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Vesa Kanniainen – Mikko Leppämäki
Research Department
12.3.2002

Financial institutions and the allocation of talent

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Financial institutions and the allocation of talent

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Abstract

The paper shows that uninformed finance gives rise to excessive entry, both in human-capital-intensive and in conventional industries when the financial institutions cannot identify the entrepreneurial talent. Introduction of informed capital (eg venture capital finance) with superior screening ability results in an institutional equilibrium with efficiency gains in human-capital industries. Contrary to received wisdom, the institutional equilibrium with informed capital is characterised by more limited entry to an industry, which requires highly talented human capital. Unexpectedly, the total welfare effect is ambiguous, as the allocation of non-informed capital is now less efficient in the conventional industry. The institutional equilibrium is shaped by investors' risk preferences, costs of establishing uninformed and informed capital, and the initial distribution ot talent in the economy.

Key words: allocation of talent, asymmetric information, financial institutions, venture capital, institutional equilibrium

JEL classification numbers: D82, G2, G24

Rahoitusinstituutiot ja kyvykkyyden jakautuminen taloudessa

Suomen Pankin keskustelualoitteita 5/2002

Vesa Kanniainen – Mikko Leppämäki
Tutkimusosasto

Tiivistelmä

Tämä tutkimus osoittaa, että ei-informoitu rahoitus johtaa ylisuureen markkinoilletuloon sekä inhimillistä pääomaa vaativalla että perinteisemmällä toimialalla, kun rahoitusinstituutiot eivät pysty identifioimaan potentiaalisen yrittäjän kyvykkyyttä. Kyvykkyyttä erottelemaan pystyvän informoidun pääoman (esim. venture capital -rahoitus) syntyminen johtaa institutionaalisen tasapainoon, jossa talouden tehokkuus inhimillistä pääomaa vaativalla sektorilla kasvaa. Päinvastoin kuin tavallisesti ajatellaan, informoidun rahoituksen syntyminen rajoittaa markkinoilletuloa tällaisella sektorilla. Hyvinvoinnin kokonaisvaikutukset ovat kuitenkin yllättäen epäselvät, koska ei-informoidun pääoman allokoituminen tulee samalla tehottomammaksi perinteisellä toimialalla. Institutionaalinen tasapaino määräytyy investoijien riskipreferensseistä, informoidun ja ei-informoidun pääoman kustannuksista ja talouden kyvykkyysjakaumasta.

Asiasanat: kyvykkyyden jakautuminen, epäsymmetrinen informaatio, rahoitusinstituutiot, riskirahoitus, institutionaalinen tasapaino

JEL-luokittelu: D82, G2, G24

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1 Introduction

It is essential for allocational efficiency that people get allocated to right occupations. Matching between tasks and talents is a challenging problem not only within any organization but in the society more generally. An occupational choice means a long-term commitment, requires costly investments and is typically accomplished under imperfect information.

How do people then choose their occupations? Some occupations or careers are inherited, not necessarily in terms of wealth but rather by culture, say the social habits within families or dynasties. One if not the most important task of the long educational process of new generations is perhaps not to teach them skills but instead to reveal and help them to learning where their special abilities are, or where each should specialize.[1] There is a third mechanism, ie the financial system, which allocates people with different talents to various occupations.

The current paper addresses this last point by raising two fundamental questions. It first asks how people with different talents get allocated to various occupations or projects in an economy under different financial institutions. It then raises the second question of what determines the scope of these institutions, the institutional equilibrium, to match with these projects. Our main argument is that the structure of financial institutions has a fundamental role in the efficient allocation of talent in the economy.

In order to show this we develop a model with existing financial institutions and examine the allocation of talent into different occupations in the economy under asymmetric information. To capture the effects of informational constraints (private information of a agent's talent) on the terms of project funding, our paper builds on the work by De Meza and Webb (1997) approach of financing projects with an unknown ability. Our paper exploits their findings but introduces a multiple industry framework where talent has industry-specific productivity and where the allocation is of concern at two margins, ie between labor markets and entrepreneurial class and at allocation of entrepreneurs between various industries. This extension turns out to be important and it provides a natural starting point for an analysis of how different financial institutions develop to match and allocate talents between industries in the economy.

In our analysis, there are two types of financial institutions, those that provide uninformed finance and those that provide informed finance. Allocation of finance is based on self-selection, where financial terms are determined by uninformed financiers' average judgement of projects and informed financiers' information advantage. The uninformed finance is provided by the institutions called banks while the informed financier will be called venture capital-

[1] These choices may not be known, say prior to the educational investment but they may become available during the education process.

ists (VCs).[2] The model suggests that uninformed financiers underprice new start-ups in the spirit of the lemon problem identified by Akerlof (1970) and Myers and Majluf (1984). The VC companies are simply better informed.[3]

We first show that uninformed finance gives rise to excessive entry both in human capital intensive and in conventional industries when the financial institutions cannot identify the entrepreneurial talent. When information of talent is asymmetric, the financial terms are tailored for the average agent starting a project within an industry, and there is cross-subsidization build into the financial contract. Losses inflicted on uninformed financiers are financed by the high-talented entrepreneurs. The allocation of talent suffers from inefficiencies and the development of more advanced financial institutions is helpful in reducing those inefficiencies.

It is shown that introduction of informed capital (eg venture capital finance) with superior screening ability results in an institutional equilibrium with efficiency gains in human capital industries. The more advanced financiers are able to exploit their expertise in screening the potential agents entering the riskier and more human capital intensive industry. In contrast to common thinking, the institutional equilibrium with informed capital is characterized by more limited entry to an industry which requires high-talented human capital. Unexpectedly, the total welfare effect is ambiguous because the allocation of non-informed capital becomes now less efficient in the conventional industry. This is due to the interaction between the two financial sectors that will activate new entry into less riskier industry, since the rationing of finance by the VCs makes some high-talent types to switch to less riskier industry. This, in turn, implies increased cross-subsidization within that industry and hence further entry of even lower talented agents. Consequently then, the total welfare effect remain ambiguous.

In the derived financial institution equilibrium the most talented agents in the human capital intensive industry acquire informed finance while the less talented agents in that industry go for the uninformed finance. And finally the least talented entrepreneurs will be financed by the uninformed finance within the conventional industry. This allocation of finance is indeed consistent with what has happened in the financial markets in the 1990s. For instance, a bank finance is very often crucial for the emergence of small scale entrepreneurs, but almost irrelevant for the formation of new firms in so called high-tech industries such biotech, m-business etc. There, the dominant form of finance that has been booming during the last ten years or so is a venture capital finance.[4]

[2]In the literature, there are two arguments for the superiority of VCs as start-up financiers. The first is their capability of providing advice to the entrepreneurs in various forms, cf. for instance Repullo and Suarez (1999), Casamatta (1999), and Schmidt (2001). The second argument relates to their superior ability to screen potential applicants ex ante and through stage financing. See for instance Amit at el (1998). We focus exlusively on the latter mechanism as the first one would only reinforce our results. See also Ueda (2000) who compares VSs and banks as start-up financiers.

[3]It has been suggested by Michelacci and Suarez (2001) that once the project value is revealed, venture capitalists' ability to extracts rents disappears and finance will be recycled.

[4]For the magnitude of VC finance see for instance European venture capital association's web site www.evca.com and and North American venture capital association's web site that provide detailed information about the VC finance.

To answer how financial institutions emerge, we extend the model by considering the financial institutional equilibrium, starting from fundamentals, ie the intermediation technologies of institutions and the risk preferences of investors. To develope these technologies is costly and requires investments which are sunk ex post. In equilibrium, returns to institutions have to cover these costs. Given that project-holders develope projects with different risk characteristics, institutions tend to specialize among the projects they finance. On the other side, investor's risk aversion dictates how they allocate their wealth between assets. Various financial institutions with different technologies can cope with investors' risk preferences. There are institutions ("banks") providing low-return but risk-free assets (deposits) and some other institutions (venture capitalists) providing risky assets with high-expected return. Banks tend to finance low-risk projects and venture capitalists, in turn, can take the advantage of the special expertise developed to target for higher returns, albeit at the cost of higher risks.[5] We show that the financial institutional equilibrium is shaped by risk preferences of investors, costs of establishing uninformed and informed capital, and the initial distribution of talent in the economy.

The paper is organized as follows. The model is presented in section 2. We start by providing a benchmark solution for the allocation of talent under first best in section 3. Section 4 in turn examines allocation of talent under asymmetric information in the case where only uninformed finance is available. There we also examine allocation of talent when the uninformed and uninformed finance co-exist, and derive the institutional equilibrium. Finally, in section 5 we explain the emergence of different financial institutions with some comparative static results. Section 6 concludes.

2 The model

The economy consists of three types of agents – investors, potential entrepreneurs and financiers. The risk averse investors are willing to invest in entrepreneurial projects via financial institutions. The risk neutral financial institutions raise funds from investors and channel those into the hands of risk neutral entrepreneurs in different sectors of the economy. The financiers however suffer from asymmetric information, since only the entrepreneurs know their talent. Consequently the problem of matching the talent of potential entrepreneurs and finance represents a non-trivial problem.

[5] Financiers, however, are subject to two types of mistakes, type I and type II mistakes. That is, they face the lemon problem, identified by Akerlof (1970). It is well-known that companies like Xerox, Kodak and IBM all have turned down success stories like copy machnine, personal computer or significant share in Microsoft, cf. Audretsch (1998).

2.1 Industries

There is a continuum of risk neutral potential entrepreneurs with no wealth, but each willing to undertake one project. The potential entrepreneurs differ according to their talent to accomplish such a project successfully. Talent is uniformly distributed, $t \in [0, T] \backsim u(t), U(t)$. The industries differ according to the required human capital intensity. We classify them into two groups, the first exploiting inherited technologies leading a "conventional industry", C. The second one is understood to be more human capital intensive, targeting to new innovations, and leading under success to a "high-tech" industry, H. To start a project in any of these industries requires an initial investment, normalized to $I > 0$. The potential entrepreneurs know their own type, but the financiers (if uninformed) only know the talent distribution. The potential entrepreneurs can also enter labor market at risk-free income, $w > 0$.[6]

The success probabilities vary across the industry and are conditional on the talent allocated. The human capital is inessential in the $C-$industry for the success. The economic idea that $H-$projects are more difficult, requiring human capital to succeed will be introduced in terms of the following success probabilities[7]

$$p^H(t) = t, \tag{1}$$

and

$$p^C(t) = \gamma + \alpha t, \tag{2}$$

where $\gamma > 0$, $\gamma + \alpha < T < 1$. The success probabilities are assumed to be common knowledge. We now introduce the basic assumptions.

Assumption 1. The underlying property of success probabilities is such that $p^C(t) > p^H(t)$ for $0 < t < t^*$ while $p^C(t) < p^H(t)$ for $t^* < t < T$.

The $H-$ projects are thus more risky than are the $C-$projects, unless sufficiently high amount of human capital is available.[8] Let π^H, π^L denote the returns under success. In order to simplify we assume:

Assumption 2. $\pi^H = \pi^L = \pi > w > 0$.

The expected profit from the project is conditional on the amount of talent allocated to it. If only a minimum amount of talent is allocated, the C-project has

[6] Another interpretation for being a worker is that one is an entrepreneur in the safe industry, which does not require investment nor talent, and where one earns return w for sure.

[7] Alternatively, if one incorporates the VCs advicing role, the success probability can read as at were the advisory effort by a VC, $a > 1$ determines the effectivenes of talent.

[8] The entrepreneurial projects in these two industries could also differ in terms of their liquidation values in the case a project turns out to be unsuccesful. Then C-projects could be interpreted as projects where assets can be liquidated at some positive liquidation value, but H-projects instead (m-business, e-commerce, biotech, hi tech, etc.) would be human capital intensive with no liquidation value at all.

greater expected return. If high -talented agents are allocated to H-projects, their expected return will, however, exceed that of the C-project. Thus, there exists a marginal talent, say t^m when the expected returns of the projects are equalized,

$$p^H(t^m)\pi = p^C(t^m)\pi.$$

Thus, from the society's point of view, an H-project should be undertaken if an agent with enough talent is involved with that project.

We do not introduce moral hazard problem of project choice by entrepreneurs as in Holmström and Tirole (1997) and many others, since financiers observe in our model in which sector entrepreneurs invest. Consequently then the terms of financial contracts do reflect the riskiness of the projects. Also, the form of the financial contract itself will not play a role in our model, and we simply refer to the payment from an entrepreneur to a financier as the return required by the financier.

2.2 Investors and financiers

We assume that there is a continuum of risk neutral agents who can specialize in establishment of institutions intermediating finance. Setting up an institution is costly. In the absence of intermediating institutions – capable of processing knowledge of the projects or sharing project risks – investors would have to invest individually and directly in risky projects. Risk-aversion of investors in the context of limited liability on projects leads to that they allocate their initial wealth among a large number of risky projects. It is, however, well known that introduction of a risk-free asset with in asset market is welfare improving.[9] Investors willingly sacrifice in terms of their expected return on safe asset to insure themselves, while maintaining access to higher expected return on the risky fund. There is demand for an institution providing insurance. Moreover, to the extent the uncertainty of the return on the risky fund can be controlled, the investors appreciate such an improvement in their knowledge of the project. These arguments point to an institutional equilibrium which allows for existence of financial institutions with different technologies. One technology can be used to insure the risks, the other to improve the information of project quality.

Institutional richness may thus be welfare-improving, as investors are willing to invest in different assets issued by different institutions. In our model, the financial institutions, when successfully established, are assumed to be equipped with rather different types of capital, "trust capital" and "expertise capital". The first institution provides riskfree assets to investors, the second provides risky but screened assets.[10] If only for brevity, the first institutions are

[9] Sharpe (1964) and Lintner (1965) are classical papers.

[10] In addition, investors could invest directly on risky projects through the "stock market". For simplicity, our model abstracts from this opportunity and focuses on institutional equilibrium with intermediate finance.

called "banks", the second are called "venture capitalists".[11] In institutional equilibrium, the return on their investments will cover the cost of developing the specific capitals, which are sunk.[12]

In the first part of the paper, we take the financial sector as given, assuming that the financial sector is simply a collection of various institutions without entrepreneurial ideas but with sufficient funds. Subsequently, we explore the determinants which shape these institutions in section 5.

3 A benchmark: First best allocation of talent

Assume just as the benchmark case perfect information where the talent of agents is observable. Potential entrepreneurs are wealth constrained and face an occupational choice between working with their idea in $H-$ or $C-$ sectors or entering the labor market. The first task is to find out the marginal entrepreneurs in different occupations in terms of their talent. It is obvious that the least able agents will only evaluate the possibility of becoming an entrepreneur within a C-project as the alternative to entering labor market. Since we consider a continuum of agents, there exists a marginal agent $\widetilde{t}$ who is just indifferent between becoming a worker and an entrepreneur within a C-project. In equilibrium, the occupational choice condition satisfies

$$w = (\gamma + \alpha\widetilde{t})(\pi - R^C). \tag{3}$$

In above, the LHS stands for the safe wage from becoming a worker and the RHS stands for the expected income of becoming an entrepreneur within a $C-$ project. Variable R^C stands for the return required by the financier and is determined by the bargaining power. Similarly, the more talented agents consider only the alternatives of becoming either entrepreneurs with $C-$ or $H-$ projects. Thus, there exists a marginal agent, $\widehat{t}$ who is just indifferent between those two streams of expected income

$$(\gamma + \alpha\widehat{t})(\pi - R^C) = \widehat{t}(\pi - R^H). \tag{4}$$

In above, the LHS stands for the expected utility (income) of being an entrepreneur within a C-project, and the RHS is the expected utility within the H-project, with R^H standing for the return required by the financier once the entrepreneur invests in H-project.

Competition in financial markets is assumed to dictate that an entrepreneur will obtain the whole surplus from the relationship from the project while the financier is left with zero expected profit. The expected profits of the financier for each project in the two industries then satisfy

[11] Basically, the trust capital will exist if an institution is funding projects with positive liquidation value. A complementary argument for the the trust capital is an outside (social) insurance, typically introduced by the governments to prevent, say bank runs.

[12] To be concrete, the assets we have in mind are then bank deposits (riskfree assets) and shares of VC companies (risky assets).

$$\pi_F^C = -I + (\gamma + \alpha t)R_t^C = 0, \qquad t \in (\widetilde{t}, \widehat{t})$$

$$\pi_F^H = -I + tR_t^H = 0, \quad t \in (\widehat{t}, T).$$

We notice that in the case of first best, the compensations to the financier R_t^C, R_t^H are industry and talent specific and can be solved as

$$R_t^C = \frac{I}{\gamma + \alpha t}, \; R_t^H = \frac{I}{t}. \tag{5}$$

From above we see that $R^H \lesseqgtr R^L$ - the cost of finance from the riskier H -projects may either exceed or fall short of the cost of the safer C -projects.

Using equations (3) and (4) and the costs of financing, R_t^C, R_t^H, one finds the marginal entrepreneurial talents in the two industries:

$$\widetilde{t_f} = \frac{w + I - \gamma\pi}{\alpha\pi}, \tag{6}$$

and

$$\widehat{t_f} = \frac{\gamma}{1 - \alpha}. \tag{7}$$

Lemma 1 *In the first best with no informational problems, agents characterized as $t < \widetilde{t_f}$ enter as workers. Agents with intermediate talent; $\widetilde{t_f} \leq t < \widehat{t_f}$ become entrepreneurs within the C- projects, while the most able agents with talent $\widehat{t_f} \leq t \leq T$ enter the H-industry.*

Proposition 2 *Under symmetric information, allocation of talent is efficient.*

Proof. It needs to be noticed that all positive net present value projects are financed. The total surplus cannot be increased by re-allocation of talents. ■

4 Allocation of talent under asymmetric information

4.1 Only uninformed finance available

Suppose now that talent is private information of an agent.[13] The financiers know only to what industries (projects) they are lending. They also know the talent distribution $u(t)$.The required compensation to the financiers, $\overline{R}^H > \overline{R}^C$ have to be industry-specific but without knowledge of the actual talent of the borrower. The only feasible equilibrium financial contract is a pooling one where all agents operating in an H-industry (respectively in $C-$ industry) are financed at the same terms. As suggested by De Meza and Webb (1987), there

[13]This should perhaps not be taken too literally. The important idea is that an agent knows more of his or her ability than does any outsider.

will be cross-subsidization between financed projects – the high-ability types suffer and the low-ability types gain.[14]

The expected profit for the financier from each agent in the H-industry is

$$\pi_F^H = -I + \left[\int_{\widehat{t}}^{T} tu^*(t)dt\right]\overline{R}^H = 0,$$

where $u^*(t) = \frac{1}{T-\widehat{t}}$ is the truncated talent distribution but where the marginal entrepreneur $\widehat{t}$ has yet to be determined. We notice that $\int_{\widehat{t}}^{T} tu^*(t)dt$ is the average success probability of a financed project in the H-industry. Solving for $\overline{R}^H$ as a function of the unknown $\widehat{t}$, one obtains the solution for the financial contract:

$$\overline{R}^H(\widehat{t}) = \frac{I}{\frac{1}{2}(\widehat{t}+T)}.$$

Similarly, the expected profit from each agent in the C-industry is

$$\pi_F^C = -I + \left[\int_{\widetilde{t}}^{\widehat{t}} (\gamma + \alpha t)u^{**}(t)dt\right]\overline{R}^C = 0, \tag{8}$$

where $u^{**}(t) = \frac{1}{\widehat{t}-\widetilde{t}}$ is the truncated talent distribution, and $\widetilde{t}$ is the unknown talent of the marginal agent who is indifferent between entering to the C - industry and becoming a worker. Solving for $\overline{R}^C$, one obtains

$$\overline{R}^C(\widetilde{t},\widehat{t}) = \frac{I}{\gamma + \frac{1}{2}\alpha(\widetilde{t}+\widehat{t})}.$$

We have thus two occupational choice conditions,

$$w = (\gamma + \alpha\widetilde{t})(\pi - \overline{R}^C), \tag{9}$$

and

$$(\gamma + \widehat{t})(\pi - \overline{R}^C) = \widehat{t}(\pi - \overline{R}^H). \tag{10}$$

After substituting in $\overline{R}^C$ and $\overline{R}^H$, we have two equations to determine the unknown marginal talents, $\widetilde{t}$ and $\widehat{t}$,

$$w = (\gamma + \alpha\widetilde{t})(\pi - \frac{I}{\gamma + \frac{1}{2}\alpha(\widetilde{t}+\widehat{t})}), \tag{11}$$

$$(\gamma + \alpha\widehat{t})(\pi - \frac{I}{\gamma + \frac{1}{2}\alpha(\widetilde{t}+\widehat{t})}) = \widehat{t}(\pi - \frac{I}{\frac{1}{2}(\widehat{t}+T)}). \tag{12}$$

It is not possible to have closed form solutions for the marginal talents. One can, however, prove a sharp analytic result:

[14]Their paper is the pioneering work that showed the possibility of excess entry via the cross-subsidization effect that arise due to asymmetric information.

Proposition 3 *Asymmetric information causes the marginal talent levels* $\widetilde{t}$ *and* $\widehat{t}$ *to fall below the first best values. Consequently, the marginal agents in both industries have lower talent levels.*

Proof. To prove, we proceed in two steps. First we show that the type which was identified as the marginal one in the first best, $\widetilde{t}_f$, obtains finance at more favorable terms in the second best. The marginal talent in the $C-$industry in the first best faced a repayment requirement $R^C = \frac{I}{\gamma+\alpha\widetilde{t}_f}$. In the second best world, the financier cannot identify him, but associates him with all talent levels $t > \widetilde{t}$ that will apply finance for entering the $C-$ industry. Consequently, the repayment requirement becomes $\overline{R}^C = \frac{I}{\gamma+\frac{1}{2}\alpha(\widetilde{t}_f+\widehat{t})}$ for all projects in the $C-$industry. Since, we know that $\widehat{t} > \widetilde{t}_f$,we can compare the repayments, and see that$\frac{I}{\gamma+\frac{1}{2}\alpha(\widetilde{t}_f+\widehat{t})} < \frac{I}{\gamma+\alpha\widetilde{t}_f}$. That is, the agent that used to be the first-best marginal type faces more favorable terms in the second best world, $\overline{R}^C < R^C$. The second step is to note from equation (11) that since repayment is now lower for the previous first-best marginal agent, her net return is greater. On the left hand side of (11), we have the fixed opportunity cost. Thus, in order to satisfy the occupational choice condition, the marginal talent level has to be lower, falling below what the marginal talent level was under the first best.

In the H -industry similar effects appear. Also there the marginal agent of the first best obtains finance at better terms. Instead of paying $R^H = \frac{I}{\widetilde{t}_f}$ that was her repayment in the first best, she pays $\overline{R}^H = \frac{I}{\frac{1}{2}(\widehat{t}_f+T)}$. Again, since we know that $\widehat{t}_f < T$, $\overline{R}^H < R^H$. Inspecting the RHS of equation (12) we see that the net return for the previous first-best marginal agent is greater, and thus even if the LHS would remain unchanged the marginal talent level should be lower to satisfy the occupational choice condition. However, since also the LHS goes down, the marginal talent level has to go down as well to ensure that the occupational condition holds. ■

The important conclusion is that as a consequence of asymmetric information, there will be too many low-ability entrepreneurs in both industries, making losses that high-talent agents have to bear. The high-talent entrepreneurs have to bear the cost of compensating the financiers for these losses.

Corollary 4 *Under asymmetric information, allocation of talent is inefficient, as too many low talented types enter both industries.*

Proof. It needs to be noticed that now some negative net present value projects are financed due to cross-subsidization. ■

Though part of the burden of financing the losses is shifted to high-quality agents, this burden only represents a transfer. The social cost arises from that the aggregate social surplus is not maximized, since too may failures of some less talented entrepreneurs cause welfare losses.

4.2 Institutional equilibrium with uninformed and informed finance

In the previous section, it was found that asymmetric information causes welfare losses since less talented agents enter both industries. We next ask whether an informed venture capitalist can improve the allocation of talent under asymmetric information. The well-known characteristic of venture capitalists is their special competence and experience in screening potential entrepreneurs in high risk-industries.[15] Without loss of generality, it is assumed that other institutions, say banks, do not have the ability to screen agents in the H -industry. That is, we view venture capitalists being more advanced financial institutions when compared to banks, in being able to reduce asymmetric information problems by better screening abilities.

We adopt the following screening technology. We assume that with fixed cost $f > 0$, each VC company is able to identify the type of the entrepreneurs out of the initial distribution $u(t)$, searching finance in the $H-$ sector.[16] We suggest that with reduced degree of informational asymmetry, cross-subsidization between projects in the H -sector is reduced. Then, a fundamental question goes as follows: which of the entrepreneurs have an incentive to be drawn into the screening process and to be identified. The previous section suggests an answer: they are the most talented who have an incentive to get screened as otherwise they have to bear the cost of informational asymmetry.

To consider the allocation when informed capital is available, define the talent of the marginal agent in the C-industry as $\widetilde{t'}$. Then, the occupational choice condition becomes

$$w = (\gamma + \alpha\widetilde{t'})(\pi - \frac{I}{\gamma + \frac{1}{2}\alpha(\widetilde{t'} + \widehat{t'})}), \tag{13}$$

determining the marginal agent which entries the $C-$industry. The occupational choice problem in the H -industry is now, however, more subtle. This is because we have to determine the marginal talent which is indifferent between informed and uninformed finance in the H -sector. We then derive the marginal agents as before. Denote the expected profit on each project financed by an informed financier as $\pi_{VC} = tR^H - I - f$. In equilibrium, $tR^H - I - f = 0$. Thus, the financial contract under venture capital finance has to satisfy $R^H = \frac{I+f}{t}$ under success. From potential entrepreneurs point of view, the problem is whether an agent with type t goes for the informed finance and get funded at terms $R_t^H = \frac{I+f}{t}$ or go for uninformed finance and get funded at terms $\overline{R}^H = \frac{I}{\frac{1}{2}(\widehat{t'}+t)}$ where $\widehat{t'}$ is the marginal agent in the $H-$sector financed by non-informed capital. It holds for the marginal agent, say t^*who is just indifferent between the two types of finance that

$$t^*(\pi - \frac{I}{\frac{1}{2}(\widehat{t'} + t^*)}) = t^*(\pi - \frac{I+f}{t^*}).$$

[15] See for instance Amit et al (1998) who argue that venture capitalists relative advatage is partly in their screening capabilities.

[16] Also VC companies make mistakes and are subject to misjudgement as wittnessed by the late 1990s experience. What our model is built on is that it is the *relative* screening ability which is superior within the VC finance.

Solving,

$$t^* = \frac{(I+f)\widehat{t'}}{I-f}. \tag{14}$$

The occupational choice conditions then are given by two equations including two unknowns, $\widetilde{t'}, \widehat{t'}$,

$$w = (\gamma + \alpha\widetilde{t'})(\pi - \frac{I}{\gamma + \frac{1}{2}\alpha(\widetilde{t'} + \widehat{t'})}). \tag{15}$$

$$(\gamma + \alpha\widehat{t'})(\pi - \frac{I}{\gamma + \frac{1}{2}\alpha(\widetilde{t'} + \widehat{t'})}) = \widehat{t'}(\pi - \frac{I}{\frac{1}{2}(\widehat{t'} + t^*)}). \tag{16}$$

The above two equations determine the marginal talents $\widetilde{t'}$ and $\widehat{t'}$, and after that on is able to solve t^*, i.e. the marginal talent indifferent between the uninformed and informed finance. Even though it is impossible to derive closed form solution for the marginal talents one is, however, able to show how they compare to the ones derived in the case of uninformed finance only:

Proposition 5 *When compared to the uninformed (bank) finance case, access to informed finance improves the allocation of talent in high-risk H industry by raising the marginal talent that enters there, but it worsens the allocation in the conventional low-risk C -industry by attracting low-ability types.*

Proof. To prove this we need three steps. First from (14) we see that $\widehat{t'} < t^* < T$. We now need to show that $\widehat{t} < \widehat{t'}$. We take once again as our reference point the marginal talent of the first-best, $\widehat{t_f}$. Under asymmetric information the financier cannot identify him, but associates him with all talent levels $t > \widehat{t_f}$ that will apply finance for entering the $H-$ industry. Consequently, the repayment requirement becomes $\overline{R}^H = \frac{I}{\frac{1}{2}(\widehat{t_f}+t^*)}$. In contrast under the first best the repayment requirement is $\overline{R}^H = \frac{I}{\widehat{t_f}}$. Since we know that $t^* > \widehat{t_f}$, the previous first-best level marginal agent gets finance in more favorable terms. However, the cross-subsidization build into the contract is smaller than in the case where only uninformed finance were available, since there the repayment requirement was $\overline{R}^H = \frac{I}{\frac{1}{2}(\widehat{t_f}+T)}$,and $t^* < T$. Thus the marginal talent level when the informed finance also is available is higher, $\widehat{t} < \widehat{t'}$. Finally we show that $\widetilde{t'} < \widetilde{t}$. Keeping $\widetilde{t_f}$ as our reference point we see that this previous first best marginal talent gets finance now even more favorable terms than in the case of uninformed finance only. Now the repayment requirement $\overline{R}^C$ reads as $\frac{I}{\gamma+\frac{1}{2}\alpha(\widetilde{t_f}+\widehat{t'})}$ instead of $\frac{I}{\gamma+\frac{1}{2}\alpha(\widetilde{t_f}+\widehat{t})}$, and since $\widehat{t} < \widehat{t'}$the repayment requirement is smaller due to the greater cross-subsidization build into the contract. Consequently then the marginal talent level now decreases, $\widetilde{t'} < \widetilde{t}$. ■

Venture capital finance (informed finance) will restrict entry of low-talented agents to high-risk industry but the interaction between the two financial sectors will result in more active entry into C-sector. The intuition is that agents

with talent within $[\widehat{t}, \widehat{t}']$ will now choose the C-sector instead of the H-sector, resulting in an increase in the profitability of uninformed (banking) finance as credit losses from the C-sector are reduced. Thus, the banks will provide funding at more favorable terms to all C-applicants, attracting even more low talented entrepreneurs who otherwise would enter the labor market, $\widetilde{t}' < \widetilde{t}$. Therefore the total welfare effects of introduction of informed finance remain ambiguous. The detailed welfare analysis would require the comparison of the total expected surplus under the two regimes. However, to carry out such a comparison requires closed form solutions for the marginal talents, which however are impossible to derive in our set up. Anyway, the total welfare effects depend on the underlying talent distribution. This explains our rather surprising ambiguous welfare result:

Proposition 6 *The effect of the introduction of informed finance on the total welfare is ambiguous.*

More advanced financial institutions do have the role of *facilitating the efficient allocation of talents* in an economy: in the H-industry, most talented agents are financed at better terms and less talented in less favorable terms compared to the economy where only uninformed finance is available. To summarize, we present the financial institution equilibrium that describes the matching of talent distribution and finance as:

Lemma 7 *The most talented agents in the H -industry acquire informed finance while less talented agents in the H -industry go for the uninformed finance. The least talented entrepreneurs will be financed by the uninformed finance within the C -sector.*

Our model also produces an unexpected result:

Corollary 8 *High wages in labor market have the role of improving allocation of talent as they reduce the entry of low-talent potential entrepreneurs.*

Proof. It only needs to be noticed that high wages represents an opportunity cost of becoming an entrepreneur in $C-$industry, and thus an increase in wages reduces the excess entry into entrepreneurship under asymmetric information. ■

Interestingly, this result relates to that of Ghatak et al (2001) who show that the collateral requirement needed to prevent less talented agents from entering as entrepreneurs decreases in wages. Here in turn, we show that the introduction of informed finance improves efficiency in terms of allocation of talent more when there are high wages in labor market.

As a final note, we point out that the model has abstracted from the advisory role of venture capitalists, found important in the recent literature, cf. Repullo and Suarez (1998) for the pioneering paper. Such an extension is, however, straightforward. Introduction of the advisory role VCs would raise the success rate of the $VC-$financed projects. This, in turn, would raise the total expected surplus in the economy. The advisory input, however, is costly and the projects have to bear the full cost. However, it is expected that the VC -finance in the $H-$industry increases because the marginal talent level in this industry is expected to be reduced.

5 How do financial institutions emerge?

With no financial institutions, the equilibrium of the economy can be expected to be rather inefficient. Risk-averse agents should individually evaluate all the potential projects. Characterization of the efficient individual risky portfolio is well-known from the classic work by Markowitz (1952) in the case where project evaluation is costless. The positive welfare consequences of introduction of institutions which supply risk-free assets and the impact on optimal risk-taking have been well-known since Sharpe (1964) and Lintner (1965). The intuition is known as the "two-fund" separation theorem, and has been the core of any finance textbook for several decades. Investors are thereby willing to sacrifice in terms of their expected return on asset to insure themselves against a risk, while maintaining access to higher risky return on the second fund. However, to the extent the uncertainty of the return on the second-fund can be controlled, the investors might be willing to pay for such an improvement in their knowledge of the project. While the first mechanism points to insurance effect, the second relates to usefulness of information acquisition. Both arguments point to an institutional equilibrium which allows for emergence of institutions which improve the information of project quality and insure the risks. To link these insights into the present context with specialized financial institutions, we introduce the costs of specialization which we have so far abstracted from.

We have assumed above that there is continuum of risk neutral agents who can specialize in establishment of institutions. To extend the model to cope with the cost of specialization, assume now that in order to set up an institution, commitment to a fixed cost is required. Assume that there are agents, capable of developing institutions by investing at fixed cost $F_b > 0$ and $F_v > 0$ to establish institutions. The two institutions, when successfully established, are assumed to be equipped with rather different types of financial technologies or capital, "trust capital" and "expertise capital". The first institution provides riskfree assets (deposits) to investors, and the second one provides risky but screened assets. In institutional equilibrium, the return for financiers have to cover the cost of developing the specific capitals, $F_{b,}$ F_v which are sunk. As a second extension to the basic model, we introduce investor's risk preferences. Investing in securities of a institution with trust capital technology is risk-free and commands zero rate of return. Investing in securities issued by an institution having informed capital technology is risky and commands a premium, $\rho > 0$.

The ex ante institutional equilibrium condition requires that the expected returns in both financial technologies coincide. The expected profit of informed financier (venture capitalist), adjusted for the cost of establishing and for the risk premium, ρ, of the financier from each agent in the H-industry satisfies

$$\pi_v^H = -(1+\rho)I - F_v/n_v + tR_v^H = 0, \tag{17}$$

where variable n_v stands for the number of projects financed by, and it reads as $n_v = u(T) - u(t^*)$. Solving for R_v^H, one obtains for the contract

$$R_v^H = \frac{(1+\rho)I + F_v/(u(T) - u(t^*))}{t}.$$

In above t belongs to the interval $[t^*, T]$. Similarly, the expected profit of the uninformed financier from each agent in the C-industry is

$$\pi_b^C = -I - F_b/n_b^C + \left[\int_{\widetilde{t}'}^{\widehat{t}'} (\gamma + \alpha t) u^{**}(t) dt\right] \overline{R}^C = 0, \tag{18}$$

where $n_b^C = u(\widehat{t}') - u(\widetilde{t}')$ is the number of projects financed by the uninformed financier in C-sector and $u^{**}(t) = \frac{1}{\widehat{t}' - \widetilde{t}'}$.

From above we can solve for the contract

$$\overline{R}_b^C = \frac{I + F_b/(u(\widehat{t}') - u(\widetilde{t}'))}{\gamma + \frac{1}{2}\alpha(\widetilde{t}' + \widehat{t}')}.$$

Banks also provide uninformed finance in H-sector:

$$\pi_b^H = -I - F_b/n_b^H + \left[\int_{\widehat{t}'}^{t^*} t u^*(t) dt\right] \overline{R}_B^H = 0,$$

where $n_B^H = u(t^*) - u(\widehat{t}')$ is the number of projects financed by the uninformed financier in $H-$sector and $u^*(t) = \frac{1}{t^* - \widehat{t}'}$. The repayment thus is:

$$\overline{R}_b^H = \frac{I + F_b/(u(t^*) - u(\widehat{t}'))}{\frac{1}{2}(\widehat{t}' + t^*)}.$$

In the extended model, the occupational choice conditions are then given by two equations;

$$w = (\gamma + \alpha\widetilde{t}')(\pi - \frac{I + F_b/(u(\widehat{t}') - u(\widetilde{t}'))}{\gamma + \frac{1}{2}\alpha(\widetilde{t}' + \widehat{t}')}), \tag{19}$$

$$(\gamma + \alpha\widehat{t}')(\pi - \frac{I + F_b/(u(\widehat{t}') - u(\widetilde{t}'))}{\gamma + \frac{1}{2}\alpha(\widetilde{t}' + \widehat{t}')}) = \widehat{t}'(\pi - \frac{I + F_b/(u(t^*) - u(\widehat{t}'))}{\frac{1}{2}(\widehat{t}' + t^*)}). \tag{20}$$

From above one can solve for $\widetilde{t}'$and $\widehat{t}'$, and the marginal agent t^*, who is indifferent between informed and uninformed finance as in the previous section. From these conditions, one can find out several comparative static results;

Proposition 9 *The institutional equilibrium is determined by the risk preferences of the ultimate investors, the relative costs of creating the uninformed and the informed capital, and the initial talent distribution in the economy.*

Intuitively, increased risk premium increases the cost of funding raised by venture capitalist, and thus increasing the marginal talent in the $H-$industry. The same follows from increased relative cost of establishing a VC company. The mechanism is, however, more complicated by the incidence of the fixed cost per each project. This however ultimately depends on the total number of projects financed.

From (17) we can see that the initial distribution of talent has a crucial effects on the number of projects financed, since the distribution itself and its upper limit affects the cost of finance per project. This has a direct implication that only in those economies where the talent distribution has high enough support the informed finance may appear. Of course in general, the slow progress of venture capital formation result from costs of establishing these institutions.

6 Concluding remarks

One of the main results of our paper is that though risky, informed capital improves allocation as it can better screen between high-quality and low-quality talents. Yet, the equilibrium still remains inefficient. The paper thus can be used to evaluate several policy implications. First, all instruments like entry subsidies on venture capital institutions that provide informed finance can be welfare improving. A structural policy which leads in restructuring of the financial sectors away from banking and toward more venture capital finance appears welfare improving. The mechanism in our model is that more informed capital reduces the risk of excessive entry to human capital intensive industries while a tax on banking leads to reduced risk of excessive entry to non-human capital intensive industries. De Meza and Webb (1999) proved that taxing may be useful in limiting the low talented agents from entering entrepreneurship. In that context our results can be interpreted in a way that one should tax bank finance and subsidize the formation of informed venture capital finance. In this respect our result that an increase in the wage rate improves the allocation of talent under asymmetric information is rather intuitive, since in the model it also reduces the risk of excessive entry to non-human capital intensive sector and in effectively works like a tax on entrepreneurship.

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