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Understanding Society

Venture Capital and Innovation Strategies

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April 2015

Abstract

Venture capital is a specialized form of financial intermediation that often provides funding for costly technological innovation. Venture capital firms need to exit portfolio companies within about five years from the investment to generate returns for institutional investors. This paper is the first to examine the association of venture capital funding with a company's choice of innovation strategies. We employ a unique dataset of over 10,000 innovative Dutch companies, some of which received venture financing. The data include detailed information on patent applications, innovation activities, financing sources, and other company characteristics. We find that companies backed by venture capital focus on the build-up of absorptive capacity, by engaging in in-house R&D, while at the same time acquiring external knowledge. We interpret this finding as a consequence of the time horizon of venture capital firms. Our results suggest that the correlation between venture capital funding and the build-up of absorptive capacity is not only due to a selection effect. We derive implications of these findings for corporate strategy and public policy.

Keywords: Venture Capital; Entrepreneurship; Innovation Strategy; Research & Development; Public Policy.

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1. Introduction

Technological innovation is a major source of competitive advantage. It is a costly activity that requires large investments. Therefore, it may not be affordable for small and medium sized entrepreneurial companies, unless they manage to attract external sources of funding (Hall and Lerner (2009)). Since banks are by their nature reluctant to lend to risky, long-term projects (Ueda (2004)), firms that want to invest in innovation may have to turn to other sources of funds. A prominent source of capital for innovative companies is venture capital. Venture capital is a form of specialized financial intermediation that finances companies with the goal of realizing a capital gain by bringing them public or having them acquired within a few years. A distinctive trait of venture capital is the screening, monitoring, and advising of its portfolio companies (Bottazzi, Da Rin, and Hellmann (2008, 2009), Gorman and Sahlman (1989), Lerner (1995)). These non-monetary services allow venture investors to select companies with high growth potential and to bring them to success. Both the 'selection' (screening) and the 'treatment' (monitoring and advising) aspects contribute to the 'venture capital advantage' over unspecialized form of finance (Sørensen (2007)).

While previous literature has examined the role of venture funding for several aspects of corporate strategy (see Da Rin, Hellmann, and Puri (2013) for a survey), we know very little about the relationship between venture capital and the innovation strategies. This is surprising, since innovation strategies contribute to a company's competitive advantage (Cassiman and Vetugelers (2002)). In this study we fill this gap bridging the finance and management literatures, by asking whether companies that are financed by venture capital firms are better able to accumulate innovation capabilities.

We base our analysis on the concept of absorptive capacity, defined by Cohen and Levinthal (1989, 1990) as the `capacity to identify, assimilate and exploit new knowledge' that has been generated outside the firm, thereby 'absorbing' it. Recent conceptualizations stress the dynamic capability nature of absorptive capacity that allows companies to learn from both in-house and extramural knowledge (Zahra and George (2002)). In this view, the routines that constitute a firm's absorptive capacity lead to the creation and continuation of a competitive advantage. Absorptive capacity is then a source of competitive advantage that contributes to improving a company's economic performance: by combining in-house ('make') and external ('buy') innovation activities, firms are able to produce more and better innovations. In fact, absorptive capacity has been shown to be beneficial to both innovation and product market performance (Cassiman and Veugelers (2006), Engelen et al. (2014)). This result also holds in our data: firms that engage in 'Make-And-Buy' obtain a higher percentage of their sales from innovative products. The implications for corporate strategy of understanding which variables may lead to the build-up of absorptive capacity are therefore potentially important. Studying the association between venture financing and absorptive capacity can therefore improve our understanding of how the source of finance affects the innovation strategy of entrepreneurial companies.

Following Cassiman and Veugelers (2006), we consider four innovation strategies that consist of exclusive combinations of two innovation activities: in-house R&D ('Make'), and the acquisition of external knowledge in the form of R&D, patents, and other know-how ('Buy'). The resulting strategies are: 'No-Make-No-Buy,' 'Buy-Only,' 'Make Only,' and 'Make-And-Buy.' We focus on the 'Make-And-Buy' strategy that is often used as an empirical correspondent of the concept of 'absorptive capacity'). Our hypothesis is based on venture investors having a tight time frame for exiting their investments, since they commit to return money back to their financial sponsors within a few years. This creates a pressure to invest in companies that are likely to mature soon from a commercial viewpoint. We therefore expect a positive association between venture capital and the build-up of absorptive capacity, i.e. with a Make-And-Buy strategy.

We base our analysis on a unique database of over 10,000 Dutch companies that engage in innovation activities. Of these, 161 receive venture financing, mostly for expansion purposes. The Netherlands represents a suitable research ground for our study, since it is the second European country in terms of patents per capita (European Patent Office (2013)) and the second largest venture capital market in the European Union in per capita terms (EVCA (2012)). Our dataset combines three sources of data. First, we obtain detailed firm-level information on innovation activities from the Community Innovation Survey (CIS) data provided by the Dutch Central Bureau of Statistics (CBS). We then augment these data with information on venture financing from ThomsonOne, the leading commercial database for venture finance, and with patent application-level information from the PATSTAT database of the European Patent Office. The resulting database is both unique and novel.

An important feature of the CIS database is that it allows us to control for firms' access to public funds distributed in the form of grants to companies that develop new technology. Public funds aim at helping technology-based companies overcome credit constraints that may deter them from innovating, without immediate regard to their profitability. Public funds, therefore, do not put any pressure on companies for immediate commercial success. By controlling for access to public funds, we are then able to disentangle the role of venture capital in nurturing commercially successful innovative companies on top of the sheer provision of money.

We first document, in univariate analysis, that venture-backed companies have different characteristics than other companies, both those that receive public funds but no venture capital, and those that do not receive any of the two sources of funding. They have higher sales, consistent with Eckhardt, Shane, and Delmar (2006), and are more likely to operate in high-tech industries. They have also produced more patents before receiving financing, consistent with Hsu and Ziedonis (2012) and Haeussler, Harhoff, and Mueller (2014), who show that patents are a good predictor of venture funding. Venture-backed companies are more often engaged in the build-up of absorptive capacity, while companies that receive only public funds are more often engaged in developing only in-house R&D. On the performance side, venture-backed companies are more aggressive in protecting their intellectual property and have higher percentage of sales from newly introduced products.

We then turn to a multivariate analysis; our central result is that companies with venture investors are more likely to engage in the Make-And-Buy strategy, but not in Buy-Only or Make-Only. Venture-backed companies are 16.8% more likely to choose the Make-And-Buy innovation strategy than companies with no venture funding. Moreover, venture-backed companies are *not* more likely to engage in pure in-house R&D. This points to venture funding relentlessly pursuing companies that build up absorptive capacity, and not companies that only engage in in-house R&D. This result is robust to several variations in the assumptions underlying the econometric analysis, and is consistent with venture capital investors' need to invest in companies that can generate financial returns within a relatively short period of time.

The association of venture capital with absorptive capacity may derive from venture capital firms' ability to select promising companies as well as from their influence on these companies. Our data do not allow separating these 'selection' and 'treatment' effects of venture capital, since we cannot rely on time- or space-based instrumental variables to disentangle selection from treatment. However, we can exploit the variation in the innovation strategies of 30 companies for which we have information both before and after the venture capital investment. When we look at the change in strategy after the arrival of a venture capital investor, the patterns we observe are consistent with venture capital selecting companies that are already building absorptive capacity, but also pushing companies in that direction after investing.

Several studies, using European and US data, have found that venture capital backed companies tend to have superior performance in producing commercially successful new technology (e.g., Bottazzi and Da Rin (2002), Engel and Keilbach (2007), and Hellmann and Puri (2000)). The correlation we document advances our understanding of how such performance is achieved. By focusing on innovation strategies that lead to building up absorptive capacity, venture backed companies are able to achieve more and better innovation, and therefore to introduce more innovative and commercially successful products.

The link between funding sources and innovation strategy has implications for corporate strategy. From a strategy perspective, our results imply that companies that seek venture capital need to develop a technology base that prepares them to incorporate external technology. They also imply that venture capital investors push their companies towards the incorporation of external knowledge. Both effects are consistent with the anecdotal evidence collected by Bhidé (2008).

Our results can also inform public policy. Governments spend large amounts of public money on promoting innovation and entrepreneurship, including support for venture capital firms (see Da Rin, Nicodano, and Sembenelli (2006) and Hall and van Reenen (2000) for a discussion).[1] Our results point to venture capital being effective for supporting the rapid creation of commercially successful innovative companies.

The remainder of the paper is organized a`s follows. Section 2 discusses the conceptual framework that guides and motivate our analysis. Section 3 presents the data and variables. Section 4 presents and discusses our results. Section 5 reports our robustness checks, and is followed by a brief conclusion.

2. Literature and Hypotheses

We start by examining the concept of absorptive capacity and the working of venture capital. From this, we derive our hypotheses on the association between a company's sources of finance and its innovation strategies that guide our empirical strategy.

The concept of absorptive capacity was introduced by Cohen and Levinthal (1989, 1990) to identify a company's capability to exploit knowledge generated outside its boundaries. The theoretical argument is that in-house R&D activities have two different effects, or 'faces.' One is that R&D allows companies to directly generate new innovations, the other is that R&D provides companies with the ability to 'identify, assimilate, and exploit' know-how that has been generated outside them, thereby 'absorbing' it. Internal know-how provides the company with the capability of incorporating external knowledge into the development of successful innovations (see Arora and Gambardella (1990, 1994), Cockburn and Henderson (1998) and Freeman (1991)).

Absorptive capacity has attracted growing attention in empirical studies (see Lane et al. (2006)). Recent theoretical formalizations frame absorptive capacity as a dynamic capability that allows companies to learn from knowledge generated both in-house and acquired from outside the company (Kamien and Zang (2000), Zahra and George (2002)).[2] In particular, Zahra and George (2002) include into absorptive capacity the 'transformation' that comes from recombining internal and external knowledge. Transformation creates the possibility to recognize innovation opportunities (McGrath, MacMillan, and

[1] For a debate on the effectiveness of such policies, and on evidence that they result in the entry of 'churning' companies which fail to develop and innovate see Da Rin, Di Giacomo, and Sembenelli (2010), Kerr and Nanda (2010), and Shane (2008).

[2] See also Leahy and Neary (2007) for an analysis of the economic policy implications of absorptive capacity.

Venkataraman (1995)) and to build the cognitive bases to exploit them, shaping in this way the firm's competitive strategy (Zahra, Ireland, and Hitt (2000)).[3] Zahra and George (2002) therefore conceptualize absorptive capacity as 'a set of organizational routines and processes by which firms acquire, assimilate, transform, and exploit knowledge to produce a dynamic organizational capability.'

From our perspective, the dynamic nature of absorptive capacity allows companies to exploit their knowledge base (internal as well as acquired) to reconfigure their resources in response to changes in a company's environment. In this sense, absorptive capacity is a source of competitive advantage that contributes to improving a company's economic performance, as documented by Cassiman and Veugelers (2002, 2006), Lane and Lubatkin (1998), Lenox and King (2004), and Spender (1996). Absorptive capacity therefore helps explain why the incorporation of knowledge from external sources leads to an increase of in-house R&D (Veugelers (1997)) and of productivity (Allen (1986), Levin and Reiss (1988)). In fact, companies that accumulate absorptive capacity are better positioned to benefit from external knowledge, and therefore to outperform rivals in terms of innovation performance (Tsai (2001)).

In our empirical analysis, we follow Cassiman and Veugelers (2006), and we consider that a firm pursues an innovation strategy of building absorptive capacity when it undertakes in-house R&D and also acquires external knowledge ('Make-And-Buy' strategy). Cassiman and Veugelers (2006) further argue that understanding which variables lead to a build-up of absorptive capacity would help making the innovation process a `manageable source of sustainable competitive advantage.' We provide a contribution in this direction, and investigate whether the build-up of absorptive capacity, the 'Make-And-Buy' strategy, is related to a company's sources of finance. The importance of the source of finance has been attracting growing attention in the finance and management literatures. For example, Hellmann (2002) shows that the strategic goals of corporate investors differ from those of venture capital firms. Ueda (2004) shows that banks are less suitable than venture capital firms for financing high-risk entrepreneurial projects. David, O'Brien, and Yoshikawa (2008) show that transactional debt is less congruent with R&D activities than relational debt.

We focus in particular on the role of venture capital, which is a form of finance that is especially suitable for innovative companies (Casamatta (2003)). Venture capital firms are specialized investors that raise money from pension funds, endowments, and other institutional investors. This occurs through investment vehicles ('funds') that make equity investments in innovative companies with high growth

[3] Narrative studies have since long provided anecdotal evidence on the importance of transformation for successful innovation. For instance, Mueller (1962) shows that fifteen of the 25 major discoveries introduced into the United States by DuPont, originated with work done outside the company, despite the company's substantial investments in path-breaking research. Johnston and Gibbons (1975) argue that information obtained from outside the company contributes significantly more to the solution of technology problems than information that is internally available.

potential (see Sahlman (1990) for a detailed analysis). To mitigate agency conflicts, venture funds have a finite life, typically ten years. They invest in their early years and then move to reap the fruits of their investments before they are liquidated and return money to investors (Gompers and Lerner (2001)). Funds' finite life span forces them to invest in companies that can quickly grow up to become ripe within a relatively short time, typically five years.

Venture capital firms are therefore specialized in identifying and supporting companies that can have a strong potential for commercial success, so that they can be soon 'exited' by being listed on a stock exchange or sold to an industrial acquirer. Venture capitalists cannot afford investing in companies whose expected maturation is far away. When selecting their portfolio companies, venture firms focus on companies that have provided tangible signs of technological maturity. Eckhardt, Shane, and Delmar (2006) find that venture investors are more likely to finance companies that have already shown 'verifiable indicators of venture development' such as marketing activities and sales. Several studies have also shown that VCs use patents as screening signals (Baum and Silvermann (2004), Hsu and Ziedonis, (2012), Mann, and Sager, (2007)). We therefore expect venture investors to be attracted by companies that have already started to build-up absorptive capacity.

The need to exit their investments within a tight timeframe makes venture capital firms be active investors and put pressure on their companies to reach commercial maturity. Several studies document the effect of venture capital firms' active involvement on different company strategies. These include the professionalization of the management team (Bottazzi, Da Rin and Hellmann (2008), Hellmann and Puri (2002)), the formation of strategic alliances (Lindsey (2008) and of R&D alliances (Colombo, Grilli, and Piva (2006), patenting (Engel and Keilbach (2008)), the degree of product innovation (Hellmann and Puri (2000)) and commercialization cooperation (Gans, Hsu, and Stern (2002), Hsu (2006)).[4] Absorptive capacity is congruent with venture capital firms' need for realizing their capital gain within few years from investing, because it makes it more likely for a company to innovate successfully.[5] We therefore expect venture-backed companies to be more likely to invest in absorptive capacity than companies that rely on other sources of finance. Our study is the first to look into the relationship between venture capital and innovation strategies.[6] Several companies in our sample receive public funds. These represent a passive form of finance that innovative companies can often access thanks to their technological prowess. However, they do not target commercially ambitious firms. By controlling for access to public funds, we can then control for the extent to which firms manage to

[4] Studies also find a stronger propensity to patent by venture-backed companies (e.g. Kortum and Lerner (2000)), though this has not been confirmed in the European context (Engel and Keilbach (2007)).
[5] Bhidé (2008) provides narrative evidence that companies that obtain venture finance have often demonstrated prior evidence of an 'incipient technological advantage' (see, for instance, p.28).
[6] There is a large literature on the effects of VC funding for portfolio companies; see Da Rin, Hellmann and Puri (2013) for an extensive survey.

overcome credit constraints. This allows us to document the role of venture capital on top of the sheer provision of finance.

Finally, we note that understanding how the source of finance can lead to the accumulation of absorptive capacity, whether by selecting innovating companies or by pushing companies to accumulate absorptive capacity, is important also from a policy perspective. Building on the theoretical contribution of Aghion and Hewitt (2002), Griffith, Redding, and van Reenen (2004) provide country-level evidence of the importance of absorptive capacity for productivity growth. In other words, absorptive capacity matters for the success of the individual firm but also for economic growth. Our study contributes also to this literature.

3. The Data

3.1 Data sources

We base our analysis on a unique company-level database of Dutch companies. The Netherlands represents an appealing research ground for our purposes, since it is the second European country in terms of patents per capita (European Patent Office (2013)) and the second largest venture capital market in the European Union in per capita terms, second only to the UK (EVCA (2012)).

We collect our data from three sources. First, we use innovation and company data from the Community Innovation Survey (CIS).[7] Since 1993, the CIS takes place every four years in all countries of the European Union to investigate companies' innovation activities. Information is gathered by national statistical offices through a survey that covers a representative sample of companies (innovative and not) stratified along the region, sector, and size dimensions.[8] CIS data are published only in aggregate form to preserve respondents' anonymity. However, the Dutch Central Bureau of Statistics (CBS) allows qualified researchers to gain access to (anonymous) company-level information. We use data from four survey waves: CIS-3, covering 1998-2000, CIS-3.5, covering 2000-2002, CIS-4, covering 2002-2004, and CIS-4.5, covering 2004-2006. Waves CIS-3.5 and CIS-4.5 were carried out by the CBS using mostly the same format as in the previous Europe-wide wave. About 10,000 Dutch companies are included in each survey wave, and there are over 28,600 companies that are surveyed over these four waves.

[7] CIS data have been used in several studies. For example, Mairesse and Mohnen (2002) and Belderbos et al. (2004) use the Dutch survey, Frenza and Ietto-Gillies (2009) use the UK survey, Cassiman and Veugelers (2002, 2006) use the Belgian survey, Griffith et al. (2006) use data for France, Germany, Spain, and the UK, and Lorenz et al.(2007) use the whole European survey.

[8] A description of the Community Innovation Survey can be found on Eurostat's website: http://ec.europa.eu/eurostat/web/microdata/community_innovation_survey.

Our second source of data is the ThomsonOne database published by Thomson Financial, a division of Reuters. ThomsonOne is the main commercial source of venture capital and private equity investment data, and has been extensively used in studies of venture capital financing (e.g., Gompers et al. (2005), Hochberg, Ljungqvist, and Lu (2007), and Sørensen (2007)). ThomsonOne is compiled from information provided directly by venture capital firms, and contains data at the level of the individual investment. For the Netherlands it includes (for the period under study) more than 1,000 investments made by nearly 300 venture firms in over 600 companies.

Our third source is the PATSTAT database developed by the OECD and the European Patent Office (EPO).[9] From PATSTAT we obtain information on the individual patent applications filed with the European Patent Office by Dutch companies.

3.2 Dataset construction

Building our dataset involved two major steps: (*i*) aggregating information from different CIS waves for each company, and (*ii*) merging the information from the CIS, ThomsonOne and PATSTAT databases.

Because we are interested in innovative companies, we restrict our sample to companies that have introduced either a product or a process innovation or that report undertaking any of the innovation activities listed in the CIS survey in any of the waves they took part in.[10] This reduces our sample from 28,600 to 10,371 companies. Of these, 51% take part in only one wave, 26% in two waves, 14% in three waves and 9% in all four waves. We aggregate the information of firms that participate in more than one wave, so that we have one observation per company in the final dataset. We also aggregate so as to ensure an accurate recording of innovation activities. Consider a company, which starts doing intramural R&D in December 2000 and buys a patent in January 2001; these two activities would fall in different CIS waves, but are clearly related, and indeed closer than if they had taken place at two distant dates within the same CIS wave (say February 1998 and November 2000). Since we do not know the exact timing of each innovation activity, but only that it happened within the three years covered by the survey wave, we consider the company actively engaged in an innovation activity if it is ever active across the CIS waves it takes part in. With this approach, we are able to exploit the richness of our data and to obtain a more accurate picture of companies' innovation strategies than with a purely cross-sectional dataset. In order to account for the fact that we have richer information for companies that take part in

[9] We obtain the PATSTAT data from EPIP (http://www.epip.eu/datacentre.php). Information on PATSTAT is available from the EPO website: http://forums.epo.org/patstat. Notice that EPO data refer to patent applications, while US Patent Office data refer to patent grants.

[10] These seven innovation activities are: intramural R&D, extramural R&D, acquisition of other external knowledge, acquisition of machinery, equipment and software, personnel training, activities for market introduction and other procedures. Respondents are asked to report those activities only when they are undertaken for 'the development of new or significantly improved products or processes.'

multiple waves, in the robustness section we also include a set of 15 dummies that control for the combinations of waves a company participates in.

The second step in the dataset construction consists of matching the data from the CIS with the data from ThomsonOne and PATSTAT. With this goal, we identify Dutch venture-backed companies and Dutch companies that filed applications with the EPO. To merge these companies with those in the CIS datasets we exploit the fact that the Dutch Chamber of Commerce assigns each Dutch company a unique identifier. This number is used in the CIS to identify companies. As ThomsonOne does not contain this information, we looked up in the Chamber of Commerce website the identifier for each company that received venture funding, using an algorithm based on the company name, city, address, and sector. By joining the Chamber of Commerce identifier of CIS respondents with that of the venture-backed companies, CBS could then precisely identify all venture-backed companies in the CIS database. Our sample contains 161 such companies. Identification of patent applicants was obtained in the same way. The sample was then anonymized by CBS by replacing the Chamber of Commerce identification numbers with random ones.

3.3 Variables

In this section we describe the variables we use in the empirical analysis. Table 1 provides formal definitions, and reports the mean value (or frequency) and the standard deviation for all variables.

3.3.1 Innovation strategies

We build our dependent variables from the two innovation activities: Make and Buy. Make consists of doing intramural R&D to develop technology within the firm. Buy consists of acquiring technology from outside the firm, ‘extramural R&D,’ and it includes two different types of purchases. The first is the purchase of R&D from external sources, and the second is the purchase or licensing of patents, or of other inventions or forms of disembodied knowledge, generated outside of the firm.[11]

Following Cassiman and Veugelers (2006) we aggregate innovation *activities* into four mutually exclusive innovation *strategies*. The baseline category is No-Make-No-Buy; this occurs when a company does not engage in any innovation activity. This group is made up of companies that report having introduced a product or process, but do not currently engage in neither Make nor Buy, presumably because they did so in the past. A company belongs to this group also if it reports (*i*) undertaking acquisition of machinery, equipment and software, (*ii*) personnel training, (iii) activities for market introduction, or (iv) other procedures (see footnote 10). Make-Only and Buy-Only are strategies

[11] Following Cassiman and Veugelers (2006) we do not include in the construction of innovation strategies the acquisition of know-how `embodied' in machinery and equipment because it is not clear whether this activity refers to technology acquisition or just to the purchase of means of production.

that consist of only one innovation activity, intramural or extramural R&D, respectively. Finally, Make-and-Buy is the strategy of combining the two innovation activities, in-house R&D and external knowledge acquisition, and corresponds to the build-up of absorptive capacity.

Our interpretation of the importance of innovation strategies relies on absorptive capacity being important for company performance. To this purpose, Table 2 reports the distribution of companies across innovation strategies (column I), and the distribution of the three measures of innovation and commercial performance across innovation strategies (columns II to IV). Column I shows that Make-And-Buy is the most frequent strategy, adopted by over a third of the firms in the sample. Buy-Only is the least frequent strategy. Almost 30% of the firms in our sample are not conducting innovation activity at the time of answering the Survey. Importantly, similar to Cassiman and Veugelers (2006), Table 2 shows that Make-And-Buy is the strategy that ranks always at the top of all the performance measures, whether innovation performance or commercial performance, consistent with this strategy providing companies with a competitive advantage. The strategy that comes second is Make-Only and the worst performers are Buy-Only and No-Make-No-Buy.

3.3.2 Independent variables

All our independent variables are measured at the company level and are obtained from the Community Innovation Survey, the Business Register of the CBS, ThomsonOne, or the PATSTAT database of the EPO. Our explanatory variable of main interest is Venture-Capital, a dummy variable equal to 1 if the company has received venture financing anytime until December 2006, and 0 otherwise. The majority of the 161 venture-backed companies received 'expansion' (or 'growth') financing from their venture capital firms, consistent with the fact that European venture capital tends to be focused on this type of deals (Bottazzi and Da Rin (2002)). Our sample is therefore largely composed by relatively mature entrepreneurial companies that engage in innovation activities for which external funding is necessary.

Innovative companies are likely to be credit rationed due to the riskiness of their activity, the lack of track record, or the presence of large agency costs (see Carpenter and Petersen (2002), Hall (2002), and Himmelberg and Petersen (1994)). The availability of public funds can therefore be an important source of financing (Hall and van Reenen (2000)). Public-Funds is a dummy variable equal to 1 if the company received national or European public funds in any of the CIS waves it took part in, 0 otherwise. We obtain this information directly from the CIS. We find that 3,208 companies receive public funding in our sample. Of these, 91 also receive VC funding. Finally, 7,093 companies receive neither form of funding.

Company age is an important variable for determining corporate strategy and the ability to reach out to external resource providers (Hsu (2006)). We obtain data on each company's founding date from the

Business Register database of CBS. We then compute the number of years until the time of its first venture financing (if venture-backed), or until the end of the first CIS wave it has responded to (if non venture-backed). We also control for firm size to capture a company's ability to mobilize resources. We measure size with the company's sales in the last year of the first CIS wave it took part in.

Since we do not have information on the pre-funding levels of innovation, it is important that we control indirectly for how innovative a company was before the arrival of the venture firm. For this, we use a standard measure of innovation output, patents. We have patent data that is particularly suited for this purpose, since it contains the entire universe of patent applications filed with the EPO, therefore providing a set of patent applications that are arguably of higher value than those filed at the purely national level. Our main patent measure (Patent-Family-Size) is the number of patent applications filed with *both* the EPO and non-EPO patent offices. This is a common measure of patent quality, which counts the total number of applications at different patent offices (see Hall, Thoma and Torrisi (2007)). We also use several alternative measures. One is the number of EPO patent applications filed by each company (Patents-EPO). A second is the number of 3-year forward citations received by the company's patent applications filed with the EPO (Patents-EPO-Citations), another common measure of patent quality (see Harhoff et al. (1999) and Trajtenberg (1990)). We aggregate the patent applications made to the EPO by each company taking into account the year of application. For each company that does not receive venture funding, we add the number of applications submitted during the six-year period from 1992 to 1997; this period ends just before the starting year of the first CIS wave. For each company that receives venture funding, we sum up the number of patent applications in the six-year period before the year of the first round of VC funding. We follow the same procedure when building our measures of patent quality.[12]

Previous studies show that an industry's R&D orientation affects the innovation activities of its companies (e.g., Colombo and Garrone (1996), Röller, Tombak, and Siebert (1997)); industry is also important for the venture investors' decision (Puri and Zarutskie (2012). In our analysis we control for the industry a company operates in. In our main regression, we aggregate this information into a dummy variable, which naturally lends itself to interpretation. We define as High-Tech those companies that operate in the following NACE 2-digit industries: Chemicals, Pharmaceuticals, Electronics, Computer Services, and R&D Services. We obtain the necessary information from the CIS; 14.8% of the companies operate in these industries. In the robustness section we replace High-Tech with industry fixed effects. Our results are robust to the inclusion of these fixed effects.

3.3.3 Other variables

[12] Our results do not change if we use for venture-backed companies the same criterion as for the other companies.

We also consider three measures of innovation output to evaluate the effectiveness of different innovation strategies. The first is whether the company applied for protection of its property rights in the form of a patent, trademark, copyright or industrial design (IPR-Protection-Application). This variable aims to capture the fact that successful innovations are often protected through IPR, and in this sense, it represents a measure of innovation performance. These forms of IPR have been shown to be valuable for innovation and commercialization.[13] Almost a third of the companies in our sample seek IPR protection for their products or processes.

The next two variables are the fraction of sales a company that derives from the introduction of products that are new to the market (Sales-Product-New-To-Market), or that are new to the firm (Sales-Product-New-To-Firm). We take the highest fraction across all waves the company participated in. These variables aim at capturing the degree to which innovation is associated with the introduction of commercially more ambitious products. We note that a substantial amount of sales is obtained by new products (see Table 1). As expected, the percentage of sales of products new to the market is lower than the percentage of sales of products new to the firm.

4. Results

4.1 Univariate analysis

We start our analysis by looking at the characteristics of the companies in our sample. In Table 3 we compare companies that receive venture capital (Venture-Capital, column I) to: (*i*) those which receive public funds but *no* venture capital (Public-Funds-Only, column II), and to (*ii*) those which do not receive either type of financing (Other, column III) and are therefore more likely to be financially constrained.[14] In Panel A, we report the median (frequency for dummy variables) and the standard deviation. Next to columns II and III, we indicate whether these companies differ from venture-backed ones in a statistically significant way. Our main comparison in this Section is between companies that receive venture capital and those that receive only public funds; the latter do not seem to be cash constrained and therefore constitute a better comparison benchmark that those with no funding.

Panel A.1 of Table 3 looks at company characteristics. Venture-backed companies are younger than other companies, though not in a statistically significant way. Since they are also larger, they are likely to have already achieved faster growth, consistent with with Eckhardt, Shane, and Delmar (2006). They are also significantly (economically and statistically) more likely to operate in a high-tech industry.

[13] See Mendonca et al. (2004), and Nabil, Landry, and Traoré (2008) for trademarks; Audretsch, Brönte, and Mahagaonkar (2012) for industrial design, the literature on patenting is very large, see Hall and Harhoff (2012) for a recent survey.

[14] Notice that 56% of venture-backed companies also receive public funds.

Panel A.2 looks at innovation strategies. Companies that do not receive external funding are more likely to engage in no innovation activity or to engage in Buy-Only than venture-backed companies. They are also less likely to engage in Make-And-Buy. Moreover, venture-backed companies are less likely to limit themselves to in-house R&D compared to companies that receive only public funds, but more likely to combine this internal R&D with the purchase of external know-how.[15] This suggests that venture capital is associated with companies that are not only undertaking in-house R&D, but are also active in incorporating external knowledge, a result we further examine in the multivariate analysis.

Panel A.3 looks at different measures of innovation output. Venture-backed companies have a higher fraction of their sales coming from new products than companies in the other two groups. This is true for products that are new to the firm, like in Cassiman and Veugelers (2006). Moreover, the result holds also for products that are new to the market, i.e., that have not yet been introduced in the market by other companies. Products that are new to the market are likely to have higher economic value, and are therefore more likely to increase profits. Finally, venture-backed companies are also substantially more likely to apply for IPR protection in any of the CIS waves, in the form of patents, trademarks, copyrights or designs, than the other two groups of companies, consistent with Kortum and Lerner (2000).

Panel B of Table 3 looks at the patent variables that we build using EPO data. The number and quality indicators for patents are highly skewed, being zero for most companies; most patent activity takes place in the fourth quartile of the distribution. Therefore, we report mean instead of median values. The EPO patent variables measure how innovative the company was in the six years before the beginning of the sample period (or before a venture-backed company received its first round of funding), and therefore provide a measure of the company's pre-existing level of innovation activity. Specifically, they measure the number and the quality of patent applications during the six-year period up to 1998 (or before the first VC round, for venture-backed companies). We find that companies with no funding have a substantially lower number of patents and of patent quality indicators than other companies. Venture-backed companies have a higher number of EPO patents than companies that receive only public funds, more than twice as many. The number of forward citations, a common measure of patent quality, is about twice as large, but is not statistically significant at conventional levels. The same applies to Patents-Family-Size. These findings suggest that venture capital is more likely to be associated with companies that have already shown some innovative capability Hsu and Ziedonis (2012). This could also be due
to venture capital investing in high-tech industries, which have higher propensity to patent.

[15] The stronger use of the Make-And-Buy strategy by venture-backed companies is confirmed by the fact that the correlation between Make and Buy activities is (statistically significantly) higher for these companies (0.34) than for those that receive only public funds (0.26).

Overall, the data reflect systematic differences between venture-backed companies and the other companies, also those that receive public funds. Younger, faster-growing venture-backed companies appear to be more focused on the build-up of absorptive capacity, and to enjoy a higher share of their revenue from newly introduced products. Whether these facts persist when controlling for other determinants of innovation strategies, can only be analyzed in a multivariate framework.

4.2 Multivariate analysis

We move to a regression analysis in order to obtain a more precise picture of the relationship between venture capital and innovation strategies. We use a multinomial probit regression to identify which factors are associated with the adoption of different innovation strategies. As explained in Section 3.3.1 we consider four mutually exclusive strategies: Make-and-Buy, Make-Only, Buy-Only, and No-Make-No-Buy.[16]

To make sure that the innovation activities are dated after the first round of venture capital investment, in the case of companies that receive VC funding, we aggregate the innovation information only from waves that take place *after* the date of the first funding round. For this reason, we rename the strategies: Make-and-Buy-Post, Make-Only-Post, Buy-Only-Post, and No-Make-No-Buy-Post.

Table 4 reports the marginal effects, and their significance levels, evaluated at the mean values of all independent variables. Columns I through III report results for three innovation strategies as No–Make–No–Buy-Post strategy is the residual (omitted) category. Our main variable of interest is Venture-Capital. The marginal effect of this variable indicates the change in the probability of an innovation strategy when a company receives venture capital funding. Since we control for whether the company receives public funds, the marginal effect of Venture-Capital indicates the change in the probability after accounting for the presence of other sources of funding that help firms overcome credit constraints.

We include several other control variables. First, we use the pre-existent quality of patent applications to control for a firm's innovation propensity (Patents-Family-Size). Second, we control for sales and for company age to account for basic determinants of corporate innovation strategies. We also include a control for whether the company operates in a high-tech industry. For the three continuous variables—company age, company size, and patent family size—we use log transformations to account for the presence of outliers.

Table 4 shows that the estimated marginal effect of venture capital financing on Make-And-Buy is positive and significant, while the estimated marginal effects of venture capital on the other innovation strategies are not significantly different from zero. This result indicates that venture capital focuses on

[16] In the robustness section we also employ a multinomial logit regression that yields very similar results.

companies that are characterized by the build-up of absorptive capacity. In particular, the probability of a Make-And-Buy strategy increases by 16.8% when a company receives venture capital funds. Given that the *predicted* probability of Make-And-Buy is 38%, the likelihood of this strategy increases by 44% when a company is venture-backed. This result holds after controlling for the availability of public funds, and reveals a different pattern between companies backed by venture capital funds and by public funds. Specifically, the results suggest that Public Funds support companies that develop in-house R&D, irrespective of whether this innovation activity is combined with the acquisition of external knowledge. Therefore, venture-backed companies can then be seen as developers of new knowledge, but also as integrators of externally generated knowledge (see Bhidé (2008: 25-27)). Venture capital, in other words, is associated with companies whose innovation strategies put together intramural and extramural innovation activities, i.e., that build-up absorptive capacity. This is our central result, which is consistent with the venture capital firms' need to invest in companies that can achieve commercial viability relatively quickly, in order to provide returns to the institutional investors from which they raise money. Focus on the Make-And-Buy strategy is one way through which this goal can be reached. The fact that Public-Funds is positively associated with internal R&D is also consistent with a focus on the creation of new knowledge without a tight deadline. In this sense, public funds are more 'patient' than venture capital.

Additional insights for the interpretation of these results come from the other explanatory variables. Companies in high-tech industries are more likely to engage in Make-Only and Make-And-Buy. This is what one would expect from companies that choose to operate in technologically innovative industries. Increasing size and raising the number of pre-existing number of quality patents has a positive and significant effect on the probability of building absorptive capacity. Finally, after controlling for the mentioned factors, an increase in the company's age decreases the probability of Make-And-Buy, indicating that younger companies may be more prone to build up absorptive capacity.

4.3 Causality and selection effects

Our results show a strong association between venture capital and the build-up of absorptive capacity. Such correlation is a novel and interesting result from both a strategy and a policy perspective. It may derive from venture capital firm's ability to select promising companies as well as from their influence on these companies. One would therefore like to separately identify the part of this correlation that is due to a selection effect, and the part that is due to a causal effect (as in Sørensen (2007)). Our data are not rich enough to allow the conclusive identification of a causal effect, since we cannot rely on time- or space-based instrumental variables. What we can do, however, is to exploit the variation that we have in innovation strategies for the 30 observations where we have information both before and after the company received venture finance.

We report the results in Table 5, where we tabulate the number of companies employing each of the four innovation strategies. Column I reports data for the pre-venture finance period, and column II for the post-venture finance period. Two results stand out. First, the majority (60%) of venture-backed companies already adopted the Make–And–Buy strategy *before* receiving venture funds. Second, the percentage of firms adopting the Make–And–Buy strategy increases (to 77%) *after* receiving venture funds. Moreover, analysis of the transition matrix shows that 16 out of 18 companies remain with the Make–And–Buy strategy after receiving venture funding, and 7 of the 8 other venture-backed companies that change strategy move to adopting Make–And–Buy. This result is inconsistent with the venture capital effect being one of pure selection. Rather, it supports the view that part of the correlation between venture capital and innovation strategies could come from venture capitalists pushing some of these companies to complement intramural R&D with the acquisition of external knowledge. In particular, venture investors have been shown to foster R&D cooperation among their portfolio companies, exploiting their network to identify appropriate providers of external knowledge (Lindsey (2008)).

What do we conclude from the evidence we have presented? Our univariate tests and multinomial regression both point to venture capital being associated with a specific type of companies. These operate in high-tech industries and are more mature in terms of their technological development than companies that receive only public funds, as reflected in their stronger pre-financing patent endowment. Venture-backed companies are also larger, consistent with the focus of venture investors on companies that have already developed some commercial expertise. Finally, these companies focus on building up absorptive capacity. The pre/post comparisons suggest that these results are unlikely to be due only to selection.

To interpret these findings, we consider that venture capital investors have a tightly defined investment horizon, around five years. Therefore, they need to select companies that can 'grow up quickly,' and push them towards successful commercial maturation. Both the selection and the causal effect of venture capital are consistent with the need to take companies with a good growth potential and quickly bring them to maturity. This is different from public funds that are provided to innovative companies without a commercial goal and without a definite 'payout' horizon. It is therefore not surprising that this source of finance is focused also on the investment in internal R&D that is by itself a longer-term investment.

5. Robustness checks

We undertake several robustness checks. Table 6, Panel A and Panel B, reports the results of four additional regressions. For each multinomial model we report the marginal effects evaluated at the mean values of all independent variables. In the same way as in Table 4, we report the marginal effects of three innovation strategies in columns I, II, and III, with No-Make-No-Buy-Post being the omitted strategy.

First, we consider that our data reflect strategy choices observed at different points in time. We therefore explicitly control for the time dimension of the data, and for the fact that we aggregate them over a different number of CIS waves. To this purpose, we build a set of 15 dummies, one for each possible combination of CIS waves.[17] In our second robustness test, we replace the High-Tech dummy with 18 industry dummies to better control for industry effects as potential drivers of innovation strategies. Third, we further exploit the information present in our patent data and build an alternative measure of patent quality, equal to the number of forward citations received by the EPO patent applications of the sample companies (see Hall, Thoma and Torrisi (2007)). Finally, we run a multinomial logit instead of a multinomial probit for our benchmark specification of Table 4.

Our results are remarkably consistent across all variations, both in statistical and economic terms. Like in Table 4, in all these specifications, the marginal effects of Venture-Capital are positive and significant only for Make-And-Buy, with the magnitude ranging between 13.6% and 17.2%, while the marginal effect for Make-Only is negative (though not significant). In contrast, the marginal effects of Public-Funds are positive and significant for both Make-Only and Make-And-Buy.

6. Conclusion

In this paper we analyze how the source of finance affects innovation strategies, focusing on the role of venture capital. We theorize that venture capital funds should be positively associated with an innovation strategy that can lead to a relatively fast commercial maturation of the company. We identify such strategy in the build-up of absorptive capacity through both internal and external R&D. We test our hypothesis with a unique, hand-collected database of over 10,000 Dutch companies and find supportive evidence. Companies that receive venture capital finance are associated only with the Make-And-Buy innovation strategy that corresponds empirically to the build-up of absorptive capacity. This result is consistent across several specifications and econometric models. We also find some evidence suggesting that the correlation we document is not purely due to a selection effect.

The strategy and policy implications of our results are potentially important. From a strategy perspective, our results imply that companies that seek venture capital need to develop a technology base that prepares them to quickly incorporate external technology, and that venture capital investors further push their companies towards the incorporation of external knowledge.

From a policy perspective, our results imply that innovation and entrepreneurship policies should take into consideration that providing support for the venture capital industry can help investments in

[17] We therefore have dummies identifying whether the value of the dependent variable of a particular observation was built using only one, two, three, or all four waves, and taking into account all possible combinations.

companies that adopt innovation strategies likely to generate commercially mature products and services within a short period.

Finally, since our study is the first to analyze the relationship between sources of funding for entrepreneurial companies and their innovation strategy, it naturally points to research issues that need further attention. Among them, we point to the inclusion of additional sources of finance, like business angels or corporate investors, and to the need for a cleaner identification of a causal effect.

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Table 1: Variable definitions

This Table reports the definitions, mean and standard deviation of all the variables used in the analysis.

Variables	Definition		
A. Company Characteristics			
Venture-Capital	Dummy variable equal to 1 if the company has received venture finance; 0 otherwise	0.015	0.124
Public-Funds	Dummy equal to 1 if the company received public funds (tax credits, grants, subsidized loans, loan guarantees) from national or European agencies, in any CIS wave it took part in; 0 otherwise	0.309	0.462
Company age	Age of the company, in years, at the time of its first venture financing (if venture-backed), or at end of the first CIS survey it has responded to (if non venture-backed)	17.1	12.5
Sales	Company turnover in the last year of the first CIS wave it took part in (in million euros)	96.8	1,329.50
Patents-EPO	Number of patent applications filed with the EPO before in the six years up to 1998 (or before the first round of venture funding)	0.131	1.920
Patents-EPO-Citations	Number of 3-year forward citations received by a company's patent applications filed with the EPO in the six years up to 1998 (or before the first round of venture funding)	0.060	1.050
Patents-Family-Size	Number of patents filed with the EPO that are also filed with non-EPO patent offices in the six years up to 1998 (or before the first round of venture funding)	0.860	19.628
High-tech industry	Dummy variable equal to 1 if the company operates in the following NACE 2-digit industries: Chemicals, pharmaceuticals, electronics, computer services, R&D services; 0 otherwise.	0.148	0.355
B. Innovation Activities			
Make	Dummy variable equal to 1 if the company engages in intramural R&D in any CIS wave it took part in; 0 otherwise.	0.622	0.485
Buy	Dummy variable equal to 1 if the company purchased extramural R&D or other know-how, including licensing of patents or of non-patented inventions, as well as other types of externally-generated knowledge in any CIS wave it took part in; 0 otherwise	0.457	0.498
C. Innovation Strategies			
No-Make-No-Buy	Dummy variable equal to 1 if the company did not engage in either Make nor Buy activities in any CIS wave it took part in; 0 otherwise	0.292	0.455
Buy-Only	Dummy variable equal to 1 if the company engaged in only in Buy activities in all CIS waves it took part in; 0 otherwise	0.085	0.279
Make-Only	Dummy variable equal to 1 if the company engaged in only in Make activities in all CIS waves it took part in; 0 otherwise	0.251	0.433
Make-And-Buy	Dummy variable equal to 1 if the company engaged in both Make and Buy activities in some of the CIS waves it took part in; 0 otherwise	0.372	0.483
D. Innovation Output			
IPR-Protection-Application	Dummy variable equal to 1 if the company applied for protection of its intellectual property rights in the form of a patent, trademark, copyright or industrial design in any of the CIS waves it took part in; 0 otherwise	0.315	0.464
Sales-Product-New-to-Market	Percentage of the sales of the company from products and services new to the market (i.e., introduced before the company's competitors). This is computed as the maximum percentange in any of the CIS waves the firm took part in; 0 otherwise	0.077	0.155
Sales-Product-New-to-Firm	Percentage of the sales of the company from products and services new to the firm (i.e, introduced when already present in the market). This is computed as the maximum percentange in any of the CIS waves the firm took part in; 0 otherwise	0.161	0.225

Table 2: Innovation outcomes

This Table reports the frequency of the four innovation strategies. For each innovation strategy, the Table also reports the share of sales from products that are new to the market, the share of sales from products that are new to the firm, and the frequency of applications for IPR protection. Variables are defined in Table 1.

	I	II	III	IV
Strategy	Frequency of Innovation Strategy	Sales-Product-New-to-Market	Sales-Product-New-to-Firm	IPR-Protection-Application
No-Make-No-Buy	29.25%	4.34%	11.95%	15.21%
Buy-Only	8.52%	4.22%	11.27%	18.73%
Make-Only	25.06%	8.10%	16.80%	30.36%
Make-And-Buy	37.16%	10.72%	19.91%	47.94%
Total	100%	7.67%	16.07%	31.51%
Observations	*10,371*	*10,184*	*10,359*	*9,605*

Table 3: Univariate analysis

This Table reports univariate comparisons between venture-backed companies (column I) and (i) companies that receive public funds but no venture capital (column II), or (ii) other companies (column III). Panel A reports company characteristics, strategies, and innovation output. Panel B reports data on pre-existing patent variables. Variables are defined in Table 1. For each variable we separately report the median (frequency for dummy variables, means for patent data) and standard deviation. All variables are defined in Table 1. For each variable, we also perform two tests of whether the median (mean) of the venture-backed group is statistically different from (i) the median (mean) of the Public-Funds-Only group and (ii) the median (mean) of the Other group. The symbols ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level respectively.

PANEL A:
COMPANY CHARACTERISTICS, INNOVATION STRATEGIES, AND INNOVATION OUTPUT

		I		II			III		
		Venture-Backed		Public-Funds-Only			Other		
		Obs: 161		Obs: 3,117			Obs: 7,093		
A1. Company Characteristics	*Unit of measurement*	Median	St.Dev.	Median	St.Dev.		Median	St.Dev.	
Company age	*(years)*	13.000	12.840	16.000	12.640		14.000	12.460	
Sales	*(€m)*	28.760	96.710	19.100	2,261.000	***	8.660	578.720	***
High-tech industry	*(dummy)*	0.348	0.478	0.215	0.411	***	0.114	0.317	***
A2. Innovation Strategies									
No-Make-No-Buy	*(dummy)*	0.087	0.283	0.083	0.276		0.389	0.487	***
Buy-Only	*(dummy)*	0.031	0.174	0.036	0.187		0.108	0.310	***
Make-Only	*(dummy)*	0.217	0.414	0.289	0.453	**	0.234	0.424	
Make-And-Buy	*(dummy)*	0.664	0.474	0.591	0.492	*	0.268	0.443	***
A3. Innovation Output									
IPR-Protection-Application	*(dummy)*	0.662	0.474	0.480	0.450	***	0.226	0.418	***
Sales-Product-New-to-Market	*(fraction)*	0.060	0.203	0.050	0.178	*	0.000	0.139	***
Sales-Product-New-to-Firm	*(fraction)*	0.200	0.256	0.110	0.242	*	0.050	0.213	***

PANEL B:
PRE-EXISTING PATENT VARIABLES

		Venture-Backed		Public-Funds-Only			Other		
		Obs: 161		Obs: 3,117			Obs: 7,093		
B. Pre-existing Patent Variables	*Unit of measurement*	Mean	St.Dev.	Mean	St.Dev.		Mean	St.Dev.	
Patents-EPO	*(number)*	0.863	3.183	0.341	3.369	**	0.022	0.363	***
Patents-EPO-Citations	*(number)*	0.329	1.391	0.165	1.858		0.008	0.207	***
Patents-Family-Size	*(number)*	3.417	14.280	2.317	35.090		0.162	4.022	***
Patents-US	*(number)*	0.342	1.810	0.200	2.674		0.006	0.140	**

Table 4: Multivariate Analysis

This Table reports results from the multinomial probit regression discussed in Section 4. The dependent variables are the innovation strategies. The baseline strategy is No-Make-No-Buy-Post. All variables are defined in Table 1 and in Section 4.2. For each independent variable, we report the marginal effect, evaluated at the mean of all explanatory variables, and in brackets, the corresponding standard errors. The symbols ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

	I	II	III
	Buy-Only-Post	Make-Only-Post	Make-And-Buy-Post
Venture-Capital	-0.029	-0.016	0.168 ***
	[0.022]	[0.038]	[0.044]
Public-Funds	-0.070 ***	0.064 ***	0.288 ***
	[0.005]	[0.01]	[0.011]
Patents-Family-Size	-0.027 **	-0.002	0.102 ***
	[0.013]	[0.014]	[0.015]
Sales	0.004 **	-0.022 ***	0.045 ***
	[0.001]	[0.002]	[0.003]
Company age	0.004	0.001	-0.019 ***
	[0.003]	[0.004]	[0.005]
High-tech	-0.039 ***	0.123 ***	0.086 ***
	[0.007]	[0.014]	[0.015]
Number of Observations	10,366		
Chi-square	1,918.5		
p-value	0.000		

Table 5: Pre/Post venture financing analysis

This Table reports the frequency of innovation strategies for the 30 companies for which we have information both before and after the first round of venture capital financing. All strategies are defined in Table 1.

	Frequency of innovation strategies	
	I	II
	Pre-VC	Post-VC
No-Make-No-Buy	2	1
Buy-Only	2	1
Make-Only	8	5
Make-And-Buy	18	23
	30	30

Table 6: Robustness − additional models

This Table reports results from multinomial probit/logit regressions. The dependent variables are the innovation strategies. The baseline strategy is No-Make-No-Buy-Post. Variables are defined in Table 1 and in Section 4.2. The models reported are discussed in Section 5. Panel A reports results from a regression which includes fixed effects for the wave structure of the CIS data, and a regression that includes individual industry fixed effects. Panel B reports results from a regression that uses forward citations as a measure of patent quality, and a regression that uses a multinomial logit model instead of a multinomial probit model. For each independent variable, we report the marginal effect, evaluated at the mean of all explanatory variables, and in brackets, the corresponding standard errors. The symbols ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

PANEL A: CIS WAVE FIXED EFFECTS AND INDUSTRY FIXED EFFECTS

	CIS wave fixed effects						Industry fixed effects					
	I		II		III		I		II		III	
	Buy-Only-Post		Make-Only-Post		Make-And-Buy-Post		Buy-Only-Post		Make-Only-Post		Make-And-Buy-Post	
Venture-Capital	-0.029		-0.007		0.136	***	-0.030		-0.021		0.169	***
	[0.023]		[0.039]		[0.045]		[0.021]		[0.038]		[0.044]	
Public-Funds	-0.073	***	0.072	***	0.289	***	-0.059	***	0.049	***	0.273	***
	[0.005]		[0.01]		[0.011]		[0.005]		[0.01]		[0.011]	
Patents-Family-Size	-0.027	**	-0.001		0.091	***	-0.022	*	-0.009		0.096	***
	[0.013]		[0.014]		[0.016]		[0.013]		[0.014]		[0.015]	
Sales	0.003	**	-0.017	***	0.038	***	0.002		-0.019	***	0.049	***
	[0.002]		[0.003]		[0.003]		[0.001]		[0.002]		[0.003]	
Company age	0.004		0.005		-0.028	***	0.006	**	0.001		-0.016	***
	[0.003]		[0.005]		[0.005]		[0.003]		[0.005]		[0.005]	
High-tech	-0.038	***	0.122	***	0.086	***						
	[0.007]		[0.014]		[0.015]							
CIS wave fixed effects	Yes		Yes		Yes		No		No		No	
Industry fixed effects	No		No		No		Yes		Yes		Yes	
Number of Observations	10,366						10,366					
Chi-square	3,816.9						3,737.3					
p-value	0.000						0.0					

PANEL B: PATENT FORWARD CITATIONS AND MULTINOMIAL LOGIT MODEL

	Patent Forward Citations			Multinomial Logit		
	I	II	III	I	II	III
	Buy-Only-Post	Make-Only-Post	Make-And-Buy-Post	Buy-Only-Post	Make-Only-Post	Make-And-Buy-Post
Venture-Capital	-0.030	-0.021	0.167 ***	-0.030	-0.019	0.172 ***
	[0.022]	[0.037]	[0.044]	[0.021]	[0.038]	[0.045]
Public-Funds	-0.071 ***	0.062 ***	0.291 ***	-0.071 ***	0.063 ***	0.287 ***
	[0.005]	[0.01]	[0.011]	[0.005]	[0.01]	[0.011]
Patents-Family-Size				-0.032 *	0.004	0.109 ***
				[0.017]	[0.016]	[0.018]
Patents-EPO-Citations	-0.046	0.042	0.270 ***			
	[0.423]	[0.047]	[0.054]			
Sales	0.004 **	-0.022 ***	0.045 ***	0.003 **	-0.024 ***	0.048 ***
	[0.001]	[0.002]	[0.002]	[0.001]	[0.002]	[0.003]
Company age	0.003	0.001	-0.018 ***	0.003	0.002	-0.020 ***
	[0.003]	[0.004]	[0.005]	[0.003]	[0.004]	[0.005]
High-tech	-0.040 ***	0.123 ***	0.088 ***	-0.041 ***	0.120 ***	0.087 ***
	[0.007]	[0.014]	[0.015]	[0.007]	[0.014]	[0.015]
Number of Observations	10,366			10,366		
Chi-square	1,908.3			2,356.7		
p-value	0.000			0.000		