Public Policy and the Creation of Active Venture Capital Markets

Marco Da Rin*
Università di Torino, ECGI, and IGIER
http://web.econ.unito.it/darin

Giovanna Nicodano
Università di Torino
http://web.econ.unito.it/nicodano

Alessandro Sembenelli
Università di Torino
http://web.econ.unito.it/sembenelli

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Abstract

In this paper we explore how public policy can contribute to the development of 'active' venture capital markets, i.e. markets with a large share of early stage and high-tech investments. We proceed in two steps. First, we provide a simple model of venture investment which extends Holmstrom and Tirole (1997) and provides testable implications. Second, we explore a panel of data for 14 European Union countries between 1988 and 2001, adopting an approach which carefully addresses identification and endogeneity issues. Our findings are novel and challenge conventional wisdom. First, we find the opening of 'New (stock) Markets' does positively affect the shares of both early stage and high-tech venture capital investments. This provides the first test of the importance of an exit option for venture capital modeled by Black and Gilson (1998) and Michelacci and Suarez (2003). Second, using a novel panel of capital gains tax rates which extends back to 1988, we find that a reduction in capital gains taxation also increases the share of high-tech and early stage investments. This provides the first study of the effects of capital gains taxation on venture capital investment. Third, we find weak evidence of lack of a shortage of risk capital for venture capital.

PRELIMINARY DRAFT, PLEASE DO NOT QUOTE

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1 Introduction

Industrialized economies are ever more dependent on innovation and entrepreneurship for their sustained growth (Bottazzi, Da Rin, and Giavazzi (2003), Nelson and Romer (1996), OECD (2001)). Venture capital is a specialized form of intermediation particularly well suited to support the creation and growth of innovative companies (Hellmann and Puri (2000), Kortum and Lerner (1998)). It specializes in financing and nurturing companies that are at an early stage of development ('start-ups') and that operate in high-tech industries. For these companies the expertise of the venture capitalist, its knowledge of markets and of the entrepreneurial process, and its network of contacts are most useful to help unfold their growth potential (Bottazzi, Da Rin and Hellmann (2004), Gompers (1995), Hellmann and Puri (2002), Lerner (1995), and Lindsey (2003)). By contrast, when venture capital is applied to companies at a later stage of their growth, or in companies which operate in technologically mature industries, it has less of an opportunity to 'make a difference.' Economics thus points to the need of ensuring an adequate share of investments for high-tech and early stage companies.

The presence of well developed venture capital markets has in fact received a high priority by economic policy, which appreciates its importance for achieving continued economic growth (European Commission (2003) OECD (2001)). Governments around the world have been trying to replicate the diffusion and success that venture capital has achieved in the United States (Megginson (2004)). These efforts have often been directed towards the creation of 'active' venture capital markets, i.e. venture capital markets which provide strong support for early stage and high-tech ventures. This is because financing early stage and high-tech ventures is arguably more effective for generating jobs and growth than financing more mature companies in low technology industries. Yet, we still know very little about what forces can help create active venture capital markets.

This is an important issue. Recent research on the economics of venture capital, based on models of double-sided moral hazard, has substantially advanced our understanding of how venture financing selects, monitors and supports innovative companies (see, e.g., Casamatta (2003), Inderst and Müller (2004) Landier (2002), Schindele (2003), and Schmidt (2003)). However, we are still far from grasping what conditions may turn the mere presence of venture capital into an active engine of growth, and what conditions make venture capital markets more active. Our study contributes a first step towards filling this gap.

We proceed in two steps. First, we provide a simple theory of the structure of venture capital markets, focussing on the conditions which determine the distribution of financing between early and late stage, and between high-tech and low-tech, investments. Our model extends the seminal article of Holmstrom and Tirole (1997) by allowing for the possibility of an excess supply of funds. As in the original model, firms are heterogeneous in their ability to pledge collateral against borrowing, but we also assume that this ability is higher for firms that possess more tangible assets, which are more easily accepted as collateral than intangible assets. As firms mature from start-ups to later stage ventures, they make larger use of tangible assets. Likewise, firms in high-tech industries make more use of intangible assets than those in traditional industries. This creates a 'pecking order' in firms' ability to pledge collateral against loans.

We define the 'innovation ratios' as the ratio of early stage (high-tech) investments to total venture investments, and take venture capital markets to be more active the higher are these ratios. While simple, our theory is rich enough to point to four factors as potential drivers of active venture capital markets. First, there is the supply of funds available for investment. Second, we turn to factors which affect project's expected returns: the level of capital gains taxation, the existence of profitable exit markets for venture investments, and the level of entrepreneurial opportunities.

Our second step consists of taking the model's predictions to the data. We introduce some variables neglected by previous empirical analyses, and find them to be important drivers of the innovation ratios. We also innovate from a methodological viewpoint. Our simple theory provides a framework which helps overcoming identification problems. These arise from the unobservability of the rate of return on venture capital investments when one cannot find convincing instruments to separate demand and supply effects. Looking at ratios only requires identifying the determinants of the composition, rather than the level, of venture capital investing—arguably a more tractable task. By taking a careful panel-data approach we also address another difficulty faced by previous studies: endogeneity.

We test our hypotheses using a panel of data from all the countries of the European Union, except Luxembourg, for the 14 years between 1988 and 2001. Our results provide several novel insights into how public policy can influece the creation of active venture capital markets. This is the first study to assess the effects of all the main available policies on venture capital markets within a comprehensive, rigorous framework.

First, we look at the taxation of capital gains, which has recently received considerable attention in theoretical studies of venture capital (e.g., Keuschingg and Nielsen (2003, 2004), Müller (2004)). Previous studies only looked at cross-sectional comparisons of taxation across OECD countries (Armour and Cummings (2003)). We are the first to extend the analysis to a panel data setting, by collecting country-level data which extend back to 1988. We find that a reduction in capital gains taxation increases both the high-tech and early stage ratios. Lower tax rates thus increase the relative attractiveness of high-tech and early stage investments, i.e., those which can result in a higher upside.

Second, we find that the opening of 'New' (stock) Markets in some countries since the mid 1990s helps explain the evolution of both the early stage and high-tech innovation ratios. Our panel setting provides the first rigorous test of the importance of an exit option for venture capital, as suggested by Black and Gilson (1998) and Michelacci and Suarez (2004).

Third, our data do not provide any evidence of a shortage of venture capital funds for European companies. Nor we find any evidence that public expenditure in research and development (R&D) favors the innovation ratios. We however caution that our approach, based on the identification of the innovation ratios, does not rule out a level effect of either the supply of funds or public R&D expenditure.

Our approch help us build on and improve from the previous literature. By focussing on active venture capital markets we look at the most relevant segment for economic growth. Our model provides us with a compelling framework to guide the empirical analysis. The resulting inclusion of new variables in the analysis makes this the first study to assess the effect of policy on venture capital in a comprehensive framework. Our panel approach avoids the endogeneity issues which made previous attempts, such as Jeng and Wells (2000), less than conclusive. The panel dimension also helps extend previous results. For instance, Gompers and Lerner (1998) also find that higher tax rates discourage venture capital investment, based on a panel of US states; however variation in state-level capital gains taxation is minimal and their results are likely to reflect simply variation across time in the federal tax rate. The greater diversity across EU countries makes our panel more appropriate and our results more convicing.

The rest of the paper is organized as follows. The next Section briefly describes recent policy programmes which attempt to create active venture capital markets. Section 3 presents our model and derives some testable predictions. Section 4 describes our data and empirical strategy. Section 5 reports our results, and Section 6 concludes.

2 Public policy for active venture capital markets

Economists are becoming increasingly interested in venture capital as a highly specialized form of financial intermediation. The interest of policy-makers, however, long predates that of academics. To the extent that growth depends on innovation and creative destruction, one could think of fostering productivity by channeling more funds into venture financing of technologically innovative companies. This reasoning has in fact held sweeping influence on policy. While venture capital was born in the U.S. out of private initiative (Gompers (1994)), its expansion and maturation benefited from the Small Business Innovation Research (SBIR) programme in the 1980s (Gans and Stern (2003), Lerner (1999)). Interestingly, the SBIR programme, which pioneered public policy towards venture capital, was largely motivated by the fear that insufficient financing was available to innovative small firms.

The perceived need to increase the supply of risk capital is probably the main motivation for public policy in favor of active venture capital markets. Such an approach has also informed recent public policy initiatives, most notably in Israel and Europe. In Israel, the Yozma programme, started in 1992, provided 100 million dollars of public funding to attract private funds for over 150 millions (Avnimelech and Teubal (2002)). Yozma helped create ten private venture capital firms and to jump-start a successful and active venture capital market. In 2001, the European Commission transformed the European Investment Fund (EIF) into Europe's largest venture investor with an injection of more than 2 billion euros (EIF (2002)), making the increase of the supply of risk capital one priority of its policy towards innovation and capital markets (European Commission (1998, 2003)).

This approach is shared also by other large national programmes, from Germany's federal and regional schemes for innnovative companies (German Federal Ministry for Economics and Technology (1999)), to the French 'Plan Innovation' (French Ministry of Industry (2003)), to the decision to turn Danish Growth Fund into a public venture fund in 2001 (Danish Growth Fund (2003)), and to the creation of the UK High Technology Fund (HM Treausury (2003)). Public programmes aimed at increasing the supply of venture capital have also been implemented in several emerging economies, from Chile to India (Carter, Barger, and Kuczynski (1996), Gilson (2003), Lerner and Schoar (2003)).

The economics foundations for such policies are however still unchecked. While venture capital may bring into being particularly innovative and dynamic companies, this does not imply that more funds would directly translate into a larger number of successful companies. Theory warns about the value-reducing effects of increasing the supply of funds to the venture capital industry when competition for good projects is high (Inderst and Müller (2004)). In such an environment, promoting innovation by increasing research and development (R&D) expenditure would be more effective than stimulating the funding of the venture capital industry.

Recent empirical work also casts doubts on the hope to increase investment into new ventures simply by increasing the supply of risk capital. Looking at U.S. sector-level data, Hirukawa and Ueda (2003) argue that, at the aggregate level, it may be innovation activity to lead the development of venture capital, and not *vice versa*. Gompers and Lerner (1998) emphasize the role of demand factors such as R&D expenditure in the development of the U.S. venture capital industry. Even some casual empiricism suggests the relevance of demand factors: the first venture capital firm was founded in 1946 in the U.S. to exploit new technologies developed during World War II (Gompers (1994)).

The view that demand factors may be important has also yielded influence over policy. In particular, the increase in R&D expenditure is seen as one of the main factors lying behind the arrival of new entrepreneurial opportunities. On these bases, the Barcelona European Council of March 2002 set the objective to increase the average investment in R&D in Europe from 1.9% to 3.0% by 2010, of which two thirds to be funded from the private sector (European Commission (2002)).

Two other factors have held influence over policies toward active venture capital markets. One is the need for appealing exit options. The realization of a large capital gain when bringing a company public is arguably the greatest incentive to venture investing. Moreover, venture capital should benefit from the ability to exit from investments when the marginal value of their time and money has started to decrease. Michelacci and Suarez (2004) formalize this notion, and show that active stock markets induce the development of a vibrant venture capital industry.[1] The Risk Capital Action Plan adopted by the European Commission in 1998, subscribed to this view and greatly influced national policies in the late 1990s (European Commission (1998)). The recent demise of the Neuer Markt and other European 'new' markets, however, cast serious doubts on the positive effect of this approach (Bottazzi and Da Rin (2004)).

Finally, the taxation of capital gains has long been pointed to as a driver of both entrepreneurship and investment (Poterba (1989), Gompers and Lerner (1998)). Recent theories argue in favor of exemption of capital tax gains on the ground of incentive effects for the provision of effort by venture capitalists (see Keuschnigg and Nielsen (2001) and Keuschnigg (2004) for overviews). Perhaps not surpisingly, the European Venture Capital Association has been the most vocal proponent of lighter taxation (EVCA (2002)). As we document in Section 4, public policy has been active also in this area, and capital gains taxation has been recently reduced in several countries.

Which of these approaches receives more, if any, support from the data is however unclear. This study provides new evidence in this respect.

[1] Brau, Francis and Kohers (2002) provide evidence that the capital gain from listing a company on the stock market is larger than when it is acquired through a 'trade sale.'

3 A model of venture capital markets

In this section we build on the seminal double moral hazard model of financial intermediation by Holmstrom and Tirole (1997) to study how the structure of venture capital investment reacts to changes in demand and supply. We start by summarizing the key ingredients of the model, which formalizes the idea that the ability to pledge collateral determines both the extent and the type of financing that a firm can obtain.

The model lasts two periods. In the first period financial contracts are signed and investments are implemented. In the second period uncertainty about project returns is resolved and payments are made. There is a continuum of firms which have access to a project that delivers a payoff equal to $R>0$ with probability p_H and to 0 otherwise. The cost of the investment is I. Therefore, firms need to borrow the amount $I-A>0$, where A denotes a firm's own equity capital which is pledged as collateral. We denote by $G(A)$ the cumulative uniform density of collateral for all types of firms.

Entrepreneurs are able to divert resources from the project and extract private benefits equal to $B>0$, which reduces the probability of success to $p_L<p_H$. Firms can borrow from arms' length ('uninformed') investors or from financial intermediaries. Uninformed investors simply provide funds and require a return γ, which reflects their opportunity cost of funds. Financial intermediaries provide funds and also monitor, which reduces private benefits to $0<b<B$, thus mitigating the moral hazard problem. In our setting, we identify financial intermediaries with venture capital firms.

We assume that only the good project is economically viable:

$$p_H R-\gamma I>0>p_L R-\gamma I+B \tag{1}$$

3.1 Direct finance

It is easy to show that some firms with low equity capital will not be financed by uninformed investors, because their equity capital is not high enough to generate the correct incentives for entrepreneurs to behave diligently. Let R_f be the share of the payoff retained by the firm, and $R_u=R-R_f$ the share paid out to uninformed investors. A necessary condition for being financed by these investors is that the firm, which gets paid R_f only if the project succeeds, prefers not to shirk:

$$p_H R_f \geq p_L R_f+B \quad or \quad R_f \geq \frac{B}{p_H-p_L}$$

A necessary and sufficient condition for a firm to be financed by uninformed investors is then:

$$\gamma(I-A) \leq p_H R_u = p_H\left[R-(\frac{B}{p_H-p_L})\right]$$

which says that the market value of the loan (the left hand side) cannot exceed the firm's pledgeable expected income (the right-hand side). Thus, firms are able to raise finance from uninformed investors if and only if:

$$A \geq \overline{A}(\gamma) = I - (\frac{p_H}{\gamma}) \left[R - \frac{B}{p_H - p_L} \right]$$

where $\overline{A}$ is increasing in γ.

3.2 Venture capital finance

Credit rationing of firms with collateral lower than $\overline{A}$ creates a role for monitoring by financial intermediaries, which in our context we interpret to be venture capital firms. A monitored entrepreneur chooses not to shirk only if:

$$p_H R_f \geq p_L R_f + b \quad \Leftrightarrow \quad R_f \geq \frac{b}{p_H - p_L}$$

Let R_{pe} be the share of the payoff paid out to the venture capital firm. Given that monitoring has a private cost $c > 0$, the venture capitalist will monitor only if her expected payoff satisfies:

$$p_H R_{pe} - c \geq p_L R_{pe} \quad \Leftrightarrow \quad R_{pe} \geq \frac{c}{p_H - p_L} \tag{2}$$

Therefore, the rate of return to venture capital, denoted by β, is given by:

$$\beta = p_H R_{pe} / I_{pe} \tag{3}$$

where I_{pe} is the amount of funds borrowed by monitored firms. Using equations (2) and (3), we see that the value of I_{pe} adjusts to satisfy the incentive compatibility constraint of the venture capitalist, so that:

$$I_{pe}(\beta) \geq \frac{c p_H}{\beta(p_H - p_L)} \tag{4}$$

Private equity finance costs more than uniformed capital, since it must compensate for monitoring effort. It follows that in equilibrium I_{pe} takes the lowest possible value which allows venture caitalists to recover its monitoring costs, the residual financing needs of a firm being provided by cheaper uninformed capital. Equation (4) thus holds as an equality.

A necessary and sufficient condition for a firm to be financed by both uninformed investors and venture capitalists is then:

$$A \geq \underline{A}(\gamma, \beta) = I - I_{pe}(\beta) - (\frac{p_H}{\gamma}) \left[R - \frac{b + c}{p_H - p_L} \right]$$

It can be shown that $\underline{A}$ increases in both its arguments, so that more projects become credit constrained as the rate of return required by either type of investor increases. Panel (a) of Figure 3 represents the financing modes of firms', depending on their own equity capital.

3.3 Equilibrium

The aggregate demand for uninformed capital, denoted by $D_u(\gamma, \beta)$ is the sum of two components. The first is the demand from monitored firms, i.e. firms with $\underline{A}(\gamma, \beta) < A < \overline{A}(\gamma)$. This amounts to $(I - A - I_{pe})$. The second component is the demand from firms which can afford not to resort to venture capital , i.e. firms with $A > \overline{A}(\gamma)$. This amounts to $(I - A)$. We can then write:

$$D_u(\gamma, \beta) = \int_{\underline{A}(\gamma,\beta)}^{\overline{A}(\gamma)} [I - A - I_{pe}(\beta)]\, dG(A) + \int_{\overline{A}(\gamma)}^{\infty} [I - A]\, dG(A)$$

The market for uninformed capital clears when demand equals supply:

$$D_u(\gamma, \beta) = S(\gamma) \tag{5}$$

where $S(\gamma)$ denotes the supply of uninformed capital, with $S'(\gamma) > 0$. The aggregate demand for venture capital is given by:

$$D_{pe}(\gamma, \beta) = \left[G(\overline{A}(\gamma)) - G(\underline{A}(\gamma, \beta))\right] I_{pe}(\beta) \tag{6}$$

which is increasing in p_H and decreasing in β. In equilibrium, this is equal to the supply of private equity, K_{pe}, which is fixed in the short run. This assumption is similar to that of limited supply of venture capitalists imposed by Michelacci and Suarez (2003). It reflects the notion that it takes time to increase the supply of specialized intermediaries. While 'money is green,' venture capital requires considerable experience and skills (Bottazzi, Da Rin, and Hellmann (2003)), which need time to accumulate. Panel (b) of Figure 3 represents the private equity market.

We denote by D_i the demand for funds for different types of venture capital investment, where $i = ES, HT$. We then define D_i as innovative investment, characterized by collateral lower than a constant A^*, with $\underline{A} \leq A^* \leq \overline{A}$:

$$D_i(\gamma, \beta) = [G(A^*) - G(\underline{A}(\gamma, \beta))]\, I_{pe}(\beta) \tag{7}$$

and study the structure of venture capital investment, which is mirrored in the 'innovation ratio:'

$$\frac{D_i}{D_{pe} - D_i}(\gamma, \beta) \equiv \frac{[G(A^*) - G(\underline{A}(\gamma, \beta))]}{\left[G(\overline{A}(\gamma)) - G(A^*)\right]} \tag{8}$$

Finally, the market clearing condition for all types of external finance is then:

$$D_u(\gamma, \beta) + D_{pe}(\gamma, \beta)) \equiv \int_{\underline{A}(\gamma,\beta)}^{\infty} [I - A]\, dG(A) = S(\gamma) + K_{pe} \tag{9}$$

Panel (c) of Figure 3 represents the equilibrium of financial markets when the supply of uninformed capital is infinitely elastic. This is not an unrealistic case because the market for private equity is small relatively to that for uninformed capital - hence the return to uninformed capital may well be insensitive to the return to private equity. This assumption is maintained below, also because proofs (in the Appendix) become simpler. However results carry over to the case of an elastic supply of uninformed capital[2].

Proposition 1 *The innovation ratios decrease following a reduction in either the supply of venture capital funds (K_{pe}) or projects' expected return (R), as firms with low own equity capital are denied credit.*

These two cases are portrayed in Panels (d) and (e) of Figure 3, respectively.This proposition establishes that more innovative investment - being characterized by lower collateral - is most sensitive to variations in the supply of private equity capital and in project returns.

3.4 Equilibrium with excess supply of venture capital

The occurrence of excess supply of private equity may not be unrealistic, since there is evidence pointing to a 'money chasing deals' phenomenon in both the 1980s and 1990s in the U.S. industry (see Gompers and Lerner (2000), Kaplan and Stein (1993)).We thus consider the case when the supply of venture capital exceeds its demand at the minimum rate of return acceptable to a venture firm.[3] This rate is given by $\underline{\beta} = \gamma \frac{p_H}{p_L}$, and is such that venture capitalists have an incentive to monitor rather than becoming an uninformed investor. It is thus increasing in γ.

The market clearing condition for all types of funds becomes:

$$\int_{\underline{A}(\gamma,\underline{\beta})}^{\infty} [I - A]\, dG(A) = \int_{\underline{A}(\gamma)}^{\infty} [I - A]\, dG(A) = S(\gamma) + K_{pe} \tag{10}$$

where $\underline{A}(\gamma) \equiv \underline{A}(\gamma,\underline{\beta})$ is increasing in γ, so that the total demand for funds is decreasing in γ. This condition uniquely determines the equilibrium rate of return on uninformed capital. Notice that the lowest possible value of $\underline{A}(\gamma,\underline{\beta})$ is reached when $\beta = \underline{\beta}$, everything else being constant. The largest number of firms is thus getting financed by venture capital in the case of an excess supply of funds, since $\overline{A}(\gamma)$ is independent of β. The excess supply of venture capital funds, $K_{pe} - D_{pe}(\gamma,\underline{\beta})$, is invested in firms with own capital above $\overline{A}$, earning a return γ.

We now examine the effects of an increase in K_{pe} on the equilibrium allocation when $K_{pe} > D_{pe}$ at $\beta = \underline{\beta}$.

Proposition 2 *(i) A contraction in the supply of venture capital funds does not affect the innovation ratios; (ii) a reduction in project return R decreases the innovation ratios.*

We refer the reader to Figure 4.

[2]Restrictions must then ensure that the supply of capital to firms is more sensitive to shocks when collateral is lower.

[3]This case is not discussed by Holmstrom and Tirole (1997), who focus on asymmetric responses of β and γ to credit crunches. These rates always move together when there is excess supply of private equity funds.

3.5 Discussion and extensions

According to our model, the response of the innovation ratios to supply and demand shocks depends on the situation characterizing the venture capital market. Indeed, a reduction in either K_{pe} or R reduces the share of investment in venture-backed firms if there is no excess supply of venture capital. On the contrary, a reduction in K_{pe} does not affect the innovation ratios, while a reduction in R does, if venture capital money is chasing deals.

This insight is unlikely to be affected by the simplifying assumptions imposed in the model. For instance, if project returns were less than perfectly correlated, risk averse intermediaries could exploit diversification (Cerasi and Daltung (2000)), but the flavour of our results would not change. Fixed project size is in turn a typical maintained assumption in models with credit rationing (Stiglitz and Weiss (1981).)[4]

We could also generalize the setting to two types of firms, where type I firms depend mainly on investment in intangible assets, whereas type T firms depend mainly on investment in tangible assets. The amount of own equity capital A is distributed according to a cumulative density function $G_j(A)$, where $j = I, T$. We assume that $G_T(A)$ dominates $G_I(A)$ in a first order stochastic sense, i.e., $G_I(A) \geq G_T(A)$ for all A. This assumption makes clear that type I firms are systematically less able than type T firms to pledge collateral. This naturally reflects that entrepreneurial firms which invest in intangible assets have a lower ability to pledge assets against loans than more mature firms which invest largely in tangible assets. The cumulative density for all types of firms would then obtain as $G(A) = G_I(A) + G_I(A)$.

The assumptions of fixed monitoring effort, fixed monitoring cost and discrete extraction of private benefits can be altered—along the lines suggested by Holmstrom and Tirole (1997)—without changing Proposition 3. Indeed, suppose that firms have a continuum of bad projects (with low probability of success), that yield different levels of private benefits b. Suppose also that monitoring at the intensity level c eliminates all projects with private benefits in excess of $b(c)$. Consider the level c_0 as being the level associated with $\underline{A}(\gamma, \beta)$. Then any firm with $A > \underline{A}(\gamma, \beta)$ will choose to increase its private benefits, thus reducing the intensity of monitoring. Indeed, the incentive compatibility constraint for the venture capitalist is satisfied at a lower level of expected payoff :

$$R_{pe} \geq \frac{c^{-1}(b)}{p_H - p_L}$$

and accordingly the amount provided:

$$I_{pe}(\beta) \geq \frac{c(b)p_H}{\beta(p_H - p_L)}$$

Thus firms that have larger equity capital will be able to extract larger private benefits and get less funds at the higher equilibrium rate β. On the contrary, firms such that

[4]An extension to variable project size is proposed by Holmstrome and Tirole (1997). A constant return to scale technology is assumed for tractability, at the cost of eliminating differences across investment types - which is what is of interest to us. Indeed firms with different equity capital are assumed to choose the same optimal investment policy, and are not being hit in a different fashion by changes in the supply of funds.

$A = \underline{A}(\gamma, \beta)$ cannot invest unless they obtain the level of monitoring funds associated with c_0.

4 Data and empirical strategy

4.1 Data sources and description

Our analysis is based on a balanced panel of data gathered from several sources. We consider all the EU countries, with the exception of Luxembourg, and the years between 1988 and 2001. The EU constitutes an ideal set of countries to look at for our pourposes. Venture capital investment in Europe has increased substantially over the 1990s (Bottazzi and Da Rin (2004)). As we discussed in Section 2, public policies have been quite active in many European countries. Moreover, the EU forms a relatively homogeneous group of economies which share broadly similar institutions and are linked by a common market. At the same time, there has been a substantial variation over time not only in the evolution of the venture capital markets but also in our explanatory variables: taxation, public R&D spending, and the availability of stock markets for entrepreneurial companies [5]

Our first source is the European Venture Capital Association (EVCA), whose yearbooks constitute the backbone of our database. These data come from an extensive yearly survey of member and non-member firms.[6] Yearbooks report data on a number of variables, organized by country. For each year and country, we look at the reported amount of total funds invested. This is divided into five categories: seed, start-up, expansion, replacement capital, and buyouts. We define venture capital (VC) to be the sum of the first four categories, and non-venture private equity to equal the last one. The sum of venture and non-venture private equity investments is referred to as (total) private equity (PE). We then partition venture capital investments into early stage (ES)–equal to the sum of seed and start-up investments–and late stage (LS)–equal to expansion investments and replacement capital.

We then define high-tech investments (HT) as the sum of investments in the following sectors: communications, computer related, other electronics related, biotechnology, medical and health related. Low-tech investments (LT) are the investments in the remaining sectors: energy, consumer related, industrial products and services, chemicals, industrial automation, other manufacturing, transportation, financial and other services, agriculture, and construction. Finally, we define the Early-Stage Ratio as the ratio of ES to VC, and the High-Tech Ratio as the ratio of HT to PE.[7]

[5] We do not include in our analysis the US, which constitute the world's largest private equity market, because the available data (collected by the National Venture Capital Association, NVCA) have been coded with different definitions than those of the EVCA. Moreover, the NVCA does not report non-venture private equity investments, so that we would not be able to compute the high-tech and the venture capital ratios for this country.

[6] For details on the EVCA database, and for definitions of variables, see the methodology section of EVCA (2001).

[7] Ideally, we would like to be able to measure the High-Tech Ratio as the ratio of HT to VC. A limitation

Our measure of the funds raised by venture capital firms is the total amount of funds raised from all sources by a country's private equity firms in given year.[8] We express all values in euros, using the synthetic euro index of Datastream for the conversion.

Our measures of capital gains taxation come from the *Worldwide Corporate Tax Guide*, published each year by Ernst&Young, a leading tax consulting firm. Each year, the *Guide* reports for over 140 countries the main corporate tax rates, including capital gains. Country information is compiled by Ernst&Young local offices, which ensures high professional standards and consistency, both over time and across countries.

From the OECD Basic Science and Technology Statistics database we obtain data on country-level total research and development (R&D) expenditure, business and government R&D, and R&D in higher-education.

From Datastream we also download population and price indices for all countries. We use population to express values in per capita terms, and price indices to obtain constant 2000 values. The following are formal definitions for all the variables we use in the analysis:

- PRIVATE EQUITY (PE_{it}) is the amount of funds invested in private equity in country i at year t. It includes both venture capital and non-venture private equity investments.

- VENTURE CAPITAL (VC_{it}) is the amount of funds invested in venture private equity in country i at year t.

- EARLY STAGE (ES_{it}) is the amount of funds invested in early stage venture private equity in country i at year t.

- HIGH-TECH (HT_{it}) is the amount of funds invested in high-tech private equity in country i at year t.

- ES-RATIO (ESR_{it})is the ratio of ES_{it} toVC_{it}.

- HT-RATIO (HTR_{it})is the ratio of HT_{it} toPE_{it}.

- CAPITAL GAINS TAX RATE (CGT_{it}) is the capital gains tax rate in country i at year t.

- SUPPLY OF FUNDS (INF_{it}) is the amount of funds raised by the private equity industry in country i in year t. It is normalized by the country's population in year t.

- PUBLIC R&D STOCK (RD_{it}) is the stock of public and academic expenditure in R&D in country i in year t. It is normalized by the country's population in year t. In the Appendix we describe the methodology we use to build RD_{it}.

of the EVCA data is that they do not provide a separate sectoral disaggregation for venture and non-venture private equity.

[8]Note that while funds invested are recorded according to which countries they go into (the 'country of destination' criterion), funds raised are recorded by the country where the venture firm is based (the 'country of management criterion,' see EVCA (2001)). Baygan and Freudenberg (2000) discuss the importance of cross-border capital flows.

- NEW MARKET (NM_{it}) is a dummy that takes value 1 if a 'New Market' is available for firms to list in country i at year t.

4.2 Empirical strategy

Our empirical strategy is guided by the attempt to assess, with the guidance of our model, the effects of alternative policies on venture capital markets. The innovation ratios form the cornerstone of our analysis. A first reason for this is that we are interested in the effects of policy not on the size of venture capital markets *per se*; rather, we want to understand the extent to which a larger size of venture capital markets translates into more early stage and high-tech investments. The ratios capture precisely this effect.

But there are also methodological reasons for our emphasis on ratios. Focussing on ratios helps us to overcome identification problems. The unobservability of the rate of return on venture capital investments, together with difficulty to find at least one variable which affects only demand or only supply makes disentangling the effects of shifts in supply and demand difficult (see Hellmann (1998)). By looking at the *composition*, rather than at the level, of venture capital investing, we only need to identify the effects of supply and demand conditions on the innovation ratios. While this is econometrically less ambitious than the identification of the underlying structural model, it leaves us with a more compelling analysis.

We thus estimate reduced form regressions which contain several unobservable variables. Our panel estimation methodology allows us to disregard country specifi and time-invariant (or slowly varying) factors. However, it does not protect us from the effects of time-varying factors. Since our panel is relatively long (fourteen years), and contains a period when several reforms have been implemented, we run the risk that some slowly-moving factors which affect our variables—like bureaucracy, legal systems, entrepreneurial quality, and even bankruptcy laws (see Armour and Cummings (2003))—may have changed considerably.

Our focus on ratios thus minimizes the mispecification risk, since it allows to omit time-varying country specific explanatory variables that equally affect the numerator and the denominator and which could be endogenously determined with it. Such an approach thus exploits the time-series dimension ('within' estimates) of our data, and asks which genuinely time-varying factors are responsible for the evolution of the innovation ratios, and thus for the development of active venture capital markets. We then use country fixed effects to identify time-invariant (or slowly varying) factors such as the industrial specialization of individual countries.

Our model suggests that an increase in the innovation ratios could be achieved in two ways. First, by increasing projects' expected return, and second, if there is no excess supply of monitoring capital, by channeling more funds towards the private equity industry. We address the empirical relevance of these two channels by estimating several versions of the following panel data equation:

$$y_{it} = \mathbf{x}_{it}^{'}\beta + y^{'}\mathbf{d}_t + \varepsilon_{it} \quad (11)$$

$$\varepsilon_{it} = \eta_i + \nu_{it} \quad (12)$$

where y_{it} denotes either the early stage or the high-tech ratio, and $\mathbf{x}_{it}$ is a vector of time varying country specific characteristics including CAPITAL GAINS TAX RATE

(CGT_{it}), PUBLIC R&D STOCK (RD_{it}), NEW MARKET (NM_{it}), and the SUPPLY OF FUNDS (INF_{it}). As discussed in Sections 2.3 and 2.4, the first three variables should affect positively our ratios through projects' expected return, whereas the latter is expected to be positively signed only if there is no excess supply of informed capital. To control for common aggregate effects we also include a full set of time dummies, where $\mathbf{d}_t$ is a $T \times 1$ vector with 1 in the t-th position and 0 otherwise. Finally, we model the error term, ε_{it} as the sum of an individual country's heterogeneity component, η_i and an idiosyncratic error term, ν_{it}.

We recover estimates of the parameters of interest by applying the so-called within-group estimator. This estimation method allows individual (country) heterogeneity to be freely correlated with the observable components of the model. As we have noticed, this is particularly important in our case since there are country specific time invariant (or at least slowly evolving) unobservable variables that are potentially correlated with some of the regressors. On the other hand, the identification of structural effects through regression coefficients in deviations from country-specific means depends on the lack of correlation between the regressors and the idiosyncratic error term at all leads and lags. This strict exogeneity assumption rules out the possibility that current values of some of the variables in the $\mathbf{x}$ vector are influenced by past idiosyncratic errors. In our context, this does not seem an unrealistic assumption, since a transitory shock to the innovation ratios is unlikely to affect present and future institutional decisions on capital gains taxation, public R&D expenditures or on the opening/closing of a local New Market. Notice that, in order to respect the requirement of strict exogeneity of the regressors, we normalize RD_{it} and INF_{it} by population and not by GDP.[9]

4.3 Descriptive statistics

We start exploring our data by looking at the facts which motivate our analysis. Table 1 shows descriptive statistics for our main variables. It should be noted that less than a quarter of venture capital investment goes to early stage projects, and less than a third of the total private equity investment finances high-tech projects. Table 2 provides some insights into the structure of our data. For both innovation ratios, we notice some variability across countries which conforms to our intuition. Such cross-country variability naturally asks for an explanation. This would require suitable data to identify the determinants of variations between countries. Given the difficulty to identify, and even more importantly obtain, such variables, we prefer to explore the time dimension of the data. We control for this by using time-invariant country-level effects, such as those of institutional factors and managerial skills.

Two Figures look at the evolution over time for the aggregate of the 14 countries we consider. Figure 1 plots the two private equity ratios, and Figure 2 the total supply of funds into private equity. What stands out is the sharp upturn in the supply of funds starting in 1996 and its equally sharp fall since 2001, which is mirrored in the sharp drop in all the two private equity ratios. At first sight, this evidence suggests that the supply

[9]Previous studies of the effects of public policy on venture capital—Armour and Cumming (2003), Gompers and Lerner (1998), Jeng-Wells (2000)—disregarded the need to abide by the requirement of strict exogeneity, and used GDP as a regressor.

of funds may in fact pose a binding constraint on investment. The two Figures provide evidence of a positive relationship over time between the supply of private equity funds and the early stage and high-tech ratios. Whether this visual evidence can be given a structural interpretation is a task we pick up in our regressions.

I would comment on the graphs and use them as both motivation–we want to say what inspired as and why Europe is a very good field to explore–and anedocatal evidence we want to delve into.

5 Regression results

5.1 Main results

Results from the estimation of different versions of equation (11) are presented in Tables 3 and 4. Each Table refers to a specific ratio, and reports estimated coefficients together with the corresponding standard errors. In each Table fours sets of estimates are reported under different concepts of the supply of funds variable (columns *(i)* and *(ii)*) or under different country or time stability assumptions (columns *(iii)* and *(iv)*) for the supply of funds variable, INF. In particular, in the first and second columns either INF_{it} alone, or INF_{it} and its lagged value INF_{it-1} enter the model.

Column *(iii)* allows the parameter on the supply of funds variable to assume different values during the years of the 'stock market bubble' of the late 1990s, which we identify with 1997 through 2000, compared to the other years in the sample period. Analogously, in Column *(iv)* the same parameter is allowed to differ between the countries with a relatively less mature private equity industry (Austria, Belgium, Finland, Germany, Greece, Italy, Portugal and Spain) and the other countries in the sample (Denmark, France, Iceland, Ireland, Netherland, Norway, Sweden, Switzerland, United Kingdom).[10] With these two equations we want to explore the possibility that evidence in favour of the 'no excess supply' of venture capital hypoyhesis is more likely to be found in countries with a less mature venture capital industry or/and in the years when financial markets are not booming.

Notice that, since (unreported) time dummies are included in all equations, our estimates genuinely pick the effects of changes in our explanatory variables. For example, the effects of the availability of a 'New' stock market targeted at entrepreneurial companies are captured beyond what one might fear is a common cyclical trend. The time dummies also suggest that a spike in the private equity ratios has occurred between 1996 and 2000, confirming the visual evidence of Figure 2.

Our main results can be summarized as follow. We find convincing evidence that two types of policy have an important effect on the innovation ratios: the taxation of capital gains and the opening of 'New' stock markets. First, the coefficients of the capital gains tax have a negative effect on the ratios which is highly statistically significants in all specifications. The intution behind this result is that investing in early stage and high-tech companies offers the greatest opportunity for capital gains, so that a lower tax

[10] Countries are included in the 'less mature venture capital industry' category if the country average value for the INF variable (net of capital gains) is below the sample median.

rate makes these investments more attractive relative to other private equity deals. This result corroborates the provious finding by Gompers and Lerner (1998), who looked at US data. However, their finding was based on a panel of US state-level data, where the variation in capital gains is very small; therefore they mainly relied on a short time-series of federal-level variations in capital gains taxation which left them with very few degrees of freedom. Our data provide a more comforting setting for a panel analisis.

Second, we also find the opening of a 'New' market to have a positive and significant effect on both the early stage and the high-tech ratios. This provides the first formal test of the model by Michelacci and Suarez (2004) that formalizes the crucial role of exit for the very functioning of venture capital markets. This results also suggest a more sobering approach to the critiques of the recent experience of the 'New' stock markets, which often focus on the (politically sensitive) issue of losses to individual investors. Our results provide a different perspective.

In all reported equations the supply of funds variables are never statistically different from zero. This holds for both innovation ratios and it is robust to the alternative definitions and time/country stability assumptions described in the previous paragraph. Therefore we do not find evidence supporting the 'no excess supply' of venture capital hypothesis in Europe during our sample period. Finally, the stock of public R&D capital is found to have a negligible effect on the innovation ratios.

Column *(ii)* of both Tables takes care of the well known fact that the funds raised by venture capital companies in one particular year are not necessarily invested in the same year (Gompers and Lerner(2000)). This may suggest that our baseline static model suffers from a dynamic misspecification problem. To address this additional concern we rerun all our equations after including the once lagged variable, INF_{it-1} to the original specification. Once again, this does not alter significantly our overall results. Columns *(iii)* and *(iv)* re

5.2 Robustness checks

In this Section we address several methodological concerns about our main results. To do so we develop, but do not report, variations of our base regressions.

First, our findings might not be robust to alternative definitions for some of the innovation ratios. In particular, it might be argued that the replacement capital component should be excluded from the pure venture capital activity. This, in turn, would alter both the numerator and the denominator of the early stage to venture capital ratio, ESR. To address this legitimate concern we rerun all our reported equations after redefining the relevant ratios. Our findings are virtually unaltered.

The same occurs if we disaggregate the effects of different sources of funds to single out the funds supplied by institutional investors and by the government.[11] It can be argued that these two catergories may have different goals than other investors, and therefore instruct ventur fund managers to comply with different objectives (see Mayers, Schoors, and Yafeh (2002)). In particular, institutional investors have a longer run perspective

[11]The EVCA data breaks the sources of funds into the following categories: realized capital gains, corporations, individuals, government agencies, banks, pension funds, insurance companies, funds of funds, academic institutions, capital markets.

than others, and the government may also be more interested in the creation of long-run growth opportunities than the sheer maximization of profits. However, when we separate these two categories from the total supply of funds, we do not find any significant changes, and the significance of these two new variables is far from any acceptable level.

We also explore in our context the results of Gompers and Lerner (1998) on the role of pension funds. They show that the clarification of the 'prudent man rule' in the context of the Employment Retirement Income Security Act brought to a surge of pension fund investments in venture capital. To date, pension funds remain the largest single source of venture capital in the US (NVCA (2003)). Several countries in Europe began reforming the structure of their social security system from pay-as-you-go to funded in the 1990s. As a consequence, the financial assets of pension funds have increased. This may have a substantial impact on the funding of venture capital, if pension funds are allowed to invest in it. In EU member states the dominant principle governing asset allocation of pension funds is the prudent man rule. Thus these institutions are allowed to invest in venture capital, as long as adequate diversification is maintained. Member states are allowed to impose quantitative limits to investments and several do regulate portfolio shares allocated to closed funds. We then isolate the supply of venture capital which comes from pensin funds. We find no evidence of a distinct role of pension funds in our data.

We also check the robustness of our results when the supply of funds variable include realized capital gains, and find comforting evidence.

Another important concern is that the real bottleneck is not money but people. Michelacci and Suarez (2004) do stress the human factor in financial intermediation, whose empirical importance is documented in Bottazzi, Da Rin, and Hellmann (2004). To address this issue, we collect a panel of data consisting of the number of venture capital firms which are members of the European Venture Capital Association. We then use this variable in alternative to the supply of funds. The resulting estimates confirm our main results by not showing any sign of a shortage.

One specific concern can be raised in relation to the Early Stage Ratio. It is well known that venture-backed companies typically receive staged financing (Gompers (1995)). This means that the company will receive funds over several rounds across a few years. Since the company would then progressively mature from the seed or start-up stages to later stage deals there is clear suspicion that the figures for late stage financing simply reflect 'life-cycle' effects and not investment decisions by the venture capitalists. We can control for this important observation by including in our regressions for the ES Ratio the lagged values of the absolute amount of early stage investments, with both one and two lags. We are comforted by noticing that our results are unchanged.

Finally, one could be concerned that our results are driven by a single country. We can easily discard this possibility by re-running our regressions excluding one country at a time. Overall, therefore, our results appear to be consistently robust to a variety of checks.

6 Conclusion

In this paper we study the determinants of the structure of private equity investment. We first extend the model introduced by Holstron and Tirole (1997) in their seminal paper with the purpose of accommodating a number of relevant features of the private equity market. This allows us to derive two main predictions on the relationship between the expected return of fundable projects, the supply of private equity funds and the composition of private equity investment. We then test these predictions against a panel of European countries over 1988-2001. We find surprising results. First, policy variables affecting the expected return of fundable projects alter the composition of private equity investment in favor of projects with less collateral, e.g., early stage projects in high-tech industries. In fact, both the availability of a viable exit channel—which we proxy with the presence of a New Market—and a decrease in capital gains taxation raise the share of early stage and high-tech investments. By contrast, the stock of public R&D hold no effect on the innovation ratios. Second, we argue that the association between the amount of funds raised in the industry and the composition of private equity investment which is observed in the aggregate data cannot be given a structural interpretation. This in turn not only implies that we do not find strong evidence supporting the "no excess supply hypothesis" but it also casts more than a passing doubt on those public policies whose main aim is to channel more funds to the private equity industry.

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Appendix

Proof of Proposition 1

(i) HT (1997) show that $\underline{A}$ increases when K_{pe} contracts (and viceversa). Since γ is exogenous, then $\overline{A}$ is unaltered and both total private equity investment, D_{pe}, and the P.E. ratio unambiguously fall.

(ii) HT (1997) show that less capitalized firms are squeezed out wher R falls. Since K_{pe} is constant and fully invested in monitoring projects, total private equity investment is unaffected, implying that the P.E. ratio falls.

Proof of Proposition 2 :

(i) A decrease in K_{pe} - such that the excess supply of overall funds persists - causes an adjustment in S at $\gamma = \gamma_0$ so as to counterbalance the fall in private equity funds invested as uninformed capital and satisfy the market clearing condition: $\int_{\underline{A}(\gamma_0)}^{\infty}[I - A]dG(A) - K_{pe} = S(\gamma_0)$.

Thus γ is unchanged, implying that $\underline{\beta}$ is unaffected, total demand for funds and its components are unchanged and ΔK_{pe} is fully invested as uninformed capital.

(ii) A fall in project return R reduces aggregate investment, due to an increase in $\underline{A}(R,\gamma)$ given γ. Its value can be found by substituting the expression for $\underline{\beta}$ into equation (7): $\underline{A}(\gamma) \equiv \underline{A}(\gamma, \underline{\beta}) = I - \frac{c}{p_H - p_L} - (\frac{p_H}{\gamma})[R - \frac{b+c}{p_H - p_L}]$. Moreover, $\overline{A(R,\gamma)}$ increases by the same amount as $\underline{A}(R,\gamma)$, so that private equity investment is unaffected while the P.E. ratio unambiguously falls.

Construction of the R&D Capital Stock

The public R&D capital stock (RD_{it}) (measured at the end of period t) in real terms is computed by a perpetual inventory method with a constant rate of depreciation ($\delta = 0.15$). The values of R&D public expenditure in local currency at current prices (R_{it}) are available for each country from 1981 onward from OECD Basic Science and Technology Statistics database. We deflate these data by using a country specific R&D deflator (P_{it}). The benchmark for the first year used in estimation (RD_{i87}) is then calculated by summing up the real expenditures from 1981 to 1987 appropriately depreciated:

$$RD_{i87} = \sum_{t=1981}^{1987} (\frac{R_{it}}{P_{it}})(1-\delta)^{1987-t} \tag{A1}$$

For subsequent years, the standard accumulation equation has been used:

$$RD_{it} = (1-\delta)RD_{it-1} + \frac{R_{it}}{P_{it}}, t = 1988, ..., 2001 \tag{A2}$$

Finally, real R&D capital stock data have been made comparable across countries by applying the 2000 exchange rate with the euro.

Table 1: Aggregate descriptive statistics

	Mean	Median	Min	Max	*Obs*
High-tech ratio	0.293	0.246	0.000	0.972	*196*
Early stage ratio	0.223	0.187	0.000	1.000	*196*
Capital Gain Tax Rate	.351	.350	.190	.500	*196*
Public R&D stock	17.454	17.522	.997	56.408	*196*
Supply of Funds	0.287	0.087	0.000	4.975	*196*
New Market dummy	0.245	–	0	1	*196*

Note: High-tech ratio is the ratio of high-tech to total private equity investments. Early stage ratio is the ratio of early stage to total venture investments. The capital gain tax rate is the rate applied to short term capital gains. Public R&D stock is the stock of public expenditure in research and development per inhabitant, as defined in the Appendix. Supply of funds is the per capita supply of funds, measured in millions of year 2000 euros. The New Market dummy equals one for all country-years for which a 'new market' is open for companies to list; for this variable the Mean column reports the frequency..

Table 2: Innovation ratios, by country

		High-tech		*Early stage*	
Country	*Obs.*	Mean	St.D.	Mean	St. D.
Austria	*16*	0.48	0.33	0.33	0.27
Belgium	*13*	0.42	0.19	0.25	0.13
Denmark	*14*	0.45	0.24	0.30	0.18
Finland	*15*	0.41	0.14	0.38	0.16
France	*16*	0.28	0.11	0.17	0.12
Germany	*16*	0.31	0.18	0.24	0.12
Greece	*8*	0.27	0.19	0.26	0.10
Ireland	*16*	0.41	0.30	0.22	0.19
Italy	*16*	0.13	0.12	0.16	0.09
Netherlands	*16*	0.30	0.09	0.19	0.06
Portugal	*16*	0.15	0.13	0.18	0.09
Spain	*16*	0.15	0.10	0.24	0.17
Sweden	*16*	0.26	0.16	0.19	0.15
UK	*16*	0.21	0.08	0.13	0.08

Note: High-tech ratio is the ratio of high-tech to total private equity investments. Early stage ratio is the ratio of early stage to total venture investments.

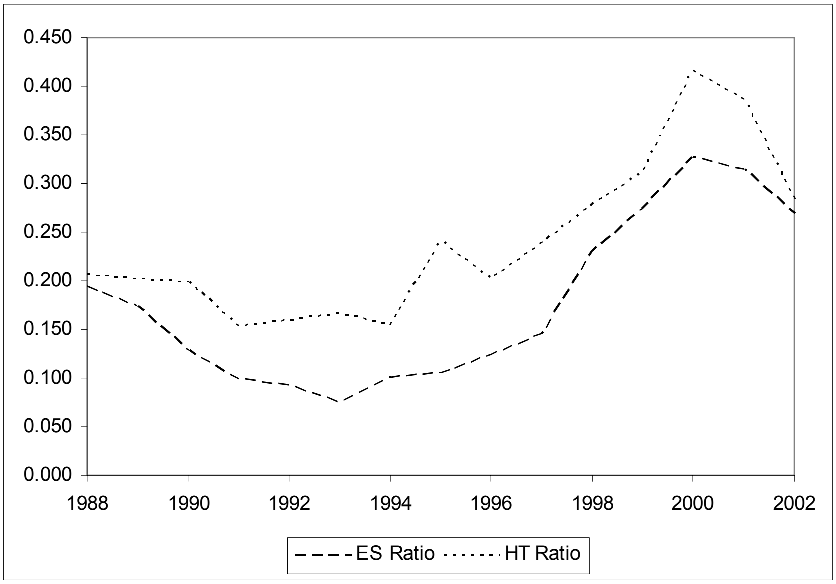


Figure 1:

Figure 1: Innovation ratios over time

Note: All Ratios are computed for the aggregate of the 14 countries we consider. The ES Ratio is defined as the ratio of ES_t *to* VC_t*. The HT Ratio is defined as the ratio of* HT_t *to* VC_t*. The Supply of Funds is the amount of funds raised by the European private equity industry. It is normalized by the European population.*

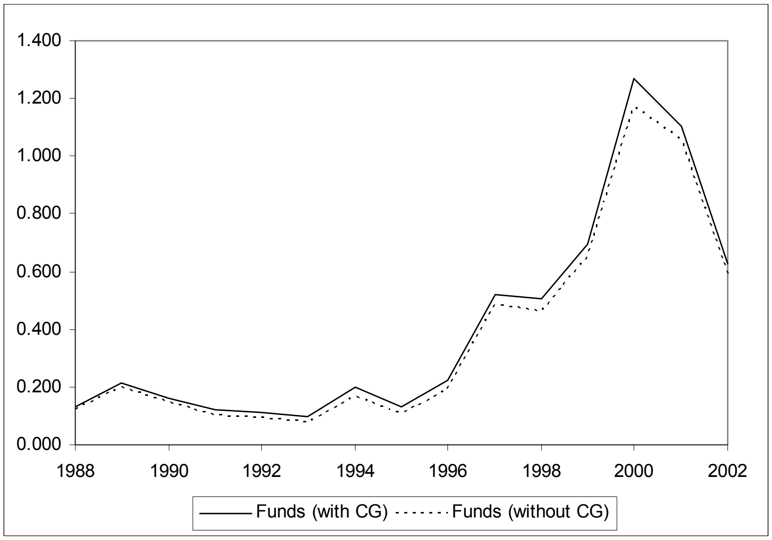


Figure 2:

Figure 2: Supply of funds over time

Table 3: Estimated Equations for the HT–RATIO (HTR_{it})

	(i)	*(ii)*	*(iii)*	*(iv)*
CGT_{it}	–0.013***	–0.013***	–0.013***	–0.012***
	(0.003)	(0.003)	(0.003)	(0.003)
NM_{it}	0.094**	0.093*	0.097**	0.089*
	(0.046)	(0.057)	(0.046)	(0.046)
RD_{it}	–0.001	–0.001	–0.001	–0.002
	(0.006)	(0.006)	(0.006)	(0.006)
INF_{it}	–0.019	–0.017		
	(0.027)	(0.039)		
INF_{it-1}		–0.001		
		(0.050)		
$INF_{it} * B_{it}$			–0.026	
			(0.032)	
$INF_{it} * (1 - B_{it})$			–0.010	
			(0.035)	
$INF_{it} * D_{it}$				–0.031
				(0.029)
$INF_{it} * (1 - D_{it})$				–0.031
				(0.023)
Time dummies included	Yes	Yes	Yes	Yes
F-test on regressors	[0.00]	[0.00]	[0.00]	[0.00]
F-test on INF$_{it}$ and INF$_{it-1}$	–	[0.82]	–	–
F-test on time dummies	[0.04]	[0.05]	[0.04]	[0.02]
F-test on individual effects	[0.00]	[0.00]	[0.00]	[0.00]
Number of observations	196	179	196	196

*Note: CGT_{it} denotes the capital gain tax rate in country i at time t. NM_{it} is a dummy variable which takes value 1 if a 'New Market' is available for firms to list in country i at time t and zero otherwise. RD_{it} is the per capita stock of public R&D expenditure in country i at time t, measured in millions of 2000 euros. INF_{it} is the per capita supply of funds in country i and time t net of capital gains, measured in millions of 2000 euros. B_{it} is a dummy which takes value 1 in the years between 1997 and 2000, and 0 otherwise. D_{it} is a dummy variable which takes value 1 for those countries where the venture capital industry is perceived as relatively mature and 0 otherwise. Time dummies included in all equations. Standard errors (probability levels) in round (squared) brackets. *, **, and *** denote 0.10, 0.05, and 0.01 significance levels.*

Table 4: Estimated Equations for the ES–RATIO (ESR_{it})

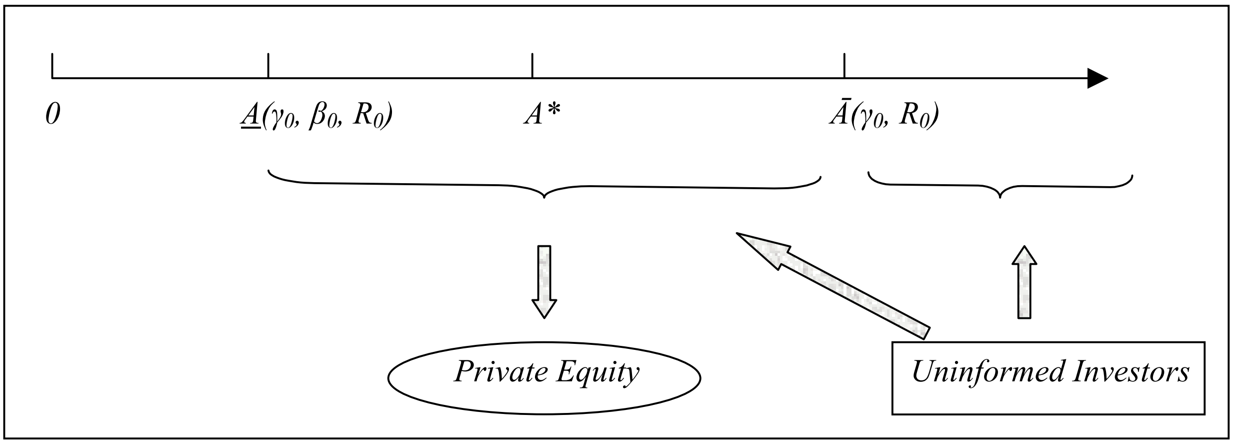
	(i)	*(ii)*	*(iii)*	*(iv)*
CGT_{it}	–0.007***	–0.007***	–0.007***	–0.007***
	(0.002)	(0.002)	(0.003)	(0.002)
NM_{it}	0.100***	0.080**	0.105***	0.098***
	(0.038)	(0.034)	(0.038)	(0.038)
RD_{it}	0.002	0.004	0.003	0.002
	(0.005)	(0.004)	(0.005)	(0.005)
INF_{it}	0.015	0.016		
	(0.022)	(0.029)		
INF_{it-1}		-0.004		
		(0.036)		
$INF_{it} * B_{it}$			0.003	
			(0.027)	
$INF_{it} * (1 - B_{it})$			0.030	
			(0.029)	
$INF_{it} * D_{it}$				0.010
				(0.024)
$INF_{it} * (1 - D_{it})$				–0.108
				(0.188)
Time dummies included	Yes	Yes	Yes	Yes
F-test on regressors	[0.00]	[0.00]	[0.00]	[0.00]
F-test on INF$_{it}$ and INF$_{it-1}$	–	[0.78]	–	–
F-test on time dummies	[0.00]	[0.00]	[0.00]	[0.00]
F-test on individual effects	[0.00]	[0.00]	[0.00]	[0.00]
Number of observations	196	179	196	196

*Note: CGT_{it} denotes the capital gain tax rate in country i at time t. NM_{it} is a dummy which takes value 1 if a 'New Market' is available for firms to list in country i at time t and zero otherwise. RD_{it} is the per capita stock of public R&D expenditure in country i at time t, measured in millions of 2000 euros. INF_{it} is the per capita supply of funds in country i and time t net of capital gains, measured in millions of 2000 euros. B_{it} is a dummy which takes value 1 in the years between 1997 and 2000, and 0 otherwise. D_{it} is a dummy variable which takes value 1 for those countries where the venture capital industry is perceived as relatively mature and 0 otherwise. Time dummies included in all equations. Standard errors (probability levels) in round (squared) brackets. *, **, and *** denote 0.10, 0.05, and 0.01 significance levels.*

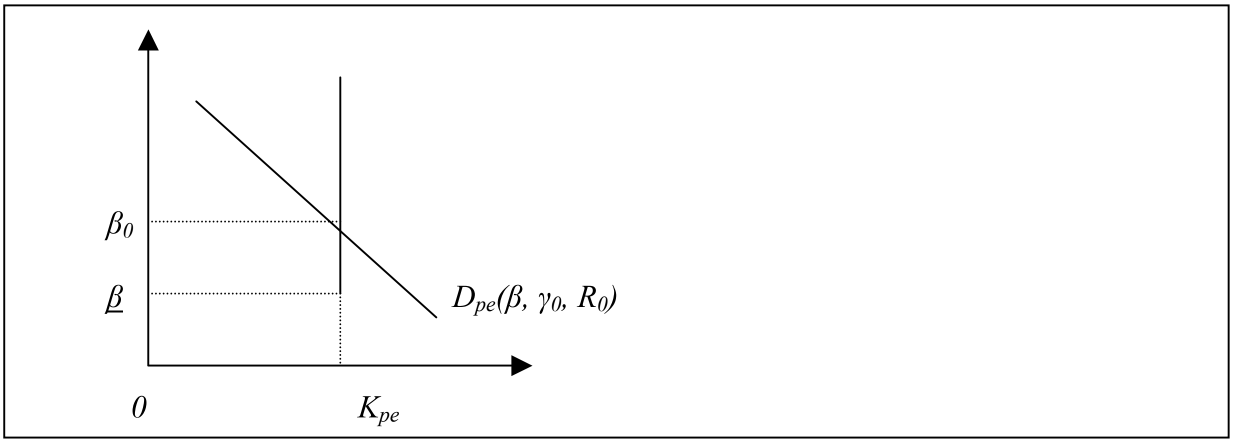
Figure 3

This figure portrays the equilibrium in financial markets when the supply of funds to PE is fully invested in PE projects. A represents firm equity capital, γ is the rate of return to informed financing, β is the rate of return to PE financing, R is the return on investments, D_{pe} and K_{pe} are the demand and supply of funds to the private equity industry, S is the supply of informed capital.

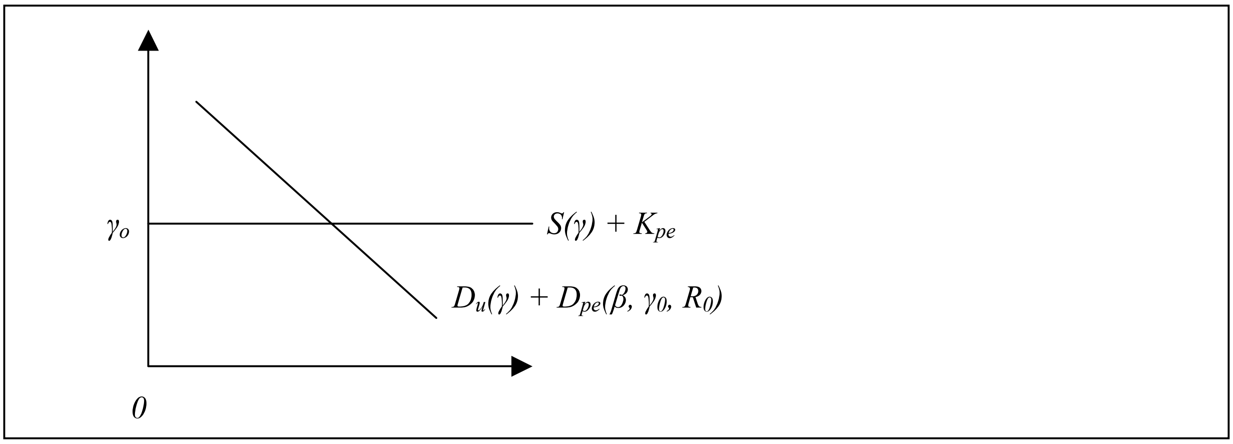
Panel (a). Financing mode of firms, depending on their equity capital A.



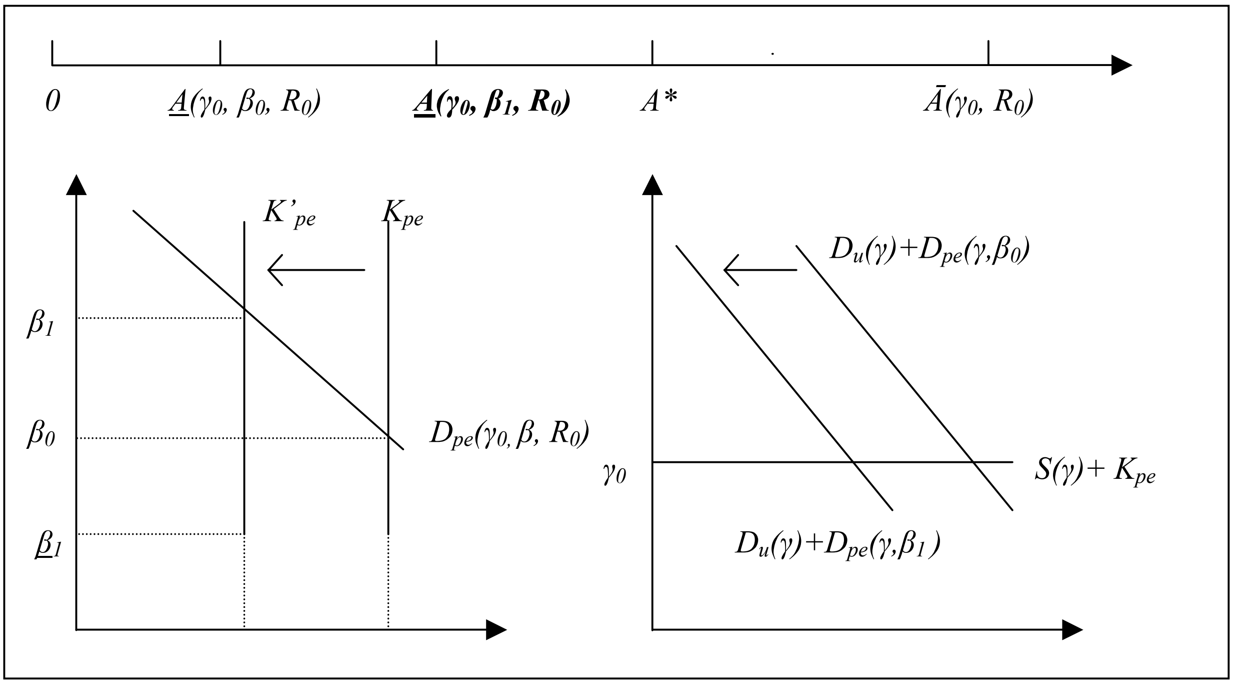
Panel (b). Private equity market when K_{pe} is fully invested in monitoring capital.



Panel (c). Financial market equilibrium, when $S(\gamma)$ is infinitely elastic at rate γ_0.



Panel (d). A reduction in K_{pe} is associated with an increase in β and a reduction in aggregate investment. Moreover the private equity ratios fall because $\underline{A}$ increases with constant $\bar{A}$.



Panel (e). A reduction in R causes an increase in both $\underline{A}$ and $\bar{A}$, a reduction in β_1 and an associated reduction in the private equity ratio.

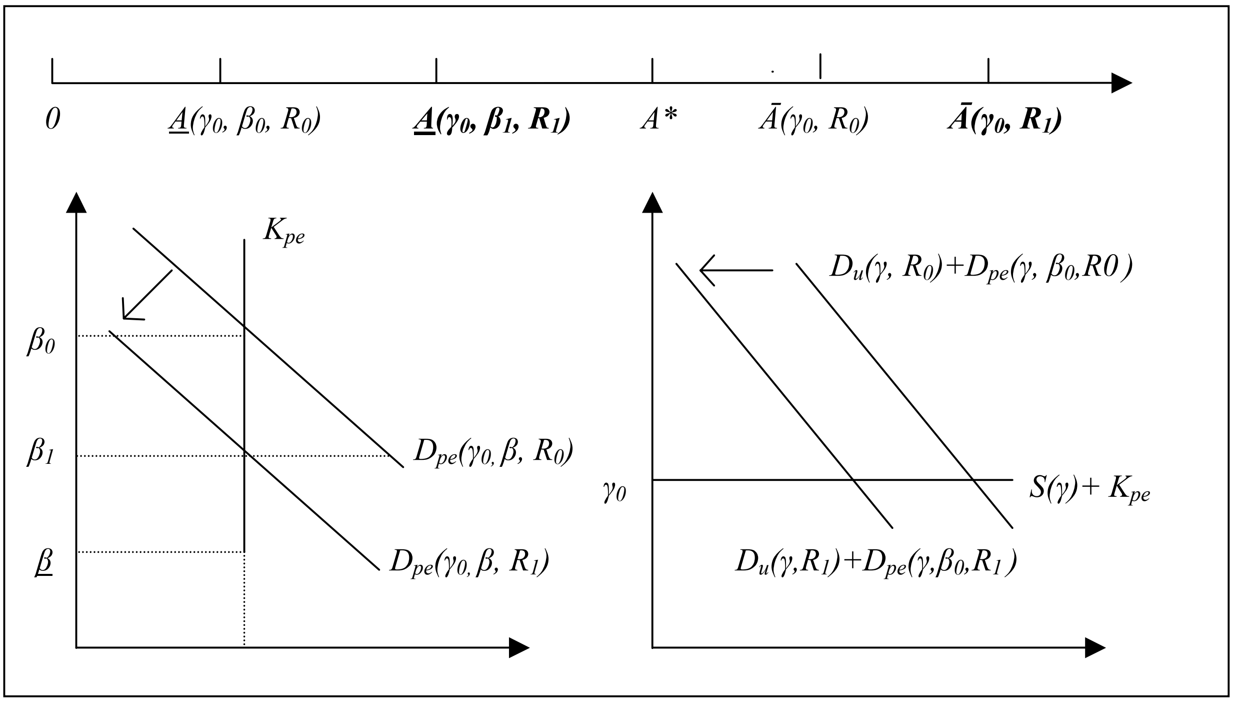
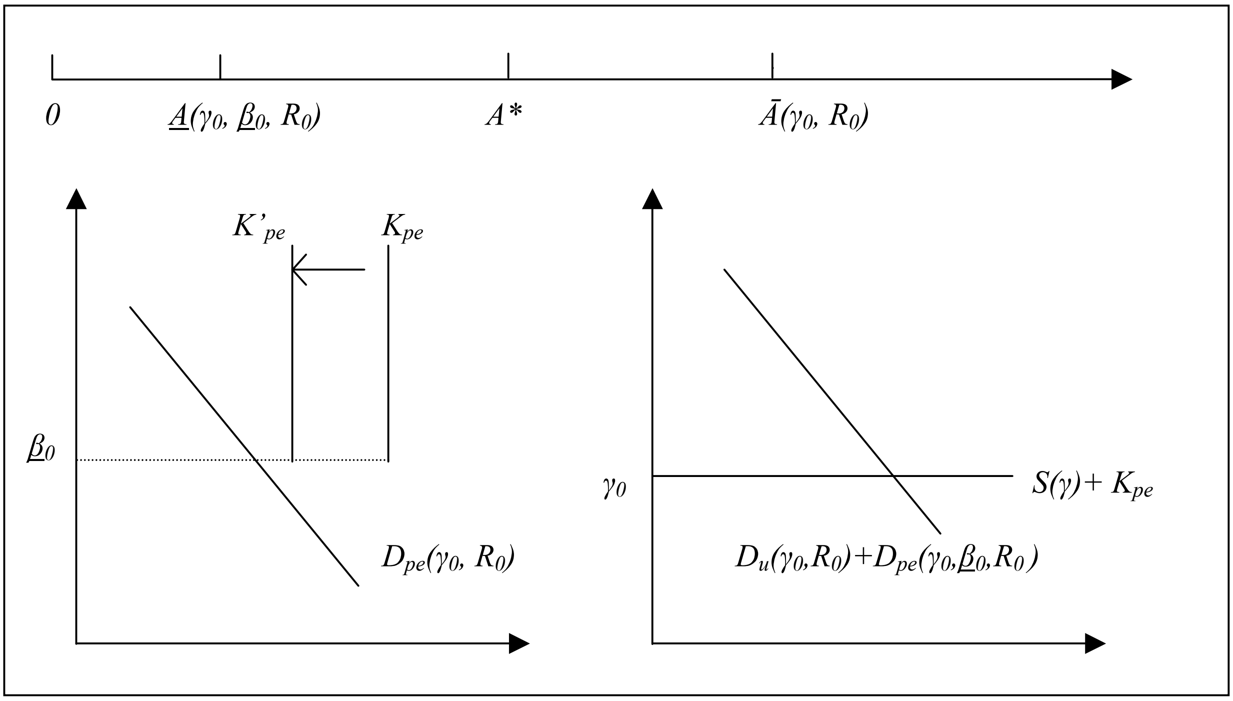


Figure 4.
This figure portrays the financial market equilibrium when there is an extra supply of funds to the PE industry.

Panel (a). When K_{pe} falls and the excess supply persists, nothing changes in the allocation.



Panel (b). Effects of a reduction in R.