



Can patent data predict the success of start-ups?

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Introduction

Recent years have seen an increasing interest in European startups companies as a potential engine for growth in a sluggish economic context. Despite its strengths (including good infrastructures and education), the European startup scene has yet some way to go before catching up with the US one. Funding in particular is regularly pinpointed as the main challenge. The lack of a fully developed banking, VC and financial community indeed curb potential European technology entrepreneurs. Raising money for a new VC fund is a long and difficult process. European venture funds tend to be about half the size of US venture funds, and they are often criticized for being excessively careful.

Overall, one needs yet to consider the whole ecosystem in order to correctly assess the problem. In Europe capital markets for innovative firms are 'thin markets': there are only limited numbers of investors and innovative growth firms, and these have difficulties finding and contracting with each other (European Commission, 2012). Due to the high level of risk, investors seek SMEs that can potentially generate a very high return. Asymmetric information on innovative projects is a major challenge in this context. European entrepreneurs or inventors are insufficiently aware of investor concerns, and they may fail or be reluctant to disclose critical information.

Improving early-stage investors' insights into what drives success can thus be a powerful leverage for European VC markets. We show in this study that the startups' intellectual property positions, as measured by their patent portfolios, provide excellent indicators in this respect.

In today's economy business success indeed depends not only on creativity and inventiveness but also on the effective and profitable transposition of new products and services to the market. Intellectual Property Rights (IPRs) such as patents, trademarks, designs, and copyright are an essential tool for enabling business success based on innovation. Patents in particular are not only legal fences against competitors: they make it possible to license out technology, to build up partnerships or negotiate access to potentially blocking positions of competitors. They can also be sold on a stand-alone basis, and therefore provide security for investors.

A few studies already highlight the impact of IPRs on the survival of SMEs. Cockburn and Wagner (2007) test whether the patent portfolio of companies listed in Nasdaq influenced their survival after the burst of the dotcom bubble in the late nineties. Helmers and Rogers (2010) measure how the patent and trademark portfolios of the 162,000 LLC companies created in the United Kingdom in 2001 influenced their survival rate after 5 years. In both cases less than half of companies did own patents, and these patent-owning companies have a significantly higher survival rate (of 34% in the first study, and 16% in the

second one). Interestingly, survival rates are even higher in the case of patents with international extensions, thus suggesting that not only IP ownership but also the strength of IP positions matter for survival.

In this study we follow a similar approach to assess whether indicators based on patent portfolios can predict the future success of startups. We consider a population of 829 SMEs and startups in which one of the 9 most active VC funds in France invested between 2002 and 2012. Taking the perspective of the VC funds, we define success as the occurrence of an IPO, merger, acquisition or LBO before the end of 2012. The questions we aim to address are twofold:

- **Are patents a good signal for VC investors?** Our problem here is to determine whether patents provide a good benchmark indicator for VC funds to make their investment decisions. To answer this question, we consider the patent position of each startup immediately before the VC investment. We then estimate whether holding at least one patent at this moment has an impact on the probability of success in the post-investment period.
- **Is there a link between patent positions and the probability of success?** In this case, we aim to assess the predictive power of various indicators of patent positions (existence, international coverage, size and quality of the patent portfolio) for startups that are already backed by VC funds. Since VC funds then already influence the startup, they can no more interpret patent indicators as an external signal of future success. A positive impact of patent positions on subsequent success would nevertheless highlight the importance for VC funds of promoting good IP management and the building of strong patent portfolios within their portfolio companies.

We find strong evidence supporting positive answers to both questions. We first show that on average a startup has about 2.5 more chances of meeting success within 10 years after the VC investment if it holds patents *before* that investment. This link between patent ownership and success is in fact particularly strong for startups related to Software and Biotechnology, while the signal effect is weaker in other sectors. We then find that the predictive power of patent ownership *after* VC investment is even stronger (it multiplies the probability of success by 3.2 to 3.6) and consistent through all sectors. Moreover, refined indicators of the strength of patent positions have a substantially better predictive power on success.

Before exposing these results in more details, we briefly present the database and methodology in the next section.

Methodology

The database

We use an original database of 829 European SMEs and startups that was collected by Thomson Reuters on request of France Brevets. The population

covered by the database corresponds to all the startups identified by Thomson Reuters in which at least one of the 9 most active VC funds in France¹ invested between 2002 and 2012. Accordingly, the sample of startups that we consider has been subject to a pre-selection: all these companies have been considered as profitable investment targets by established VC funds, and therefore constitute more likely candidates for subsequent success than an average startup at the seed or pre-seed stage.

Table 1 below presents summary statistics for key variables in the database, at the global and sector level. Overall about one third of the observed startups experienced a successful exit between 2002 and 2012, and 20% of them held at least one patent in 2007. The startups belong to a large variety of sectors among which the Software, Manufacturing, Web, Telecom and Biotech sectors are the most represented and are therefore identified as such in the database. It can be seen in Table 1 that companies differ across sectors with respect to their rate of success, the frequency of patent ownership and the average size of patent portfolios. In particular, success rates are higher in Software, Manufacturing and Biotech, and the share of patent holding startups is higher Manufacturing and Biotech.

Table 1: Summary statistics

	Number of startups (A)	Success rate	Patent owning companies (B)	Share (A/B)	Average portfolio size^a
All sectors	829	31%	138	20%	3.7
Software	180	37%	29	16%	0.8
Manufacturing	105	38%	31	30%	7.0
Web	88	27%	9	10%	0.3
Telecom	68	25%	13	19%	8.9
Biotech	50	44%	13	26%	6.3
Others	338	26%	43	13%	3.7

^a The average portfolio size is the average over all startups of the number of patents granted or applied for until 2012.

The database includes information on the type (IPO, merger, acquisition or LBO) and dates of successful exits that occur before the end of 2012. Importantly, it also contains information on the creation dates and funding rounds of the startups. Availability of these data is important to identify and neutralize other potential determinants of the probability of success.

¹ These nine VC funds are the following: Idinvest Partners SA, Seventure Partners SA, Sofinnova Partners SAS, I-Source Gestion SA, XAnge Private Equity SA, Alven Capital Partners SA, Innovacom SA, Truffle Capital SAS, and Ventech SA.

Using econometric models to isolate the effect of patents

The methodological challenge is to properly isolate the effect of patent indicators from the effect of other variables – namely the companies' age, received funding and sector of activity – that may influence success and/or the patent indicators themselves. An older startup may for instance be more likely to hold patents and to succeed, thus making it difficult to attribute success to its age or its patents.

In order to do so, we employ econometrics techniques that make it possible to simultaneously estimate the respective correlations of all these variables with the probability of success, and thus to isolate the predictive power of patent indicators “all other variables being held equal”. We can then calculate the probability of success of a particular startup with given age, funding and sector of activity in case it has patents or not.

We use semi-parametric Cox proportional hazard regression models for this purpose. The Cox model is a class of survival models that makes it possible to estimate the likelihood of an event (here, success) within each short time interval over a long time period. In order to correctly account for differences between sectors, we use a stratified version of the Cox model that allows for different expected time-to-success in each of the main sectors covered by the database. Our reference model also accounts for specific impacts of age, funding and patent indicators within each sector.

Results

Are patents a good signal for VC investors?

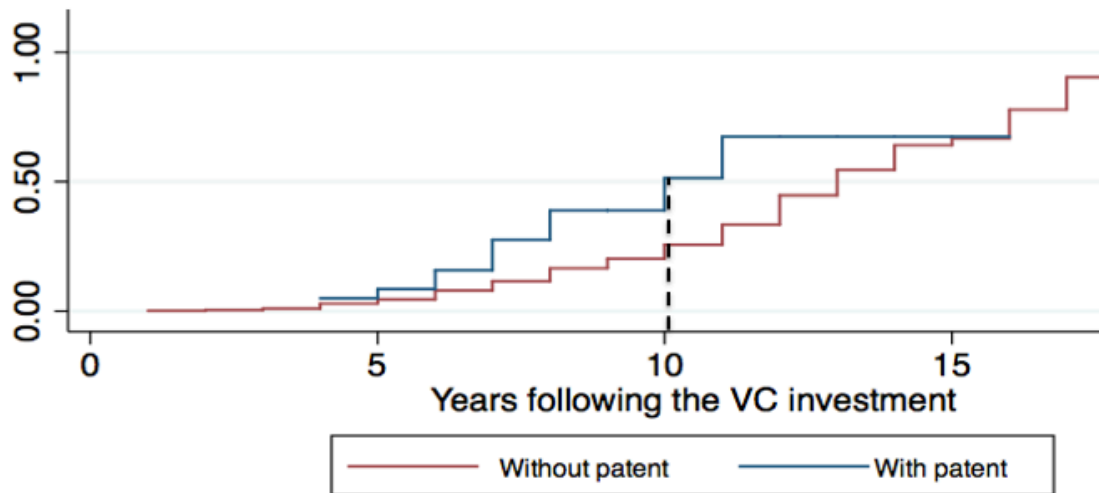
We focus first on the patent portfolio of startups immediately before VC investment, in order to assess whether patent ownership can be a good predictor of subsequent success. We thus adopt the perspective of the VC fund before it makes an investment decision. At this moment of time the fund has indeed to form expectations about future returns, by using all information available. Obviously, it has no direct influence yet on the startup's patent portfolio.

We address this question by estimating a “survival” model over a panel of 749 distinct startups observed annually between 1994 and 2012, with a success rate of 29% on average. Besides patent ownership, we use age, prior funding and sector of activity of the startups as other parameters to predict future success. Our results provide evidence of a significant correlation between patent ownership and subsequent success.

To appreciate this patent effect, it is convenient as a first step to represent it over time. Figure 1 below reports the cumulative probability of success of a representative startup over the time of the study, depending on whether it owned patents or not before the VC investment. As an example, the dashed vertical line shows **that a startup initially endowed with patents has about**

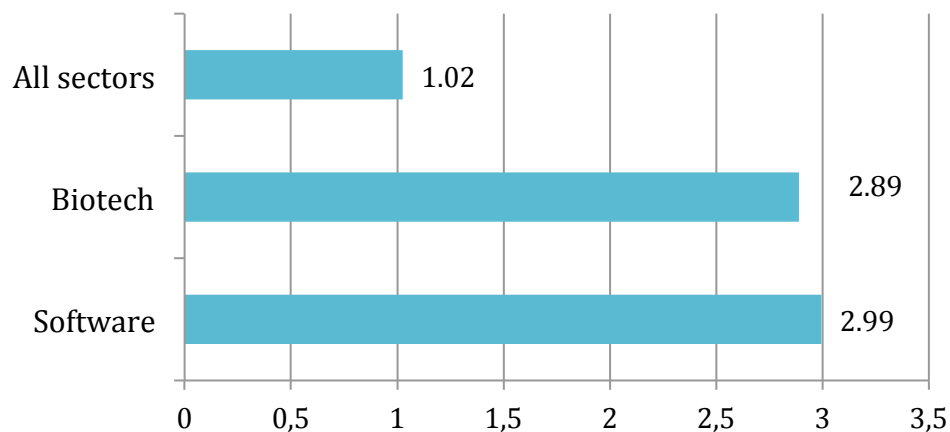
50% chances of meeting success within 10 years after the VC investment, while without patent the chances of the same startup fall to about 30%. More generally, we can see that **patent ownership induces a significantly higher probability of success in the 5 to 15 years that follow the VC investment.**

Figure 1: Cumulative probability of success of a representative startup



Defining a “representative” startup at the level of the entire database however does not properly account for differences between sectors. Indeed, closer analysis reveals that the link between initial patents and success is not uniform in this respect. As reported in Figure 2, **patent ownership has a very strong correlation with subsequent success in the Software and Biotechnology sectors**: in these sectors startup companies that own patents before the VC investment are respectively 2.89 and 2.99 times more likely to succeed afterwards. By contrast, patent ownership has a much weaker predictive power in the other sectors, with a modest (though statistically significant) success factor of 1.02.

Figure 2: Success factor of patent ownership



These results suggest that **patent ownership does provide a strong signal of future success for VC investors**. This is however true mainly in the Biotechnology and Software sectors – where patent ownership almost trebles the chances of success. In other sectors, patents have a much smaller degree of correlation with success. Accordingly, they cannot be seen as a strong signal of future success in these sectors.

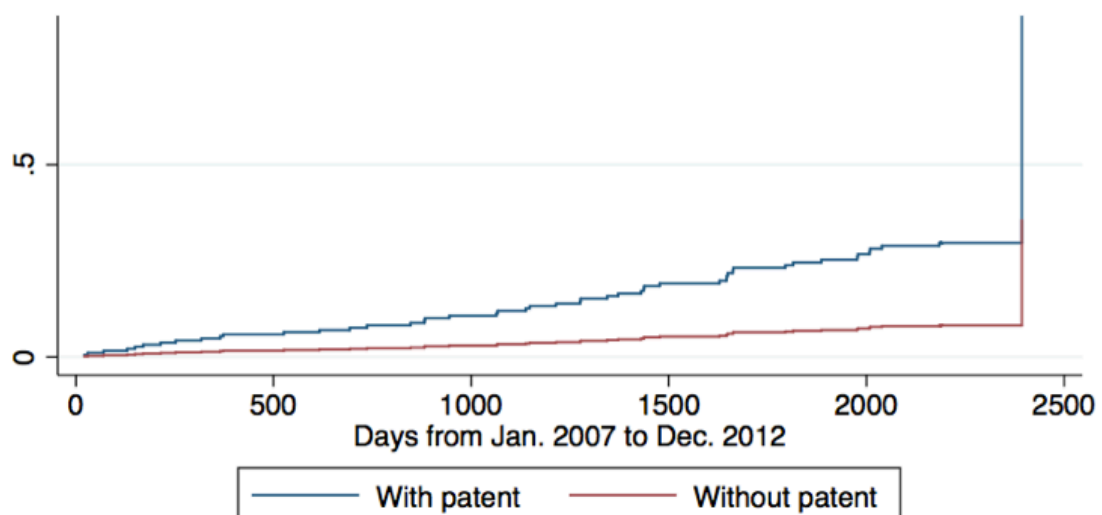
Is there a link between patent positions and the probability of success?

We examine as a second step whether active companies in VC funds portfolios are more likely to be listed or acquired if they own patents. To do so, we consider a subsample of 587 VC backed startups as of January 2007, and observe their evolution until the end of 2012². The main difference with the previous approach is that we now focus on a post investment stage: therefore a startups' patent portfolio in 2007 is already subject to the influence of the backing VC funds.

Besides patent ownership and the sector of activity of the startups, we now use their age and total funding as of 2007 as other control parameters to predict future success. Our results again provide evidence of a significant correlation between patent ownership and subsequent success.

We first report the cumulative probability of success of a representative startup between 2007 and 2012 (Figure 3). Again, it clearly appears that success is more likely when this startup has one or more patents at the beginning of the period. Moreover, the ratio of success probabilities with and without patent appears to be remarkably stable over the entire 6 years period.

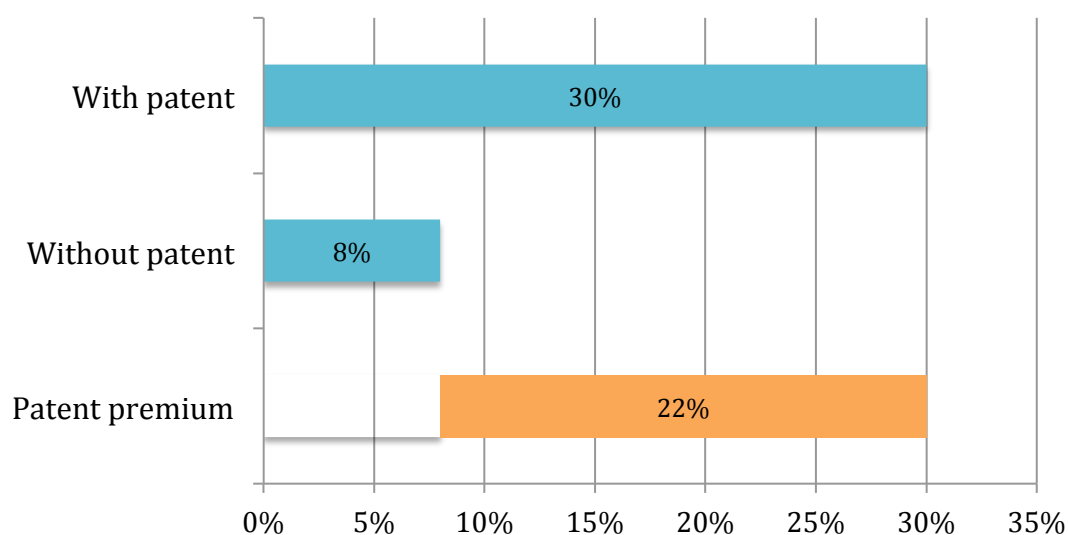
Figure 3: Cumulative probability of success



² In that case the average success rate is 13%.

The estimation makes it possible to infer the probability of success of a representative startup between January 2007 and December 2012, depending on whether it owns or not patents at the beginning or the period. As indicated in Figure 4, patent ownership is associated with a 30% likelihood of success in the six following years, against 8% without patents. **Patent ownership thus generates a success premium of 22% or, put differently, it multiplies by 2.75 the chances of success in the next 6 years.**

Figure 4: Probability of success between 2007 and 2012



Since we consider here the “average” startup in the sample, this general result does not correctly account for sector heterogeneity. A more detailed approach accounting for different expected time-to-success and different effects of key factors (age, funding, patents) between the main sectors nevertheless confirms our general finding. We find in this case that **patent ownership consistently and significantly multiplies the probability of success by a factor of 3.6 in all sectors**. Our estimations suggest stronger effects in some sectors such as Software and Biotechnology, but these results are not statistically significant, due to the limited number of observations³.

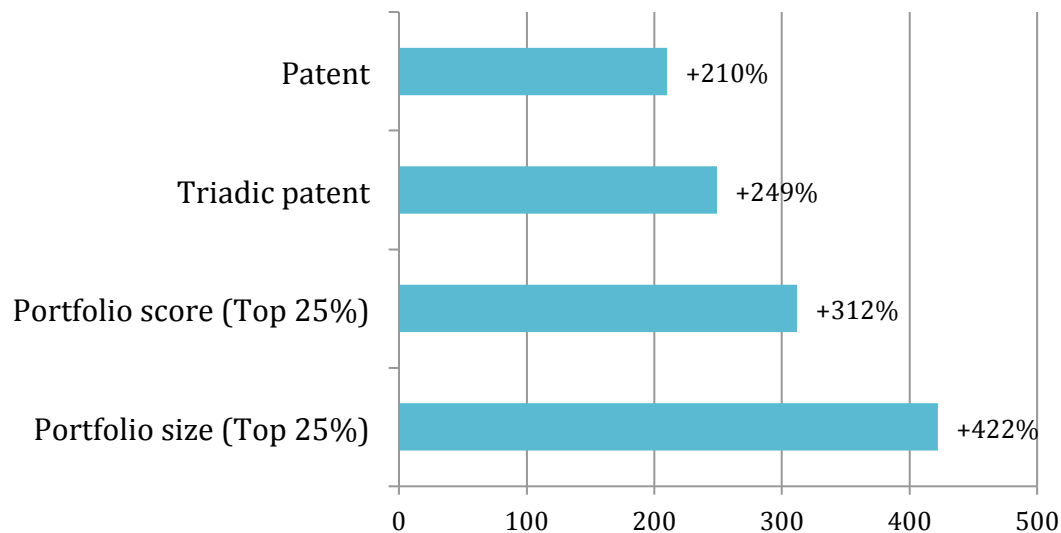
As compared with the pre-investment analysis, these results indicate that **in the post-investment period patent ownership is strongly related to success in all sectors, although its impact is probably stronger in Software and Biotechnology**. This suggests that the management of IP policy is a powerful strategic leverage for any VC backed startup to achieve economic success.

It is therefore interesting to have a closer look at the startups’ patent portfolios in order to refine the analysis. To do so we estimate another set of econometric models where patent ownership is replaced by alternative patent indicators. We first use ownership of triadic patents to approximate the international coverage

³ We observe for instance only 30 Biotech startups in VC portfolios as of 2007, of which only 3 own patents. Only 3 out of these 30 startups succeeded in the following 6 years, and 2 of these 3 successful startups had patents initially.

of patent portfolios in 2007⁴. We also construct two groups of patent holding startups with respectively the top 25% largest patent portfolios, and the top 25% portfolio quality scores in 2007. The latter indicator is based on the sum of patent scores calculated by Thomson Innovation, based in particular on the number of subsequent citations among other qualitative patent indicators.

Figure 5: Predictive power of different patent indicators



The results of this analysis are reported in Figure 5. They clearly show that **refined patent indicators can better predict the probability of success than mere patent ownership**. In line with our previous estimations, patent ownership multiplying the probability of success by 3.1, thereby generating a success premium of 210%. By contrast, **startups that own a triadic patent are 3.5 times more likely to succeed** in the next 6 years. **This factor in turn goes up to 4.1 and 5.1 for the top 25% portfolio scores and portfolio sizes respectively.**

Conclusion

Our results clearly highlight the strong predictive power of patent positions on the chances of successful exit for VC backed startups.

- We first find evidence of a significant signaling effect of patent ownership prior to VC investment: patents significantly increase the likelihood of subsequent success, especially in the Software and Biotechnology sectors

⁴ A patent is defined as triadic when the underlying invention is protected by patents in Europe, the USA and Japan. About 3% of the active startup in VC portfolios as of 2007 own triadic patents. They represent about 30% of the patent owning startups at this date.

where patent-holding startups are respectively 2.89 and 2.99 times more likely to succeed.

- We find as a second step that active startups in VC portfolios are about 3.5 times more likely to succeed in the next 6 years if they own at least one patent. Interestingly, the impact on the likelihood of success is even stronger when we consider refined patent indicators that better capture the strength of the startups' patent positions. The success premium raises from +210% to +250% when only triadic patents are taken into account, and to respectively +312% and +422% for the top 25% startups in terms of patent portfolio rating (as measured by Thomson Reuters) and size. Beyond the mere need for patent protection, this clearly highlights the importance of being able to build strong IP positions for startups.

It is important to keep in mind that we formally establish the existence of correlations – not causal effects – between patent positions and success. In other words, filing a first patent will not automatically multiply the applicant's chances of success by 3.5! As a matter of fact, there are other important drivers of success that we cannot observe, and some of them (such as good management and technology) are likely to influence patent positions. The strong correlations that we observe probably also reflect their influence – the unobserved factors being then “captured” by patent indicators. This again implies that simply filing patents is not sufficient: the key driver of success is in fact the startup's ability to build strong and relevant IP positions.

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