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Has Europe Been Catching Up? An Industry Level Analysis of Venture Capital Success over 1985 – 2009[f]

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Résumé

Après deux décennies de leadership des États-Unis dans les années 1980 et 1990, les marchés européens de capital-risque ont-ils comblé une partie de leur retard en termes de nombre de financements accordés et d'issues réussies de ces financements, ou l'écart est-il plus grand que jamais? Peut-on voir des nouvelles encourageantes dans la situation globalement sinistrée que traverse actuellement le capital-risque ? Nous nous efforçons de répondre à ces questions, en suivant un échantillon de plus de 40.000 entreprises financées par capital-risque pour six industries et dans 13 pays européens ainsi qu'aux Etats-Unis. En particulier, nous déterminons quel type de sortie du fond – lorsqu'elle a eu lieu - les investisseurs ont choisi pour chaque entreprise sur la période 1985-2009. Nos résultats empiriques suggèrent que: (i) les investisseurs européens ont réduit leur retard en termes de nombre d'entreprises soutenues par les capital-risqueurs qui sont finalement introduit publiquement en bourse, quoique ceci aille de pair avec une dégradation globale du nombre d'entrées en bourse ; (ii) l'Europe reste derrière les États-Unis en ce qui concerne les fusions et acquisitions ainsi que pour sorties de fonds réussies des startups, (iii) le montant moyen investi ainsi que les dépenses de recherche & développement sont des déterminants importants de la réussite du capital-risque, mais ils ont un impact positif seulement après 2000, et (iv) les différences idiosyncrasiques entre industries semblent être plus pertinentes que les caractéristiques spécifiques à chaque pays pour expliquer les différences dans la performance.

Mots-clés: capital-risque; capital d'investissement (private equity); taux de réussite; performance; introduction publique en bourse

Codes JEL: G24, G3

Abstract

After nearly two decades of U.S. leadership in the 1980s and 1990s, are Europe's venture capital markets in the 2000s finally catching up regarding the provision of financing and successful exits, or is the performance gap as wide as ever? Are we amidst overall dismal performance of the venture capital experience without any encouraging news? We attempt to answer these questions by tracking down over 40,000 venture capital--backed firms of six industries in 13 European countries and the U.S., and determine which type of exit – if any – each particular firm's investors have chosen between 1985 and 2009. Our empirical findings suggest that: (i) in terms of the number of venture capital-backed firms successfully going public, European venture capitalists have closed the gap with respect to the U.S., albeit as a result of a worse initial public offering performance overall; (ii) Europe continues to lag behind the U.S. by means of mergers and acquisitions, and in successful exits of seed/start-up and early stage firms, (iii) average investment and R&D are important determinants of venture capital success, but only have a positive impact after 2000; and (iv) idiosyncratic differences across industries seem to be more relevant than country-specific characteristics in explaining differences in performance.

Keywords: Venture capital; private equity; success rates; performance; IPOs

JEL Classification Codes: G24, G3

I Introduction

Entrepreneurship, innovation, and venture capital (VC) are pivotal to success in economic development, as they provide for wealth creation and a rising standard of living. Over the past decade, extensive research has been done to compare the performance of VC financing in European Union (EU) countries to those in the U.S. (Black and Gilson, 1998; Bottazi and Da Rin, 2002; Da Rin, Nicodano and Sembenelli, 2006; Aussenegg and Jelic, 2007; Hege, Palomino and Schwienbacher, 2009). Differences in stock market development, contract and tax legislation, labor market regulations, and entrepreneurial spirit, have been often cited in connection to the consistent underperformance of European VC investments relative to their American counterparts. Even as recently as the pre-crisis period of 2005-2007, there have been no signs of a decrease in the performance gap between European and Americian VC investments (Raade and Dantas Machado, 2008).

Although VC financing has experienced rapid growth over the last two decades (Aizenman and Kendall, 2008; Kraeussl and Wuebker, 2011), the literature is still lacking a comprehensive analysis of whether this performance gap is not solely explained by a "Europe is lagging behind" argument, but may also be attributable to industry-specific and/or financing stage specific characteristics. Therefore, the objective of our study is to determine whether VC-backed companies active in specific industries across countries and within countries are more likely to become profitable so that venture capitalists can exit successfully.

A typical VC fund is liquidated after one decade. Consequently, if a VC-backed portfolio company does not have sufficient potential to be exited before the end of a decade, a venture capitalist is unlikely to invest in the company. Successful exits are critical to these investors to ensure attractive returns and, in turn, to raise additional capital. However, interest in certain industries by public investors is susceptible to change and, as such, it is not equally easy to exit investments of all types at all times (Maksimovic and Pichler, 2001). For example, in recent years, 'hot issue markets' like Computer Hardware, Biotechnology, Multimedia, and Internet companies have appeared and disappeared. Concerns about the ability to exit investments may have led to too many

private equity transactions being undertaken in these 'hot' industries (Gompers and Lerner, 2000; Lerner, 2002). On the flip side, industries that are not in the public spotlight may have received only insufficient funds. This causes an imbalance in the distribution of VC across different industries.

We explore whether venture capitalists in certain industries are more likely to exit their investments via initial public offerings (IPOs), sales, or by means of leveraged buy-outs (LBOs). To this end, we examine VC investments and exits in the U.S. and 13 EU countries over the period 1985-2009, while further classifying firms into six distinct industries. The wide dimensionality of our data set (whose characteristics we describe in detail in Section II) allows us to uncover significant relationships and common factors that lead to VC-backed firms completing the exit phase. We also seek to understand the institutional features and the legal environment associated with successful VC financing in the U.S. and in Europe.

Another relevant issue that we address in this paper is the asymmetry in performance between VC-backed firms at different investment stages (i.e., seed/start-up and early stage firms versus mature firms) and its effect on the performance gap. As shown by Jeng and Wells (2000), early and later stage venture investments are affected quite differently by the determinants of VC. Hence, we intend to find out whether the weak performance of European early stage venture investments relative to the U.S., as documented by Raade and Dantas Machado (2008), is more prevalent in certain industries.

To the best of our knowledge, our paper provides the first comprehensive comparative analysis between the success of European and American VC-backed portfolio companies. This allows us to uncover relationships and common factors that lead to a successful exit of VC-backed portfolio companies and, as a result, strong performance by VC funds. We control for industry-specific factors, investment stage, macroeconomic conditions, and the legal environment in the European countries and the U.S. that are known to affect the exiting environment. First, we explore for which industries the difference in success between VC-backed companies from 13 EU countries and the U.S. are most prominent and for which industries the performance gap is smallest. Subsequently, we try to identify whether perceptible differences exist between

the successes of VC-backed companies that have received financing at an early stage vis-à-vis those that have received financing at a later stage. Finally, we break our sample into two sub-periods, 1985-1999 and 2000-2009, in order to explicitly analyze whether the performance gap has narrowed (for specific industries) or, in other words, whether Europe has been able to catch up over the last years.

Our results suggest that, inasmuch as some of the differences in performance can be explained by country-specific factors (in particular, when considering early stage companies) there exist significant idiosyncratic differences in success across industries. We find that, for instance, venture capitalists invested in companies active in the Biotech and the Health, Medical and Life Science sectors are significantly more likely to successfully exit these investments via IPOs, while those invested in companies active in the Computer industry and in the Communications and Media sector are more likely to successfully exit via mergers and acquisitions. Significant differences across industries also emerge when considering early stage versus later stage VC-backed companies and the preferred method of exit.

The findings of our sub-period analysis show that during the second sub-period of 2000-2009 the difference between the success of European and American VC-backed companies became smaller and that Europe indeed has been able to catch up. The number of European companies that received VC financing is almost at par with their American counterparts. Furthermore, successful exits by IPOs have converged as well although overall they have shown a worse performance relative to the first sub-period. However, with regard to exits by mergers and acquisitions of VC-backed companies the U.S. has clearly retained its edge over Europe.

The remainder of this paper is organized as follows. In Section II we provide an overview of the data used in this study followed by a description of how we construct the different variables associated with VC success rate. Our initial empirical results based on a set of summary statistics are discussed in section III while section IV presents the results of our regression analyses based on probit models that allow us to identify the relative importance of different determinants in the probability of successful exit. Finally, section V concludes.

II. Data and Measures

II.1 Sample

Our sample covers the period 1985-2009 and includes data on exits of VC-backed firms and several determinants for the U.S. and 13 EU countries (Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom). The remaining two of the original EU-15 countries – Greece and Luxembourg – were excluded from the analysis as a result of missing information for some variables. From here on out, we will refer to the group of 13 European countries that make up our sample as EU-13.

Data on VC-backed companies stem from VentureXpert, which includes data on VC and private equity firms, funds, financing rounds, industry benchmark statistics, and more. The variables include company specific information such as nation, date of the first round of financing, industry classification, and outcome/exit. Data on country specific variables (Gross Domestic Product, Population, and Research and Development figures) are obtained from Euromonitor and the SourceOECD database. We control for three legal system variables in our study: *Rule of Law* and *Creditor Rights* originate from the seminal paper by La Porta, Lopez-de-Silanes, Shleifer and Vishny (1997), while a revised index for *Anti-Director Rights* was obtained from Spamann (2010). The use of these variables in controlling for performance in financial markets has been motivated by the works of La Porta, Lopez-de-Silanes, Shleifer and Vishny (1998), Cumming, Fleming and Schwienbacher (2006), and Bottazzi, Da Rin and Hellmann (2009).

In total, we have data on the evolution of 41,266 firms that received VC funding over the period 1985-2009. This data allows us to determine which investments venture capitalists exited – if at all – and how. Table I summarizes the composition of this data set; the statistics are presented by country, stage of development of the firm when it received its first round of VC financing (seed, start-up and early stage, or mature), and by industry. This latter classification is explained in more detail below. As expected, most VC-backed companies have their origin in the U.S. (27,583 making up approximately 2/3 of the entire sample). In contrast, for Portugal and Austria we collected information on only 250 and 222 firms, respectively.

<Insert Table I about here>

Given that this paper seeks to determine whether industry-specific factors play a significant role in determining the likelihood of a successful venture exit, it would be beneficial to obtain as many independent industry-specific variables as possible that match the industry categories used by VentureXpert. Following Gompers, Kovner, Lerner and Scharfstein (2008), we group firms into categories that exhibit similarities in technology and management expertise. To link the industry trend data to the firms obtained from VentureXpert we matched ISIC codes with the VentureXpert industry classifications as follows. We initially mapped out a categorization table of the VentureXpert industry classification system from its most broad level 'Major Group' down to the most detailed level titled 'Sub-category 3'. Then, by evaluating each line on the ISIC category list, we assigned them to their appropriate VentureXpert Sub-category 3 listing. The outcome is the classification into six main industry groups: *Computer Software and Hardware*; *Semi-conductors and Other Electronics*; *Biotechnology*; *Medical, Health and Life Sciences*; *Communications and Media*; and *Non-high Technology*. This allows us to keep the main recipients of VC disbursements (Gompers and Lerner, 2001) separated, while allowing for a reasonable level of aggregation in the data that will assist us in our empirical analysis.

Table I also indicates that for both the EU-13 and the U.S non-high tech is the sector with most transactions, while the smallest number of VC-backed firms can be found in semi-conductors and other electronics, and the biotech industry. Moreover, we can see a similar amount of infant firms (infant firms include seed, start-up, and early stage companies) as mature firms for the case of the U.S. In sharp contrast, there exists roughly a 5-to-2 ratio of mature vis-à-vis infant firms in the case of the EU-13, revealing a bias against the provision of early-stage financing in Europe.

In our empirical analysis, we split our sample into two sub-periods, 1985-1999 and 2000-2009, which allows us to explicitly investigate whether Europe has been able to catch up with the U.S. with respect to successful exits of VC-backed firms. We note that it is unlikely that venture capitalists have exited firms that received their initial funding (i.e. first financing round) in recent years. Including these companies would likely bias

our results downward. In order to address this issue, even though we consider exits that have occurred up until July 2009, we exclude from the sample companies that have been operating for less than 4 years after receiving their final round of venture funding. Hence, our sample includes companies that received funding through 2005 and exits that took place through July 2009. Other than correcting for this potential downward bias, an additional advantage of this sample split is that it provides an almost equal distribution of transactions across the two periods. We examine 20,283 firms that received VC between 1985 and 1999, and 20,983 that were VC-backed in or after the year 2000. We provide further details as to the composition of the data per sub-period in Section III.

II.2 Measuring Success

Studies that have analyzed to date historical performance for European and American VC investments utilize diverging computation methods for returns and, thus, varying results. In particular, issues regarding definitions, investment classification and valuation but also self-reporting and survivorship biases make these performance figures difficult to compare. Previous studies that have dealt with how to compute returns on VC investments include Cumming and MacIntosh (2003), who examine a sample of 248 hand-collected VC exits in Canada and the U.S., and Cochrane (2005), who analyzes exits using VentureOne data. In order to measure success of an investment, ideally one would require data on the actual returns on venture capital funds' investments. Unfortunately, this is not possible because neither VentureOne nor VentureXpert, the two main databases, collect valuation data on all the companies that are or have been part of a VC fund. Therefore, we proceed to measure success as a binary variable: whether a venture capitalist has exited an investment; and if so, we also record the exit strategy present.

Following Gompers et al. (2008), our proposed measure of 'success' takes the type of exit of a particular company into consideration. We define S*uccess by IPO (S1)* as the number of firms that received VC financing, and were exited via IPO. *Success by Merger or Acquisition (S2)* is defined analogously, this time considering VC-backed firms that were either merged with or acquired by other firms. Finally, we introduce a measure of *Overall Success (OS)*, which is the sum of *S1* and *S2*.

We make one further classification, which consists of separating the performance of infant firms that received VC financing, from the performance of mature firms. For all company data we recorded whether the firm was seed/start-up or early stage at the time it received its first VC investment. *Success of Infant Firms (IS)* is computed as the number of seed, start-up, and early stage firms funded by venture capitalists who exited the firm by taking it public, or through a merger or acquisition. Similarly, *Success of Mature Firms (MS)* is computed as the number of mature firms funded by venture capitalists who exited the firm through any of the two above-mentioned channels.

The success variables are constructed by analyzing the final sample of VC-backed companies, where the investment domiciles are set equal to the companies' nations. The success variables are then ordered by country, by year, and by industry to obtain a success rate, which is defined as the number of VC-backed companies that were successfully exited in a given year for a given country divided by the total number of VC-backed companies for that given year and country. The year specified in this case is set to be equal to the year in which the firm received its first round investment. This means, for example, that the future success of all companies that received their first round of financing in the year 2000 would be attributed to the year the first investment round was received, in this case 2000, irrespective of the year in which they exited.

III Have European Countries Closed the Performance Gap?

In this section we provide a first answer to the questions as to whether there still exists a gap between the success rates of U.S. and European VC-backed portfolio companies; if this discrepancy has become more or less pronounced; and whether this can be explained by industry and/or investment stage specific characteristics by analyzing a set of sample statistics. We will begin by providing a comparison between the success rates by IPO (S1) and Merger and Acquisition (S2) of U.S. and European VC-backed companies over the two sub-periods. Then, we will explore whether a company's investment stage affects the likelihood for success. Finally, we will present a comprehensive industry-by-industry analysis of success rates across the two regions, exit strategies, investment stages, and

periods. The insights gained here will form the basis of the subsequent comprehensive regression analyses, which we perform in section IV.

III.1 Comparison of Success Rates by Exit Strategy

We begin by providing a comparison between the performance of the U.S. and European countries over the entire period of study, comparing their performances in both sub-periods. Table II presents a breakdown of success rates of both U.S. and EU-13 VC-backed companies by exit strategy.

<Insert Table II about here>

As suspected, the table reveals that the sub-period analysis is indeed a story of two tales. Until 1999, it is clear that the U.S. dominates Europe in most relevant categories: for every European firm receiving VC financing between 1985 and 1999, more than four American firms were financed during that same period. During that same span, while American firms backed by VC were taken public in 22 percent of the occasions and another 29 percent had been merged with or were acquired by one or more other firms, the corresponding numbers for European companies are 15 and 20 percent, respectively. This confirms what had been documented in previous studies (Black and Gilson, 1998; Murray and Marriott, 1998; Bottazi and Da Rin, 2002). Finally, LBOs were particularly prevalent in the case of European firms (over 17 percent), but almost non-existent when considering American firms (less than 2%). These results are also in line with the seminal paper by Pagano, Panetta and Zingales (1998) and the recent empirical findings by Brau and Fawcett (2006) and Bancel and Mittoo (2009) who present in a survey of chief financial officers (CFOs) substantial differences regarding the preferred exit strategy. European CFOs favor maintaining control of the firm while American CFOs value the ability of the pre-IPO investors to exit and experience significant changes in ownership structure after the IPO.

Starting from the year 2000, our findings in Table II show that the VC success story has been a more balanced one – albeit not quite as successful as between the mid-1980s and late 1990s. The number of European firms backed by VC is roughly equal to

that of their American counterparts. The number of exits by IPO has also converged, although to a very low level of about six percent for all firms receiving funding; in fact, the average success rate for the 13 European countries is slightly higher than that for the U.S. Nevertheless, this mostly reflects a "cooling down" in overall IPO activity, as documented by Ritter and Welch (2002) and Gompers et al. (2008).

Regarding mergers and acquisitions of VC-backed firms, a slowdown is also observable, albeit much less dramatic compared to the slowdown in IPO activity. Here, the U.S. has clearly retained its edge over Europe: while nearly 22 percent of American firms have merged or have been acquired by others, their European counterparts have only exhibited a less than 11 percent success rate during the same period. For illustration and comparison purposes, we once again report the percentage of exits via LBOs, which remained basically unchanged for European countries (16 percent), and slightly increased in the case of American firms to 5 percent. This is indicative that exit strategies chosen differ substantially between the U.S. and Europe: while acquisitions and mergers are more prevalent in American VC-backed firms, LBOs are a more frequent event for their European counterparts. We note that since LBOs do not necessarily constitute a successful exit, we do not include them when computing overall success for the reminder of the analysis.

III.2 Comparison of Success Rates by Investment Stage

Another decomposition that is worthwhile analyzing is whether the relative maturity of a firm receiving VC financing affects its likelihood of success. Jeng and Wells (2000) describe how early and later stage ventures are affected quite differently by the determinants of VC. To assess whether there are differences by areas and periods, Table III displays the comparison of VC investments and success rates between the U.S. and Europe separating infant and mature firms.

<Insert Table III about here>

During the period between 1985 and 1999, roughly an equal number of mature vis-à-vis infant firms were financed in the U.S. On the contrary, for the average 13

European countries, mature firms receiving VC funds outnumbered infant firms by a larger than 3-to-1 ratio. However, given that the success rate for infant firms was slightly higher than that of mature firms for European countries (while it was roughly similar for the U.S.), the "survival" or ex-post ratio – i.e. the ratio of successful mature firms to infant firms – fell to 2.83 in Europe, while remaining close to par in the case of the U.S.

The analysis of the second period paints a grim picture for infant firms in Europe: even though the ex-ante ratio between mature and infant firms is lower starting in 2000 (2.32), much of the underperformance in this period is due to the relatively low success rate for infant firms in Europe. Table III indicates that less than 1 in 8 infant firms exited either via IPO or M&A, while almost twice as many mature firms had a successful exit via these two channels. The outcome is that successful mature firms outnumber successful infant firms in Europe by nearly a 4-to-1 ratio; in contrast, for the U.S. the ex-post ratio after 2000 is again close to 1.

The above-described results are consistent with previous findings in the literature: seed/start-up and early stage firms in Europe largely underperform in comparison to their American counterparts (see Murray and Marriott, 1998, for evidence for the period between 1991 and 1997, and Raade and Dantas Machado, 2008, and Hege et al., 2009, for more recent evidence). In contrast, mature VC-backed firms have shown between 20 and 30 percent probability of success both in Europe and the U.S.

III.3 Comparison of Success Rates by Industry

This section investigates whether there are significant differences in performance across the six different industries. Focusing on the first sub-period, our empirical findings included in Table IV provide an industry-by-industry summary analysis for 1985-1999. Our results show that the U.S. outperforms Europe in success by acquisition in all sectors, and in success by IPO (albeit only marginally in computer hardware and software; medical, health and life sciences; and communications and media). Moreover, the U.S. outperforms Europe in success of early-stage firms, and in success of mature firms.

<Insert Table IV about here>

Table IV also indicates that exit by acquisition had a higher rate of success than exit by IPO, except for VC-backed Biotech firms and, to a lesser extent, in the Medical, Health, and Life Sciences sector. Exit by IPO, as documented by Gompers and Lerner (1998), provides significantly higher returns when compared to other exit strategies. The observation that the Biotech sector is the "best" performer comes as no surprise - over the last decade, this sector has been identified as one of the thriving new industries in the U.S. (Gordon, 2002; Guo, Lev and Zhou, 2005). Similarly, in the case of Europe, its characteristics confirm that it is one of the most dynamic industries. According to Popov and Roosenboom (2009), as of 2005, 55% of Biotech companies in Europe were less than 5 years old, the rate of new business incorporation was 14% on average, 44% of Biotech employees in Europe have been actively involved in research and development (R&D), and the industry spent 7.5 billion Euro on R&D in 2004 alone, becoming one of the most R&D intensive sectors in Europe.

Turning to the analysis of the second sub-period, which includes the years between 2000 and 2009, we observe quite a few important features. First, consistent with the aggregate numbers reported in Table II, we note –without exception– a drastic reduction in the percentage of both European and American VC-backed firms from all industries that have been taken public. In terms of mergers and acquisitions, we see a fall in the success rates across all industries although this reduction is not as sharp as in the case of IPOs.

When specifically looking at IPOs, we observe in Table IV that the U.S. no longer dominates Europe in all sectors; on average, the 13 European countries show better success rates in 3 industries: Computer Hardware and Software, Semi-conductors and other Electronics, and Communications and Media. Yet, success via mergers and acquisitions is still greater in the U.S.: American firms outperform their European counterparts by ratios ranging between 3-to-2 and 5-to-2 depending on the particular industry. Finally, whereas the U.S. continues to dominate Europe in terms of the success of infant firms, the gap when it comes to mature companies has sharply decreased – mostly due to a fall in the success rates for U.S. firms – in all industries, except for the Medical, Health and Life Sciences sector.

IV. Regression Analysis

In the following pages, we investigate which factors are associated with successful VC investments by means of a multivariate probit regression analysis. We begin by providing a brief discussion as to which indicators serve as a good proxy for determinants we expect to play a significant role in enhancing the likelihood of a successful exit by a VC-backed firm.

Venture Capital Investment by Industry Group

First of all, it is important to distinguish between funds raised and funds invested. A VC fund will raise resources each year; however, it may not necessarily invest those funds in the same year. VC funds are actively managing current portfolio companies until the proper exit time, and may not be ready to take on a new investment until a current company has exited because of management availability. Likewise, the amount of money raised may be inaccurate as a proxy because many times they simply correspond to a rollover process of investment from one project to the next. To further elaborate, when a VC fund exits a portfolio company, investment is then returned to their original investors, who many times become repeat clients to the VC fund and reinvest their desired level of capital back into the fund, which then represents the way capital is re-utilized in a VC fund. Another reason why the amount of money raised may not show a logical pattern to actual investment is that VC funds may have not found what they consider high potential investments, and may decide to wait and keep the funds sitting until an opportune venture is found.

In contrast, data on VC disbursements is exactly the capital given a designation into a venture company, and best represents the activity of VC on the supply side regarding investment level of funds. This variable is best suited to identify how much capital has been put into VC-backed companies in each industry and country. It is more interesting to see whether one industry or country is spending more or less in relative terms; and moreover, what type of impact has it had on the ability of each portfolio company to reach an exit stage.

For our probit analysis we employ the *average investment per firm* (in millions of Euro), classified by industry and country, over the two sub-periods (1985-1999 and 2000-2009). Since we do not have data for all firms, we compute average investment based on the total reported, divided by the number of firms that reported the amount of funds received, rather than the total number of firms. A priori, one would expect that the larger the amount of resources devoted to a representative firm belonging to a particular industry, the more likely it will be that this representative firm has a successful exit.

Gross Domestic Product

A high level of aggregate economic activity might indicate favorable entrepreneurial conditions; as periods of increased GDP might indicate that possibilities to commercialize technological innovations have increased (Gompers and Lerner, 1998; Jeng and Wells, 2000). Given that we are using averages over time and not a year-by-year analysis, we opt for using average *GDP per capita* (in thousands of Euro), for each of the sub-periods, and for every country of interest. We would expect in general that higher GDP per capita should be associated with a higher likelihood of a successful VC project. Since several studies that use cross-country data also control for real GDP growth as a determinant of VC investment (Jeng and Wells, 2000; Gomes Santana Felix, Gulamhussen and Pires, 2007), we run a separate set of regressions employing real growth instead of GDP per capita. The results, which are presented in Tables B and C in the Appendix, suggest that our main findings are robust to the use of this alternative measure of economic activity.

Research and Development Expenditures

VC investments are high-risk, high-reward projects, which makes them comparable with R&D investments. Thus, an increase in domestic expenditure on R&D would imply a greater supply of resources raised which are available for VC and also demand for similar high-tech, high-risk companies. When R&D is better funded, the chances of technological and other advanced science opportunities should increase and may dually lead to more VC ventures.

In expectation, times during which investments in R&D are higher might indicate more technological or innovative opportunities. Besides the idea that R&D spending might capture demand effects over time, it might also capture demand effects across countries. Therefore, countries with higher levels of R&D spending might contain a higher number of entrepreneurs with potentially fruitful ideas. This effect has been described by Gompers and Lerner (1998) who show, within the U.S., that states with higher levels of both academic and corporate R&D spending also have higher levels of VC financing activity.

Our analysis controls therefore for aggregate *R&D per capita*, also for both sub-periods (1985-1999 and 2000-2009), and all countries in our sample. All other things equal, a larger amount of funds devoted for R&D would be associated with higher technological or innovative opportunities, and therefore, higher likelihood of success of VC-financed projects.

Regulatory Environment and Legal Variables

Previous literature has shown that for all countries that want to increase successful VC investments it is vital to remove obstacles that hamper the growth of their financial markets, in particular their VC market. For instance, Gompers and Lerner (1998) examine the determinants of VC fundraising in the U.S. They study industry-aggregate, state-level, and firm-specific fundraising to determine if macroeconomic, regulatory, or performance factors affect VC activity and conclude that the regulatory environment and indicators of the legal system play a crucial role. Cumming and MacIntosh (2003) also highlight the impact of legal and institutional factors on exit strategies when comparing U.S. and Canadian venture financing. In sum, most previous papers conclude that countries with a weak tradition of equity culture and limited asset mobility should ensure that administrative and regulatory obstacles are minimized to enable innovative companies to get the VC financing and exit opportunities they need (Myers, 1999; Jaffee and Levonian, 2001; Ferreira and Ferreira, 2006; Kaplan, Martel and Stromberg, 2007). The regulatory environment and legal variables we employ in our analysis, i.e. *Rule of Law* and *Creditor Rights*, originate from La Porta et al. (1997); while *Anti-Director Rights* were obtained from Spamann (2010).

Industry-specific variables

Our baseline specification for the regression analyses is to model our alternative measures of success as a linear function of *average investment per firm* (in millions of Euro); *GDP per capita*, and *R&D per capita* (both measured in thousands of Euro); and three legal variables as controls (*Rule of Law*, *Anti-Director Rights,* and *Creditor Rights*). We proceed with our sample of 13 European countries and across the six industries of interest. Given the documented differences in performance of VC-funded firms in the U.S. and Europe, we run the regressions with and without the U.S., to verify if the main results at the industry level still apply.

We also add industry-specific dummy variables to test whether there are significant differences between industries in regards to the probability of success. Specifically, we will use the Non-high tech sector as the benchmark for comparison. This broad sector comprises firms of the following industries: business services, agricultural, forestry, financial services, utilities, manufacturing, transportation, construction, chemicals and materials, pollution and recycling, industrial equipment, oil and gas exploration, consumer products, entertainment and leisure, and food and beverage; and it represents 34% and 52% of all firms receiving VC funding for the U.S. and the EU-13, respectively.

Estimation procedure

For our multivariate specification, the nature of the data set would a priori be suitable for a panel data analysis. Nonetheless, this may prove counterproductive given that, for some countries and industries, there are only very few observations of VC funded firms and exits; and this very well may both provide some unusually high weights to these observations and rather awkward results for years in which no exits were recorded. An example of this is the Biotech industry for Portugal, Italy and Austria: between 1985 and 2005, only 4, 6, and 9 Biotech firms received VC funds, respectively; which would leave several years with missing information or just one data point.

Instead, we proceed to separate the data into the two same sub-periods as in our descriptive analysis (before and after 2000), and estimate the model via a probit model, in

which we try to determine the importance of each of the explanatory variables in predicting the likelihood of success of a VC-backed firm. As a result of missing observations – mainly with respect to the available information on average investment per firm – we are forced to limit our sample to analyzing exits for 33,358 (12,477 for 1985-1999; and 20,881 from 2000 onwards).

The results are reported as follows: In a first step, we differentiate between the two successful exit strategies: exit via IPO and exit via M&A. In a second step, we run separate probit regressions for infant and mature firms.

IV.1 Explaining Success by Exit Strategy

Table V reports the results when considering exit via IPO. For the sub-period between 1985 and 1999, the coefficient on average investment is negative and significant, if firms from both the U.S. and European countries are considered. Thus we fail to find evidence suggesting that a higher level of VC funding to a particular industry makes firms from this industry more likely to successfully go public.

<Insert Table V about here>

With respect to the Non high-tech sector, VC investment in Biotech, Medical, Health and Life Sciences (MHL), and Communications and Media (CM) has a higher likelihood of resulting in an IPO. For Semi-conductors and Other Electronics this difference is not significant, while firms in the Computer sector underperform relatively to their Non-high tech counterparts. In particular, success rate for the biotech industry, controlling for all other factors, is significantly higher than the benchmark sector (with a coefficient of 0.3). Regarding the other control variables, *GDP per capita* enters the regression with a negative and significant coefficient, contrary to our expectations; whereas higher levels of *Rule of Law* are associated with better performance of IPOs. Finally, neither *R&D per capita*, nor the other legal variables enter the regression with significant coefficients.

Column 2 replicates these results, excluding the data on the U.S. from the sample. The impact of average investment on the likelihood of VC-backed firms going public

becomes insignificant, while biotech, MHL, and CM remain the most successful industries. Interestingly, when considering only European VC-backed firms, *GDP per capita* becomes a positive and significant explanatory variable; while *Rule of Law* is no longer significant. As before, none of the other control variables have any significant impact on exit via IPO.

Turning to our analysis of the period starting 2000, displayed in the last two columns of Table V, we can verify that average investment is positively and significantly correlated with success via IPO – both with and without U.S. data in the sample. However, once we control for all other factors, only biotech and MHL have a significantly higher success rate compared to the non-high tech sector over this period, with all other industries having either a similar, or even a relatively worse performance (this latter case applies to both the computer and semi-conductors industries when firms from all countries are considered). Contrary to our expectations, *GDP per capita* again enters the regression with a negative sign (albeit it becomes insignificant once we exclude American VC-backed firms). The coefficient on *R&D per capita* is positive and significant (with and without U.S. data); while finally, higher scores for the legal control variables *Rule of Law* and *Anti-Director Rights* are associated with lower successful exits via IPO from 2000 onward (again, with or without American VC-backed firms in the sample).

Summarizing this first set of results, the main driving factors of VC-backed firms going public were mainly the particular characteristics of each industry and, after 2000 the amount of funding these firms received. The differences between the relevance of the determinants of VC success in the U.S. and in European countries can be mainly identified by the apparent asymmetric effects of *GDP per capita*, and for the period between 1985 and 1999, by the striking difference between the correlation of success and *Rule of Law*, when one excludes American VC-backed firms from the sample.

Table VI displays the case of successful exit via a merger or an acquisition. For the period 1985-1999, reported in the first two columns, average investment appears with a negative and insignificant sign, suggesting that, for this particular period, the amount of money received by VC-backed firms did not have any impact on their likelihood of being acquired by or merging with other firms, irrespective of whether or not U.S. data is

considered in the sample. It is interesting to note that while firms from all industries except biotech experienced a higher probability of success than the non-high tech sector, none of the industries performed any differently from the benchmark once American VC-backed firms are excluded from the sample. *GDP per capita* enters the regression with a negative sign (albeit only significant when American ventures are in the sample); and *R&D per capita* has an insignificant effect. Finally, higher scores for *Rule of Law* and *Anti-Director Rights* (and lower scores of *Creditor Rights*) are associated with a higher probability of exit via M&A, but once we exclude the U.S. data from the sample only Anti-Director Rights remains significant.

<Insert Table VI about here>

The period starting the year 2000 does suggest that average investment per firm becomes an important variable in explaining the acquisition or merger of VC-backed firms, but only when American VC-backed firms are included. As for the sector specific variables, while all of them are positive and significant when all firms are considered, only firms in the computer sector and CM industry are more likely to exit via M&A than those in the non-high tech sector, once U.S. data are excluded. *GDP per capita* enters the regression with a negative and significant sign and *R&D per capita* has a positive significant coefficient (with or without American ventures in our sample). As for the legal environment variables, higher scores of *Anti-Director Rights* are associated with a higher probability of exit via M&A. This continues to be the case when considering only European ventures, and in this smaller sample creditor rights also enter the regression with a positive and significant coefficient.

IV.2 Explaining Success by Life Cycle

In the following we also investigate whether the life cycle of the VC-backed firms might play a pivotal role in the determination of successful exits. Table VII presents our findings of successful exits of infants firms. The first two columns report the results for the period 1985-1999 and only when limiting the sample to European ventures do we find a positive significant effect of average VC investment in the overall success of seed/start-

up and early stage firms. The explanatory power of the likelihood of a successful exit by infant firms lies mainly on industry-specific characteristics: firms in all sectors perform better than their counterparts in the non-high tech industry, while only biotech and CM do so when one leaves out American ventures. *GDP per capita* once again enters the regression with a negative and significant coefficient, and the effect disappears for European VC-backed firms. Finally, *Anti-Director Rights* and *Rule of Law* appear with positive coefficients (when all firms are considered); while *Creditor Rights* has a negative effect only when the U.S. data is excluded from the sample.

<Insert Table VII about here>

Starting 2000, infant firms do seem to be more successful when receiving more funds, but this finding is not as strong if the U.S. ventures are excluded from the sample. All industries exhibit, on average, better performance than the benchmark, but for firms in the semi-conductor sector these results become insignificant when excluding American VC-backed firms. For the entire sample and the one that only includes European ventures, *GDP per capita* enters the regression with a negative and significant sign and *R&D per capita* has a positive significant coefficient. Finally, higher scores of *Anti-Director Rights* are associated with a higher probability of exit of infant firms; while the coefficient of *Rule of Law* becomes negative and significant when excluding American VC-backed firms; and *Creditor Rights* is negative and significant only when all firms in the sample are considered.

Summarizing, success for VC-backed infant firms in either sub-period is linked more with industry-specific elements, rather than with funding received or any macroeconomic or legal variables. For the period beginning 2000, research and development plays a more important role. Excluding American ventures from our sample affects some of the findings, confirming our previous observation that, when dealing with success at the seed/start-up and early stage levels, the U.S. and the European countries have quite different characteristics.

Table VIII presents the results on linking the success of established VC-backed firms to its determinants. For the period comprising 1985-1999, higher average

investment is counter-intuitively associated with a lower likelihood of success. The industry-specific dummies point to better performance of all industries with respect to the non-high tech sector, with the sole exception of European ventures in the computer industry. Finally, the country-specific controls and legal variables only seem relevant when American VC-backed firms are included in the sample.

<Insert Table VIII about here>

The period after 2000 does suggest some evidence as to a positive impact of average investment on a successful exit by VC-backed mature firms; while all industries perform better than the non-high tech sector. Here, *R&D per capita* enters the regression with a positive and significant sign while *GDP per capita* appears with a negative and significant coefficient. The aforementioned results are robust to excluding the U.S. data. Only for the legal control variables do we see changes between the specification that includes all VC-backed firms and the one that only considers European ventures.

Our general findings are also similar when employing *GDP growth* instead of *GDP per capita* as a control variable. These additional probit results are available in the Appendix: Table A (for IPO versus M&A exit) and Table B (for infant versus mature firms).

IV.3 General Discussion

In sum, we have observed that higher levels of average investment are linked to better performance by VC-backed firms going public, when considering the period after 2000. This does not come as a big surprise. Campbell and Kraeussl (2007) conclude "size matters" for the success of the VC industry in Central and Eastern Europe. Numerous public policy research groups have also confirmed the crucial role of sufficient VC financing. For instance, the Conference Board of Canada frequently asserts that the investment amounts per deal for VC in Canada are too low to generate any meaningful success (see, e.g., the latest report by the Conference Board of Canada (2009) on the Western provinces.

The level of average investment also is a robust variable in explaining better performance of mergers and acquisitions and the overall success of mature firms, albeit again only after 2000. We have also seen that industry-specific characteristics tend to explain differences in success mainly over the first period, when looking at success via IPO and success of infant firms. Overall, when compared to the benchmark of non-high tech firms, we find evidence that VC-backed firms in the Medical, Health and Life Sciences; and the biotech industry tend to have a preferred exit via IPO; while computer software and hardware as well as semi-conductors and other electronics tend to be more prone to exit via an acquisition or merger. For the communications and media sector, both types of exits are usually more likely than for the non-high tech sector, depending on the period analyzed (exits via IPO between 1985 and 1999, and exists via M&A after 2000).

As for the decomposition stages of VC financing, most of what we can observe is that success by infant firms on the non-high tech sector was significantly lower than for any of the other industries between 1985 and 1999, although some of these sector specific differences have gotten much narrower since the year 2000. Interestingly, neither the country-specific macroeconomic variables (*GDP per capita* and *R&D per capita*), nor the legal variables (*Rule of Law*, *Anti-Director Rights*, and *Creditor Rights*) have a robust significant effect on the likelihood of exit across both sub-periods. While this does not necessarily rule out country-specific characteristics as explanatory variables, it does reiterate the importance of amount of funding and industry-specific characteristics in determining which paths will be more likely conducive to successful exits of VC-backed firms.

We can conclude that while we have indeed observed a better performance in the U.S. vis-à-vis Europe before the end of the 1990s, most of it has been a result of the American infant firms performing better than their European counterparts. After 2000, the gap has closed, but mostly due to a sharp reduction in the percentage of American VC-backed firms that have successfully gone public. The gap with respect to infant firms has however not narrowed: European countries are still experiencing a great deal of trouble in making seed/start-up and early stage firms into successful ventures, irrespective of the type of industry they belong to.

V Conclusion

Previous research has concluded that the success of VC-backed firms depends on a large number of factors, many of which are quite specific. The contribution of this paper consists of explaining the difference in success documented in the literature between U.S. and European VC financing. It has been suggested that, although the European VC industry has undergone substantial development and growth over the past two decades, a distinct gap in performance still exists. By looking at specific factors that include a venture's industry and financing stage (which we argue may also determine in part venture capitalists' success in exiting their investments), we attempt to explain this performance gap.

Indeed, our findings show that differences in the rates of success and thus performance are only partly due to the intrinsic differences between the U.S. and European VC experiences. We find that industry-specific characteristics play an important role – in particular, our results suggest that the relatively higher success rate found in VC-backed biotech firms, for instance, may be mostly due to the intrinsic dynamic nature of this sector, and less to where the firms are located and where the funds come from.

We were also interested in analyzing whether substantial differences across industries and countries arise when looking separately at the success' rate of firms that have received VC at the seed/start-up and early stage versus firms that received funding at later stages. We also observe – confirming the findings of previous studies – that differences in the stage at which firms received VC funding tends to be a crucial determinant of success – mainly for European countries.

Our results suggest that, inasmuch as some of the differences in performance can be explained by country-specific factors (in particular, when considering seed/start-up and early stage firms), there are also important idiosyncratic differences across industries. For instance, firms in the biotech and the medical, health and life science sectors tend to be significantly more likely to have a successful exit via IPO, while firms in the computer industry as well as in the communications and media sector are more prone to exit via

merger or acquisition. Important differences across industries also emerge when considering *infant* versus *mature* firms, and their preferred exit.

Finally, we recognize that this constitutes only a first step towards explaining differences in rates of VC success and types of exits. Other factors, such as the degree of experience of venture capitalists (Hochberg, Ljungqvist and Lu, 2007; Gompers et al., 2008; Hartmann-Wendels, Keienburg and Sievers, 2010), and other industry-specific characteristics, need to be controlled for to draw more definite conclusions. Moreover, the performance gap might also (partly) be explained by a potential lack of valuable projects in Europe. For instance, the most recent Global Entrepreneurship Monitor (2009) indicates such a shortage rather than that investors in Europe do not provide as much value adding. Unfortunately, the variables required to control for this phenomenon are just available from 2004 onwards, which would render any comparison between sub-periods useless. Nonetheless, these and other extensions are in our sights for future research.

References

Aizenman, J., and J. Kendall, 2008, The internationalization of venture capital and private equity, NBER Working Paper No. 14344.

Aussenegg, W., and R. Jelic, 2007, Operating performance of newly privatized firms in Central European transition economies, *European Financial Management* 13, 853-879.

Bancel, F., and U.R. Mittoo, 2009, Why do European firms go public? *European Financial Management* 15, 844-884.

Black, B.S., and R.J. Gilson, 1998, Venture capital and the structure of capital markets: Bank versus stock markets, *Journal of Financial Economics* 47, 243-277.

Bottazzi, L., and M. Da Rin, 2002, Venture capital in Europe and the financing of innovative companies, *Economic Policy* 17, 229-270.

Bottazzi, Laura, M. Da Rin, and T. Hellmann, 2009, What role of legal systems in financial intermediation? Theory and evidence, *Journal of Financial Intermediation* 18, 559-598.

Brau, J.C., and S. Fawcett, 2006, Initial public offerings: An analysis of theory and practice, *Journal of Finance* 61, 399-436.

Campbell, R.A., and R. Kraeussl, 2007, A survey of the venture capital industry in Central and Eastern Europe, in G.N. Gregoriou, M. Kooli, and R. Kraeussl (eds.): *Venture capital in Europe*, chap. 4, Elsevier – North Holland, Quantitative Finance Series, New York, USA.

Carpenter, R.E., and B.C. Petersen, 2002, Capital market imperfections, high-tech investment, and new equity financing, *Economic Journal* 112, 54-72.

Cochrane, J., 2005, The risk and return of venture capital, *Journal of Financial Economics* 75, 3-52.

Conference Board of Canada, 2009, *Western Canada productivity, competitiveness, and potential: Key findings*, www.conferenceboard.ca/documents.aspx?did=3122.

Cumming, D., 2008, Contracts and exits in venture capital finance, *Review of Financial Studies* 21, 1947-1982.

Cumming, D., G. Fleming, and A. Schwienbacher, 2006, Legality and venture capital exits, *Journal of Corporate Finance* 12, 214-245.

Cumming, D., and J.G. MacIntosh, 2003, A cross-country comparison of full and partial venture capital exits, *Journal of Banking and Finance* 27, 511-548.

Da Rin, M., G. Nicodano, and A. Sembenelli, 2006, Public policy and the creation of active venture capital markets, *Journal of Public Economics* 90, 1699-1723.

Ferreira, M.A., and M.A. Ferreira, 2006, The importance of industry and country effects in the EMU equity markets, *European Financial Management* 12, 341-373.

Global Entrepreneurship Monitor, 2009, *Global Report*, www.gemconsortium.org/about.aspx?page=pub_gem_global_reports.

Gomes Santana Felix, E., M.A. Gulamhussen, and C. Pires, 2007, The determinants of venture capital in Europe – Evidence across countries, *CEFAGE* Working Paper 2007/01.

Gompers, P.A., and J. Lerner, 1998, What drives venture capital fundraising? *Brooking Papers on Economic Activity (Microeconomics)*, 149-180.

Gompers, P.A., and J. Lerner, 2000, Money chasing deals? The impact of fund inflows on private equity valuations, *Journal of Financial Economics* 55, 281-325.

Gompers, P.A., and J. Lerner, 2001, The venture capital revolution, *Journal of Economic Perspectives* 15, 145-168.

Gompers, P.A., A. Kovner, J. Lerner, and D. Scharfstein, 2008, Venture capital investment cycles: The impact of public markets, *Journal of Financial Economics* 87, 1-23.

Gordon, R.J., 2002, Technology and economic performance in the American economy, *NBER* Working Paper No. 8771.

Guo, R.J., B.I. Lev, and N. Zhou, 2005, The valuation of biotech IPOs, *Journal of Accounting, Auditing and Finance* 20, 423-459.

Hartmann-Wendels, T., G. Keienburg, and S. Sievers, 2010, Adverse selection, investor experience and security choice in venture capital finance: Evidence from Germany, forthcoming in *European Financial Management*.

Hege, U., F. Palomino, and A. Schwienbacher. 2009, Venture capital performance: The disparity between Europe and the United States, *Revue Finance* 30, 7-50.

Hochberg, Y., A. Ljungqvist, and Y. Lu, 2007, Whom you know matters: Venture capital networks and investment performance, *Journal of Finance* 62, 251-302.

Jaffee, D., and M. Levonian, 2001, The structure of banking systems in developed and transition economies, *European Financial Management* 7, 161-181.

Jeng, L.A., and P.C. Wells, 2000, The determinants of venture capital funding: Evidence across countries, *Journal of Corporate Finance* 6, 241-289.

Kaplan, S.N., F. Martel, and P. Stromberg, 2007, How do legal differences and experience affect financial contracts?, *Journal of Financial Intermediation* 16, 273-311.

Kortum, S., and J. Lerner, 2000, Assessing the contribution of venture capital to innovation, *RAND Journal of Economics* 31, 674-692.

Kraeussl, R., and S. Krause, 2011, Are particular industries more likely to succeed? A comparative analysis of VC investment in the U.S. and Europe, forthcoming in D. Cumming (ed.): *Handbook of private equity and venture capital*, Oxford University Press.

Kraeussl, R., and R. Wuebker, 2011, Investment patterns, practices and performance in cross-border venture capital: How a "local business goes global", SSRN Working Paper No. 1753195.

La Porta, R., F. Lopez-de-Silanes, A. Shleifer, and R. Vishny, 1997, Legal determinants of external finance", *Journal of Finance* 52, 1131-1150.

La Porta, R., F. Lopez-de-Silanes, A. Shleifer, and R. Vishny, 1998, Law and finance, *Journal of Political Economy* 106, 1113-1155.

Lerner, J., 2002, Boom and bust in the venture capital industry and the impact on innovation, *Federal Reserve Bank of Atlanta Economic Review*, Fourth Quarter 2002, 25-39.

Maksimovic, V., and P. Pichler, 2001, Technological innovation and initial public offerings, *Review of Financial Studies* 14, 459-494.

Mayer, C., K. Schoors, and Y. Yafeh, 2005, Sources of funds and investment activities of venture capital funds: Evidence from Germany, Israel, Japan and the United Kingdom, *Journal of Corporate Finance* 11, 586-608.

Murray, G.C., and R. Marriott, 1998, Why has the investment performance of technology-specialist, European venture capital funds been so poor? *Research Policy* 27, 947-976.

Myers, S.C., 1999, Financial architecture, *European Financial Management* 5, 133-141.

Pagano, M., F. Panetta, and L. Zingales, 1998, Why do companies go public? An empirical analysis, *Journal of Finance* 53, 27-64.

Popov, A., and P. Roosenboom, 2009, Does private equity investment spur innovation? Evidence from Europe, *ECB* Working Paper No. 1063.

Raade, K., and C. Dantas Machado, 2008, Recent developments in the European private equity markets, *European Commission*, Economic Paper No. 319.

Ritter, J., 2003, Differences between European and American IPO markets, *European Financial Management* 9, 421-434.

Ritter, J., and I. Welch, 2002, A review of IPO activity, pricing, and allocations, *Journal of Finance* 57, 1795-1828.

Spamann, H., 2010, The antidirector rights index revisited, *Review of Financial Studies* 23, 467-486.

Table I: Distribution of Firms receiving VC Funding - by Country and by Industry

Note: This table summarizes the data of all firms receiving venture capital financing between 1985 and 2005. Firms are classified by country and industry; and also by whether they received the first round of funding as a seed and start-up, early-stage, or mature stage firm.

Country	Total	Seed and Start-up	Early Stage	Mature	Computer Hardware and Software	Semi-conductors / Other Electronics	Biotech-nology	Non high-tech sector	Medical, Health and Life Sciences	Communi-cations and Media
Austria	222	32	27	163	52	14	9	118	10	19
Belgium	390	73	65	252	113	17	24	184	23	29
Denmark	410	119	61	230	100	28	46	153	43	40
Finland	698	219	121	358	171	49	22	328	48	80
France	2,788	308	402	2,078	670	135	94	1,568	137	184
Germany	1,721	297	291	1,133	516	113	163	627	99	203
Ireland	310	65	74	171	120	20	13	98	18	41
Italy	527	45	44	438	69	18	6	369	17	48
Netherlands	731	74	81	576	155	24	29	424	32	67
Portugal	250	72	14	164	22	8	4	191	14	11
Spain	670	70	35	565	102	10	13	463	34	48
Sweden	831	170	129	532	197	41	44	364	80	105
United Kingdom	4,135	433	562	3,140	954	162	145	2,252	298	324
United States	27,583	5,233	8,543	13,807	8,915	1,591	1,188	9,518	2,591	3,780
EU-13	**13,683**	**1,977**	**1,906**	**9,800**	**3,241**	**639**	**612**	**7,139**	**853**	**1,199**
All countries	**41,266**	**7,210**	**10,449**	**23,607**	**12,156**	**2,230**	**1,800**	**16,657**	**3,444**	**4,979**

Table II. U.S. Versus EU-13: VC Funding and Success by IPO and by M&A

Notes: *Success by IPO* is computed as the number of firms venture capitalists successfully exited by initial public offering divided by the total number of firms receiving VC funding. *Success by Merger or Acquisition* is computed as the number of firms venture capitalists successfully exited by merging with or being acquired by other firms, divided by the total number of firms receiving VC. *Leveraged Buyouts*, includes the cases in which the company or a controlling interest of it were bought out by the owners through other means of funding. For all three measures, the rates were computed considering all transactions between 1985 and 1999; and between 2000 and 2009 (with companies receiving VC-funding through 2005), by industry and country, and were multiplied by a factor of 100.

		Number of VC-backed firms	Success by IPO	Success by Merger or Acquisition	Leveraged Buyouts
1985-1999	EU-13	3,605	14.67	19.53	17.15
	U.S.	16,678	21.98	29.43	1.84
2000-2009	EU-13	10,078	6.53	10.42	16.31
	U.S.	10,905	6.28	21.71	5.37

Table III. U.S. Versus EU-13: VC Funding and Success by Infant and Mature Firms

Notes: *Success by Infant Firms* is computed as the number of seed/start-up and early-stage firms venture capitalists successfully exited by going public or through merger and acquisition, divided by the total number of seed/start-up and early-stage firms, which received VC funding. *Success by Mature Firms* is computed as the number of established or later stage firms venture capitalists successfully exited by going public or through merger and acquisition, divided by the total number of established firms, which received VC. For both measures, the rates were computed considering all transactions between 1985 and 1999; and between 2000 and 2009 (with companies receiving VC funding through 2005), by industry and country, and were multiplied by a factor of 100.

		Ex-ante ratio (mature firms to infant firms)	Success by infant firms	Success by mature firms	Ex-post ratio (mature firms to infant firms)
1985-1999	EU-13	3.27	38.51	33.29	2.83
	U.S.	1.15	50.55	52.15	1.18
2000-2009	EU-13	2.32	11.68	19.22	3.81
	U.S.	0.81	26.46	29.88	0.92

Table IV. U.S. Versus EU-13: Success by Industry

Notes: *Success by IPO* and *Success by Acquisition or Merger* are computed as the number of firms venture capitalists successfully exited via IPO and through merger or acquisition respectively, divided by the total number of firms receiving VC funding. *Success by Infant Firms* is computed as the number of seed/start-up and early-stage firms that experienced *overall success*, divided by the total number of seed/start-up and early-stage firms, which received VC. *Success by Mature Firms* is computed as the number of established firms that experienced *overall success*, divided by the total number of established firms, which received VC. For all measures, the rates were computed considering all transactions between 1985-1999, and 2000-2009 (with companies receiving VC funding through 2005), by industry and country, and were multiplied by a factor of 100.

		1985-1999				2000-2009			
		Success by IPO	Success by Merger or Acquisition	Success by Infant Firms	Success by Mature Firms	Success by IPO	Success by Merger or Acquisition	Success by Infant Firms	Success by Mature Firms
Computer Hardware and Software	EU-13	16.20	20.98	36.25	38.34	5.95	11.86	12.36	22.66
	U.S.	18.39	35.56	51.33	58.64	2.69	27.99	29.55	33.23
Semi-conductors and Other Electronics	EU-13	15.82	22.78	32.65	42.20	7.07	10.40	10.83	24.07
	U.S.	25.49	32.40	58.06	57.66	4.82	23.21	24.95	35.98
Biotechnology	EU-13	26.88	15.00	49.51	28.07	9.01	9.45	13.97	28.57
	U.S.	39.44	23.78	60.41	74.63	11.15	15.26	22.14	39.37
Medical, Health and Life Sciences	EU-13	26.85	19.44	43.02	48.46	8.48	10.36	11.16	23.83
	U.S.	28.49	27.84	53.30	60.86	9.57	16.69	20.93	35.00
Communications and Media	EU-13	20.45	20.82	48.60	37.04	6.24	14.73	15.14	25.43
	U.S.	21.14	33.16	53.41	55.36	4.44	25.38	28.01	33.98
Non-High Technology / Other	EU-13	11.06	18.91	29.12	30.37	6.35	9.02	7.76	16.50
	U.S.	20.98	24.08	37.97	47.05	10.46	13.93	18.92	25.77

Table V. Success 1: Exit via IPO

Notes: *Successful Exit via IPO* takes the value of *'1'* if a firm successfully exited by going public, and *'0'* otherwise. *Average investment per firm* is measured in millions of Euro. *GDP per capita* and *R&D per capita* are measured in thousands of Euro. All legal variables (*Rule of Law*, *Anti-Director Rights*, and *Creditor Rights*) originate from La Porta et al. (1997) and Spamann (2010). The analysis is conducted for the two sub-periods (1985-1999 and 2000-2009; with companies receiving VC funding through 2005), controlling for results with and without data for the U.S. Standard errors are in parentheses; asterisks ***, **, and * determine significance at the 1%, 5%, and 10% levels, respectively.

	1985-1999 (all countries)	1985-1999 (excl. U.S.)	2000-2009 (all countries)	2000-2009 (excl. U.S.)
Average investment per firm	-0.013***	-0.005	0.005***	0.007***
	(0.003)	(0.004)	(0.002)	(0.002)
Computer Hardware and Software	-0.144***	0.138	-0.281***	0.065
	(0.044)	(0.088)	(0.042)	(0.058)
Semi-conductors and Other Electronics	0.054	0.075	-0.107*	0.146
	(0.072)	(0.164)	(0.064)	(0.095)
Biotechnology	0.300***	0.344**	0.213***	0.273***
	(0.074)	(0.151)	(0.064)	(0.093)
Medical, Health and Life Sciences	0.101*	0.528***	0.155***	0.234***
	(0.056)	(0.134)	(0.054)	(0.080)
Communications and Media	0.079***	0.273**	-0.196	0.068
	(0.045)	(0.117)	(0.049)	(0.075)
GDP per capita	-0.044***	0.025*	-0.011***	-0.001
	(0.012)	(0.015)	(0.003)	(0.003)
R&D per capita	-0.086	0.006	0.501***	0.319*
	(0.356)	(0.396)	(0.156)	(0.168)
Rule of Law	0.399***	-0.112	-0.168***	-0.210***
	(0.079)	(0.099)	(0.060)	(0.061)
Anti-Director Rights	0.033	-0.076	-0.060**	-0.085***
	(0.044)	(0.048)	(0.029)	(0.030)
Creditor Rights	-0.042	-0.010	0.030*	0.039**
	(0.026)	(0.029)	(0.016)	(0.017)
Likelihood Ratio	243.66***	51.32***	182.40***	37.55***
Number of Observations	12,477	2,821	20,881	9,976

Table VI. Success 2: Exit via Merger or Acquisition

Notes: *Successful Exit via Merger or Acquisition* takes the value of *'1'* if a firm successfully exited by merging with or being acquired by other firms, and *'0'* otherwise. *Average investment per firm* is measured in millions of Euro. *GDP per capita* and *R&D per capita* are measured in thousands of Euro. All legal variables (*Rule of Law*, *Anti-Director Rights*, and *Creditor Rights*) originate from La Porta et al. (1997) and Spamann (2010). The analysis is conducted for the two sub-periods (1985-1999 and 2000-2009; with companies receiving VC funding through 2005), controlling for results with and without data for the U.S. Standard errors are in parentheses; asterisks ***, **, and * determine significance at the 1%, 5%, and 10% levels, respectively.

	1985-1999 (all countries)	1985-1999 (excl. U.S.)	2000-2009 (all countries)	2000-2009 (excl. U.S.)
Average investment per firm	-0.001 (0.002)	-0.005 (0.003)	0.009*** (0.001)	0.002 (0.002)
Computer Hardware and Software	0.359*** (0.040)	0.023 (0.078)	0.503*** (0.033)	0.109** (0.050)
Semi-conductors and Other Electronics	0.385*** (0.064)	0.207 (0.137)	0.358*** (0.049)	0.075 (0.087)
Biotechnology	0.063 (0.074)	-0.161 (0.154)	0.176*** (0.060)	0.039 (0.090)
Medical, Health and Life Sciences	0.152*** (0.053)	-0.057 (0.133)	0.222*** (0.048)	0.086 (0.075)
Communications and Media	0.323*** (0.040)	0.015 (0.109)	0.407*** (0.036)	0.231*** (0.062)
GDP per capita	-0.022** (0.011)	-0.015 (0.126)	-0.026*** (0.003)	-0.028*** (0.003)
R&D per capita	0.407 (0.318)	0.211 (0.344)	1.138*** (0.131)	0.649*** (0.145)
Rule of Law	0.247*** (0.072)	0.103 (0.086)	0.033 (0.051)	-0.066 (0.054)
Anti-Director Rights	0.176*** (0.041)	0.103** (0.044)	0.139*** (0.026)	0.101*** (0.026)
Creditor Rights	-0.065*** (0.024)	-0.007 (0.026)	-0.017 (0.014)	0.043** (0.015)
Likelihood Ratio	314.24***	16.54	766.89***	179.20***
Number of Observations	12,477	2,821	20,881	9,976

Table VII. Successful Exit of Infant Firms

Notes: *Successful Exit of Infant Firms* takes the value of *'1'* if a seed, start-up, and early-stage firm experienced overall success, and '*0'* otherwise. *Average investment per firm* is measured in millions of Euro. *GDP per capita* and *R&D per capita* are measured in thousands of Euro. All legal variables (*Rule of Law*, *Anti-Director Rights*, and *Creditor Rights*) originate from La Porta et al. (1997) and Spamann (2010). The analysis is conducted for the two sub-periods (1985-1999 and 2000-2009; with companies receiving VC funding through 2005), controlling for results with and without data for the U.S. Standard errors are in parentheses; asterisks ***, **, and * determine significance at the 1%, 5%, and 10% levels, respectively.

	1985-1999 (all countries)	1985-1999 (excl. U.S.)	2000-2009 (all countries)	2000-2009 (excl. U.S.)
Average investment per firm	-0.002 (0.005)	0.021** (0.010)	0.017*** (0.002)	0.005 (0.005)
Computer Hardware and Software	0.487*** (0.080)	0.265 (0.187)	0.587*** (0.061)	0.234** (0.103)
Semi-conductors and Other Electronics	0.624*** (0.101)	0.198 (0.274)	0.416*** (0.074)	0.181 (0.142)
Biotechnology	0.521*** (0.104)	0.673*** (0.231)	0.478*** (0.081)	0.410*** (0.125)
Medical, Health and Life Sciences	0.325*** (0.087)	0.339 (0.244)	0.372*** (0.076)	0.257* (0.134)
Communications and Media	0.550*** (0.067)	0.512** (0.205)	0.429*** (0.060)	0.328*** (0.116)
GDP per capita	-0.102*** (0.021)	-0.020 (0.030)	-0.031*** (0.003)	-0.032*** (0.006)
R&D per capita	0.498 (0.615)	0.617 (0.651)	1.392*** (0.226)	0.822*** (0.254)
Rule of Law	0.541*** (0.126)	-0.117 (0.156)	-0.045 (0.087)	-0.200** (0.095)
Anti-Director Rights	0.285*** (0.067)	0.109 (0.074)	0.140*** (0.044)	0.116** (0.047)
Creditor Rights	-0.164 (0.039)	-0.111** (0.045)	-0.090*** (0.025)	-0.018 (0.026)
Likelihood Ratio	228.64***	19.96**	341.46***	67.38***
Number of Observations	5,479	648	9,017	3,005

Table VIII. Successful Exit of Mature Firms

Notes: *Successful Exit by Mature Firms* takes the value of *'1'* if a mature firm experienced overall success, and *'0'* otherwise. *Average investment per firm* is measured in millions of Euro. *GDP per capita* and *R&D per capita* are measured in thousands of Euro. All legal variables (*Rule of Law*, *Anti-Director Rights*, and *Creditor Rights*) originate from La Porta et al. (1997) and Spamann (2010). The analysis is conducted for the two sub-periods (1985-1999 and 2000-2009; with companies receiving VC funding through 2005), controlling for results with and without data for the U.S. Standard errors are in parentheses; asterisks ***, **, and * determine significance at the 1%, 5%, and 10% levels, respectively.

	1985-1999 (all countries)	1985-1999 (excl. U.S.)	2000-2009 (all countries)	2000-2009 (excl. U.S.)
Average investment per firm	-0.008***	-0.009***	0.008***	0.005**
	(0.002)	(0.003)	(0.001)	(0.002)
Computer Hardware and Software	0.227***	0.081	0.309***	0.229***
	(0.047)	(0.085)	(0.038)	(0.052)
Semi-conductors and Other Electronics	0.332***	0.279*	0.378***	0.332***
	(0.085)	(0.153)	(0.068)	(0.095)
Biotechnology	0.373***	0.639**	0.495***	0.438***
	(0.124)	(0.267)	(0.085)	(0.120)
Medical, Health and Life Sciences	0.312***	0.367**	0.369***	0.295***
	(0.068)	(0.145)	(0.056)	(0.077)
Communications and Media	0.306***	-0.003	0.312***	0.306***
	(0.054)	(0.123)	(0.048)	(0.068)
GDP per capita	-0.024**	0.002	-0.024***	-0.020***
	(0.011)	(0.013)	(0.003)	(0.003)
R&D per capita	0.446	0.132	1.069***	0.625***
	(0.341)	(0.368)	(0.137)	(0.149)
Rule of Law	0.334***	0.050	-0.031	-0.112**
	(0.080)	(0.093)	(0.053)	(0.054)
Anti-Director Rights	0.108**	0.007	0.064**	0.024
	(0.044)	(0.047)	(0.027)	(0.027)
Creditor Rights	-0.048*	0.025	0.025*	0.062***
	(0.026)	(0.028)	(0.015)	(0.015)
Likelihood Ratio	323.55***	40.15***	338.23***	153.60***
Number of Observations	6,998	2,173	11,864	6,971

Table A. Success by Exit via IPO and M&A, controlling by GDP growth

Notes: *Success by IPO* and *Success by M&A* take the value of '*1'* if a firm successfully exited by going public, or by merging with or being acquired by other firms, respectively, and '*0'* otherwise. *Average investment per firm* is measured in millions of Euro. *Real GDP* growth takes the average growth rate over each sub-period multiplied by a factor of 100, while *R&D per capita* is measured in thousands of Euro. All legal variables (*Rule of Law*, *Anti-Director Rights*, and *Creditor Rights*) originate from La Porta et al. (1997) and Spamann (2010). The analysis is conducted for the two sub-periods (1985-1999 and 2000-2009; with companies receiving VC funding through 2005). Standard errors are in parentheses; asterisks ***, **, and * determine significance at the 1%, 5%, and 10% levels, respectively.

	1985-1999 (IPO – all countries)	1985-1999 (M&A – all countries)	2000-2009 (IPO – all countries)	2000-2009 (M&A – all countries)
Average investment per firm	-0.013*** (0.003)	-0.003 (0.002)	0.005** (0.002)	0.006*** (0.001)
Computer Hardware and Software	-0.151*** (0.044)	0.335*** (0.038)	-0.261 (0.043)	0.483*** (0.034)
Semi-conductors and Other Electronics	0.048 (0.071)	0.365*** (0.164)	0.107* (0.064)	0.327*** (0.049)
Biotechnology	0.287*** (0.074)	0.043 (0.073)	0.208*** (0.064)	0.133** (0.059)
Medical, Health and Life Sciences	0.097* (0.056)	0.138*** (0.052)	0.145*** (0.053)	0.169*** (0.047)
Communications and Media	0.077*** (0.045)	0.312** (0.040)	-0.169*** (0.050)	0.416*** (0.037)
Real GDP growth	-0.123*** (0.020)	0.007 (0.017)	-0.036*** (0.012)	0.006 (0.009)
R&D per capita	-0.613*** (0.249)	-0.119 (0.223)	0.422*** (0.154)	0.831*** (0.127)
Rule of Law	0.404*** (0.078)	0.290*** (0.071)	-0.207*** (0.060)	-0.037 (0.050)
Anti-Director Rights	0.162*** (0.044)	0.192*** (0.041)	-0.059** (0.030)	0.088*** (0.026)
Creditor Rights	-0.113*** (0.026)	-0.072*** (0.025)	0.031* (0.016)	-0.007 (0.014)
Likelihood Ratio	270.74***	310.01***	178.86***	658.62***
Number of Observations	12,477	12,477	20,881	20,881

Table B. Success by Stage of Funding, controlling by GDP growth

Notes: *Success by Infant Firms* and *Success by Mature Firms* take the value of '*1'* if a seed, start-up, and early-stage firm (mature firm, respectively), experienced overall success, and '*0'* otherwise. *Average investment per firm* is measured in millions of Euro. *Real GDP* growth takes the average growth rate over each sub-period multiplied by a factor of 100, while *R&D per capita* is measured in thousands of Euro. All legal variables (*Rule of Law*, *Anti-Director Rights*, and *Creditor Rights*) originate from La Porta et al. (1997) and Spamann (2010). The analysis is conducted for the two sub-periods (1985-1999 and 2000-2009; with companies receiving VC funding through 2005). Standard errors are in parentheses; asterisks ***, **, and * determine significance at the 1%, 5%, and 10% levels, respectively.

	1985-1999 (Infant Firms -all countries)	1985-1999 (Mature Firms – all countries)	2000-2009 (Infant Firms - all countries)	2000-2009 (Mature Firms – all countries)
Average investment per firm	-0.013**	-0.009***	0.015***	0.005***
	(0.005)	(0.002)	(0.002)	(0.001)
Computer Hardware and Software	0.369***	0.219***	0.597***	0.295***
	(0.075)	(0.046)	(0.063)	(0.039)
Semi-conductors and Other Electronics	0.524***	0.324***	0.395***	0.349***
	(0.099)	(0.085)	(0.074)	(0.067)
Biotechnology	0.393***	0.363***	0.435***	0.465***
	(0.100)	(0.124)	(0.081)	(0.085)
Medical, Health and Life Sciences	0.239***	0.305***	0.323***	0.319***
	(0.085)	(0.067)	(0.075)	(0.055)
Communications and Media	0.509***	0.301***	0.463***	0.317***
	(0.066)	(0.053)	(0.061)	(0.048)
Real GDP growth	-0.096***	-0.048**	-0.034**	0.007
	(0.027)	(0.020)	(0.013)	(0.011)
R&D per capita	-1.297***	0.067	0.989***	0.805***
	(0.417)	(0.245)	(0.220)	(0.134)
Rule of Law	0.602***	0.350***	-0.124	-0.102**
	(0.125)	(0.079)	(0.086)	(0.052)
Anti-Director Rights	0.399***	0.169***	0.090**	0.021
	(0.068)	(0.045)	(0.045)	(0.027)
Creditor Rights	-0.240***	-0.083***	-0.066***	0.036*
	(0.041)	(0.027)	(0.025)	(0.015)
Likelihood Ratio	216.24***	325.08***	285.22***	263.83***
Number of Observations	5,479	6,998	9,017	11,864

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