigma > 0$ is the (constant) standard deviation of the price process returns, and $W(t)$ is a standard Brownian motion.

In order to invest and acquire assets in place, the firm must incur the fixed and irreversible investment cost $I > 0$. The investment cost I can be financed by either equity-

[4] The assumption of risk neutrality is not crucial for the development of the model's testable implications. The model's propositions can be easily extended to risk-aversion, only at the cost of additional notation.

only, or by a combination of a bank loan and equity. After investment (real option exercised), the assets in place generate profit at the rate of:

$$y = mY - k, \tag{2}$$

where k is the constant operating cost and m is the constant rate of output produced by the assets in place. Assume that the firm faces a constant tax rate $\tau > 0$ on its profits, and let

$$A(Y) = (1-\tau)\left[\frac{mY}{r-\mu} - \frac{k}{r}\right] \tag{3}$$

denote the after-tax, present value of profits after investment, under *all-equity financing*. Let $V^{ae}(Y)$ denote optimal firm expected value under all-equity financing, and Y^{ae} the optimal growth-option exercising threshold under all-equity financing, both of which are to be determined.

Alternatively, the firm can finance the investment using an optimally chosen (and timed) level of borrowed funds, in the form of a bank loan. On the one hand, the use of borrowed funds has a tax advantage (tax shield), since the firm faces a positive tax rate $\tau > 0$ on its profits after interest service payments. However, the use of debt in the financing of the investment also introduces the possibility of default. If the flows in (3) are too low, the debt-and-equity financed firm might find it optimal to default on its debt obligations and surrender the assets in place to the firm creditors. Let $L(Y)$ denote the proceeds from liquidation upon default; as in Leland (1994) and Sundaresan *et al*., (2015), assume that upon default, the firm uncovers only a $(1-\gamma)$ fraction of $A(Y)$, the present value of existing assets in place, *i.e.*:

$$L(Y) = (1-\gamma)A(Y) \tag{4}$$

Furthermore, as in Sundaresan *et al*., (2015), we assume that external financing is in the form of a bank loan that is perpetual and issued at par. Applying for a loan entails fixed and unrecoverable application costs, which we denote by $K > 0$. Finally, as in Kon and Storey (2003), firms applying for a loan are subject to screening by banks, but the screening is imperfect in that there is an exogenous (to the firm) probability $\pi \in [0,1]$ that the loan application of a firm is accepted by a bank.[5]

[5] As in Kon and Storey (2003), loan application costs K cover all of the financial, in-kind and psychic costs associated with the application procedure. As they put it, financial costs “include the costs of paying others to provide information required by the bank”, in-kind costs “cover the applicants time in completing forms, traveling to, and meeting with, the bank”, while psychic costs “include the discomfort which many

Let Y^i denote the (yet undetermined) investment threshold when equity and debt financing is opted for by the firm. When the price process first reaches Y^i (to be determined) from below, the firm finds it optimal to invest using a mix of own funds and a bank loan, whose amount is to be determined endogenously. At $Y = \text{Y}^i$, the firm applies for the bank loan, its application is screened instantaneously, and if accepted (with probability π) the investment is implemented.[6]

Post-investment (when Y has exceeded Y^i and conditional on a successful loan application), an operating firm can optimally decide to default on its loan obligations if the price process retreats to low levels. Let Y^d denote the (yet undetermined) default threshold, and let $V(Y)$ denote optimal firm value under both debt and equity financing.

2.2 Model results

The main results of the model are summarized in the following two propositions (The proofs of the main results are relegated to Appendix A).

Proposition 1 [All equity financing]: *Under the setting and assumptions of section 2.1, if the firm finances the investment with its own funds (equity only), then firm value under all-equity financing is given by*:

$$V^{ae}(Y) = \begin{cases} \left(\frac{Y}{Y^{ae}}\right)^{\beta_1} [A(Y^{ae}) - I] = \left(\frac{Y}{Y^{ae}}\right)^{\beta_1} \left[(1-\tau)\left(\frac{mY^{ae}}{r-\mu} - \frac{k}{r}\right) - I\right], & Y < Y^{ae} \\ A(Y) = (1-\tau)\left[\frac{mY}{r-\mu} - \frac{k}{r}\right], & Y \geq Y^{ae} \end{cases} \qquad \textbf{(5)}$$

where Y^{ae} is the optimal growth-option exercising threshold under all-equity financing, given by:

$$Y^{ae} = \frac{r-\mu}{1-\tau}\frac{\beta_1}{\beta_1 - 1}\frac{(1-\tau)k + rI}{mr}, \qquad \textbf{(6)}$$

with β_1 the (positive) option parameter given by:

entrepreneurs experience in passing on information about themselves and their enterprise to a third party" (Kon and Storey, 2003, p. 38). Moreover, we assume that all banks are homogenous, in that they use the same imperfect screening procedure; thus the firms have no incentive to repeatedly approach alternative banks in applying for a loan.

[6] The assumption of instantaneous loan screening and investment is not crucial; delays in the loan application screening and decision could be incorporated as in Majd and Pindyck (1987).

$$\beta_1 = \frac{-\mu+\frac{1}{2}\sigma^2+\sqrt{2r\sigma^2+(\mu-\frac{1}{2}\sigma^2)^2}}{\sigma^2} > 1. \quad \textbf{(7)}$$

Proof: Follows directly from McDonald and Siegel (1986) and Lemma 1 of Sundaresan *et al*., (2015). See Appendix A.

Proposition 2 [Bank loan application timing]: *Under the setting and assumptions of section 2.1, if the firm finances the investment with a combination of a bank loan and equity, then firm value under the optimal financing mix (and conditional on an approved bank loan application) is given by*:

$$V(Y) = \begin{cases} \left[\pi\left(V_1(Y^i) - I\right) - K\right]\left(\frac{Y}{Y^i}\right)^{\beta_1}, & Y < Y^i \\ V_1(Y) = A(Y) + \frac{\tau C^*}{r} - \left[\gamma A(Y^d) + \frac{\tau C^*}{r}\right]\left(\frac{Y}{Y^d}\right)^{\beta_2}, & Y \geq Y^i > Y^d \end{cases} \quad \textbf{(8)}$$

where β_1 as in (7) and β_2 the (negative) option parameter given by:

$$\beta_2 = \frac{-\mu+\frac{1}{2}\sigma^2-\sqrt{2r\sigma^2+(\mu-\frac{1}{2}\sigma^2)^2}}{\sigma^2} < 0. \quad \textbf{(9)}$$

The optimal investment threshold where the firm applies for a bank loan, Y^i, the optimal default threshold, Y^d,and the optimal interest payment on the bank loan that the firm applies for, C^*, are collectively determined by solving the following system of implicit equations:

$$Y^d = \frac{\beta_2}{\beta_2-1}\frac{r-\mu}{m}\frac{C^*+k}{r} \quad \textbf{(10)}$$

$$Y^i = \frac{1}{1-\tau}\frac{r-\mu}{m}\frac{\beta_1\pi}{\beta_1\pi-1}\left[\left(I + \frac{K}{\pi} + \frac{(1-\tau)k}{r} - \frac{\tau C^*}{r}\right) + \frac{\beta_1\pi-\beta_2}{\beta_1\pi}\left(\gamma A(Y^d) + \frac{\tau C^*}{r}\right)\left(\frac{Y^i}{Y^d}\right)^{\beta_2}\right] \quad \textbf{(11)}$$

$$1 - \frac{\beta_2 C^*(1-\gamma+\frac{\gamma}{\tau})}{C^*+k} = \left(\frac{Y^d}{Y^i}\right)^{\beta_2}. \quad \textbf{(12)}$$

Proof: See Appendix A.

Although the main result in Proposition 2 does not lend itself easily to closed-form comparative statics, it is not difficult to verify that the investment threshold, Y^i, where the firm optimally applies for a bank loan of face value $F^* = C^*/r$ is increasing in:

(a) the loan application costs, K,

(b) the rejection probability of bank loan application, $1-\pi$,

(c) the uncertainty in the present value of the contemplated investment, σ, and,

(d) the profit tax rate that the firm faces, τ.

Figures 1-3 summarize the predictions of the model over a range of parameter values. The parameters employed for the Figures are identical to the numerical section of Sundaresan *et al*., (2015). Figure 1 shows that the firm postpones the loan bank application and the investment threshold Y^i as the probability of loan application acceptance π decreases and the loan application costs K increase. The lower part of the Figure demonstrates that the firm adjusts its optimal default level, Y^d, accordingly. Figure 2 establishes numerically that the firm optimally postpones the loan bank application and the investment threshold Y^i in the face of increasing uncertainty, σ, and for a higher tax rate, τ. A higher tax rate increases the tax shield, making the firm apply for a higher loan (C^*). Higher loan, ceteris paribus, makes the firm more risky. This is manifested by a higher spread charged as τ increases (Figure 3). Higher and riskier loans "pull" the default level "closer" (*i.e.* Y^d is higher). As Y^i (investment and loan application timing) is determined for a given $C^*$and Y^d, the "payoff" of real option exercise is decreasing in τ, making deferral optimal (Y^i increases).

Finally, Figure 3 demonstrates that depending on parameter values, the firm would apply optimally for a different bank loan level, $F^* = C^*/r$, in its effort to achieve optimal leverage for the investment under consideration, and will be charged a spread over the risk-free rate accordingly. In line with the benefits of a tax shield, the firm optimally aims for higher leverage and applies for a higher loan, the higher the tax rate τ is. However, as the uncertainty (either in the economic value of the project, σ, or in the approval of the loan by the bank, $1-\pi$) increases, the loan applied for is riskier; it is charged a higher interest rate spread, thus decreasing the market value of debt (and the targeted leverage in market values).

[Insert Figures 1-3 about here]

2.3 Testable implications

In this section we discuss the testable implications generated by our theoretical model with respect to discouragement and the optimal timing of the apply decision of firms.

The probability of loan acceptance is to a large extent linked to the score a firm achieves in the bank's application evaluation score sheet. Although the score is unobserved, we know that certain firm characteristics directly affect it. For instance it is known that better operational performance and a healthier financial profile tend to increase firm score and therefore tend to increase the chances of loan application acceptance. Additionally, firm size and age tend to increase firm score and consequently raise the probability that the loan is granted. Thus, we expect that discouragement will be more likely, due to a lower perceived probability of approval, for: (i) firms with lower operating performance, (ii) firms with lower financial health, (iii) younger firms, and (iv) smaller firms.

We conjecture that the perceived probability of acceptance not only depends on its past and current operational and financial profile, but also on their expected trajectory. For instance, if a firm considers that its past and current profile lead to a low probability of loan application acceptance it might find it optimal to defer its application. Similarly, if the firm expects an improvement in its future profile that would possibly raise the future probability of application acceptance, it increases the value of waiting and hence the firm defers its application. Hence there are two testable implications:

Implication 1a: *Higher (perceived) probability of loan application acceptance decreases the likelihood of application deferral.*

Implication 1b: *Higher future (perceived) probability of loan application acceptance increases the likelihood of application deferral.*

Loan application costs are not available in any dataset, but we know from banking practice that typically they are fixed and non-refundable. Given their fixed nature, it is easily deduced that as the loan amount requested increases, the application unit cost decreases. Hence, assuming that larger firms on average request higher loan amounts, we deduce that unit application costs decrease with firm size (Saito and Villanueva, 1981; Treichel and Scott 2006). This produces the following implication to be tested:

Implication 2: *Higher application costs increase the likelihood of application deferral.*

A higher tax rate increases the firm's incentive to use leverage due to the effect of the tax shield. However, the higher the loan amount applied for is, the more probable future default becomes due to higher applicant's risk. As the firm optimizes its investment timing according to the amount of the loan applied for and the possibility of default, it delays the loan application in the face of higher tax rates.

Implication 3: *Higher corporate tax rate increases the likelihood of application deferral.*

Uncertainty plays a central role in any real options context; however its source and therefore its empirical measurement are usually elusive (Bulan, 2005; Drakos, 2011). We make an attempt to capture uncertainty at two levels: firm and sectoral. At the firm level, by exploiting the difference between firm's past turnover growth and its expected turnover growth, we construct a proxy for firm-specific uncertainty. In addition, our dataset (described in the next section) provides us with a potentially useful piece of information, since firms are asked whether they have introduced a new organization in management. We conjecture that firms with such a characteristic face higher uncertainty and therefore are more likely to defer their bank loan application. The second level captures sectoral uncertainty and therefore accounts for any cross-sectoral uncertainty heterogeneity.

Implication 4: *Higher uncertainty increases the likelihood of application deferral.*

The actual investments that are financed with approved bank loans might be unobservable in any given survey sample like the one we employ; but there is vast empirical evidence (e.g. Leahy and Whited, 1996; Guiso and Parigi, 1999; Bulan, 2005; Drakos, 2006; Drakos and Goulas, 2006; Drakos, 2011) that the degree of capital irreversibility exacerbates the negative relationship between uncertainty and investment. Dixit and Pindyck (1994) argue that the irreversibility of capital expenditure is more pronounced at the sector/industry-level, since capital is sector/industry-specific, and Bulan (2005) and Drakos and Goulas (2006), among others, construct sector/industry-level irreversibility metrics in their empirical investigations. Thus we expect that discouragement, in the form of loan application deferral will be more pronounced in sectors/industries that are associated with higher irreversibility of capital:

Implication 5: *Higher investment irreversibility increases the likelihood of application deferral.*

The following summarizes the expected effects on the probability of loan application discouragement (deferral) that are tested in our empirical section:

$$\begin{aligned} Discouragement \\ = f[&current\ probability\ of\ \ loan\ acceptance\ (-), future\ probability\ of\ loan\ acceptance\ (+), \\ &loan\ application\ costs\ (+), uncertainty\ (+), \\ &profit\ tax\ rate\ (+), irreversibility\ (+)] \end{aligned}$$

3. Data collection and background analysis

We employ data from the **Survey of Access to Finance of Enterprises** (SAFE), a firm-level survey launched in 2009, and conducted twice a year by the European Commission and the European Central Bank. In particular, we use the waves that correspond to the first halves of 2009, 2011, 2013, and 2014. We are particularly interested in those waves because they contain questions that enable us to capture the potential real options effects on discouragement, as we describe in detail below.

Table B.1 in Appendix B reports the number of firm observations across countries and waves in the sample. Our econometric analysis will utilize the SMEs for the Eurozone countries in order to ensure greater sample homogeneity. However, for all conducted analysis we will also report results for the whole sample for comparison purposes, which may also serve as robustness analysis.

The SAFE questionnaire does not provide hard financial information for firms but rather qualitative only. In particular, it offers firm-specific discrete indicators reflecting the trajectory (increase, unchanged, decrease) of firms' financial condition and performance such as: turnover, net interest expenses, and profits. In addition, it also provides non-financial firm characteristics such as: size (micro, small, medium, large), and age.

3.1 Identifying discouraged firms

Correct identification of discouraged firms is clearly a cornerstone for our analysis and as we will show it is also a delicate task. According to theory, a firm that does not apply for a loan because of fear of rejection is considered as discouraged insofar it needs a bank loan. Hence, a salient feature of discouragement is its conditionality on the need of a bank loan, which not only affects the measurement of discouragement *per se*, but also determines the estimation technique to be deployed.

By combining the answers from two questions of SAFE we are in a position to empirically match the theoretical definition of discouragement, and therefore identify discouraged firms. Our starting point for this identification is based on the following survey question, which in the SAFE questionnaire is posed as follows (*Q7A* in the survey questionnaire):

Could you please indicate whether you applied for a Bank Loan over the past 6 months, or if you did not apply because you thought you would be rejected, because you had sufficient internal funds, or you did not apply for other reasons?

- Applied
- Did not apply because of possible rejection
- Did not apply because of sufficient internal funds
- Did not apply for other reasons
- [DK/NA]

Figure 4 depicts the distribution of answers provided by firms for the whole sample (across all waves and all countries).[7] About 40% of firms did not apply for a bank loan because they had sufficient internal funds, while just above 28% of firms applied for a bank loan. Roughly a combined 30% of firms answered that they did not apply for a bank loan, being the sum of 6% of firms who stated the fear of possible rejection of their application as the reason for not applying and 24% stating that they did not apply for other reasons.

[Insert Figure 4 about here]

As already mentioned, discouraged firms are necessarily a subset of firms who need a bank loan. In other words, discouragement is only observed conditional on a firm's need of a bank loan. From the above question we can easily classify a firm as needing or not needing a bank loan.

Let N_i be an indicator showing whether the i-th firm needs or does not need a bank loan, attaining the following values (excluding those firms who answered DK/NA):

$$N_i = \begin{cases} 0 & \text{if firm } i \text{ answered: 'Did not apply because of sufficient funds'} \\ 1 & \text{otherwise} \end{cases} \quad \textbf{(13)}$$

Then we define D_i as a dichotomous indicator that classifies the i-th firm as discouraged or not as follows:

$$D_i = \begin{cases} 1 & \text{if } N_i = 1 \text{ and } i \text{ answered: 'Did not apply because of possible rejection'} \\ 0 & \text{if } N_i = 0 \\ 0 & \text{if } N_i = 1 \text{ and } i \text{ answered: 'Applied' or 'Didn't apply for other reason'} \end{cases} \quad \textbf{(14)}$$

Table 1 summarizes the sample properties of the in-need and discouraged variables by wave and country. We see that 53.82% of firms answered that they need a bank loan, while 46.18% answered that they possess the necessary funds internally. Conditional on the need for bank loan, we see that 9.67% of firms are characterized as discouraged, *i.e.* although they need a bank loan they did not apply because of fear of possible rejection.

[7] Table B.2 in the Appendix provides the answers by country and by wave.

[Insert Table 1 about here]

Discouraged firms are a sizeable portion of in-need of a bank loan firms. To further gauge the prevalence of discouragement, it would be fruitful to compare it to another benchmark credit market outcome, namely the percentage of firms who applied for a bank loan but their application was rejected.[8] This information is provided in another survey question (*Q7B* in SAFE questionnaire). Figure 5 depicts, for comparison purposes, the prevalence of discouragement and loan application rejection rates across countries. It becomes apparent that the discouragement rate is higher than the rejection rate in every country, although their difference varies in size. The intensity of (raw) discouragement varies considerably across countries, reaching its highest value in Ireland (28%) and its lowest value in Switzerland (4.7%).

It turns out that firms whose loan application was rejected represent about 9.7% of the firms who applied for a bank loan, which is almost identical to the percentage of discouraged firms. Thus, the occurrence of discouragement is as prevalent as the Stiglitz and Weiss (1981) form of credit rationing.

[Insert Figure 5 about here]

3.2 Proxying Real Option covariates

In this section we will present the construction of variables proxying for the factors affecting the value of the option to apply for a bank loan. The probability of loan application acceptance is proxied by size, age, operational performance and financial health, which are measured as follows:

- **MICRO:** 1, if # of employees ≤ 9; 0, otherwise
- **SMALL:** 1, if 10 ≤ # of employees ≤ 49; 0, otherwise
- **MEDIUM:** 1, if 50 ≤ # of employees ≤ 249; 0, otherwise
- **AGE2:** 1, if firm age between 5 and 10 years; 0 otherwise
- **AGE3:** 1, if firm age between 2 and 5 years; 0, otherwise
- **AGE4:** 1, if firm age less than 2 years; 0, otherwise
- **PROFINC:** 1, if profits increased; 0, otherwise
- **PROFIDEC:** 1, if profits decreased; 0, otherwise

[8] Note that in the banking literature the sum of discouraged firms and the firms whose loan application was rejected correspond to the group of Credit Rationed firms.

- **NIEINC:** 1, if net interest expenses increased; 0, otherwise
- **NIEDEC:** 1, if net interest expenses decreased; 0, otherwise

The loan application cost is proxied by size, defined as above, while the impact of taxation is measured by the country's marginal corporate tax rate. Data on marginal tax rates have been compiled by KPMG.[9]

As discussed earlier we will employ both firm-specific and sector-specific uncertainty metrics. The former are constructed based on the firm-specific answers to the following two survey questions:

Survey question (Q1_c in SAFE questionnaire):

During the past 12 months have you introduced a new organization of management?
- Yes
- No
- [DK/NA]

Thus we construct a dichotomous variable as follows:

$$NEWMANG_i = \begin{cases} 1 & \text{if firm } i \text{ answered 'YES' in Q1\_c} \\ 0 & \text{if firm } i \text{ answered 'NO' in Q1\_c} \end{cases} \quad \textbf{(15)}$$

Firms were also asked about their turnover growth during the past three years (*Q16_b* in SAFE questionnaire) but also about their expected growth over the next three years (*Q17* in SAFE questionnaire), as shown in the questions below:

Over the last three years, how much did your firm grow on average per year in terms of turnover?
- Over 20% per year
- Less than 20% per year
- No growth
- Got smaller
- [Not applicable, the firm is too recent]

Considering the turnover over the next two to three years, how much does your company expect to grow?
- Over 20% per year in terms of turnover
- Below 20% per year in terms of turnover
- Stay the same size
- Become smaller
- [DK/NA]

[9]Available at http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/countrytaxrate.htm.

Based on the answers to the above questions, we construct a dichotomous indicator that separates firms between those whose expected turnover growth (g_i^e) will be higher compared to their past turnover growth (g_i) from the rest of the sample:

$$EXPIMPGR_i = \begin{cases} 1 & \text{if firm } (g_i^e - g_i) > 0 \\ 0 & \text{if firm } (g_i^e - g_i) \leq 0 \end{cases} \quad \textbf{(16)}$$

We utilize the same questions in order to device a firm-specific uncertainty metric. Essentially, for each firm we construct the absolute value of the difference $|g_i^e - g_i|$ that denotes the size of a firm's expected movement in its turnover growth. Based on that we construct the following variable:

$$FIRMUNC_i = \begin{cases} 0 & \text{if zero expected movement by firm } i \\ 1 & \text{if one} - \text{state expected movement} \\ 2 & \text{if two} - \text{state expected movement} \\ 3 & \text{if three} - \text{state expected movement} \end{cases} \quad \textbf{(17)}$$

We also construct a country/sector-wide metric of uncertainty, which we denote $SECTORUNC_i$. To construct this country/sector-specific uncertainty proxy, firm respondents of the SAFE questionnaire are first classified in one of the following four broad industries: *Construction*, *Manufacturing and Industrial Production*, *Services*, and *Retail and Trade*. Their classification is based on the survey firm answers to question *D3* from the SAFE questionnaire:

What is the main activity of your company? [ONLY ONE ANSWER]

- Mining
- Construction
- Manufacturing
- Wholesale or retail trade
- Transport
- Real estate
- Other services to businesses or persons

Respondents answering either mining or manufacturing are classified as *Manufacturing and Industrial Production*, Transport, answers Real estate and Other services are classified as *Services*, while Construction and Wholesale or retail trade are classified as *Construction* and *Retail and Trade* respectively. Then, for each country and broad industry separately, we construct an uncertainty proxy using the annualized historical volatility of the relevant country stock market sectoral index.[10]

Finally, in line with the existing literature, we create a dichotomous capital investment irreversibility metric, which when attains the value of unity denotes higher irreversibility, while the value of zero denotes lower irreversibility. The indicator is defined as follows:

$$IRR_i = \begin{cases} 1 & \text{if firm } i \text{ belongs to Industry or Construction sectors} \\ 0 & \text{if firm } i \text{ belongs to Trade or Services sectors} \end{cases} \quad \textbf{(18)}$$

Table 2 summarizes the full set of factors affecting the probability of loan application deferral, the variables used to proxy them, as well as, their expected sign, and Table 3 reports the summary statistics of all variables involved in the analysis.

[Insert Tables 2 and 3 about here]

4. Econometric Methodology and Empirical Results

4.1 Bivariate Probit Model with Selection

We aim at modeling discouragement, which is a binary response and therefore adopting a probit or a logit model would seem an appropriate estimation technique. However, according to the theoretical definition, and thus the construction of the discouragement indicator, discouraged firms are only observed if they need a loan, a fact which corresponds to a straightforward Sample Selection problem (Heckman, 1979). In other words, the sample of discouraged firms does not correspond to a random draw from the population, since its generation is conditional on the probability of needing a loan. Hence, the appropriate modeling approach compels the use of a Bivariate Probit with selection, with the *Selection rule* corresponding to the need for a bank loan and the *Outcome equation* to discouragement.

In order to formally estimate a model of discouragement we assume that the degree of discouragement the i^{th} firm faces is a latent function of observed factors, X_i, and of an exogenous unobserved shock e_i, *i.e.*, $D_i^* = f(X_i, e_i)$. However, since we cannot observe the actual level of discouragement D_i^* (latent mechanism), what we observe is the outcome of a

[10] We use the 24 months preceding each SAFE wave to calculate the historical volatility, before annualizing. The country-level stock market sectoral indices we employ correspond to Level 4 of the Industry Classification Benchmark (ICB) of FTSE, and are obtained from Datastream.

dichotomous process that identifies a firm as being discouraged (D_i). In this framework the observed discouragement equation for the i^{th} firm is of the following form:

$$D_i = \begin{cases} 1 & \text{if } D_i^* > 0 \\ 0 & \text{otherwise} \end{cases} \qquad \textbf{(19)}$$

where, 1 denotes that the i^{th} firm is discouraged and 0 otherwise. However, D_i is observed only if a firm needs a loan (*i.e.*, the sampling rule). Given this, the second required specification involves the modeling of the need for loan equation for the i^{th} firm. For this purpose we assume that the demand for loan for the i^{th} firm is also a latent function of firm-specific observed characteristics Z_i, and of an exogenous unobserved shock u_i, *i.e.*, $N_i^* = f(Z_i, u_i)$. Given the latent nature of loan need, we again only observe whether or not a firm needs a loan (N_i). Thus the observed loan equation for the i^{th} firm is of the following form:

$$N_i = \begin{cases} 1 & \text{if } N_i^* > 0 \\ 0 & \text{otherwise} \end{cases} \qquad \textbf{(20)}$$

where, 1 denotes that the i^{th} firm needs a loan, and 0 otherwise, while N_i and Z_i are observed for the whole population of firms. Having established the two discrete model specifications and the corresponding sampling rule, the structural model can be represented as follows:

$$D_i^* = \beta_1 X_i + e_i, \qquad D_i = \begin{cases} 1 & \text{if } D_i^* > 0 \\ 0 & \text{otherwise} \end{cases}, \qquad [e_i, u_i]' = N\left(\begin{bmatrix}0\\0\end{bmatrix}, \begin{bmatrix}1\\1\end{bmatrix}, \rho_{eu}\right),$$

$$N_i^* = \beta_2 \mathrm{Z}_i + u_i, \qquad N_i = \begin{cases} 1 & \text{if } N_i^* > 0 \\ 0 & \text{otherwise} \end{cases} \qquad (D_i, X_i) \text{ observed only for } N_i = 1 \qquad \textbf{(21)}$$

Given the structure of specification (21) and the discrete outcomes on need and discouragement, the log-likelihood function of interest to be maximized is the one of discouragement given the need for loan, which is:

$$logL = \prod_{D=1,N=1} \Phi[\beta_1 X_i, \beta_2 Z_i, \rho] \cdot \prod_{D=0,N=1} \Phi[\beta_1 X_i, \beta_2 Z_i, -\rho] \cdot \prod_{D=1,N=1} \varphi[\beta_2 Z_i] \qquad \textbf{(22)}$$

where $\Phi[\cdot]$ is the bivariate normal cumulative probability and $\varphi[\cdot]$ is the normal cumulative probability for the need equation and $\rho = Cov\,[e_i, u_i]$. Equation (22) is maximized with respect to parameters β_1, β_2 and ρ via Full Information Maximum Likelihood (FIML) estimation techniques (van de Ven and van Praag 1981; Boyes, *et. al*., 1989; Greene 1992, 1998).

4.2 Empirical results

4.2.1 Are there Real Option Effects in Discouragement?

As mentioned above we employ a Bivariate Probit model with Selection, where the Selection equation relates to the firm's need of a bank loan, and the Outcome equation to firm discouragement. Both equations, apart from the factors potentially affecting the optimal decision to apply in a real options context, also take into account other potential sources of heterogeneity. In particular, we allow for sectoral, country, and period fixed effects, by using sets of zero/one industry, country and time (wave) dummies. In addition, to achieve identification between the need and discouragement equations, we impose two zero restrictions on the latter (by not including as covariates whether firm sales have increased or decreased). We assess the statistical significance of estimated parameters by using robust standard errors, which are calculated with clustering for firm size, sector, and country.

The full set of estimation results is reported in Table B.3 in Appendix B. The estimated marginal effects are reported in Table 4, where at the bottom we report the Wald equation independence test, which across all models is highly significant, supporting the deployment of the Bivariate Probit with Selection. In particular, the correlation coefficient between the two equations is estimated as 0.84 indicating the strong interdependence of the need and discouragement equations.

We find evidence supporting **Implication 1a** [*higher (perceived) probability of loan application acceptance decreases the likelihood of discouragement*], since the factors that typically raise the probability of loan acceptance enter the model significantly and with the correct signs. In particular, the estimated marginal effects show that, having firms with unchanged profits as the reference group, firms with decreased profits show 1.6 percentage points (pp. hereafter) higher probability of being discouraged. In contrast, their peers whose profits were increased have a 1 pp. lower probability of being discouraged, but this effect is weakly significant (only at the 10 percent level).

Furthermore, using firms with unchanged net interest expenses as the control group, we find that firms with increased (decreased) net interest expenses exhibit higher (lower) discouragement likelihood. In terms of marginal effects, net interest expenses have a sizeable effect, as firms with increased net interest expenses exhibit 3.4 pp. higher discouragement likelihood and firms with decreased net interest expenses show a 1.6 pp. drop in the discouragement likelihood.

Compared to firms aged more than 10 years, discouragement is 2.4 pp. higher for firms aged between 2-5 years, and 1.8 pp. higher for firms aged between 5-10 years.

In addition we find that the likelihood of discouragement is 2.2 pp. higher for firms who expect an improvement in their future growth relative to their past growth. This suggests that discouragement may also be observed because firms expecting an improvement of their future performance, which would increase their (perceived) chances of obtaining the loan, may find it optimal to defer loan application, a finding that is supportive of **Implication 1b**.

Hence, we find both past and expected performance as well as past financial health, through their effects on the perceived probability of loan application acceptance, to have an impact on discouragement.

As it regards **Implication 2 [***Higher application costs increase the likelihood of application discouragement*] it is also supported by the data, since we find that the probability of discouragement significantly drops with firm size. Recall that we use size as an inverse proxy for loan application unit cost. According to the estimated marginal effects, in comparison to medium-sized firms, micro firms are by 5.6 pp. more likely to be discouraged, while small firms are 2.7 pp. more likely to be discouraged. To the extent that size is also a proxy for the perceived probability of acceptance, these findings would also reinforce **Implication 1a**.

Implication 3 [*Higher corporate tax rate increases the likelihood of application deferral*] is not supported by the data, since the corporate profit tax rate is highly insignificant.

Regarding **Implication 4** [*Higher uncertainty increases the likelihood of application deferral*] we find that firm-specific uncertainty, based on the expected sales growth trajectory, is not significant. However, we find that firms whose sector-wide uncertainty is higher, are by 8.3 pp. more likely to be discouraged. Another interesting finding is that firms who have introduced a new management method, and are therefore subject to higher uncertainty, exhibit 1.4 pp. higher probability of discouragement.

The last testable implication, **Implication 5** [*Higher investment irreversibility increases the likelihood of application deferral*], is also supported by the data since we find that discouragement is strongly and positively associated to the irreversibility of capital expenditures proxy. The marginal effect shows that firms belonging to sectors characterized by higher investment irreversibility have an additional 1.3 pp. in the probability of being discouraged. This implies that SMEs in-need of bank credit are more likely to be discouraged from applying if they invest in ventures that entail higher sunk costs.

We also detect significant country heterogeneity in discouragement suggesting that country differences significantly affect this shadow credit market outcome.

The marginal effects of the time (wave) fixed effects are all negative and dropping in absolute magnitude, and having as a reference Wave 4, they indicate that the average discouragement rate has been on an upward trend.

[Insert Table 4 about here]

4.2.2 The impact of Real Option Effects on Discouragement Probability

In the previous section we showed that real option factors are able to account for the observed variation between discouraged and non-discouraged SMEs. We proceed by further quantifying the effects of these factors on the probability of discouragement in order to further measure their impact. We base our analysis on the calculated predicted probability of discouragement for various sub-groups of SMEs according to appropriately designed scenarios.

To put things into context let us provide two benchmark quantities, (i) the sample raw probability of discouragement that stands at 11.43% and (ii) the average conditional predicted probability of discouragement as produced by our model that stands at 15.78%.

In Table 5 we report the conditional predicted probabilities calculated for SMEs sub-groups with different profiles, which we think are quite informative. In order to conserve space we will comment only on two selected scenarios. Consider the scenario (19 in Table 5) of a micro firm, whose profits have decreased, and its net interest expenses increased. Such a hypothetical firm would face a 22.3% predicted probability of being discouraged, while its hypothetical extreme opposite firm (scenario 20 in Table 5) would face only 9.7%. In other words, the Predicted Probability Ratio implies that discouragement for the former firm would be 2 times more likely.

Then we augment the above scenario by adding to firm profile irreversibility and the introduction of new organisation or management. The specific scenario (22 in Table 5) is a micro firm belonging to a sector with higher irreversibility, whose profits have decreased, its net interest expenses increased, and has also introduced a new organisation or management. Such a hypothetical firm would face a 30.7% predicted probability of being discouraged, while its hypothetical extreme opposite firm (scenario 23 in Table 5) only 8.5%, suggesting that discouragement for the former firm would be 3.6 times more likely.

[Insert Table 5 about here]

5. Conclusion

Discouragement is a shadow credit market outcome whose prevalence is far from negligible. Despite this fact, there is a disproportionally thin academic literature on the root causes of discouragement. In the present study we contribute to the literature by proposing a structural financial explanation for the discouragement phenomenon, exploiting the loan application decision's Real Option features. This context allowed us to shed light on which factors tend to increase (decrease) the option value and consequently decrease (increase) the likelihood of applying for a bank loan.

From our theoretical model a set of testable hypotheses were derived, which were put to the test empirically by employing firm-level data from the Survey of Access to Finance of Enterprises covering Eurozone SMEs. The appropriate econometric setup was given by a Bivariate Probit with Selection, with the *Selection rule* corresponding to the need for a bank loan and the *Outcome equation* to discouragement.

Our results provided empirical support for the ability of Real Option effects to explain the discouragement phenomenon. In particular, we found that factors which decrease the (perceived) probability of loan application acceptance tend to increase the likelihood of discouragement. In addition, the implication that higher application costs increase the likelihood of discouragement is also supported by the data. Empirical evidence in favor of the implication that higher investment irreversibility increases the likelihood of discouragement is also uncovered. Regarding the impact of uncertainty, both firm-specific and sector-wide uncertainty plays a substantial role in discouragement. In contrast to the rest of implications, we could not find any significant evidence that the corporate tax rate affects discouragement.

The current research could be extended by the use of firm-level longitudinal data that would allow the incorporation of dynamics with the aim to explore direct causal effects and an explicit testing of application deferral. In addition, having richer firm-level financial data would enhance the set of covariates used in our econometric analysis.

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Appendix A

This appendix summarizes the proofs of Propositions 1 and 2 in the text.

Proof of Proposition 1

In the all-equity financing case, before firm investment (*i.e.* $Y < Y^{ae}$, with Y^{ae} to be determined), the value of the firm $\mathrm{V}_0^{ae}(Y)$ (which coincides with the value of equity, $E_0(Y)$) must satisfy:

$$\frac{1}{2}\sigma^2 Y^2 [\mathrm{V}_0^{ae}(Y)]'' + \mu Y [\mathrm{V}_0^{ae}(Y)]' - r\mathrm{V}_0^{ae}(Y) = 0,$$

subject to $\lim_{Y\to 0} \mathrm{V}_0^{ae}(Y) = 0$. This yields:

$$\mathrm{V}_0^{ae}(Y) = \left(\frac{Y}{Y^{ae}}\right)^{\beta_1} [A(Y^{ae}) - I], \tag{A.1}$$

with β_1 as in equation (7). Similarly, after firm investment (*i.e.* $Y \geq Y^{ae}$, with Y^{ae} to be determined), the value of the firm $\mathrm{V}_1^{ae}(Y)$ (which coincides with the value of equity, $E_1(Y)$) must satisfy:

$$\frac{1}{2}\sigma^2 Y^2 [\mathrm{V}_1^{ae}(Y)]'' + \mu Y [\mathrm{V}_1^{ae}(Y)]' - r\mathrm{V}_1^{ae}(Y) + mY - k = 0$$

subject to $\lim_{Y\to +\infty} \mathrm{V}_1^{ae}(Y) = (1-\tau)\left[\frac{mY}{r-\mu} - \frac{k}{r}\right]$. This yields:

$$\mathrm{V}_1^{ae}(Y) = (1-\tau)\left[\frac{mY}{r-\mu} - \frac{k}{r}\right]. \tag{A.2}$$

Equations (A.1) and (A.2), along with the 'value-matching' condition:

$$\mathrm{V}_0^{ae}(Y^{ae}) + I = \mathrm{V}_1^{ae}(Y^{ae})$$

produce equation (5) in the text. In order to determine the all-equity investment threshold Y^{ae} in equation (6), employ the 'smooth-pasting' condition that ensures optimality of the all-equity investment threshold:

$$[\mathrm{V}_0^{ae}(Y^{ae})]' = [\mathrm{V}_1^{ae}(Y^{ae})]'.$$

Substituting (A.1)-(A.2) into the equation above and rearranging yields equation (6) in the text.

Proof of Proposition 2

Post-investment (when Y has exceeded Y^i, and conditional on a successful loan application), an operating firm can optimally decide to default on its loan obligations if the price process retreats to low levels. Let Y^d denote the (yet undetermined) default threshold, and C^* the (yet undetermined) interest payment on the perpetual bank loan applied for by the firm.

Let $\mathrm{V}_1(Y)$ denote the value of an operating firm after investment, when both equity and debt (bank loan) are employed. Similarly, let $\mathrm{E}_1(Y)$ and $\mathrm{D}_1(Y)$ denote respectively the market value of the firm's equity and the market value of its bank loan. For $Y \geq \mathrm{Y}^i$and $Y \geq \mathrm{Y}^d$, *i.e.* post-investment but before default, the firm's equity value must satisfy:

$$\frac{1}{2}\sigma^2 Y^2 \mathrm{E}_1''(Y) + \mu Y \mathrm{E}_1'(Y) - r\mathrm{E}_1(Y) + (1-\tau)(\mu Y - k - C^*) = 0. \qquad \text{(A.3)}$$

Equation (A.3) is solved subject to the following boundary conditions:

$$\lim_{Y\to 0} \mathrm{E}_1(Y) = 0$$

$$\mathrm{E}_1(Y^d) = 0$$

$$\mathrm{E}_1'(Y^d) = 0$$

The second equation is the 'value-matching' condition associated with the default threshold (at default, firm's equity is worthless), while the last one is the 'smooth-pasting' condition that ensures the optimality of default (*i.e.* the default threshold is selected so as to maximize equity value). Solving the above yields:

$$\mathrm{E}_1(Y) = (1-\tau)\left[\frac{mY}{r-\mu} - \frac{k+C}{r}\right] + (1-\tau)\left[\frac{k+C}{r} - \frac{mY^d}{r-\mu}\right]\left(\frac{Y}{Y^d}\right)^{\beta_2}, \tag{A.4}$$

with

$$\beta_2 = \frac{-\mu+\frac{1}{2}\sigma^2 - \sqrt{2r\sigma^2+(\mu-\frac{1}{2}\sigma^2)^2}}{\sigma^2} < 0 \tag{A.5}$$

and the optimal default threshold for a (yet undetermined) interest payment C^* is given by:

$$Y^d = \frac{\beta_2}{\beta_2 - 1}\frac{r-\mu}{m}\frac{C^*+k}{r}. \tag{A.6}$$

In equation (A.4), the first term captures the after-tax, expected present value of operating forever, while the second term captures the value of the option to default.

Similarly, for $Y \geq \mathrm{Y}^i$ and $Y \geq \mathrm{Y}^d$, *i.e.* post-investment but before default, the market value of the bank loan must satisfy:

$$\frac{1}{2}\sigma^2 Y^2 \mathrm{D}_1''(Y) + \mu Y \mathrm{D}_1'(Y) - r\mathrm{D}_1(Y) + C^* = 0, \tag{A.7}$$

subject to the following boundary conditions:

$$\lim_{Y\to+\infty} \mathrm{D}_1(Y) = \frac{C^*}{r}$$

$$\mathrm{D}_1(Y^d) = L(Y^d)$$

This yields:

$$D_1(Y) = \frac{C^*}{r} - \left[\frac{C^*}{r} - (1-\gamma)A(Y^d)\right]\left(\frac{Y}{Y^d}\right)^{\beta_2}, \tag{A.8}$$

where the last term captures the discount, over riskless debt C^*/r, due to the possibility of default. Adding up equations (A.4) and (A.8), provides the expected value of an operating firm after investment, $\mathrm{V}_1(Y) = \mathrm{E}_1(Y) + \mathrm{D}_1(Y)$, as:

$$V_1(Y) = A(Y) + \frac{\tau C^*}{r} - \left[\gamma A(Y^d) + \frac{\tau C^*}{r}\right]\left(\frac{Y}{Y^d}\right)^{\beta_2}. \tag{A.9}$$

The first two terms are respectively, the after-tax, present value of cash flows under all-equity financing and the present value of the tax-shield from the use of the bank loan. The last term is the value loss upon exercise of the default option by the firm equity holders.

Finally, in order to determine the optimal loan level, the firm first chooses the interest payment C^* so as to maximize firm value (in equation A.9), and then the maximization first-order condition is evaluated at $Y = Y^i$, the time when the firm applies for the bank loan. In algebraic terms, this means chooseC^*, so that:

$$\frac{\partial}{\partial C^*} V_1\left(Y^i\right) = 0.$$

Substituting $V_1(Y)$ from (A.9), differentiate and evaluate at $Y = Y^i$ to get:

$$\tau = \left[\frac{(C^* + k)\tau + \beta_2 C^*(\gamma(\tau - 1) - \tau)}{C^* + k}\right]\left(\frac{Y^i}{Y^d}\right)^{\beta_2}$$

One arrives at equation (12) in the text after some algebraic manipulation of the above.

To get equation (11), first consider that before investment (*i.e.* for $Y < Y^i$), the firm only holds the option to invest (conditional on a successful loan application). Let $E_0(Y) \equiv V_0(Y)$ denote this firm value before investment.

When Y reaches the investment threshold Y^i, the firm incurs the loan application cost K, and with probability π (loan application acceptance) exercises its option by paying the investment cost I, in order to receive the 'underlying asset' which is worth $V_1(Y)$ as in equation (A.9).

Thus, for $Y < Y^i$, firm value $E_0(Y)$ must satisfy:

$$\frac{1}{2}\sigma^2 Y^2 \mathrm{E}_0''(Y) + \mu Y \mathrm{E}_0'(Y) - r\mathrm{E}_0(Y) = 0, \qquad \text{(A.10)}$$

subject to:

$$\lim_{Y\to 0} \mathrm{E}_0(Y) = 0 \qquad \text{(A.11)}$$

$$\mathrm{E}_0(Y^i) = \pi\left[V_1\left(Y^i\right) - I\right] - K \qquad \text{(A.12)}$$

$$\mathrm{E}_0'\left(Y^i\right) = \pi \mathrm{V}_1'\left(Y^i\right). \qquad \text{(A.13)}$$

The 'value-matching' condition (A.12) highlights that when Y^i is reached, the firm pays the loan application cost K, and upon acceptance of the loan application (with probability π), receives the 'debt-and-equity' financed value V_1 in (A.9) and pays the investment cost I.

Solving (A.10) subject to (A.11)-(A.12) yields:

$$\mathrm{E}_0(Y) = \left[\pi\left(V_1\left(Y^i\right) - I\right) - K\right]\left(\frac{Y}{Y^i}\right)^{\beta_1}, \qquad \text{(A.14)}$$

with β_1 as in equation (7). To determine the optimal investment threshold Y^i, substitute equations (A.9) and (A.14) in the 'smooth-pasting' condition (A.13), to get:

$$\frac{\beta_1}{Y^i}\left[\pi\left(V_1\left(Y^i\right) - I\right) - K\right] = \frac{(1-\tau)m}{r-\mu} - \beta_2\left(\frac{Y^i}{Y^d}\right)^{\beta_2}\frac{1}{Y^i}\left(\gamma A(Y^d) + \frac{\tau C^*}{r}\right)$$

Multiply both sides with Y^i, substitute in $V_1\left(Y^i\right)$ from (A.9), collect similar terms and simplify to get equation (11) in the text.

Appendix B

Table B.1. Sample breakdown by wave and country					
Country / Wave	**1st half 2009**	**1st half 2011**	**1st half 2013**	**1st half 2014**	**All Waves**
Austria (EZ)	224	502	501	502	1,729
Belgium (EZ)	220	500	500	501	1,721
Bulgaria	220	501	502	500	1,723
Croatia	100	100	100	300	600
Cyprus (EZ)	110	100	100	101	411
Czech Rep.	221	500	429	500	1,650
Denmark	221	500	500	500	1,721
Finland (EZ)	111	500	501	501	1,613
France (EZ)	1,000	1,002	1,002	1,500	4,504
Germany (EZ)	1,003	1,006	1,000	1,337	4,346
Greece (EZ)	220	500	500	501	1,721
Hungary	228	500	500	501	1,729
Iceland	101	102	100	100	403
Ireland (EZ)	110	502	500	500	1,612
Israel	0	100	90	0	190
Italy (EZ)	1,006	1,001	1,000	1,500	4,507
Luxembourg (EZ)	103	100	100	102	405
Netherlands (EZ)	323	500	500	800	2,123
Norway	100	200	150	0	450
Poland	506	1,000	1,011	1,305	3,822
Portugal (EZ)	327	502	500	501	1,830
Romania	221	541	500	500	1,762
Slovenia (EZ)	110	100	100	200	510
Spain (EZ)	1,012	1,001	1,001	1,303	4,317
Sweden	220	500	507	500	1,727
Switzerland	0	100	0	0	100
Turkey	0	301	253	0	554
United Kingdom	502	1,001	1,000	1,218	3,721
All countries	7,333	11,766	11,624	13,442	44,165
Notes: (a) SAFE questionnaires, (b) EZ denotes a Eurozone country.					

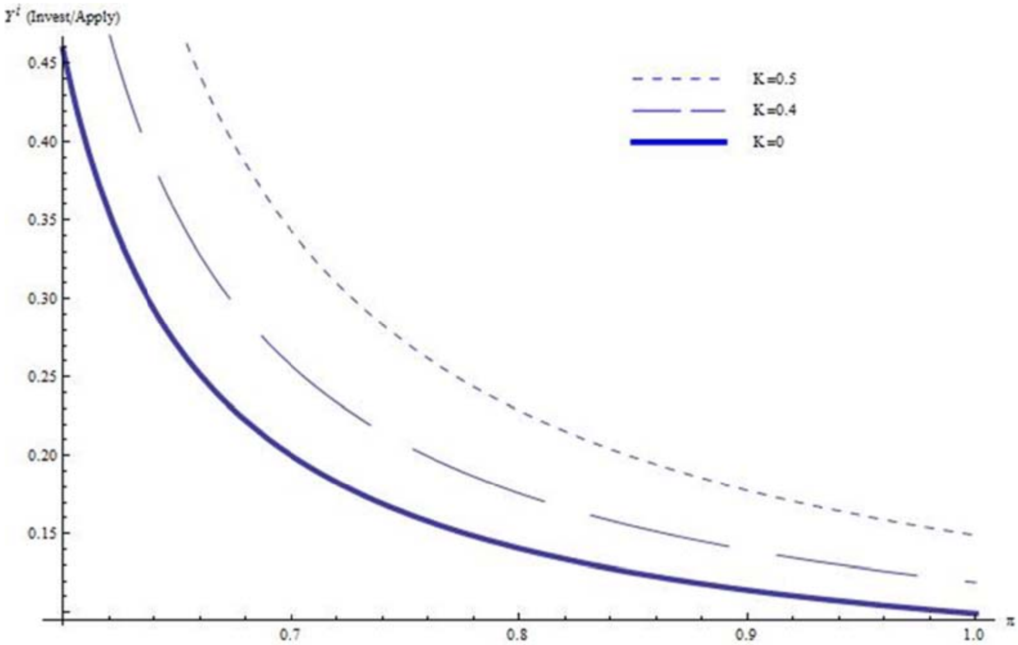
Table B.2. Answers to question Q7A in SAFE questionnaire					
	Applied	**Did not apply because of possible rejection**	**Did not apply because of sufficient internal funds**	**Did not apply for other reasons**	**DK/NA**
Panel A: By SAFE wave					
1st half 2009	0.263	0.054	0.380	0.282	0.019
1st half 2011	0.268	0.060	0.436	0.216	0.018
1st half 2013	0.292	0.066	0.431	0.197	0.011
1st half 2014	0.287	0.080	0.368	0.246	0.016
Panel B: By country					
Austria (EZ)	0.263	0.036	0.573	0.112	0.013
Belgium (EZ)	0.299	0.049	0.434	0.204	0.012
Bulgaria	0.208	0.047	0.287	0.417	0.039
Croatia	0.325	0.044	0.300	0.325	0.004
Cyprus (EZ)	0.249	0.115	0.334	0.279	0.021
Czech Rep.	0.251	0.035	0.438	0.270	0.003
Denmark	0.173	0.051	0.434	0.297	0.042
Finland (EZ)	0.226	0.016	0.481	0.269	0.006
France (EZ)	0.341	0.051	0.395	0.206	0.004
Germany (EZ)	0.274	0.046	0.524	0.149	0.005
Greece (EZ)	0.336	0.161	0.221	0.273	0.007
Hungary	0.229	0.047	0.403	0.312	0.007
Iceland	0.214	0.037	0.447	0.229	0.071
Ireland (EZ)	0.203	0.152	0.437	0.189	0.016
Israel	0.335	0.064	0.193	0.103	0.303
Italy (EZ)	0.362	0.054	0.323	0.248	0.011
Luxembourg (EZ)	0.248	0.029	0.541	0.154	0.025
Netherlands (EZ)	0.211	0.108	0.418	0.235	0.025
Norway	0.187	0.025	0.466	0.295	0.025
Poland	0.274	0.047	0.450	0.212	0.015
Portugal (EZ)	0.248	0.073	0.319	0.345	0.013
Romania	0.242	0.086	0.327	0.338	0.010
Slovenia (EZ)	0.430	0.095	0.311	0.157	0.004
Spain (EZ)	0.372	0.066	0.335	0.222	0.003
Sweden	0.234	0.027	0.569	0.117	0.050
Switzerland	0.290	0.018	0.618	0.072	0.000
Turkey	0.479	0.035	0.208	0.230	0.044
United Kingdom	0.182	0.051	0.524	0.200	0.041
All countries	0.278	0.066	0.404	0.234	0.016
Notes: Reported quantities based on authors calculations.					

Table B.3. Bivariate Probit with Selection model for SMEs (selection: NEED, outcome: DISCOURAGED)				
	Eurozone countries		All countries	
	NEED	DISCOURAGED	NEED	DISCOURAGED
Real Options effects factors				
MICRO	-0.029 (-0.91)	0.415*** (10.99)	-0.015 (-0.63)	0.413*** (13.15)
SMALL	-0.034 (-1.20)	0.199*** (5.02)	-0.034 (-1.55)	0.181*** (5.35)
AGE2 (5-10 years old)	0.068** (2.13)	0.134*** (3.34)	0.079*** (3.09)	0.122*** (3.49)
AGE3 (2-5 years old)	0.036 (0.79)	0.181*** (2.67)	0.064* (1.93)	0.183*** (3.64)
AGE4 (0-2 years old)	0.002 (0.03)	-	0.051 (0.63)	-
PROFINC	-0.071** (-2.33)	-0.075* (-1.71)	-0.075*** (-3.19)	-0.069** (-2.02)
PROFIDEC	0.127*** (4.72)	0.123*** (3.12)	0.126*** (5.86)	0.116*** (3.44)
NIEINC	0.541*** (17.30)	0.251*** (7.37)	0.515*** (21.70)	0.250*** (9.29)
NIEDEC	0.078*** (2.91)	-0.118*** (-2.61)	0.096*** (4.24)	-0.093** (-2.56)
EXPIMP	0.078*** (2.81)	0.163*** (3.77)	0.100*** (4.39)	0.169*** (4.68)
TAX	-7.405*** (-4.06)	-0.066 (-0.04)	-1.748* (-1.67)	0.562 (0.39)
NEWMAG	0.122*** (5.03)	0.107*** (3.17)	0.122*** (6.14)	0.088*** (3.03)
FIRMUNC	-0.004 (-0.34)	0.014 (0.58)	-0.008 (-0.66)	0.024 (1.20)
SECTORUNC	-0.092 (-0.44)	0.615** (2.06)	0.009 (0.009)	0.093 (0.52)
IRR	0.062** (2.43)	0.099*** (3.30)	0.037* (1.79)	0.090*** (3.67)
Control variables				
SALESINC	0.011 (0.40)	-	0.018 (0.76)	-
SALESDEC	0.094*** (3.08)	-	0.085*** (3.53)	-
Time dummy (1st half 2009)	-0.041 (-0.90)	-0.418*** (-5.94)	-0.074** (-2.04)	-0.238*** (-3.91)
Time dummy (1st half 2011)	-0.344*** (-9.50)	-0.246*** (-4.45)	-0.273*** (-9.28)	-0.179*** (-4.02)
Time dummy (1st half 2013)	-0.219*** (-6.01)	-0.196*** (-3.89)	-0.207*** (-7.58)	-0.122*** (-3.05)
Country fixed effects	Included	Included	Included	Included
Diagnostics				
Observations	16,726		25,229	
Censored observations	6,669		10,334	
Uncensored observations	10,057		14,895	
Log-Likelihood	-14,148.35		-21,096.76	
Rho	0.847		0.863	
Wald Independence test	16.75***		27.87***	
Test for zero country effects	154.13***		338.04***	

Notes: (a) *, **, *** denote statistical significance at the 10, 5, or 1 percent, (b) numbers in brackets denote z statistics with robust standard errors allowing for sector, size and country clustering, (c) Rho stands for the correlation coefficient of errors between the Selection and Outcome equations. (d) 1st half 2014 used as the wave reference group.

Figures

Figure 1: The Figure plots the optimal investment threshold,Y^i, where the firm applies for a bank loan, and the optimal default threshold, Y^d, for an equity-and-debt financed firm, as functions of the probability of bank loan application acceptance, π, for different values of loan application costs K. The rest of the parameters are$r = 0.05$, $\mu = 0.01$, $I = 1$, $m = 1$, $\sigma = 0.20$, $\gamma = 0.25$, $\tau = 0.20$ and $k = 0$.



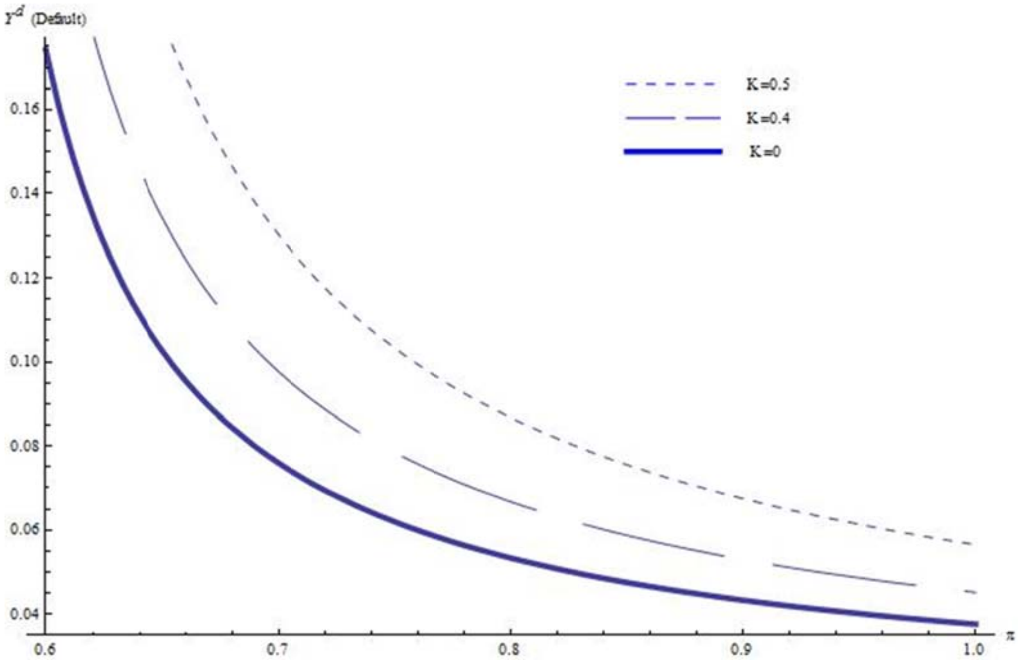
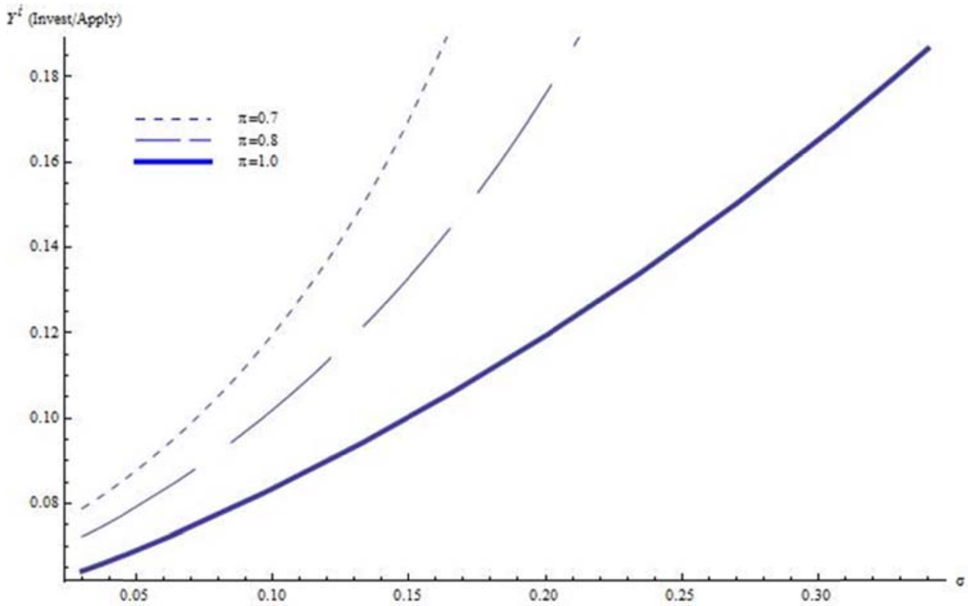


Figure 2: The Figure plots the optimal investment threshold,Y^i, where the firm applies for a bank loan, as a function of (a) the uncertainty of the investment, σ, and (b) the profit tax rate τ, for different probabilities of bank loan application acceptance, π. The rest of the parameters are $r = 0.05$, $\mu = 0.01$,$I = 1$, $m = 1$, $\gamma = 0.25$, $K = 0.40$,$k = 0$, $\tau = 0.20$ (for upper graph) and $\sigma = 0.20$ (for lower graph).



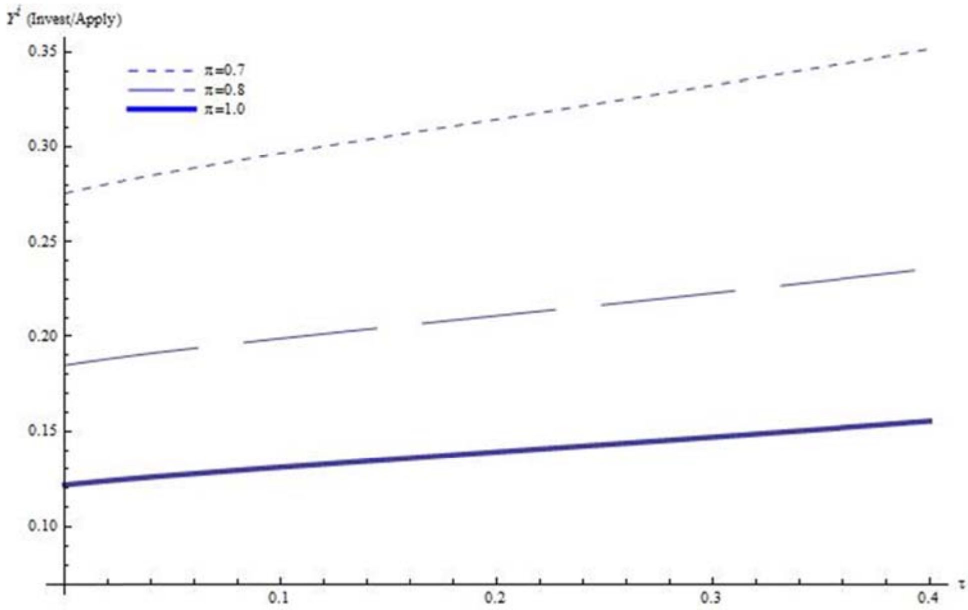
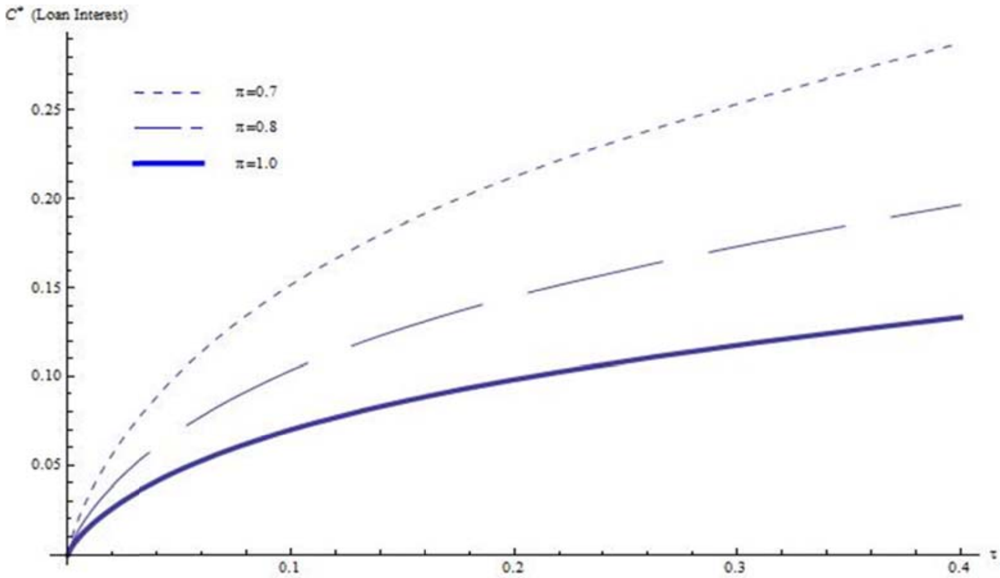
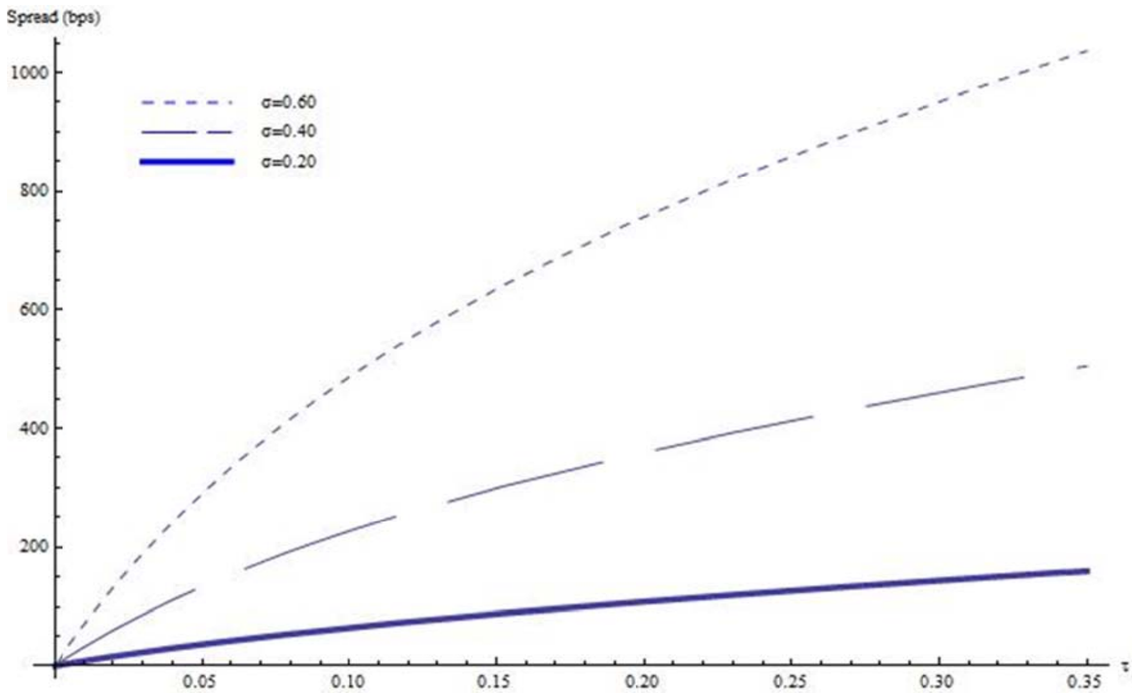


Figure 3: The Figure plots the interest C^* on the bank loan that the firm optimally applies for (Panel a), the spread of the bank loan, over the risk-free rate (in basis points, Panel b), and the leverage ratio that the firm optimally applies for (Panel c), as functions of the profit tax rate τ that the firm faces, for different probabilities of bank loan application acceptance, π, and different values for the uncertainty of the investment, σ. The rest of the parameters, unless otherwise stated, are $r = 0.05$, $\mu = 0.01$, $I = 1$, $m = 1$, $\gamma = 0.25$, $K = 0.40$, $k = 0$, $\pi = 0.80$, and $\sigma = 0.20$.

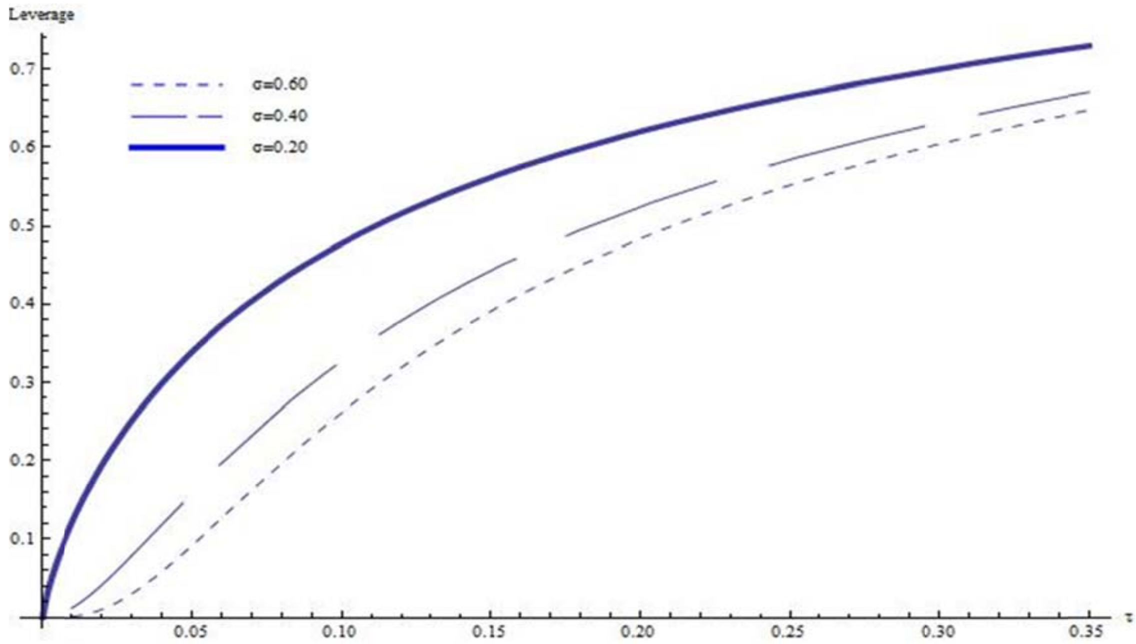
Panel (a)



Panel (b)



Panel (c)



Leverage
0.7
0.6
0.5
0.4
0.3
0.2
0.1
σ=0.60
σ=0.40
σ=0.20
0.05
0.10
0.15
0.20
0.25
0.30
0.35
τ

Figure 4: The distribution of answers that were provided by sample firms (across all waves and all countries) to question Q7A in the SAFE questionnaire. Source: (a) answers to question Q7Aof SAFE questionnaires for waves 1st half 2009, 1st half 2011, 1st half 2013, 1st half 2014, and (b) authors own calculations.

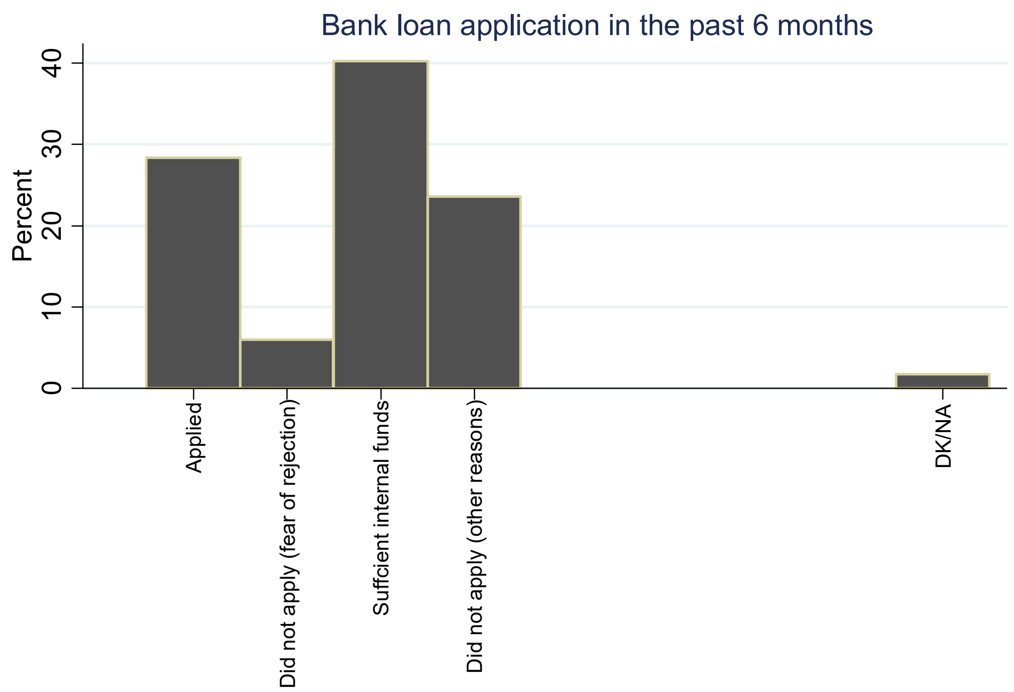
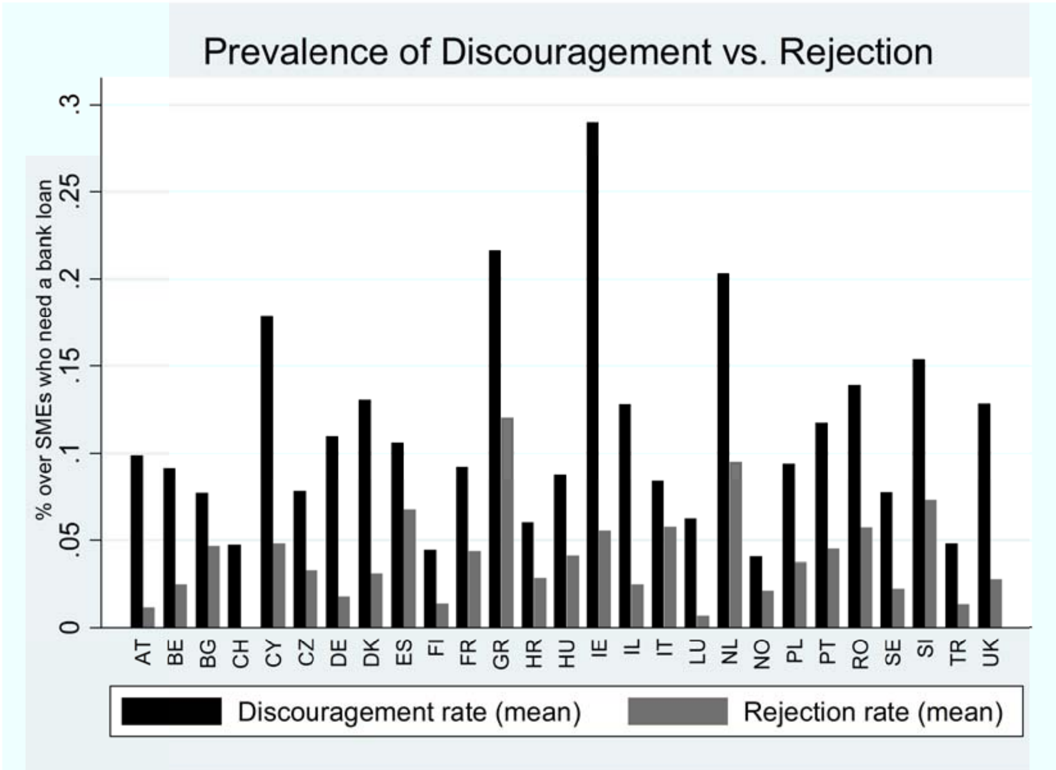


Figure 5: The prevalence of discouragement and loan application rejection rates across countries. Means are calculated across SAFE waves.



Tables

Table 1. Prevalence of Need and Discouragement by wave and country		
	Proportion of firms that Need a bank loan over all firms	**Proportion of Discouraged firms over firms that need a bank loan**
Panel A: By SAFE wave		
1st half 2009	0.612	0.090
1st half 2011	0.555	0.111
1st half 2013	0.563	0.120
1st half 2014	0.625	0.131
Panel B: By country		
Austria (EZ)	0.418	0.088
Belgium (EZ)	0.560	0.089
Bulgaria	0.700	0.069
Croatia	0.698	0.063
Cyprus (EZ)	0.658	0.179
Czech Rep.	0.559	0.063
Denmark	0.545	0.098
Finland (EZ)	0.515	0.032
France (EZ)	0.603	0.086
Germany (EZ)	0.472	0.099
Greece (EZ)	0.776	0.209
Hungary	0.593	0.080
Iceland	0.518	0.077
Ireland (EZ)	0.555	0.280
Israel	0.722	0.128
Italy (EZ)	0.672	0.081
Luxembourg (EZ)	0.443	0.067
Netherlands (EZ)	0.570	0.195
Norway	0.521	0.050
Poland	0.542	0.088
Portugal (EZ)	0.676	0.109
Romania	0.669	0.131
Slovenia (EZ)	0.687	0.139
Spain (EZ)	0.663	0.103
Sweden	0.400	0.072
Switzerland	0.381	0.047
Turkey	0.781	0.048
United Kingdom	0.453	0.118
All countries	0.588	0.114

Notes: (a) source: answers to questions Q7A, Q7B of SAFE questionnaires for waves 1st half 2009, 1st half 2011, 1st half 2013, 1st half 2014, (b) authors own calculations, (c) Discouraged calculated as the ratio of firms who did not apply for a bank loan due to fear of rejection over firms who need a bank loan, (d) EZ denotes a Eurozone country.

Table 2. Factors affecting application deferral			
Factor	**Depending on**	**Proxy Definition**	**Expected effect on deferral**
Probability of acceptance	**Age**	**AGE2:** 1, if firm age between 5 and 10 years; 0 otherwise	+
		AGE3: 1, if firm age between 2 and 5 years; 0, otherwise	+
		AGE4: 1, if firm age less than 2 years; 0, otherwise	+
	Past Operational Performance	**PROFINC:** 1, if profits increased; 0, otherwise	-
		PROFDEC: 1, if profits decreased; 0, otherwise	+
	Expected Operational Performance	**EXPIMP:** 1, if expected turnover growth higher than past turnover growth; 0, otherwise	+
	Past Financial Health	**NIEINC:** 1, if net interest expenses increased; 0, otherwise	-
		NIEDEC: 1, if net interest expenses decreased; 0, otherwise	+
Application Cost	**Size**	**MICRO:** 1, if # of employees ≤ 9; 0, otherwise	+
		SMALL: 1, if 10 ≤ # of employees ≤ 49; 0, otherwise	+
		MEDIUM: 1, if 50 ≤ # of employees ≤ 249; 0, otherwise	+
Taxation	**Corporate Tax Rate**	**TAX:** marginal tax rate on profits	+
Uncertainty	**Firm-specific uncertainty**	**NEWMAG:** 1 if during the past 12 months firm has introduced a new organization of management; 0 otherwise	+
		FIRMUNC: the size of a firm's expected movement in its turnover growth	+
	Sector-level uncertainty	**SECTORUNC:** annualized historical volatility of the country stock market sectoral index	+
Irreversibility	**Sector-specific irreversibility**	**IRR**: 1 if firm belongs to Industry or Construction; 0 if firm belongs to Trade or Services	+

Table 3. Summary statistics of variables				
	All Countries		Eurozone Countries	
Variable	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**
NEED	0.588	0.492	0.600	0.489
DISCOURAGED	0.114	0.318	0.122	0.327
MICRO	0.385	0.486	0.395	0.488
SMALL	0.336	0.472	0.348	0.474
MEDIUM	0.278	0.448	0.261	0.439
AGE2 (5-10 years old)	0.151	0.358	0.136	0.343
AGE3 (2-5 years old)	0.079	0.270	0.068	0.251
AGE4 (0-2 years old)	0.022	0.149	0.02	0.15
SALESINC	0.377	0.484	0.35	0.48
SALESDEC	0.317	0.465	0.35	0.48
PROFINC	0.284	0.451	0.249	0.432
PROFIDEC	0.420	0.493	0.460	0.498
NIEINC	0.302	0.459	0.319	0.466
NIEDEC	0.161	0.367	0.171	0.377
EXPIMP	0.307	0.461	0.315	0.464
TAX	0.251	0.064	0.279	0.054
NEWMANG	0.243	0.428	0.258	0.437
FIRMUNC	0.758	0.799	0.772	0.797
SECTORUNC	0.231	0.105	0.23	0.08
IRR	0.365	0.481	0.371	0.483
Source: Survey on the access to finance of SMEs (SAFE) Questionnaire. Section 3: Financing of the firm, question Q7B.				

Table 4. Marginal Effects from Bivariate Probit with Selection model for Eurozone SMEs (selection: NEED, outcome: DISCOURAGED)	
Real Options factors	
MICRO	0.056*** (11.06)
SMALL	0.027*** (5.01)
AGE2 (5-10 years old)	0.018*** (3.35)
AGE3 (2-5 years old)	0.024*** (2.67)
AGE4 (0-2 years old)	-
PROFINC	-0.010* (-1.71)
PROFIDEC	0.016*** (3.10)
NIEINC	0.034*** (7.60)
NIEDEC	-0.016*** (-2.59)
EXPIMP	0.022*** (3.75)
TAX	-0.009 (-0.04)
NEWMAG	0.014*** (3.15)
FIRMUNC	0.001 (0.58)
SECTORUNC	0.083*** (2.07)
IRR	0.013*** (3.33)
Control variables	
SALESINC	-
SALESDEC	-
Time dummy (1st half 2009)	-0.057*** (-5.98)
Time dummy (1st half 2011)	-0.033*** (-4.50)
Time dummy (1st half 2013)	-0.026*** (-3.92)
Country fixed effects	Included
Diagnostics	
Observations	16,726
Censored observations	6,669
Uncensored observations	10,057
Log-Likelihood	-14,148.35
Rho	0.847
Wald Independence test	16.75***
Test for zero country effects	154.13***

Notes: (a) *, **, *** denote statistical significance at the 10, 5, or 1 percent, (b) numbers in brackets denote z statistics with robust standard errors allowing for sector, size and country clustering, (c) Rho stands for the correlation coefficient of errors between the Selection and Outcome equations. (d) 1st half 2014 used as the wave reference group.

Table 5. Predicted Probability of Discouragement Across Eurozone SMEs Sub-Groups	
Raw sample probability	**0.122**
Average Conditional Predicted Probability	**0.141**
Firm profile scenarios	
[1] profits decreased, all other factors at means	0.157
[2] profits increased, all other factors at means	0.123
Predicted Probability Ratio [3]=[1] / [2]	**1.27**
[4] net interest expenses increased, all other factors at means	0.160
[5] net interest expenses decreased, all other factors at means	0.098
Predicted Probability Ratio [6]=[4] / [5]	**1.63**
[7] higher expected turnover growth, all other factors at means	0.175
[8] lower or equal expected turnover growth, all other factors at means	0.125
Predicted Probability Ratio [9]=[7] / [8]	**1.40**
[10] micro, all other factors at means	0.193
[11] non micro, all other factors at means	0.110
Predicted Probability Ratio [12]=[10] / [11]	**1.75**
[13] new organisation or management, all other factors at means	0.148
[14] no new organisation or management, all other factors at means	0.138
Predicted Probability Ratio [15]=[13] / [14]	**1.07**
[16] higher irreversibility, all other factors at means	0.131
[17] lower irreversibility, all other factors at means	0.146
Predicted Probability Ratio [18]=[16] / [17]	**0.89**
[19] micro, profits decreased, net interest expenses increased, all other factors at means	0.223
[20] non-micro, profits increased, net interest expenses decreased, all other factors at means	0.097
Predicted Probability Ratio [21]=[19] / [20]	**2.29**
[22] profits decreased, net interest expenses increased, micro, introduction of new organisation or management, higher irreversibility, all other factors at means	0.307
[23] profits increased, net interest expenses decreased, non-micro, no introduction of new organisation or management, lower irreversibility, all other factors at means	0.085
Predicted Probability Ratio [24]=[22] / [23]	**3.61**