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COMPARING FINANCIAL SYSTEMS

A STRUCTURAL ANALYSIS

by Sylvain Champonnois

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In 2006 all ECB publications will feature a motif taken from the €5 banknote.

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CONTENTS

Abstract. This paper builds a model of investment and financing that incorporates heterogeneous firms into general equilibrium. In order to characterize the financial structure of an economy, the model connects the share of market finance in total external finance and the distribution of firm sizes into a simple structural equation, with parameters related to the cost of market finance (compared to intermediated finance). We estimate the relative cost of market finance across countries with data on external financing and firm sizes from France, Germany, Italy, Spain and the United Kingdom. Using the structural model, we propose an explanation of the empirical correlation across countries between estimated financing costs and the characteristics of the population of firms based on welfare maximization.

JEL classification. E20, E44, C13.
Keywords. Heterogeneous firms, financing patterns, distribution of firm sizes, structural estimation, welfare analysis.

Non-technical summary

This paper analyzes how financial systems differ across countries and how financial structure interacts with the real economy. We estimate country specific financing costs characterizing the financial systems using a model of investment and financing that incorporates heterogeneous firms into general equilibrium. We then use the model to explore the welfare consequences of the match between financial structure and the characteristics of the population of firms.

First using data on external financing and firm sizes from France, Germany, Italy, Spain and the UK, we find that the UK and Germany have a low cost of market finance relative to intermediated finance while Italy has a high relative cost of market finance. Indeed in the UK and Germany the financial system channels market finance to all industries while in Italy, it allocates funds through financial markets mainly to industries with a high proportion of large firms. Moreover, we also find a negative correlation between the cost of market finance relative to intermediated finance and the proportion of large firms.

Second to interpret these empirical findings, we explore the welfare predictions of the model. Using the welfare of private agents (entrepreneurs and investors) as a proxy for the marginal incentives to modify the financing costs or the distribution of productivity, we show that the financial structure and the characteristics of firms are complementary in following sense. On the one hand, economies with a high proportion of very productive (and therefore very large) firms have a higher incentive than economies with smaller firms to decrease the cost of market finance (relative to intermediated finance). On the other hand, economies with a low cost of market finance (relative to those with a high relative cost) have an incentive to increase the proportion of very productive firms.

The main policy implication from this study is that financial systems should be evaluated in terms of how they match the external financing needs of the population of heterogeneous firms. In particular, our sample of industrialized countries suggests a good fit between financial structure and firm characteristics.

How does financial structure affect investment and consumption? Cross-country regressions have shown that the development of financial markets and intermediaries matters for economic growth (see Levine, 2005, for a survey). Yet it has been difficult to identify the mechanisms through which financial markets or intermediaries affect the real economy, in part because of poor measurement and lack of clear exogeneity of the financial structure. That is, the observed financial system is endogenous in the sense that it also depends on the population of firms. For instance, the share of market finance in total external finance, typically used to classify financial systems into "market-based" and "intermediary-based", depends not only on the cost of market finance relative to intermediated finance, but also on the proportion of large firms in the economy.[1]

This paper estimates an equilibrium model of investment and financing that links and extends the corporate finance and asset pricing literatures. First, we show that the identification of the financing costs depends on a property of the equilibrium that solves the endogeneity problem: the share of market finance in external finance is more sensitive to the cost of market finance relative to intermediated finance in industries with smaller firms. Second, observing the allocation of market and intermediated finance across industries with different firm size distributions, we recover the relative cost of market finance across countries with data from France, Germany, Italy, Spain and the United Kingdom. Third, we use the estimated relative cost of market finance to assess the relation between financial structure and technology. We show that financial systems with a low cost of market finance are better matched to technologies with a high proportion of very productive firms (and reciprocally) which is consistent with our data on developed countries.

[1]To illustrate this endogeneity problem, take a typical test to assess whether "bank-based" or "market-based" financial systems are better (see Levine, 2002; Tadesse, 2002). It consists in regressing the growth of a country on the share of market finance in total external finance (for a given horizon). Yet large firms raise more market finance (see below) and grow less (see for instance Cooley and Quadrini, 2001). So a country with a high proportion of large firms should have mechanically a lower growth and higher share of market finance, independently of the effect of financial structure on growth.

In the model at the microeconomic level, an entrepreneur raises external finance from outside investors through financial markets and intermediaries. Like in the corporate finance literature, the characteristics of the project are correlated with the instrument choice and the investment size. The most productive firms need to raise more external finance and because of economies of scale in the issuance size of public securities, productivity is correlated with firm size and the probability of raising market finance. Blackwell and Kidwell (1986) and Altinkilic and Hansen (2000) argue that there are economies of scale with the issuance of public securities while there is ample evidence that the probability of issuing market finance is correlated with firm size.[2]

At the macroeconomic level, this transaction between the entrepreneur and the investors is integrated into a market equilibrium with a distribution of heterogeneous firms. Like the asset pricing literature, the price of capital is determined by the consumption of a representative investor allocating his capital between consumption and investment for risky returns. The model generates at the industry level endogenous distributions of firm sizes and financing patterns given exogenous industry-level distributions of productivity across firms and exogenous country-level financing costs.

The identification of the financing costs relies on a property of the equilibrium: the share of market finance in external finance is more sensitive to the relative cost of market finance in industries with smaller firms. We show that this is a very general property and it holds under generic production and utility functions. It implies that countries in which even small-firm industries raise market finance (relative to large-firm industries) have a low cost of market finance (compared to intermediated finance). We recover structural parameters characterizing the financial system at the country level. Using data from France, Germany, Italy, Spain and the UK we find

[2] See for instance Easterwood and Kapapakkam (1991); Krishnaswami, Spindt, and Subramaniam (1999); Esho, Lam, and Sharpe (2001); Denis and Mihov (2003); Kwan and Carleton (2004). In this paper, the main firm characteristic to be correlated with the probability of raising market finance is productivity. It is possible to study several factors correlated with the probability of raising market finance. This paper focuses only on one factor (firm productivity) because of its first-order importance.

that the cost of market finance relative to intermediated finance is low for the UK and high for Italy.

With estimates of the financing costs, we then study the relation between financial structure and the characteristics of the population of firms. This paper highlights a complementarity between financial structure and the distribution of firm productivity. We use the welfare of private agents (entrepreneurs and investors) as a proxy for the marginal incentives to modify the financing costs or the distribution of productivity. On the one hand, economies with a high proportion of very productive (and therefore very large) firms have a higher incentive than economies with smaller firms to decrease the cost of market finance (relative to intermediated finance). On the other hand, economies with a low cost of market finance (relative to those with a high relative cost) have an incentive to increase the proportion of very productive firms.[3] This is consistent with our sample of industrialized European countries in which we find a negative correlation between the cost of market finance and the proportion of large firms in the economy: the UK has both the lowest relative cost of market finance and the largest firms, and Italy has the smallest firms and the lowest relative cost of intermediated finance.

Related to this paper are Giné and Townsend (2004) and Martin and Rey (2004). Giné and Townsend (2004) estimate structural parameters of the Thai economy to study the effects of financial liberalization based on a general equilibrium model. The main methodological difference is that Giné and Townsend make strong parametric assumptions to estimate most of the parameters of their model. In contrast, we derive a particular structural equation and argue that it is very general because it relies only on very weak parametric assumptions. Martin and Rey (2004) derive a gravity equation for international financial flows from a model with endogenous supply and demand of financial assets. Our model is more general in that we focus on the joint investment and financing decision of an entrepreneur. Moreover, we

[3]This reciprocity between financial structure and population of firms means that this approach will be unable to identify any causal link. However it also suggests that a policy recommendation advocating a change in financial structure regardless of the population of firms may create deadweight costs rather than welfare gains.

use the structural equation that we derived from the model to estimate parameters characterizing the financial system.[4]

The rest of the paper proceeds as follows. Section I presents a model of the financial system. Section II describes the identification strategy and the empirical implementation. Section III introduces the data and shows the empirical results. Section IV looks at the endogenous relation between financial structure and characteristics of the population of firms. Section V presents robustness tests of the identification strategy. Section VI concludes. Proofs and additional information are in the appendices.

I. An equilibrium model of the financial system.

This paper builds an equilibrium model of the financial system with explicit microeconomic foundations. On the one hand a continuum of investors allocates funds optimally across heterogeneous firms. On the other hand, the entrepreneurs who run the firms set the level of investment in order to maximize their profit. The supply of securities available to the investors is endogenous and the price of capital at which the transaction between an investor and a firm takes place depends on the population of firms that produce. In section I.1, we illustrate the equilibrium with a representative firm. In section I.2, we introduce heterogeneity across firms. In section I.3, we describe the financial system and solve for the equilibrium.

I.1. **Consumption and investment with a representative firm.** There is a continuum of identical investors modeled as a representative investor. This representative investor has to decide how to allocate the capital Y he owns between immediate consumption c and investment k into a single firm. This firm has a project that produces $r(k)$ and repays $r_l(k)$ with probability p. Otherwise it yields no income. To take into account limited liability, we impose $r(k) \geq r_l(k) \geq 0$ and the profit of the

[4]Several papers use structural models in partial equilibrium to study the link between financial structure and the real economy at the entrepreneur or firm level. Demirguc-Kunt and Maksimovic (1998) and Love (2003) identify financially constrained firms using an investment model to study the country determinants of financial frictions. Paulson, Townsend, and Karaivanov (2006) estimate an entrepreneurship model with limited liability and morel hazard to assess the sources of financial frictions.

firm is $r_b = r - r_l$. The probability p measures the productivity of the firm. Figure 1 summarizes the timing.

Preferences. The representative investor is risk-averse and maximizes the expected time-separable utility:[5]

$$u(c) + \beta E[u(\rho k)]$$

where

$$c + k = Y \quad \text{and} \quad \rho = \begin{cases} \frac{r_l(k)}{k} & \text{probability} \quad p \\ 0 & \text{probability} \quad 1-p \end{cases}$$

The parameter β is the discount factor. The investor is a price-taker and in particular takes the price of capital ρ as given when deciding how much to consume immediately and how much to invest in the firm for later consumption. The first-order condition with respect to k yields the usual Euler equation:

$$\beta p \frac{u'(r_l)}{u'(c)} = \frac{k}{r_l} \tag{1.1}$$

which in turn implicitly defines the repayment r_l as a function of the investment k:

$$r_l = \tilde{r}_l(k|p, c)$$

The relative risk-aversion is defined by $\gamma(c) = -\frac{cu''(c)}{u'(c)}$.

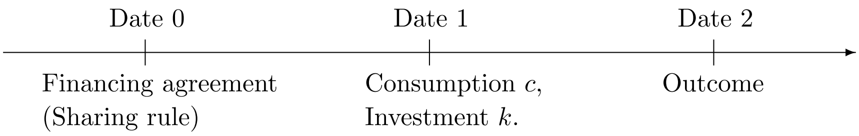
Assumption 1. *The relative risk-aversion γ of utility u is strictly positive and smaller than 1.*

Assumption 1 means that the risk-aversion of the investor is in an intermediate range and implies that the repayment function $\tilde{r}_l(k|p, c)$ is strictly increasing in the investment size k and strictly decreasing in the productivity p. A higher investment k requires a higher repayment r_l and for a given investment size, a project with a higher probability of producing p has to promise a lower repayment r_l.[6] The usual

[5] The utility is normalized such that $u(0) = 0$.

[6] For simplicity, we do not allow any risk-free security, but this could be added without changing qualitatively the results. Moreover, with a risk-free security, we can relax Assumption 1 for values of γ larger than 1.

FIGURE 1.



assumption in corporate finance is that external investors are risk-neutral (ie. the relative risk aversion is equal to 0). In this case, equation (1.1) leads to the "zero-profit constraint":[7] $k = p\beta r_l$.

Production. The problem of raising external finance is to find investors willing to lend capital to the firm. The entrepreneur chooses the investment size to maximize $r_b(k) = r(k) - \tilde{r}_l(k|p,c)$. The elasticity of production is defined by $\alpha(k) = \frac{kr''(k)}{r'(k)} + 1$. For the investment problem to have a solution we assume:

Assumption 2. *The profit function $k \mapsto r(k) - \tilde{r}_l(k|p,c)$ is concave.*[8]

This holds when the returns to scale of the production function are not too high (relative to the risk-aversion of the investor). The following lemma yields the partial-equilibrium decision functions of the entrepreneur given the supply of capital from the investor:

Lemma 1. *In equilibrium, the repayment $r_l^e(p,c)$, the supply of size $k^e(p,c)$, the firm's profit $r_b^e(p,c)$ and the total production $r^e(p,c)$ are increasing functions of the probability of production p and the first-period consumption c.*

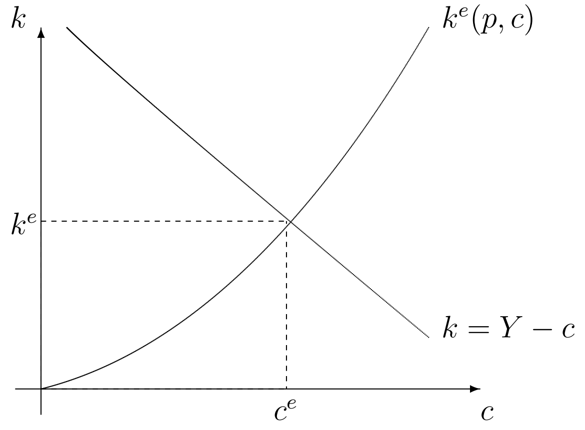
In particular, for a given p, the aggregate investment function is increasing in the first-period consumption c. This relation comes from an indifference condition for the

[7] See Tirole (2006), chapter 3.

[8] The condition for Assumption 2 is $\frac{1}{\alpha(k)}\left[1 + \frac{r_l\gamma'(r_l)}{1-\gamma(r_l)}\right] + \gamma(r_l) - 1 > 0$. When the production function r is Cobb-Douglas and the utility u is CRRA, α and γ are constant.

FIGURE 2.

Consumption-Investment equilibrium. c is the first-period consumption and k is the investment that generates consumption in the second period.



representative investor. The more the investor consumes in the first period, the more he expects to consume in the second period, otherwise he would shift consumption from one period to the other. Moreover, c measures the price of capital as in a consumption-based asset pricing model.

An equilibrium in this economy is an allocation $\langle c^e, k^e \rangle$ and a price of capital $\langle \rho^e \rangle$ such that the investor consumes c^e and allocates k^e given the price ρ^e and such that the firm invests k^e and repays $\rho^e k^e$ if it produces. Given the budget constraint $Y = c + k$ and the fact that $c \mapsto k^e(p,c)$ is increasing, there exists a unique allocation $\langle c^e, k^e, \rho^e \rangle$ that satisfies the allocation problem of the investor and the maximization of profit for the entrepreneur. Figure 2 illustrates the equilibrium.

Remark 1. If the project is more productive (the probability of production p increases or the marginal productivity pr' increases uniformly), the function $k^e(p,c)$ shifts up and there is more investment (ie. k^e increases and c^e decreases). This comes from Assumption 1 that the risk-aversion γ is smaller than 1. In that case, the substitution effect dominates the wealth effect and an increase in the expected return leads to an increase in investment.[9]

Remark 2. The fact that the firm does not produce (and is in bankruptcy) with probability $(1-p)$ is not essential and there could be non-zero production in that state without altering the qualitative results. The assumption of only two states (positive production with probability p, no production otherwise) is also made for tractability.

I.2. **A distribution of heterogeneous projects.** There is now a continuum of projects requiring the investment k in order to generate the revenue $r(k)$ with a probability density p (and 0 otherwise). To analyze the correlation structure of production across firms, we introduce two steps for the resolution of uncertainty. Nature picks first how many firms produce and then which ones produce. For all $m \leq M$, we introduce the functions $\mu_m : \mathcal{R}^m \to \mathcal{R}$ determining the probability density that exactly m firms indexed by $(\varphi_1, .., \varphi_m) \in \mathcal{R}^m$ produce at the same time.[10] For a given lower boundary φ_0, the density f of types is such that with probability one at least one project (if financed) generates revenues:

$$\sum_{m=1}^{m=M} \underbrace{\int_{\varphi_0}^{+\infty} .. \int_{\varphi_0}^{+\infty}}_{m \text{ times}} \mu_m(\varphi_1, .., \varphi_m) \prod_{j=1}^{j=m} f(\varphi_j) d\varphi_j = 1 \tag{1.2}$$

Each term indexed by m represents the probability that exactly m firms produce. For simplicity, we assume that $\mu_1(\varphi) = \varphi$ and that for each $m \geq 2$, the function μ_m is a constant. In this case, we differentiate the projects by their idiosyncratic part (assuming the correlated part is symmetric across all projects). Projects with a

[9]Another property of the equilibrium is that steeper the investment function curve in Figure 2 the less sensitive consumption and output are to shocks to the production function. The curvature of the investment function increases with the elasticity of production $\alpha(\cdot)$ and decreases with the relative risk-aversion $\gamma(\cdot)$.

[10]For instance, the probability that the two firms indexed by φ_1 and φ_2 produce at the same time is $\mu_2(\varphi_1, \varphi_2) d\varphi_1 d\varphi_2$. The probability that exactly two firms produce is $\int_{\varphi_0}^{\infty} \int_{\varphi_0}^{\infty} \mu_2(\varphi_1, \varphi_2) f(\varphi_2) f(\varphi_1) d\varphi_2 d\varphi_1$. It is possible to have $M = +\infty$ if the probability densities μ_m have a sufficient uniform decay in m. For instance $\forall(\varphi_1, .., \varphi_m)$, $|\mu_m(\varphi_1, .., \varphi_m)| < e^{-m}$

higher φ have a higher probability of producing. The probability density of generating positive revenues is now:[11]

$$p(\varphi) = \varphi + \sum_{m=2}^{m=M} \mu_m \left[\int_{\varphi_0}^{+\infty} f(\varphi) d\varphi \right]^{m-1} \tag{1.3}$$

Remark 3. If we assume perfectly efficient internal allocation markets, we do not need to define precisely the boundaries of the firm. A firm can be a collection of projects and it values individual internal projects the same way the representative investor does.

Remark 4. The assumption of a continuum of firms is not crucial and we could consider a large number of firms. This is done for analytical reasons.

As before, the representative investor owns the capital Y, chooses between consuming c immediately or allocating capital k to firms for risky payoffs r_l. He maximizes the expected utility:

$$U = u(c) + \beta \sum_{m=1}^{m=M} \underbrace{\int_{\varphi_0}^{+\infty} .. \int_{\varphi_0}^{+\infty}}_{m \text{ times}} \mu_m u \left(\sum_{j \leq m} r_l(\varphi_j) \right) \prod_{j=1}^{j=m} f(\varphi_j) d\varphi_j$$

where u is concave. The budget constraint is:

$$Y = c + \int_{\varphi_0}^{+\infty} k(\varphi) f(\varphi) d\varphi \tag{1.4}$$

From the investor's maximization, we get the Euler equation:

$$\beta \left[\varphi \frac{u'(r_l)}{u'(c)} + \sum_{m=2}^{m=M} \mu_m \underbrace{\int_{\varphi_0}^{+\infty} .. \int_{\varphi_0}^{+\infty}}_{(m-1) \text{ times}} \frac{u'\left(r_l + \sum_j r_l(\varphi_j) \right)}{u'(c)} \prod_{j=2}^{j=m} f(\varphi_j) d\varphi_j \right] = \frac{k}{r_l}$$

[11]This is a very general formulation of the problem because it can match many patterns of correlation across firms. The particular indexation is not essential and other indexations yield similar qualitative results.

As in section I.1, under assumption 1, the repayment function $\tilde{r}_l(k|\varphi, c)$ is an increasing function of the investment k and a decreasing function of φ.[12]

The investor spreads his allocation across firms because he is risk-averse. Given that only a finite number of firms produces, so that only a finite number of investments generates a positive return, the investor cannot diversify the investment risk and he invests in as many projects as possible.

I.3. **Financial instruments and investment.** This section describes how the financial structure affects the financing and investment decisions of the entrepreneurs. We are interested in a specification of the financial system generating general patterns of financing with a parsimonious set of parameters. Given this requirement we abstract from monitoring and agency problems and assume that the financing choice of an entrepreneur depends on the costs structures of the available financial instruments. We introduce the particular parametrization of the financial system and then describe how it affects the investment decision. Appendix B shows that the theoretical results generated by this parametrization are robust to more general cost structures.

Institutional environment and financing costs. We consider public securities for market finance and private securities for intermediated finance. Public securities are issued to a large pool of investors and are floated on secondary markets, while private securities are sold to a limited number of specialized agents with restrictions on inter-institution trading. In this model, the choice between public and private securities depends on payment structures that involve (deadweight) costs.[13]

[12]Note for any $a \geq 0$, the function $r_l \mapsto r_l u'(r_l + a)$ is increasing. Indeed, $[r_l u'(r_l + a)]' = (1-\gamma)u'(r_l + a) - au''(r_l + a) > 0$ since $u'' < 0$.

[13]The financial instruments that we consider are public and private securities. We abstract from the Debt-versus-Equity debate for several reasons. First, we believe the main issue for the financial system is the relative roles of financial markets and intermediaries. Second, a continuum of securities between pure debt and pure equity has emerged (convertibles, preferred shares, etc.) making this distinction less crucial than before. In this model, because there is no payment in the case of default, debt and equity securities are identical (see Tirole 2006, chapter 3). See Boot, Gopalan, and Thakor (2006) for a model of the choice between private and public ownership.

Assumption 3. *The cost of transferring funds from the investors to the population of firms characterizes the financial system:*

(i) *The issuance of public securities requires a fixed cost η.*

(ii) *The issuance of private securities requires an intermediation cost which is a combination of a per-unit-of-profit cost δ and an interest rate wedge ξ.*

We interpret η, δ and ξ as the marginal costs of market and intermediated finance by assuming perfect competition inside the financial sector, so that the price of transferring funds from investor to entrepreneurs is equal to the marginal cost.

These financing costs arise from a number of sources. First, the cost of issuing public securities includes the costs of underwriting (origination, distribution, certification, SEC registration) and of compliance with secondary market regulations (disclosure, auditing, legal fees, accountant's fees, trustee's fees, preselling activities). What characterizes market finance instruments is that they are standardized (or "commoditized") into generic simple contracts: a large component of the cost of market finance is generally made of fixed costs and does not vary much with the characteristics of the firm or the contract.

Second, the cost of issuing private securities includes the cost of intermediation (more private capital means larger bank syndicates or more private equity firms, which is costly), the cost of supervision (writing and enforcing covenants, involvement of venture capitalists, etc.) and indirect costs (screening of deals, cost of illiquidity). In contrast to market instruments, intermediated finance instruments are very flexible and the intermediary, whether a bank as in Rajan (1992) or a venture capitalist as in Admati and Pfleiderer (1994) has some bargaining power not only in shaping the terms of the contract to facilitate the transaction but also to capture a share δ of the profits. An interpretation for the cost ξ can be capital requirements (for instance imposed by the Basel I and II regulatory frameworks) which induce a wedge between the deposit and the lending rates. We typically assume that ξ is small.[14]

[14] See Remark 5 for an explanation of the role played by the cost ξ. It is included for generality. We show below that a positive ξ allows the distribution of firm sizes to depend on the financing cost η and δ.

Investment and financing decision. The investment size depends on the maximization:

$$r_b = \max_k (1 - \delta 1_b)[r(k) - (1 + \xi 1_b)\tilde{r}_l(k|\varphi, c)] - \eta(1 - 1_b)$$

where 1_b is a dummy equal to 1 if intermediated finance is used (0 otherwise). The first-order condition is:

$$r'(k) - (1 + \xi 1_b)\frac{\partial \tilde{r}_l}{\partial k} = 0 \tag{1.5}$$

Equation (1.5) implies that there is underinvestment whenever $\xi > 0$. When $\xi = 0$, the first-best level of investment is set such that $r'(k) - \frac{\partial \tilde{r}_l}{\partial k} = 0$ and does not depend on which financial instrument is being used. The profit of the firm r_b determines the choice of instrument. Because of the envelope theorem, we have:

$$\frac{\partial r_b}{\partial \varphi} = -(1 - \delta 1_b)(1 + \xi 1_b)\frac{\partial \tilde{r}_l(k|\varphi, c)}{\partial \varphi} > 0 \tag{1.6}$$

Equation (1.6) has several important implications. The profit r_b is increasing in φ. Moreover, if the wedge ξ is small, the profit of the entrepreneur is increasing more with the type φ when he uses market finance instead of intermediated finance. Finally, there exists a threshold φ_M at which firms switch from intermediated to market finance and this threshold is unique.

For simplicity, we assume that the firms with the lowest productivity level φ_0 do not profit by raising external finance and exit. This comes for instance from some start-up cost: $r(0) < 0$. This implies that there exists a threshold φ_B such that firms with $\varphi < \varphi_B$ do not raise external finance and firms with $\varphi \in [\varphi_B, \varphi_M]$ raise intermediated finance. The fact that $\varphi_B > \varphi_0$ generates some endogenous incompleteness. The representative investor is not perfectly diversified and there is residual uncertainty.

To summarize, if the profit function $k \mapsto r(k) - \tilde{r}_l(k|\varphi, c)$ is concave (Assumption 2), we get the same result of Lemma 1 that in equilibrium, the repayment $r_l^e(\varphi, c)$, the supply of size $k^e(\varphi, c)$, the firm's profit $r_b^e(\varphi, c)$ and the total production $r^e(\varphi, c)$ are increasing functions of the productivity φ and of the first-period consumption c.

Remark 5. When $\xi > 0$, the investment size is discontinuous because the cost structure of intermediated finance generates underinvestment for the small firms to which it provides funding. In φ_M, we have $k(\varphi_M^-, c) < k(\varphi_M^+, c)$.

Aggregation. The total supply for productive capital is then:

$$K(c) = \int_{\varphi_0}^{+\infty} 1_{\{r_b^*(\varphi,c)\geq 0\}} k^e(\varphi, c) f(\varphi) d\varphi \tag{1.7}$$

Lemma 2. *The aggregate investment function $K(c)$ is increasing in c.*

Similarly to the previous section, there exists a unique equilibrium in the variables $\langle c^e, k^e\{\cdot\}, \rho^e\{\cdot\}, \varphi_B, \varphi_M\rangle$.

II. Identification of the financial structure

This section describes the estimation of the financing costs from the observation of the share of market finance in total external finance and the distribution of firm sizes. The identification stems from a property of the equilibrium at the industry-level.[15] Section II.1 describes the economy at the industry level and the properties of the equilibrium that lead to identification of the financing costs. Section II.2 describes the parametrization of the firm size distribution and the empirical implementation.

II.1. **Industry approach.** Industries are identical except in the distribution of productivity f_i. The aggregate distribution at the country level is $f = \sum_i f_i$. We refer

[15] Our industry approach is related to Rajan and Zingales (1998) whose identification strategy also relies on the sign of a cross-derivative. The main difference is that in their context, Rajan and Zingales argue that the industry characteristics are exogenous. Here, the industry characteristics do not depend on the financing costs (ie. are exogenous with respect to the financial system) only when there are no frictions (ie. $\xi = 0$). However, the theoretical model yields an identifying relation even when observable industry characteristics are endogenous (ie. $\xi > 0$)

to the investment size k as "firm size". The distribution of firm sizes that we observe in the data at the industry level is given by:

$$g_i(u,c) = \frac{f_i[k^{-1}(u,c)]}{k'[k^{-1}(u,c),c]} \tag{2.1}$$

From Remark 5, when there are no financial frictions ($\xi = 0$), the investment size $k^e(\varphi, c)$, the aggregate investment, the equilibrium consumption and the distribution of firm sizes g_i do not depend on the financing costs. However, when $\xi > 0$, a change in the financial fees affects the equilibrium allocation. To order the distribution of firm sizes, we make the following definition:

Definition 1. *An industry i with productivity density f_i has more productive firms than industry j with productivity density f_j (denoted $f_i \succ f_j$) if $\frac{f_i(t)}{f_j(t)}$ is increasing in t. Similarly, an industry i with firm size density g_i has larger firms than industry j with firm density g_j (denoted $g_i \succ g_j$) if $\frac{g_i(t)}{g_j(t)}$ is increasing in t.*

This definition is related to the monotone likelihood ratio in Milgrom (1981). Milgrom describes distributions of probabilities but such order also applies to distribution of sizes.[16] Obviously the order induced by Definition 1 is only partial: for two industries it might be impossible to say that one has larger firms than the other. Using equation (2.1) to compare the size distribution of two industries in the same country, an increasing investment function $k' > 0$ implies that $f_i \succ f_j \Leftrightarrow g_i \succ g_j$. The share of market finance in industry i is:

$$S_i = \frac{\int_{\varphi_M}^{+\infty} k(\varphi) f_i(\varphi) d\varphi}{\int_{\varphi_B}^{\infty} k(\varphi) f_i(\varphi) d\varphi} = \frac{\int_{k_M}^{+\infty} k g_i(k) dk}{\int_{k_B}^{\infty} k g_i(k) dk}$$

where $k_B = k(\varphi_B)$ and $k_M = k(\varphi_M)$. We now look at properties of the equilibrium.

Lemma 3. *An industry with larger firms raises more market finance:*

$$g_i \succ g_j \quad \Rightarrow \quad S_i > S_j$$

This result stems from the demand for market finance generated by the large firms in an industry.

[16] See also Shaked and Shanthikumar (1994) for an extensive review of the properties of the likelihood order.

Lemma 4. *An industry i raises less market finance (relative to intermediated finance) in a country with a higher cost of market finance* η*:*

$$\frac{\partial \log S_i}{\partial \eta} < 0$$

or more market finance in a country with a higher cost of intermediated finance δ*:*

$$\frac{\partial \log S_i}{\partial \delta} > 0$$

This second lemma shows that financing costs also affect the demand for finance. A higher efficiency of financial markets relative to intermediaries (because of a lower cost of market finance η or a higher cost of intermediated finance δ) increases the share of market finance.

Proposition 1 (Monotone sensitivity property)**.** *The share of market finance decreases more with the cost of market finance* η *in industries with small firms than in industries with large firms:*

$$g_i \succ g_j \Rightarrow \frac{\partial \log S_i}{\partial \eta} > \frac{\partial \log S_j}{\partial \eta}$$

Similarly, the share of market finance increases more with the cost of intermediated finance δ *in industries with small firms than in industries with large firms:*

$$g_i \succ g_j \Rightarrow \frac{\partial \log S_i}{\partial \delta} < \frac{\partial \log S_j}{\partial \delta}$$

The implication of Proposition 1 is to provide a robust identifying restriction. This proposition means that allocation of market finance across industries allows to make a statement on the relative financing costs. When industries with small firms raise relatively large amounts of market finance (when compared to industries with large firms) this suggests that the relative cost of market finance is low.

An intuition for Proposition 1 comes from recognizing that small firms are constrained in raising market finance, especially in countries with costly financial markets (relative to intermediaries). When a decrease in the relative cost of market finance takes place, the share of market increases in all industries. However an industry with large firms was already raising high levels of market finance and its share of market increases by less compared to industries with small firms who were raising mainly intermediated finance.

The logic of the proof for Proposition 1 is as follows. There are two cases that are interesting to distinguish. When there are no frictions ($\xi = 0$), the investment decision does not depend on the financial instrument used, so that the distribution of firm sizes is independent of the market and intermediated financing costs. In this case, a change in the financing costs does not affect the equilibrium consumption of the agent or the aggregate investment: it only modifies the threshold at which a firm raises market finance. This frictionless case is reminiscent of a Modigliani-Miller world. It is a good benchmark because there are reasons to think that financial intermediaries try to limit deadweight cost with their financing fees (just like a government tries to limit the deadweight loss from taxation). When the friction parameter ξ is non zero, we have to take into account a general-equilibrium impact for the change of the financing cost.

II.2. **Parametrization of the firm size distribution.** Some evidence suggests that Pareto and log-Normal distributions provide a good fit for the distribution of firm sizes (Axtell, 2001; Cabral and Mata, 2003). To facilitate the interpretation of the results, we parameterize the upper tail of the firm size distribution:

$$g(k|\sigma) = \tilde{g}\frac{e^{-\frac{1}{n}\left[\frac{1}{\sigma}\log\left(\frac{k}{k_B}\right)\right]^n}}{k} \tag{2.2}$$

where $\sigma \in (0,1)$ and $\tilde{g}$ is a constant. If $n = 1$, the parametrization is that of a power law (Pareto distribution) $g(k|\sigma) = \frac{\tilde{g}}{k_B}\left[\frac{k}{k_B}\right]^{-\left(\frac{1}{\sigma}+1\right)}$. If $n = 2$, the distribution is a half log Normal law. The scale parameter σ characterizes how thick the tail distribution is. For two industries with distributions g_i (parameters σ_i) and g_j (parameters σ_j), the order induced by Definition 1 is such that:

$$g_i \succ g_j \quad \Leftrightarrow \sigma_i > \sigma_j$$

The parameter σ_i is then a proxy for the proportion of large firms in the industry. Given this parametrization of the distribution of firm sizes with σ_i as a proxy for the proportion of large firms, Proposition 1 leads to:

$$\frac{\partial^2 \log S_i}{\partial\delta\partial\sigma_i} < 0 \text{ and } \frac{\partial^2 \log S_i}{\partial\eta\partial\sigma_i} > 0 \quad \Leftrightarrow \quad \frac{\partial \log S_i}{\partial\sigma_i} \text{ decreasing in } \delta \text{ increasing in } \eta$$

We consider the OLS regression for country j, industry i:

$$\log S_{ij} = [\text{controls}] + \theta_j \sigma_{ij} + \epsilon_{ij} \tag{2.3}$$

where θ_j is a country-specific slope and the controls are country dummies.[17] The parameter θ_j is positive and decreasing in the relative efficiency of the financial markets, ie. decreasing in δ and increasing in η.

Corollary 1. *Given two countries j_1 and j_2 and the coefficients $\hat{\theta}_{j_1}$ and $\hat{\theta}_{j_2}$, estimated in regression (2.3), the country j_1 has more efficient financial markets (relative to financial intermediaries) than country j_2 if $\hat{\theta}_{j_1}$ is statistically smaller than $\hat{\theta}_{j_2}$.*

III. Estimation of the financing costs

This section presents the estimation of the cost of market finance relative to intermediated finance implied by the model. Section III.1 describes the sample and the dependent variable. Section III.2 describes the empirical methods. Section III.3 shows the results.

III.1. **Data sources and sample selection.**

Sources. There are two sources of data. Balance-sheet and income statement information come from Amadeus (Bureau Van Dijk Electronic Publishing). Information about financial deals is drawn from SDC Platinum New Issues (Thomson Financial).[18]

Amadeus provides standardized data on the balance-sheet and income statements for several million of firms throughout Europe. The data covers both listed and non-listed companies and is therefore well suited to characterize the full distribution of firm sizes.

[17] We also use a set of country and industry dummies.

[18] Note that in this paper we aggregate firm-level data that we match at the industry level. It is very difficult and potentially problematic to directly match balance-sheet and issuance data as the firm level. Matching the taxable entity of a firm (for the balance-sheet data) and the financial arm of the firm (for the issuance data) is particularly difficult since the two are generally separated.

A limitation of Amadeus is that, because of differences in accounting standards, no size proxy (Total asset, Employment, Operating revenues, etc) is available for all countries. Filing Operating revenues is standard in Germany but Total assets is missing for most German firms. The opposite happens for the UK: not Total asset, but Operating revenues is missing for most UK firms.

SDC Platinum collects data on financing deals which allows to precisely characterize the financial instruments and to construct a measure of market finance in total external finance.[19] For each deal, SDC Platinum provides information on the market used (public or private markets), the instrument (debt, equity, hybrids), the use of proceeds, and for syndicated bank loans, how many bookrunners participated in the transaction.

Sample. In order to study the relationship between financing and firm characteristics, we match Amadeus and SDC at the industry level. The industry level of aggregation is the "mid-industry" defined by Thomson Financial.[20] We focus on five big European countries (France, Germany, Italy, Spain and the United Kingdom) so that each country has a large cross-section of industries.

To characterize the financing environment we need as many deals as possible and therefore we keep all the deals in SDC from 1990 and 2005. To characterize the firm size distribution, we keep all the firms in Amadeus in 2003. We focus on medium-term characteristics of the financial system and the implicit assumption is that the underlying structural parameters generating the distribution of firm sizes and the share of market finance do not vary over time. In order to construct a fairly homogenous sample, the financial and real-estate sectors as well as government-owned companies or highly regulated or subsidized industries are excluded.[21] We keep all

[19]Note that using only balance-sheet information is limited because it does not distinguish between bank loans, private and public debt.

[20]"Mid-industries" in Thomson Financial are essentially combinations of 3-digit US SIC-level industries, and so they are slightly more precise than 2-digit US SIC-level industries.

[21]The regulated or subsidized industries are the "Power" and "Motion Picture / Audio Visual" industries. Financial and real-estate sectors are excluded because financial ratios are generally

the deals with a maturity longer than one year. We drop the deals where the use of proceeds indicates that the deal is merely a change of ownership.[22]

The restriction we impose on industries is to have more than 10 deals in SDC, 200 firms in Amadeus and at least one public and one private deal (ie the share of market finance strictly between 0 and 1). If either is violated, the financing patterns or the firm size distribution will be poorly characterized. Table 1 shows the number of matched industries across countries.

Dependent variable: share of market finance in total external finance. The dependent variable characterizes external financing patterns at the industry-level. The share of market finance in total external finance measures the proportion of financing raised through financial markets. On the one hand, intermediated finance includes all privately-placed securities (private debt, private equity and bank loans). On the other hand, market finance includes the public securities (public bonds and public equity). As argued by Dennis and Mullineaux (2000) and Drucker and Puri (2006), syndicated loans lie somewhere between private-placement debt and public securities. When a syndicated loan involves a syndicate of more than 5 bookrunners, it is considered a public security.[23] The share of market finance in total external finance is:

$$S = \frac{\sum_{\text{Public deals}} \frac{Proceeds}{GDP}}{\sum_{\text{All deals}} \frac{Proceeds}{GDP}}$$

where $Proceeds$ is the deal proceed and GDP is the GDP of the country at the year of the deal (for aggregation over time, the deals are normalized by the country's GDP).

difficult to compare for financial and non-financial companies and regulations of the financial sector tend to be country-specific.

[22]In that case, the holding company is the one raising external finance to potentially finance investment. However, we simply drop these deals because the name of the holding company is not always indicated.

[23]A threshold at 5 bookrunners is an ad hoc choice but changing it does not alter qualitatively the results.

III.2. **Estimation method.** The econometric problem consists of estimating the parameter that characterizes the upper tail of the distribution of firm sizes and of relating it to the share of market finance.

Explanatory variable: distribution of firm sizes. The parametrization of the firm size distribution introduced in section II.2 is estimated using Amadeus data. Following Champonnois (2006), we fit a distribution that extends the parametrization of g in equation (2.2) with a lower branch accounting for the fact that the densities for small firms and large firms are different.[24] Specifically, we fit Asymmetric Exponential Power (AEP) distributions for the log of firm size. AEP distributions are defined by:

$$u \in \mathcal{R}: \qquad q(u|\sigma^+, \sigma^-, t, n) = \begin{cases} \frac{1}{2(\sigma^+ + \sigma^-) n^{1/n} \Gamma(1+1/n)} e^{-\frac{1}{n}\left[\frac{|u-t|}{\sigma^+}\right]^n} & \text{if } u > t \\ \frac{1}{2(\sigma^+ + \sigma^-) n^{1/n} \Gamma(1+1/n)} e^{-\frac{1}{n}\left[\frac{|u-t|}{\sigma^-}\right]^n} & \text{if } u \leq t \end{cases} \tag{3.1}$$

where t is the location parameter, σ^+ and σ^- are the scale parameters for the upper and lower tail, and n is the shape parameter.[25] When $n = 1$, the log size $\log x$ follows an asymmetric Laplace distribution. In this case, the size x follows a power law for in the upper tail. When $n = 2$, the log size $\log x$ follows an asymmetric log normal. The parameters (σ^+, σ^-, t) are estimated by maximum likelihood estimation for each industry-country pair for $n = 1$ and $n = 2$. In particular, this provides a scale parameter σ_{ij} of the upper tail for country j, industry i.

Main regression. The predictions of the model are embedded in the estimation of the structural equation (2.3):

$$\log S_{ij} = [\text{controls}] + \theta_j \sigma_{ij} + \epsilon_{ij} \tag{2.3}$$

The explanatory variable is the estimated scale parameter σ_{ij} of the distribution of firm sizes for industry i, country j. The controls include country dummies. The country specific slope captures how the market finance is allocated across industries with different distribution of firm sizes.

[24]Extending the parametrization of equation (2.2) allows to use untrimmed data. Trimming the data is problematic when considering a large cross-section of industries and countries.

[25]Γ is the Gamma function. Particular values are: $\Gamma(2) = 1$ and $\Gamma(3/2) = \sqrt{\pi}/2$. The Gamma function is defined as: $\Gamma(x) = \int_0^{+\infty} u^{x-1} e^{-u} du$.

This empirical procedure involves a two-stage procedure and the asymptotic distribution of the second stage parameters depends in general on adjustments due to the first stage. The following lemma shows however that when the number of observations used in the first-stage estimation (the number of firms per industry) is much larger than the number of observations in the second stage (the number of industries) the adjustment is asymptotically zero.

Lemma 5. *For a number I of industries and a number N_i of firms in industry i, the adjustment due to the first stage is approximately of order* $\frac{1}{I}\sum_i \sqrt{\frac{I}{N_i}}$.

Table 3 shows that the adjustment is about 10% of the first stage variance which is of order 0.001. The adjustment is therefore very small and in what follows we neglect it.

III.3. **Results.**

Estimating the firm size distribution. Table 2 presents an ordering of the countries in terms of their distribution of firm sizes. The UK has the highest proportion of large firms, ahead of France and Germany while Spain and Italy have the highest proportion of small firms. Figure 3 shows the fit for a particular industry. The (asymmetric) log Normal fits the general shape of the distribution weil but the upper tail poorly. The (asymmetric) log Laplace fits the upper tail distribution of firm sizes well (Axtell, 2001; Gabaix, 2005). Overall, the value of the log-likelihood provides a comparison of the fit of the two parameterizations and in the case of Figure 3, the log Laplace has a better fit.

Comparing financial systems. The results are shown in Tables 4 and 5. Table 4 presents the OLS estimates and their t-statistics for the size proxy Total assets and Table 5 for Operating revenues. Not surprisingly a firm's size is an important determinant of financing. Across all parameterizations and all size proxies, we find a strong relation between the share of market finance in total external finance and the proportion of large firms. A one standard deviation increase in the scale parameter σ leads to a 20% increase in the share of market finance for regressions (1), (3), (5) and (7). This estimated slope $\hat{\theta}_0$ is positively significant at the 1 % level and this is consistent with the existing empirical literature conducted at the firm level which finds a correlation between the probability of raising market finance and the firm size (Easterwood and Kapapakkam, 1991; Krishnaswami, Spindt, and Subramaniam, 1999; Esho, Lam, and Sharpe, 2001; Denis and Mihov, 2003; Kwan and Carleton, 2004).

We also get a ranking of the relative efficiency of the financial markets across countries which is consistent across parameterizations and size proxies. Table 4 shows that the UK is good at allocating market finance to all the industries and not just the industries with large firms. Table 5 shows that a similar result holds for Germany. In contrast, the French, Italian and Spanish economies seem to mainly allocate intermediated finance to industries with small firms and this suggests that these financial systems are characterized by a higher relative cost of market finance.

Tables 6 and 7 show a similar picture after adding industry fixed effects. Yet because of the small cross-section of countries, some of the estimated coefficient are not significantly different from zero. Further research on including data from more countries is necessary to allow more precise estimates of the coefficients.

Interpretation. A low estimated cost of market finance relative to intermediated finance for the UK is consistent with the existing literature that categorizes it as a "market-based" financial system (Allen and Gale, 2000). London is a major international center for banking and financial markets.

However, since Germany has been considered an archetype of a "bank-based" financial system, the estimated low relative cost of market finance can be surprising. Yet, Vitols (2005) describes the deep transformation of the German financial system over the last 10 years. He argues that large privately owned banks "are attempting to weaken their links with companies and shift their focus toward fee-based activities such as investment banking and asset management. Partly in response to the demands of these banks, German policymakers have initiated regulatory reforms in an effort to strengthen the role of equity markets." The main innovations have been the introduction of new regulation and the creation of the Neuer Markt which led to a sharp increase in IPO activity. This is consistent with a decrease in the lower cost of market finance in Germany over the period we study (1990-2005).

France, Italy and Spain are typically classified as "bank-based" financial systems and this is consistent with our findings. Pagano, Panetta, and Zingales (1998) reports that firms raising equity finance from an IPO are much larger in Italy than in the US, which suggests that raising market finance in Italy is relatively expensive. Saá-Requejo (1996) reports in 1996 that banks are at the core of the Spanish economy and that security markets are underdeveloped.

Previous literature has classified financial systems using endogenous financing patterns (in particular the share of market finance in total external finance) instead of estimated structural parameters as we do here (see Allen and Gale 2000; Demirguc-Kunt and Levine 2001). Estimating the financing costs allows to decompose two components that influence financing patterns. We rewrite the estimated equation as:

$$\log S_{ij} = \log S^* + \hat{\theta}_j(\sigma_{ij} - \sigma^*)$$

The regression country-fixed effect is $\log S^* - \sigma^*\hat{\theta}_j$ where σ^* the scale parameter for a reference industry with very large firms and S^* is the share of market finance for such industry. The difference in the share of market finance for a given industry i across two countries j_1 and j_2:

$$\log S_{i,j_1} - \log S_{i,j_2} = \underbrace{\hat{\theta}_{j_1}(\sigma_{i,j_1} - \sigma_{i,j_2})}_{(1)} + \underbrace{(\hat{\theta}_{j_2} - \hat{\theta}_{j_1})(\sigma^* - \sigma_{i,j_2})}_{(2)} \tag{3.2}$$

where $\sigma^* > \sigma_{i,j_2}$. In equation (3.2), a high share of market finance S_{i,j_1} can be due to a high proportion of large firms (term (1): a high $\sigma_{i,j}$) or a low cost of market finance (term (2) : low $\hat{\theta}_{j_1}$).

When the cost of market finance and the distribution of firms sizes are estimated separately, we find a correlation between the two. Figure 4 shows a plot with the size ordering and the average ranking for the estimated relative costs of market finance across countries. Although with only a few data points, this plot suggests that there might be a positive relation between the relative cost of market finance and the proportion of large firms. This means that the two effects in equation (3.2) reinforce each other. The UK has a high share of market finance not only because it has a low cost of market finance but also because it has larger firms. Similarly, Italy has a low share of market finance because it has smaller firms and a higher relative cost of market finance. The following section provides an explanation based on welfare maximization for the correlation between the financing costs and the distribution of firms sizes.

IV. Evaluation of the financial system

In this section, we evaluate the link between financial structure and the characteristics of the population of firms. In an attempt to partially endogenize the relation between financing costs and the distribution of productivity across firms, we look at how the marginal incentives of a planner to modify the financial structure depend on the characteristics population of firms. Note that the analysis in this section does not suggest any causal link beyond the correlation. We show that the incentive to modify the financing costs given the distribution of productivity is closely related to the incentive to modify the distribution of productivity given the financing costs. We first study at the case without financial frictions ($\xi = 0$). We then discuss how financial frictions modify the analysis.

Problem 1: Incentives to modify the financial structure given the distribution of productivity. The welfare of the private agents (investors and entrepreneurs) is evaluated for different combinations of financing costs $\langle \eta, \delta \rangle$ against the distribution of firm sizes. More precisely, we analyze the marginal incentives of a planner who maximizes the welfare of private agents to decrease the costs of market and intermediated finance for different distribution of productivity (and hence different distribution of firm sizes). A simple utilitarian welfare criteria adds the utility of the representative investor and the profit of the entrepreneurs:

$$W = U + V$$

where U is the utility that investors derive from consumption in the two periods and V is the sum of profits of entrepreneurs: $V = \int_{\varphi_B}^{+\infty} p(\varphi) r_b(\varphi) f(\varphi) d\varphi$. The welfare

W is a decreasing function of the financing costs $\langle \delta, \eta \rangle$. The following proposition considers the situation when there are no financial frictions.

Proposition 2. *When there are no financial frictions ($\xi = 0$), economies with large firms have a marginal incentive to decrease the fixed cost of finance η while economies with small firms have a marginal incentive to decrease the proportional cost of intermediated finance δ, ie. for two countries j_1 and j_2:*

$$f_{j_1} \succ f_{j_2} \quad \Rightarrow \quad \left. \frac{\frac{\partial W}{\partial \eta}}{\frac{\partial W}{\partial \delta}} \right|_{j_1} > \left. \frac{\frac{\partial W}{\partial \eta}}{\frac{\partial W}{\partial \delta}} \right|_{j_2} \tag{4.1}$$

The intuition for Proposition 2 is that, when there are no frictions, decreasing the cost of one instrument only affects the profit of firms using this instrument. Decreasing the cost of market finance only affects the large firms while decreasing the cost of intermediated finance only affects the small firms. Hence, the larger the firms, the bigger the incentive to decrease the cost of market finance and the smaller the incentive to decrease the cost of intermediate finance.

This result rationalizes that countries with large firms have a lower cost of market finance because the accumulation of policy decisions concerning the financial structure should take into account the marginal incentives of investors and entrepreneurs and lead to adjusting the relative cost of market finance given the distribution of firm sizes.

Problem 2: Incentives to modify the the distribution of productivity given the financial structure. The result of proposition 2 does not suggest a causal link between the financing costs and the distribution of productivity. In fact equation (4.1) can be interpreted as the incentives of a planner to adjust the distribution of productivity given the financial structure and we now show that the two problems are equivalent. Assume that the two countries j_1 and j_2 have the same distribution of productivity f but have two different financial structures characterized by the financing costs $\langle \delta_1, \eta_1 \rangle$ and $\langle \delta_2, \eta_2 \rangle$. We assume that the country 2 has a lower cost of market finance but that the countries have the same welfare in the sense that:

$$W(\delta_1, \eta_1 | f) = W(\delta_2, \eta_2 | f)$$

where we made it explicit the welfare W depends on the financing costs and the distribution of productivity f. To make this assumption clear, we assume:

$$\delta_2 = \delta_1 - \nu \frac{\partial W(\delta_1, \eta_1|f)}{\partial \eta} \qquad \eta_2 = \eta_1 + \nu \frac{\partial W(\delta_1, \eta_1|f)}{\partial \delta}$$

where $\nu > 0$ is small.[26] We consider the incentives of countries j_1 and j_2 to increase the proportion of high productivity firms from distribution f to distribution $h \succ f$. The welfare of country j_2 under distribution h:

$$W(\delta_2, \eta_2|h) = W(\delta_1, \eta_1|h) + \nu \frac{\partial W(\delta_1, \eta_1|f)}{\partial \delta} \frac{\partial W(\delta_1, \eta_1|h)}{\partial \delta} \left[\frac{\frac{\partial W(\delta_1,\eta_1|h)}{\partial \eta}}{\frac{\partial W(\delta_1,\eta_1|h)}{\partial \delta}} - \frac{\frac{\partial W(\delta_1,\eta_1|f)}{\partial \eta}}{\frac{\partial W(\delta_1,\eta_1|f)}{\partial \delta}} \right]$$

It is clear that $W(\delta_2, \eta_2|h)$ is higher than $W(\delta_1, \eta_1|h)$ if $\frac{\frac{\partial W(\delta_1,\eta_1|h)}{\partial \eta}}{\frac{\partial W(\delta_1,\eta_1|h)}{\partial \delta}} > \frac{\frac{\partial W(\delta_1,\eta_1|f)}{\partial \eta}}{\frac{\partial W(\delta_1,\eta_1|f)}{\partial \delta}}$ which is exactly what we showed in Proposition 2 with $h \succ f$. In words, country j_2 has a higher incentive to modify the distribution of productivity from f to $h \succ f$ than country j_1 because it has a lower relative cost of market finance.

Introducing financial frictions. When there are financial frictions ($\xi > 0$), following Remark 5 and the discussion in Section II.1, the aggregate allocation $\langle c^e, K(c^e) \rangle$ depends on the financing costs. So changing the financing costs has not only a direct effect on the profit of the entrepreneurs but also an indirect effect on the welfare of all the agents through the equilibrium allocation. In what follows, we break down the different effects of a change in the financing costs. First, when we look at a decrease in the cost of market finance $\partial \eta < 0$, we have:

$$\frac{\partial W}{\partial \eta} = \int_{\varphi_M}^{\infty} p(\varphi) \frac{\partial r_b}{\partial \eta} f \left[1 - \underbrace{\frac{\frac{\partial c}{\partial \eta} \int_{\varphi_B}^{\infty} p \frac{\partial r_b}{\partial c} f}{\int_{\varphi_M}^{\infty} p \left(-\frac{\partial r_b}{\partial \eta} \right) f}}_{(1)} - \underbrace{\frac{\frac{\partial \varphi_M}{\partial \eta} p(\varphi_M) \Delta u[r_l(\varphi)] f(\varphi_M)}{\int_{\varphi_M}^{\infty} p \left(-\frac{\partial r_b}{\partial \eta} \right) f}}_{(2)} - \underbrace{\frac{\frac{\partial c}{\partial \eta} \left(u'(c) + \frac{\partial \hat{u}}{\partial c} \right)}{\int_{\varphi_M}^{\infty} p \left(-\frac{\partial r_b}{\partial \eta} \right) f}}_{(3)} \right] \tag{4.2}$$

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[26] Given that ν is small, a first-order expansion yields: $W(\delta_2, \eta_2|f) = W(\delta_1, \eta_1, f) - \nu \frac{\partial W(\delta_1,\eta_1|f)}{\partial \eta} \frac{\partial W(\delta_1,\eta_1|f)}{\partial \delta} + \nu \frac{\partial W(\delta_1,\eta_1|f)}{\partial \delta} \frac{\partial W(\delta_1,\eta_1|f)}{\partial \eta} = W(\delta_1, \eta_1, f)$ but since ν is positive and $\frac{\partial W(\delta_1,\eta_1|f)}{\partial \eta}$ and $\frac{\partial W(\delta_1,\eta_1|f)}{\partial \delta}$ are negative, country j_2 has a lower relative cost of market finance.

where $\hat{u}$ is the expected utility of the agent in the second period[27] and $\Delta u[r_l(\varphi)] = u[r_l(\varphi_M^+)] - u[r_l(\varphi_M^-)]$. First note that $\frac{\partial \varphi_M}{\partial \eta} > 0$ and $\frac{\partial c}{\partial \eta} > 0$. When the cost of market finance η decreases, so does the threshold for market finance φ_M. Also when there are frictions, a decrease in η reduces the domain for intermediated finance and overall the frictions in investment. In turn because of the substitution effect, consumption decreases and aggregate investment increases.

We now look at equation (4.2). The term (1) is related to a reallocation effect for the profit of the entrepreneurs. From a decrease in the cost of market finance $\partial \eta < 0$ and in first-period consumption $\partial c < 0$, the profit of all firms decreases except for those switching from intermediated to market finance. From the point of view of a country with large firms, this effect is ambiguous. On the one hand, it decreases the profit of small firms, so the fewer small firms the better. However on the other hand, the reallocation leads to spreading investment across all firms receiving market finance which tends to be unfavorable to large firms (and so countries with large firms).[28] The term (2) is a switching effect for the entrepreneurs. Firms switching from intermediated finance to market finance set the optimal investment size because they are no longer subjected to financial frictions and thereby see a jump in profit. The larger the firms in the country, the stronger this effect is. The term (3) is also a reallocation effect, this time for the investor. Similarly to the reallocation effect for entrepreneurs, it is ambiguous. The same decomposition can be done for the effect of decreasing the cost of intermediated finance δ:

$$\frac{\partial W}{\partial \delta} = \int_{\varphi_M}^{\infty} p(\varphi) \frac{\partial r_b}{\partial \delta} f \left[1 - \frac{\frac{\partial c}{\partial \delta} \int_{\varphi_B}^{\infty} p \frac{\partial r_b}{\partial c} f}{\int_{\varphi_M}^{\infty} p \left(-\frac{\partial r_b}{\partial \delta}\right) f} - \frac{\frac{\partial \varphi_M}{\partial \delta} p(\varphi_M) \Delta u[r_l(\varphi)] f(\varphi_M)}{\int_{\varphi_M}^{\infty} p \left(-\frac{\partial r_b}{\partial \delta}\right) f} - \frac{\frac{\partial c}{\partial \delta} \left(u'(c) + \frac{\partial \hat{u}}{\partial c}\right)}{\int_{\varphi_M}^{\infty} p \left(-\frac{\partial r_b}{\partial \delta}\right) f} \right]$$

Note now that $\frac{\partial \varphi_M}{\partial \delta} < 0$ and $\frac{\partial c}{\partial \delta} < 0$. When the cost of intermediated finance δ decreases, the threshold for market finance φ_M increases. In addition, a decrease in

[27] $\hat{u} = \beta \sum_{m=1}^{m=M} \underbrace{\int_{\varphi_0}^{+\infty} .. \int_{\varphi_0}^{+\infty}}_{m \text{ times}} \mu_m u \left(\sum_{j \le m} r_l(\varphi_j) \right) \prod_{j=1}^{j=m} f(\varphi_j) d\varphi_j$

[28] Note that from an extension of Lemma 1 in Section I.3, we have $\frac{\partial r_b}{\partial c} > 0$. It is also possible to show that $\left(\frac{\partial r_b}{\partial c}\right) / \left(-\frac{\partial r_b}{\partial \eta}\right)$ is increasing in φ which is the key to showing that spreading the allocation across all firms receiving market finance is unfavorable to countries with large firm.

δ expands the domain for intermediated finance and overall increases the frictions in investment. In turn because of the substitution effect, consumption increases and aggregate investment decreases. As before the reallocation effects are ambiguous. However the switching effect reinforces the direct effect. The profit of some firms decreases from switching to intermediated finance because the threshold for market finance increases when $\partial\delta < 0$. However, this switching effect is decreasing with the proportion of small firms. Another perspective comes from thinking of decreasing the financial frictions parameter ξ. Intuitively the direct effect of reducing ξ is to increase the profit of firms raising intermediated finance, and this is most favorable to countries with small firms.

When do these indirect effects matter? The importance of these effects depends crucially on the derivatives of the equilibrium consumption on the financing costs $\frac{\partial c}{\partial \eta}$, $\frac{\partial c}{\partial \delta}$ and $\frac{\partial c}{\partial \xi}$. These derivatives are small when the financial frictions ξ are small. Another case is when the elasticity of production α is large or the relative risk aversion γ is small. In that case, from Remark 1, we know that the investment function $c \mapsto K(c)$ has a steep slope and a perturbation on the function K has a small impact on the equilibrium consumption c^e.[29]

V. Robustness of the identification method

This section demonstrates that our main identification is robust to alternative specifications of the structural relation between financing patterns and the firm size distribution. Instead of characterizing financing patterns using the share of market finance in total external finance, we consider the ratio of market finance to intermediated finance. Section V.1 provides some motivation for using the ratio of market finance and derive the condition under which the financing costs can be identified. Section V.2 shows that the empirical results using the ratio of market finance are in line with those of Section III.3.

[29]Since $\frac{\partial c}{\partial \omega} = \frac{\frac{\partial K}{\omega}}{1+\frac{\partial K}{\partial c}}$, $\frac{\partial c}{\partial \omega}$ is small when $\frac{\partial K}{\omega}$ is small (small frictions) or when $\frac{\partial K}{\partial c}$ is large (high elasticity of production or small relative risk-aversion).

V.1. **Identification with the ratio of market finance.** We consider the ratio of market finance to intermediated finance R for industry i:

$$R_i = \frac{\int_{\varphi_M}^{\infty} k(\varphi) f_i(\varphi) d\varphi}{\int_{\varphi_B}^{\varphi_M} k(\varphi) f_i(\varphi) d\varphi} = \frac{\int_{k_M}^{+\infty} k g_i(k) dk}{\int_{k_B}^{k_M} k g(k) dk}$$

where $k_M = k(\varphi_M)$ and $k_B = k(\varphi_B)$. Similarly to what has been done for the share of market finance, we are interested in studying properties of the equilibrium concerning the ratio of market finance R_i.

The motivation for using the ratio of market finance to intermediated finance (instead of the share of market finance) is that any country-bias in the collection of data will be absorbed by the country fixed effects. Indeed, if you suppose for instance that only a proportion ζ_c of intermediated finance is collected in country c, then the difference between the true (log) ratio of market finance and the observed (log) ratio of market finance is exactly $\log \zeta_c$. For the regression

$$\log R_{ij} = [\text{controls}] + \vartheta_j \sigma_{ij} + \epsilon_{ij} \tag{5.1}$$

the estimate of the country-specific slope ϑ_j is not biased. Of course, in order to interpret ϑ_j the same way as we did for θ_i (Section II.1), the model has to yield a monotone relation between the distribution of firm sizes (as ordered by Definition 1) and the derivative of the (log) ratio of market finance to intermediated finance with respect to the financing costs η and δ. Unfortunately, a decrease in the cost of market finance η (or similarly an increase in the cost of intermediated finance δ) has two effects. Not only does it increase the number of firms raising market finance, but it also decreases the number of firm raising intermediated finance. Both effects contribute to decreasing the ratio of market finance but the first effect is bigger when there are large firms and the second is bigger when there are small firms.

We show however the parametrization of Section II.2 have some properties implying that the identification of financing costs from using the ratio of market finance (instead of the share of market finance) is still valid. We start with the exponential parametrization of the firm size distribution:

$$g_i(k) = \tilde{g} \frac{e^{-\frac{1}{n}\left[\frac{1}{\sigma_i} \log\left(\frac{k}{k_B}\right)\right]^n}}{k}$$

for the industry i. Since we parameterize the firm size distribution, we also assume for simplicity that it does not depend on the financing costs. This is the case when there are no frictions ($\xi = 0$).

Proposition 3. *An industry with larger firms raises more market finance:*

$$\sigma_i > \sigma_j \quad \Rightarrow \quad R_i > R_j$$

A country with more efficient financial markets raises more market finance:

$$\frac{\partial \log R_i}{\partial \delta} > 0 \quad \text{and} \quad \frac{\partial \log R_i}{\partial \eta} < 0$$

The ratio of market finance to intermediated finance increases more with the relative efficiency of markets in industries with small firms:

$$\sigma_i > \sigma_j \Rightarrow \begin{cases} \frac{\partial \log R_i}{\partial \delta} < \frac{\partial \log R_j}{\partial \delta} \\ \frac{\partial \log R_i}{\partial \eta} > \frac{\partial \log R_j}{\partial \eta} \end{cases}$$

V.2. **Regression results with the ratio of market finance.** Tables 8 and 9 show the results. As for the share of market finance, we find that the estimated country-specific slope coefficient is much flatter for the UK and Germany than for France, Germany and Spain. Italy has a much larger slope coefficient. These results confirm that the UK and Germany have a low relative cost of market finance and Italy, a high relative cost of market finance, with Spain and France somewhere in between.

VI. Conclusion

In this paper we developed a structural model of financing and investment with an endogenous aggregate supply of capital from a representative investor and an endogenous aggregate demand for capital from a population of entrepreneurs running heterogeneous projects. The model linked the share of market finance in total external finance and the distribution of firm sizes through a structural relation that depends on the technology and on the financial system. We used data on financing patterns and characteristics of the population of firms from France, Germany, Italy, Spain and the United Kingdom to estimate the financing costs that characterize the financial system and found that the United Kingdom has a low cost of market finance (relative to intermediated finance) and Italy has a high relative cost of market finance.

Using the structural model, we then explored the incentives of a central planner who maximizes the sum of the welfare of private agents (entrepreneurs and investors) to modify the financial structure or the technology. We found a complementarity between financial structure and distribution of firm sizes, in the sense that economies with large firms have a higher marginal incentive to decrease the cost of market finance than economies with smaller firms. This was mirrored by the finding that economies with a low relative cost of market finance have a higher incentive to increase the proportion of high productivity firms than economies with a higher relative cost of market finance. This complementarity between financial and distribution of firm sizes provided a preliminary explanation for the negative correlation across countries between the proportion of large firms and the cost of market finance (relative to intermediated finance).

This paper suggests two possible avenues for further research. First the generality and robustness of the identification strategy for estimating the financing costs came from a model with generic correlation across projects and generic utility and production functions. However the ability of the model to produce interesting counterfactual exercises has been limited precisely because we only estimated parts of it. Estimating the full model would allow to provide more precise statements on the optimal financial structure given our stylized welfare measure. Second, the implicit assumption of this paper was that countries are in financial autarky. This is a stark assumption especially for countries in the European Union. Opening international financial trade in such a framework generates diversification gains for the investors and higher investment and profit for some of the entrepreneurs (those with the most productive projects). Further research is necessary to derive precise predictions for the structure of international financial flows and the gains from financial integration.

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APPENDIX A: PROOFS

Lemma 1. In equilibrium, the repayment $r_l^e(p,c)$, the supply of size $k^e(p,c)$, the firm's profit $r_b^e(p,c)$ and the total production $r^e(p,c)$ are increasing functions of the probability of production p and the equilibrium consumption c.

Proof. Denote $r(r_l,p) \equiv r[\tilde{k}(r_l,p)] = r\left[\frac{\beta p}{\lambda} r_l u'(r_l)\right]$. Because $r(r_l,p)$ is concave in r_l (Assumption 2), the function $r_l \mapsto \frac{\partial r(r_l,p)}{\partial r_l}$ is decreasing in r_l. It is also increasing in p (since the revenue function has at least positive returns to scale, ie. $k \mapsto kr'(k)$ is increasing). Therefore $p \mapsto r_l^e(p)$ is increasing.

Given $r_l^e(\overset{+}{p})$ and $\tilde{k}(\overset{+}{r_l},\overset{+}{p})$, we get $k^e(\overset{+}{p})$. Moreover, by the envelope theorem, $\frac{\partial(r[k^e(p)]-r_l[k^e(p),p])}{\partial p} = -\frac{\partial r_l[k^e(p),p]}{\partial p} > 0$, so $r_b^e(\overset{+}{p})$. Finally $r^e(p) = r_b^e(p) + r_l^e(p)$ is also increasing in p. □

Lemma 2. The aggregate investment function $K(c)$ is increasing in c.

Proof. Since r_b^* is a increasing function of c, then for all φ, $1_{\{r_b^*(\varphi,c)\}}$ is also a increasing function of c, and finally also $K(\overset{+}{c})$. □

Lemma 3. An industry with larger firms raises more market finance:

$$f_i \succ f_j \Leftrightarrow g_i \succ g_j \quad \Rightarrow \quad S_i > S_j$$

Proof. From the definition we have for $u > v$, $f_i(u)f_j(v) \geq f_i(v)f_j(u)$. This implies that:

$$\int_{\varphi_B}^{\varphi_M} k^e(v)f_j(v)dv \int_{\varphi_M}^{\infty} k^e(u)f_i(u)du > \int_{\varphi_B}^{\varphi_M} k^e(v)f_i(v)dv \int_{\varphi_M}^{\infty} k^e(u)f_j(u)du$$

After rearranging the terms, we find $S_i > S_j$. □

Proposition 1. A country with more efficient financial markets raises more market finance:

$$\omega \in \{\delta, \eta^{-1}\}, \forall i : \qquad \frac{\partial \log S_i}{\partial \omega} > 0$$

Monotone sensitivity property: The share of market finance increases more with the relative efficiency of markets in industries with small firms:

$$\omega \in \{\delta, \eta^{-1}\} \qquad f_i \succ f_j \Leftrightarrow g_i \succ g_j \Rightarrow \frac{\partial \log S_i}{\partial \omega} < \frac{\partial \log S_j}{\partial \omega} \tag{A.1}$$

Proof. We look separately at the cases with and without financial frictions.

Case $\xi = 0$. Since there is no friction and for any $\omega \in \{\delta, \eta^{-1}\}$, $\frac{\partial \varphi_M}{\partial \omega} \leq 0$, we have:

$$\frac{\partial \log S_i}{\partial \omega} = \frac{k(\varphi_M)f(\varphi_M)}{\int_{\varphi_M}^{+\infty} kf}\left(-\frac{\partial \varphi_M}{\partial \omega}\right) \geq 0$$

From the definition, we have for $u > v$, $f_i(u)f_j(v) \geq f_i(v)f_j(u)$. This implies that $k(\varphi_M)f_i(\varphi_M)\int_{\varphi_M}^{+\infty} kf_j \leq k(\varphi_M)f_j(\varphi_M)\int_{\varphi_M}^{\infty} kf_i$.

Case $\xi > 0$. The aggregate investment is: $K(c) = \int_{\varphi_B}^{+\infty} k^e(\varphi, c)f(\varphi)d\varphi$. Because of frictions ($\xi > 0$), the investment function $k^e(\varphi, c)$ is discontinuous at φ_M. It is only because of the frictions that in turn $K(c)$ depends on φ_M:

$$\frac{\partial K(c)}{\partial \varphi_M} = f(\varphi_M)[k^e(\varphi_M^+, c) - k^e(\varphi_M^-, c)]f(\varphi_M) > 0$$

Moreover, φ_M depends on the relative costs of finance η, δ. So with frictions, $K(c)$ depends on $\omega \in \{\delta, \eta^{-1}\}$. Differentiating the equilibrium budget constraint $c + K(c) = Y$, we have:

$$dc\left[1+\frac{\partial K}{\partial c}\right]+d\omega\frac{\partial K}{\partial \omega}=0$$

Denote $K_M(c) = \int_{\varphi_M}^{+\infty} k^e(\varphi, c) f(\varphi) d\varphi$. Since $S = K_M/K$, we have:

$$\begin{aligned}
\frac{\partial \log S}{\partial \omega} &= \left[\frac{1}{K_M}\frac{\partial K_M}{\partial \omega}-\frac{1}{K}\frac{\partial K}{\partial \omega}\right]+\frac{dc}{d\omega}\left[\frac{1}{K_M}\frac{\partial K_M}{\partial c}-\frac{1}{K}\frac{\partial K}{\partial c}\right]\\
&= \left[\frac{1}{K_M}\frac{\partial K_M}{\partial \omega}-\frac{1}{K}\frac{\partial K}{\partial \omega}\right]-\frac{\frac{\partial K}{\partial \omega}}{1+\frac{\partial K}{\partial c}}\left[\frac{1}{K_M}\frac{\partial K_M}{\partial c}-\frac{1}{K}\frac{\partial K}{\partial c}\right]\\
&= \frac{1}{K_M}\frac{\partial K_M}{\partial \omega}-\frac{\frac{\partial K}{\partial \omega}}{1+\frac{\partial K}{\partial c}}\left[\frac{1}{K_M}\frac{\partial K_M}{\partial c}+\frac{1}{K}\right]\\
&= \frac{1}{1+\frac{\partial K}{\partial c}}\left(\frac{1}{K_M}\frac{\partial K_M}{\partial \omega}\left[1+\frac{\partial K}{\partial c}\right]-\frac{\partial K}{\partial \omega}\left[\frac{1}{K_M}\frac{\partial K_M}{\partial c}+\frac{1}{K}\right]\right)\\
&= \frac{1}{1+\frac{\partial K}{\partial c}}\left(\frac{1}{K_M}\frac{\partial K_M}{\partial \omega}-\frac{1}{K}\frac{\partial K}{\partial \omega}+\frac{1}{K_M}\left[\frac{\partial K_M}{\partial \omega}\frac{\partial K}{\partial c}-\frac{\partial K}{\partial \omega}\frac{\partial K_M}{\partial c}\right]\right)
\end{aligned}$$

We have:

$$\begin{aligned}
\frac{1}{K_M}\frac{\partial K_M}{\partial \omega}-\frac{1}{K}\frac{\partial K}{\partial \omega} &= \frac{\left(-\frac{\partial \varphi_M}{\partial \omega}f(\varphi_M)\right)\left(k^e(\varphi_M^+,c)K-[k^e(\varphi_M^+,c)-k^e(\varphi_M^-,c)]K_M\right)}{K_M K}\\
&= \frac{\left(-\frac{\partial \varphi_M}{\partial \omega}f(\varphi_M)\right)\left(k^e(\varphi_M^+,c)\int_{\varphi_B}^{\varphi_M}\frac{k^e(\cdot,c)}{K}f+k^e(\varphi_M^-,c)\int_{\varphi_M}^{\infty}\frac{k^e(\cdot,c)}{K}f\right)}{K_M}
\end{aligned}$$

Similarly,

$$\frac{1}{K_M}\left[\frac{\partial K_M}{\partial \omega}\frac{\partial K}{\partial c}-\frac{\partial K}{\partial \omega}\frac{\partial K_M}{\partial c}\right] = \frac{\left(-\frac{\partial \varphi_M}{\partial \omega}f(\varphi_M)\right)\left(k^e(\varphi_M^+,c)\int_{\varphi_B}^{\varphi_M}\frac{\partial k^e(\cdot,c)}{\partial c}f+k^e(\varphi_M^-,c)\int_{\varphi_M}^{\infty}\frac{\partial k^e(\cdot,c)}{\partial c}f\right)}{K_M}$$

Moreover,

$$1+\frac{\partial K}{\partial c}=\int_{\varphi_B}^{\infty}\left[\frac{k^e(\cdot,c)}{K}+\frac{\partial k^e(\cdot,c)}{\partial c}\right]f$$

$$\frac{\partial \log S}{\partial \omega} = \left[-\frac{\frac{\partial \varphi_M}{\partial \omega}k^e(\varphi_M^+,c)f(\varphi_M)}{K_M}\right]\Delta_{GE} \tag{A.2}$$

where

$$\Delta_{GE}=\left[\frac{\int_{\varphi_B}^{\varphi_M}\left[\frac{k^e(\cdot,c)}{K}+\frac{\partial k^e(\cdot,c)}{\partial c}\right]f+\frac{k^e(\varphi_M^-,c)}{k^e(\varphi_M^+,c)}\int_{\varphi_M}^{\infty}\left[\frac{k^e(\cdot,c)}{K}+\frac{\partial k^e(\cdot,c)}{\partial c}\right]f}{\int_{\varphi_B}^{\infty}\left[\frac{k^e(\cdot,c)}{K}+\frac{\partial k^e(\cdot,c)}{\partial c}\right]f}\right]$$

The first term $\left[-\frac{\frac{\partial \varphi_M}{\partial \omega}k^e(\varphi_M^+,c)f(\varphi_M)}{K_M}\right]$ is the derivative without the general equilibrium effect. The term Δ_{GE} is the adjustment due to the general equilibrium effect that goes through the discontinuity of $k^e(\cdot,c)$ in φ_M. If there is no frictions ($\xi = 0$), $k^e(\varphi_M^-,c) = k^e(\varphi_M^+,c)$ and Δ_{GE} is equal to 1. Otherwise, $\Delta_{GE} < 1$. The equation (A.2) shows that $\frac{\partial \log S}{\partial \omega} > 0$.

We turn to the monotone sensitivity property. We assume $f_i \succ f_j$ and denote Δ^i_{GE} and Δ^i_{GE} the expressions associated to f_i and f_j. After introducing $h = \left[\frac{k^e(\cdot,c)}{K} + \frac{\partial k^e(\cdot,c)}{\partial c}\right]$, the sign of $\Delta^i_{GE} - \Delta^j_{GE}$ depends on:

$$\begin{aligned} INT &= \left(\int_{\varphi_B}^{\varphi_M} hf_i + \frac{k^e(\varphi_M^-,c)}{k^e(\varphi_M^+,c)}\int_{\varphi_M}^{\infty} hf_i\right)\left(\int_{\varphi_B}^{\infty} hf_j\right) - \left(\int_{\varphi_B}^{\varphi_M} hf_j + \frac{k^e(\varphi_M^-,c)}{k^e(\varphi_M^+,c)}\int_{\varphi_M}^{\infty} hf_j\right)\left(\int_{\varphi_B}^{\infty} hf_i\right) \\ &= \left(1 - \frac{k^e(\varphi_M^-,c)}{k^e(\varphi_M^+,c)}\right)\left(\int_{\varphi_M}^{\infty} hf_j \int_{\varphi_B}^{\varphi_M} hf_i - \int_{\varphi_M}^{\infty} hf_i \int_{\varphi_B}^{\varphi_M} hf_j\right) \\ &= \left(1 - \frac{k^e(\varphi_M^-,c)}{k^e(\varphi_M^+,c)}\right)\left(\int_{u=\varphi_B}^{\varphi_M}\int_{v=\varphi_M}^{\infty} h(u)h(v)\underbrace{[f_i(u)f_j(v) - f_j(v)f_i(u)]}_{<0} dudv\right) \end{aligned}$$

where $\forall u \leq \varphi_M \leq v$, $f_i \succ f_j$ implies that $f_i(u)f_j(v) - f_j(v)f_i(u) < 0$. Therefore

$$\Delta^i_{GE} < \Delta^j_{GE}$$

and the general equilibrium effect amplifies the monotone sensitivity property. □

Lemma 5. The adjustment due to the first stage is approximately $\frac{1}{I}\sum_i \sqrt{\frac{I}{N_i}}$.

Proof. Data in one country $\{S_i, x_{ni} : i \in [1,I], n \in [1,N_i]\}$. Denote $N = \sum N_i$ and $n_i = \frac{N_i}{N}$. In the first stage, we estimate σ_i by maximum likelihood using the AEP distribution. We then have $\hat{\sigma}_i \to_p \sigma_i^0$. In the second stage we regress the log of the share of market finance $\log S_i$ on $\hat{\sigma}_i$ using for instance ordinary-least squares (OLS). Denote s the score of the second stage. We are interested in the adjustment to the asymptotic distribution due to the first-stage. Assume I and N go to ∞, while n_i stays constant. We have:

$$\begin{aligned} \sqrt{I}(\hat{v} - v_0) &= -A_0^{-1}\left[\frac{1}{\sqrt{I}}\sum_i s(v_0,\hat{\sigma}_i)\right] \\ &= -A_0^{-1}\left[\frac{1}{\sqrt{I}}\sum_i s(v_0,\sigma_i^0) + \frac{1}{I}\sum_i \sqrt{\frac{I}{N_i}}\frac{\partial s(v_0,\sigma_i^0)}{\partial \sigma_i}\sqrt{N_i}(\hat{\sigma}_i - \sigma_i^0)\right] \end{aligned}$$

where $A_0 = E[H(v_0,\sigma_i^0)]$ is the expectation of the Hessian of the second stage. $\sqrt{N_i}(\hat{\sigma}_i - \sigma_i^0)$ converges to a Normal distribution with mean 0 from the first stage. So the adjustment due to the first stage is approximately $\frac{1}{I}\sum_i \sqrt{\frac{I}{N_i}}$. □

Proposition 2.When there are no financial frictions, financial systems with large firms have a marginal incentives to decrease the fixed cost of finance η while financial systems with small firms have a marginal incentives to decrease the proportional cost of intermediated finance δ, ie. for two countries c and d:

$$f_c \succ f_d \quad \Rightarrow \quad \left.\frac{\frac{\partial W}{\partial \eta}}{\frac{\partial W}{\partial \delta}}\right|_c > \left.\frac{\frac{\partial W}{\partial \eta}}{\frac{\partial W}{\partial \delta}}\right|_d$$

Proof. First, if there is not financial frictions, then the welfare of the investors U is independent of financing fees. It sufficient to look at the welfare of entrepreneur V. Denote $\hat{r}(\varphi) = r^e(\varphi) - r^e_l(\varphi) > 0$ the equilibrium pre-financing fees profit. Then

$$V = (1-\delta)\int_{\varphi_B}^{\varphi_M} p(\varphi)\hat{r}(\varphi)f(\varphi)d\varphi + \int_{\varphi_M}^{+\infty} p(\varphi)[\hat{r}(\varphi) - \eta]f(\varphi)d\varphi$$

Then

$$\frac{\frac{\partial V}{\partial \delta}}{\frac{\partial V}{\partial \eta}} = \frac{\int_{\varphi_B}^{\varphi_M} p(\varphi)\hat{r}(\varphi)f(\varphi)d\varphi}{\int_{\varphi_M}^{\infty} p(\varphi)f(\varphi)d\varphi}$$

For two countries c and d with productivity distributions f_c and f_d we are interested in the signs of:

$$\begin{aligned} INT &= \int_{\varphi_B}^{\varphi_M} p(\varphi)\hat{r}(\varphi)f_c(\varphi)d\varphi \int_{\varphi_M}^{\infty} p(\varphi)f_d(\varphi)d\varphi - ... \\ &\quad ... - \int_{\varphi_B}^{\varphi_M} p(\varphi)\hat{r}(\varphi)f_d(\varphi)d\varphi \int_{\varphi_M}^{\infty} p(\varphi)f_c(\varphi)d\varphi \\ &= \int_{u=\varphi_B}^{\varphi_M}\int_{v=\varphi_M}^{\infty} \hat{r}(u)p(u)p(v)[f_c(u)f_d(v) - f_d(u)f_c(v)]dudv \end{aligned}$$

If $f_c \succ f_d$, then for $u < v$, $f_c(u)f_d(v) - f_d(u)f_c(v) < 0$, and since $\hat{r}(\varphi) > 0$, this yields the result. □

Proposition 3 An industry with larger firms raises more market finance:

$$\sigma_i > \sigma_j \quad \Rightarrow \quad R_i > R_j$$

A country with more efficient financial markets raises more market finance:

$$\frac{\partial \log R_i}{\partial \delta} > 0 \quad \text{and} \quad \frac{\partial \log R_i}{\partial \eta} < 0$$

The ratio of market finance to intermediated finance increases more with the relative efficiency of markets in industries with small firms:

$$\sigma_i > \sigma_j \Rightarrow \begin{cases} \frac{\partial \log R_i}{\partial \delta} < \frac{\partial \log R_j}{\partial \delta} \\ \frac{\partial \log R_i}{\partial \eta} > \frac{\partial \log R_j}{\partial \eta} \end{cases}$$

Proof. We only consider the case without financial frictions (Case $\xi = 0$). Since there is no friction and for any $\omega \in \{\delta, \eta^{-1}\}$, $\frac{\partial k_M}{\partial \omega} \leq 0$, we have:

$$\frac{\partial \log R_i}{\partial \omega} = \left[\underbrace{\frac{k_M g(k_M)}{\int_{k_M}^{+\infty} kg(k)dk}}_{(1)} + \underbrace{\frac{k_M g(k_M)}{\int_{k_B}^{k_M} kg(k)}}_{(2)} \right] \left(-\frac{\partial k_M}{\partial \omega} \right) \geq 0 \tag{A.3}$$

The essential difference is that an increase in the relative market efficiency parameter ω has two effects formalized by the terms (1) and (2) in equation (A.3). The term (1) is the same term as in the share of market finance and it means that an increase in ω increase the proportion of firms raising market finance. This term is "decreasing" in the sense that industries with larger firms have a smaller increase in market finance due to term (1). The second term (2) is a new term and is related to the fact that as ω increases, the proportion of firms raising intermediated finance decreases. This term is "increasing" in the sense that industries with larger firms have a bigger decrease in intermediated finance due to term (2). Therefore, the contributions of the terms (1) and (2) go in opposite directions as functions of the distribution g.

To study this problem, we introduce:

$$H(a, b, g) = \frac{ag(a)}{\int_a^b kg(k)dk}$$

We have:

$$\frac{\partial \log R_i}{\partial \omega} = [H(k_M, +\infty, g_i) - H(k_M, k_B, g_i)] \left(-\frac{\partial k_M}{\partial \omega} \right)$$

It is therefore sufficient to study how the function $\frac{\partial H(a,b,g)}{\partial b}$ depends on f. For $\frac{\log R}{\partial \omega}$ decreasing in g, it is sufficient to have:

$$\frac{\partial H(a, b, g)}{\partial b} = -\frac{abg(a)g(b)}{\left[\int_a^b kg(k)dk\right]^2} \text{ decreasing in } g$$

which in turn is equivalent to:

$$\frac{1}{2} \left[\frac{g_\sigma(a)}{g(a)} + \frac{g_\sigma(b)}{g(b)} \right] - \frac{\int_a^b kg_\sigma(k)dk}{\int_a^b kg(k)dk} \geq 0 \tag{A.4}$$

where $g_\sigma = \frac{\partial g}{\partial \sigma}$. We introduce $K(x) = \int^x kg(k)dk$ and $l(x) = \frac{g_\sigma[K^{-1}(k)]}{f[K^{-1}(k)]}$ and and rewrite equation (A.4):

$$\frac{1}{2}[l[K(a)] + l[K(b)] - \frac{\int_{K(a)}^{K(b)} l(x)dx}{K(b) - K(a)} \geq 0 \tag{A.5}$$

It is clear that inequality (A.5) holds for any a and b if and only if l is convex. We now show that the exponential power parametrization of g implies that l is convex. The convexity of l is determined by the sign of:

$$(K^{-1})''\left(\frac{g_\sigma}{f}\right)' + \left[(K^{-1})'\right]^2\left(\frac{g_\sigma}{f}\right)'' = \left(\frac{g_\sigma}{g}\right)'\left[\frac{\frac{\left(\frac{g_\sigma}{g}\right)''}{\left(\frac{g_\sigma}{g}\right)'} - \frac{K''}{K'}}{[K']^2}\right]$$

So l is convex if and only if the function $\left(\frac{\left(\frac{g_\sigma}{g}\right)'}{K'}\right) = \left(\frac{\left(\frac{g_\sigma}{g}\right)'}{kf}\right)$ is increasing. Moreover for the exponential power parametrization we have:

$$\log\left(\frac{\left(\frac{g_\sigma}{g}\right)'}{kf}\right) = [\text{constant}] + \frac{1}{n\sigma}\left(\log\frac{k}{k_B}\right)^n + n\log\frac{k}{k_B}$$

which is indeed an increasing function. □

Appendix B: General specification of the financing cost structure

In this section, we consider more general functional forms for the choice between public and private securities. It now depends on payment structures that involve the (deadweight) costs $\kappa^M(\pi, r_l, \varphi)$ and $\kappa^B(\pi, r_l, \varphi)$, where r_l is the repayment to the investor and $\pi = r(k) - r_l$ is the surplus generated by production. We only assume that market finance involves a higher fixed cost component than intermediated finance and intermediated finance involves a higher proportional cost component:

$$\kappa^M(0,0,\varphi_0) > 0; \qquad \kappa^M_\pi(\pi, r_l, \varphi) \approx \kappa^M_{r_l}(\pi, r_l, \varphi) \approx \kappa^M_\varphi(\pi, r_l, \varphi) \approx 0 \tag{B.1}$$

and

$$\begin{array}{ll} \kappa^B(0,0,\varphi_0) \approx 0; & \kappa^B_\pi(\pi, r_l, \varphi) > 0 \\ \kappa^B_{r_l}(\pi, r_l, \varphi) > 0; & \kappa^B_\varphi(\pi, r_l, \varphi) < 0 \end{array} \tag{B.2}$$

where by notation, for any y, $\kappa_y = \frac{\partial \kappa}{\partial y}$. The investment size depends on the maximization:

$$r_b = \begin{cases} \max_k \pi - \kappa^B[\pi, \tilde{r}_l(k|\varphi, c), \varphi] & \text{if intermediated finance} \\ \max_k \pi - \kappa^M[\pi, \tilde{r}_l(k|\varphi, c), \varphi] & \text{if market finance} \end{cases}$$

where $\pi = r(k) - \tilde{r}_l(k|\varphi, c)$. The first-order condition is:

$$\frac{\partial \pi}{\partial k}(1 - \kappa_\pi) - \frac{\partial \tilde{r}_l}{\partial k}\kappa_{r_l} = 0 \tag{B.3}$$

Equation (B.3) implies that there is underinvestment whenever $\kappa_{r_l} > 0$. When $\kappa_{r_l} = 0$, the first-best level of investment is set such that $\frac{\partial \pi}{\partial k} = 0$ and does not depend on which financial instrument is being used. The profit of the firm r_b determines the choice of instrument. Using the first-order condition in equation (B.3) and the investment function $\tilde{k}(r_l|\varphi, c)$, we have:

$$\frac{\partial r_b}{\partial \varphi} = \left[\frac{\frac{\partial \tilde{k}}{\partial \varphi}}{\frac{\partial \tilde{k}}{\partial r_l}} \right] (1 - \kappa_\pi - \kappa_{r_l}) - \kappa_\varphi \tag{B.4}$$

Equation (B.4) has several important implications. Whenever the values of the derivatives κ_π, κ_{r_l} and κ_φ are small enough, the profit r_b is increasing in φ. Moreover, under the assumptions of equations (B.1-B.2), when κ_φ is small, the profit of the entrepreneur is increasing more with the type φ when he uses market finance instead of intermediated finance. Finally, assuming that the fixed cost component of market finance is larger than that of intermediated finance ($\kappa^M(0, 0, \varphi_0) > \kappa^B(0, 0, \varphi_0)$), there exists a threshold φ_M at which firms switch from intermediated to market finance and this threshold is unique.

Table 1.

Number of issuance deals and matched industries per country.. The data on the share of market finance comes from SDC Platinum New Issues Database (years 1990-2005). The data on the distribution of firm sizes comes from Amadeus (year 2003).

Size proxy	Deals	Total assets	Operating revenues
France	2502	39	39
Germany	1680		32
Italy	700	17	17
Spain	772	19	19
United Kingdom	7415	47	
Total	13069	122	107

Table 2.

Scale parameters per country. This table describes the scale parameters for the Asymmetric-Laplace (AL) and Asymmetric Normal (AN) distributions. The standard deviation is in parenthesis.

	Total assets			Operating revenues		
Country name	N	σ^{AL}	σ^{AN}	N	σ^{AL}	σ^{AN}
France	679666	1.616	2.186	649021	1.494	1.964
		(0.002)	(0.004)		(0.002)	(0.004)
Germany				460710	1.491	1.854
					(0.003)	(0.004)
Italy	212010	1.347	1.691	209737	1.238	1.513
		(0.004)	(0.006)		(0.003)	(0.005)
Spain	540493	1.460	1.907	501914	1.334	1.725
		(0.003)	(0.004)		(0.003)	(0.004)
United Kingdom	952151	1.762	2.304			
		(0.003)	(0.005)			

Table 3.

Index for the econometric adjustment due to first stage estimation.. This table shows an index that relates the number of observations of firm sizes in each industry to the number of industries in a country. The data on the share of market finance comes from SDC Platinum New Issues Database (years 1990-2005). The data on the distribution of firm sizes comes from Amadeus (year 2003).

Size proxy	Total assets	Total assets
France	.180	.184
Germany		.133
Italy	.087	.087
Spain	.056	.058
United Kingdom	.170	

Table 4.

Share of market finance regressions: Total Assets. We relate the share of market finance S_{ic} for industry i, country c to the the scale parameter σ_{ic} of the distribution of firm sizes (size variable: total assets). Data: SDC Platinum New Issues Database (years 1990-2005), Amadeus (year 2003). The t-statistics are indicated (robust errors).

Dependent variable	(Log) Share of market finance			
Model	Asymmetric log-Laplace		Asymmetric log-Normal	
	(1)	(2)	(3)	(4)
θ_0	.518		.462	
	(4.42)		(4.82)	
θ_{FRA}		.687		.538
		(3.01)		(3.06)
θ_{ITA}		.657		.521
		(3.79)		(3.99)
θ_{SPA}		.711		.643
		(4.42)		(4.00)
θ_{UK}		.358		.358
		(1.94)		(2.27)
Country dummies	yes	yes	yes	yes
Industry dummies	no	no	no	no
N	122	122	122	122
R^2	.208	.205	.243	.234

Table 5.

Share of market finance regressions: Operating revenues. We relate the share of market finance S_{ic} for industry i, country c to the the scale parameter σ_{ic} of the distribution of firm sizes (size variable: total assets). Data: SDC Platinum New Issues Database (years 1990-2005), Amadeus (year 2003). The t-statistics are indicated (robust errors).

Dependent variable	(Log) Share of market finance			
Model	Asymmetric log-Laplace		Asymmetric log-Normal	
	(5)	(6)	(7)	(8)
θ_0	.592		.456	
	(5.57)		(5.38)	
θ_{FRA}		.682		.518
		(3.62)		(3.36)
θ_{GER}		.329		.271
		(2.13)		(2.25)
θ_{ITA}		.741		.642
		(2.04)		(3.25)
θ_{SPA}		.704		.548
		(4.39)		(4.53)
Country dummies	yes	yes	yes	yes
Industry dummies	no	no	no	no
N	107	107	107	107
R^2	.174	.16	.178	.164

Table 6.

Robustness check. Share of market finance regressions with industry controls: Total Assets. We relate the share of market finance S_{ic} for industry i, country c to the the scale parameter σ_{ic} of the distribution of firm sizes (size variable: total assets). Data: SDC Platinum New Issues Database (years 1990-2005), Amadeus (year 2003). The t-statistics are indicated (robust errors).

Dependent variable	(Log) Share of market finance			
Model	Asymmetric log-Laplace		Asymmetric log-Normal	
	(1)	(2)	(3)	(4)
θ_0	.342		.342	
	(2.02)		(2.31)	
θ_{FRA}		.367		.308
		(1.84)		(2.05)
θ_{ITA}		.58		.545
		(1.67)		(2.19)
θ_{SPA}		.576		.562
		(2.42)		(2.66)
θ_{UK}		.213		.253
		(1.31)		(1.74)
Country dummies	yes	yes	yes	yes
Industry dummies	yes	yes	yes	yes
N	122	122	122	122
R^2	.441	.433	.452	.445

Table 7.

Robustness check. Share of market finance regressions with industry controls: Operating revenues. We relate the share of market finance S_{ic} for industry i, country c to the the scale parameter σ_{ic} of the distribution of firm sizes (size variable: total assets). Data: SDC Platinum New Issues Database (years 1990-2005), Amadeus (year 2003). The t-statistics are indicated (robust errors).

Dependent variable	(Log) Share of market finance			
Model	Asymmetric log-Laplace		Asymmetric log-Normal	
	(1)	(2)	(3)	(4)
θ_0	.417		.373	
	(1.91)		(1.74)	
θ_{FRA}		.182		.203
		(0.85)		(1.02)
θ_{GER}		.409		.431
		(1.81)		(1.70)
θ_{ITA}		1.087		.901
		(1.98)		(2.20)
θ_{SPA}		.618		.497
		(2.17)		(2.20)
Country dummies	yes	yes	yes	yes
Industry dummies	yes	yes	yes	yes
N	107	107	107	107
R^2	.293	.282	.292	.28

Table 8.

Ratio of market finance regressions: Total Assets. We relate the ratio of market finance R_{ic} for industry i, country c to the the scale parameter σ_{ic} of the distribution of firm sizes (size variable: total assets). Data: SDC Platinum New Issues Database (years 1990-2005), Amadeus (year 2003). The t-statistics are indicated (robust errors).

Dependent variable	(Log) Ratio of market finance			
Model	Asymmetric log-Laplace		Asymmetric log-Normal	
	(1)	(2)	(3)	(4)
ϑ_0	1.250		1.097	
	(4.47)		(4.75)	
ϑ_{FRA}		1.822		1.388
		(2.91)		(2.85)
ϑ_{ITA}		2.386		1.846
		(4.17)		(3.99)
ϑ_{SPA}		1.298		1.166
		(4.41)		(3.84)
ϑ_{UK}		0.797		0.750
		(1.97)		(2.18)
Country dummies	yes	yes	yes	yes
Industry dummies	no	no	no	no
N	122	122	122	122
R^2	0.234	0.248	0.267	0.273

Table 9.

Ratio of market finance regressions: Operating revenues. We relate the ratio of market finance R_{ic} for industry i, country c to the the scale parameter σ_{ic} of the distribution of firm sizes (size variable: total assets). Data: SDC Platinum New Issues Database (years 1990-2005), Amadeus (year 2003). The t-statistics are indicated (robust errors).

Dependent variable	(Log) Ratio of market finance			
Model	Asymmetric log-Laplace		Asymmetric log-Normal	
	(5)	(6)	(7)	(8)
ϑ_0	1.419		1.090	
	(4.70)		(4.65)	
ϑ_{FRA}		1.772		1.333
		(3.12)		(2.94)
ϑ_{GER}		0.601		0.479
		(2.22)		(2.32)
ϑ_{ITA}		2.857		2.505
		(2.35)		(3.98)
ϑ_{SPA}		1.286		1.020
		(4.53)		(4.79)
Country dummies	yes	yes	yes	yes
Industry dummies	no	no	no	no
N	107	107	107	107
R^2	0.229	0.238	0.233	0.251

Table 10.

Robustness check. Ratio of market finance regressions with industry controls: Total Assets. We relate the ratio of market finance R_{ic} for industry i, country c to the the scale parameter σ_{ic} of the distribution of firm sizes (size variable: total assets). Data: SDC Platinum New Issues Database (years 1990-2005), Amadeus (year 2003). The t-statistics are indicated (robust errors).

Dependent variable	(Log) Ratio of market finance			
Model	Asymmetric log-Laplace		Asymmetric log-Normal	
	(1)	(2)	(3)	(4)
ϑ_0	0.769		0.766	
	(2.14)		(2.54)	
ϑ_{FRA}		0.970		0.741
		(2.36)		(2.53)
ϑ_{ITA}		2.043		1.760
		(2.83)		(3.24)
ϑ_{SPA}		0.940		0.838
		(1.88)		(1.78)
ϑ_{UK}		0.410		0.448
		(1.26)		(1.63)
Country dummies	yes	yes	yes	yes
Industry dummies	yes	yes	yes	yes
N	122	122	122	122
R^2	0.528	0.537	0.538	0.551

Table 11.

Robustness check. Ratio of market finance regressions with industry controls: Operating revenues. We relate the ratio of market finance R_{ic} for industry i, country c to the the scale parameter σ_{ic} of the distribution of firm sizes (size variable: total assets). Data: SDC Platinum New Issues Database (years 1990-2005), Amadeus (year 2003). The t-statistics are indicated (robust errors).

Dependent variable	(Log) Ratio of market finance			
Model	Asymmetric log-Laplace		Asymmetric log-Normal	
	(1)	(2)	(3)	(4)
ϑ_0	0.980		0.976	
	(1.93)		(2.11)	
ϑ_{FRA}		0.712		0.708
		(1.48)		(1.64)
ϑ_{GER}		0.636		0.855
		(1.23)		(1.82)
ϑ_{ITA}		3.358		2.973
		(2.61)		(3.59)
ϑ_{SPA}		1.131		0.990
		(2.03)		(2.30)
Country dummies	yes	yes	yes	yes
Industry dummies	yes	yes	yes	yes
N	107	107	107	107
R^2	0.390	0.404	0.397	0.418

FIGURE 3.

Fit of firm size distribution: an example. This figure describes the distribution of the size proxy "Operating revenue" for the industry "Building/Construction & Engineering" in Germany as fit by a (log) Asymmetric Laplace and (log) Asymmetric Normal parameterizations. Each parametrization fits the distribution with three parameters (one location parameter and two scale parameters). The log-likelihood is -1.654 for the (log) Laplace and -1.662 for the (log) Normal.

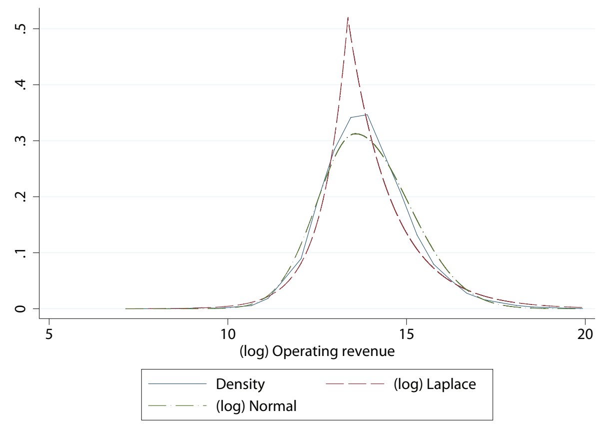
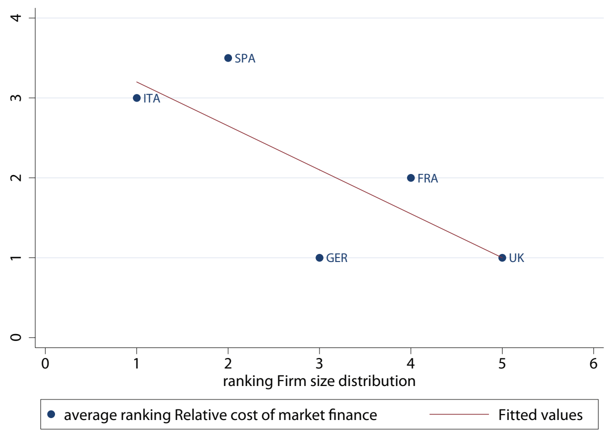


FIGURE 4.

The relation between financial structure and firm size distribution. This figure plots at the country level the average rankings of the estimated relative cost of market finance against the ranking of the estimated scale parameter of the firm size distributions.



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