Venture capital financing and the growth of high-tech start-ups: Disentangling treatment from selection effects

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ABSTRACT

The financial and innovation literature generally claims that venture capital (VC) investments spur the growth of new technology-based firms (NTBFs). However, it has proved difficult so far to separate the "treatment" effect of the VC investment from the "selection" effect attributable to the ability of the VC investor to screen high growth NTBFs. The aim of this work is to test whether VC investments have a positive treatment effect on the growth of employment and sales of NTBFs. For this purpose we consider a 10-year longitudinal data set for 538 Italian NTBFs, most of which are privately held. The sample includes both VC-backed and non-VC-backed firms. We estimate Gibrat-law-type dynamic panel-data models augmented with time-varying variables that capture the VC status of firms. To control for the endogeneity of VC investments we use several GMM estimators. The econometric results strongly support the view that VC investments positively influence firm growth. The treatment effect of VC investments is of large economic magnitude, especially on growth of employment. Most of it is obtained immediately after the first round of VC finance. Conversely, the selection effect of VC appears to be negligible in the Italian context.

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1. Introduction

It is widely recognized by scholars, practitioners and policy makers that new technology-based firms (NTBFs) play a crucial role for the static and dynamic efficiency of the economic system (Audretsch, 1995). In this area European countries lag behind their international competitors. In particular, high-tech entrepreneurial ventures which from the very beginning of their existence, experience high growth rates and eventually either become leaders in the industries in which they operate or even manage to create a new industry – companies like Intel, Microsoft, Google or Genentech, are quite rare in Europe while they abound in the US. To explain this difference governmental documents often mention the greater development of the venture capital (VC) sector in the US (see e.g. Revest and Sapio, forthcoming, and the early documents cited by Lockett et al., 2002).

There are several reasons why VC-backed NTBFs are likely to outperform their non-VC-backed counterparts (see e.g. Gompers and Lerner, 2001a,b; Denis, 2004). First, NTBFs are the firms most likely to be financially constrained (Carpenter and Petersen, 2002; Hall, 2002; Colombo and Grilli, 2007). Owing to superior scout-

ing capabilities (Chan, 1983; Amit et al., 1998), VC investors can identify firms with hidden value and provide them with the necessary financing. Second, VC investors actively monitor portfolio companies and perform a valuable coaching function (Gorman and Sahlman, 1989; Sapienza, 1992; Lerner, 1995; Sapienza et al., 1996; Kaplan and Strömberg, 2003, 2004). Third, VC investment is a "signal" of the quality of portfolio companies for uninformed third parties. VC-backed firms also benefit from the business contact network of VC investors. Hence, these firms have access to external resources and competencies that would be out of reach without the endorsement of a VC investor (Stuart et al., 1999; Colombo et al., 2006; Hsu, 2006; Lindsey, 2008).

Nonetheless, it has also been argued that the agency relation between VC investors and entrepreneurs may engender conflicts that are detrimental to portfolio firms (Ueda, 2004; Atanasov et al., 2006; Masulis and Nahata, 2009). First, VC investors may have objectives and strategies that are different from those of entrepreneurs. Second, VC finance might pose appropriability hazards for portfolio firms because VC investors might poach the innovative business ideas of entrepreneurs and exploit these themselves. Thus, it cannot be taken for granted that VC investments are beneficial to portfolio firms.

The aim of this work is to analyze the effect of VC investments on firm growth. We follow previous studies in considering growth as

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an indicator of the business success of NTBFs (Feeser and Willard, 1990; Fischer and Reuber, 2003; Barringer et al., 2005; Colombo and Grilli, 2005, 2010a). Even though it is quite difficult to find an unambiguous indicator of the performance of these firms, rapid growth generally signals wide market acceptance of their products or services. Moreover, growth is difficult to achieve and most high-tech start-ups remain small several years after their foundation. More precisely, we address the following research questions. First, do VC-backed firms enjoy higher growth than their non-VC-backed counterparts? Second, if this is the case, is this positive association mainly attributable to the ability of VC investors to select firms with future high growth prospects (i.e. to "pick winners", Baum and Silverman, 2004) or is it a consequence of the (financial and non-financial) support they offer to portfolio firms (i.e. their ability to "build winners")? In other words, do VC investments have a positive "treatment" effect on portfolio firms over and beyond the "selection" effect? Third, is the (allegedly positive) treatment effect of VC investments spread over time? Or does it occur immediately after the first round of VC finance?

To answer these questions, we empirically analyze the impact of VC investments on the growth of Italian NTBFs taking advantage of a 10-year (1994–2003) longitudinal data set for 538 start-ups in high-tech manufacturing and services sectors, 58 of which are VC-backed. We measure growth in both employees and sales. Our data set has several strengths in comparison with those used in previous studies. First, to the best of our knowledge this is the first study that uses a long longitudinal data set for both VC-backed and non-VC-backed firms, most (but not all) of which are privately held. Hence, our data set is not affected by the selection bias inherent in samples exclusively composed of IPO firms. In addition, as a consequence of the process used to build the sample (see Appendix A.1 for details), the dataset includes only NTBFs that are typical targets of VC investors. Conversely, lifestyle firms and other non-growth-oriented firms that would be very unlikely to be selected by VC investors are excluded from the data set. This yields more precise estimates of the relevant counterfactual (i.e. the growth rate VC-backed firms would experience if they were not VC-backed) than would be possible if we considered only VC-backed firms, or if low-tech firms and high-tech lifestyle firms, which clearly have different finance needs, were included in the sample. Second, data on VC investments were obtained from public sources (Italian Venture Capital and Private Equity Association, AIFI; and the financial reports of VC investors), from commercial databases (VentureXpert), and from a survey administered to NTBFs. Hence, coverage of VC investments, especially those made by small and medium industrial firms which generally are not covered by secondary sources, is more complete than in previous studies. Third, we implemented robust controls for the endogeneity of VC investments. The rather long observation period allowed the use of generalized method of moments (GMM) estimation techniques for panel data models. Moreover, our data set is very informative on sample firms since it includes detailed firm-, industry- and location-specific information. Hence, in testing the causality relation between VC investments and growth we included in the set of explanatory variables controls that account for selection based on observable variables and used a rich set of instruments for VC variables to control for selection based on unobservables. Fourth, in spite of the use of survey-based data, we controlled for possible survivorship bias, albeit in a partial way.

Our results clearly support the view that VC investments have a large positive effect on the growth of firm's employment and sales that is not attributable to the ability of VC investors to select firms with superior growth prospects. In fact, the selection effect of VC investments is found to be negligible for Italian NTBFs. Quite interestingly, the treatment effect of VC investments on growth is larger

for employees than for sales, and it materializes almost immediately after the first round of VC finance regardless of which growth indicator is considered.

The remainder of the paper is structured as follows. In the next section we survey the literature on the effect of VC investments on firm growth. In Section 3 we provide some descriptive statistics for VC in Italy. In Section 4 we describe the sample of firms and analyze the pattern of VC investments among Italian NTBFs. In Section 5 we illustrate the econometric methodology and highlight the strengths and weaknesses of the different estimation techniques used in the paper. In Section 6 we present the econometric analysis results on the effect of VC investments on the growth of Italian NTBFs. In Section 7 we discuss the results, provide additional qualitative evidence on the nature of the treatment effect of VC investments and the matching process of VC investors and portfolio firms, acknowledge limitations and illustrate policy implications.

2. The effect of VC investments on firm growth: stylized facts and methodological weaknesses

Most studies that have analyzed the effects of VC investments on firm growth have relied on matched pair techniques or cross-sectional regressions to compare the growth rates of sales, employment or total assets of VC-backed and non-VC-backed firms (see e.g. Jain and Kini, 1995; Manigart and Van Hyfte, 1999; Audretsch and Lehmann, 2004; Alemany and Martì, 2005; Engel and Keilbach, 2007; Puri and Zarutskie, 2008). In general, a positive association between VC finance and growth is observed, although the results are not unanimous (see e.g. Bottazzi and Da Rin, 2002).

These studies suffer from serious methodological weaknesses. First, most of them only consider IPO firms. This engenders a serious sample selection bias. With IPOs generally being considered the most successful exit for VC investors, it is questionable whether results obtained for IPO firms can be generalized to privately held firms. Moreover, comparison of the growth of VC-backed and non-VC-backed firms in the period following an IPO provides an assessment of the moderating role played by VC investments on the effect of listing on firm growth. Second, and even more important, the above studies do not properly take into account the endogenous nature of VC investments. Firms might attract VC because of observable characteristics (e.g. the human capital of the firm's founding team) or unobservable characteristics (e.g. their good business prospects). Matching and standard regression techniques can control for selection based on observable factors; the larger the set of these factors, the more likely it is that the estimated treatment effect of VC investments is unbiased. Nonetheless, to the extent that both firm growth and the likelihood of the focal firm being VC-backed are influenced by unobservable factors, lack of proper control for these factors leads to distorted estimates of the effect of VC investments on growth.

To disentangle the treatment and selection effect of VC investments some cross-sectional studies use a two-step approach inspired by the literature on "endogenous treatment" (Heckman, 1990; Vella and Verbeek, 1999). They first consider the likelihood of obtaining VC finance using a selection equation. Then, in analyzing firm growth, they include in the set of covariates an inverse Mill's ratio type of factor calculated from estimates of the selection equation. Alternatively, VC finance is instrumented through the predicted probability of obtaining such finance. Engel (2002) and Colombo and Grilli (2005, 2010a) use this methodology and document a positive treatment effect of VC investment on the growth of German firms and Italian NTBFs, respectively. Quite interestingly, in these studies there is no evidence of a positive selection effect. In other words, unobservable factors that favor obtaining VC seem