POLITECNICO
MILANO 1863

School of Industrial and Information Engineering
Master of Science in Management Engineering – Supply Chain Management

The Investment Behaviour of Italian Innovative Start-ups: the Role of Law 221/2012

Supervisor: Prof. Grilli Luca
Co-supervisors: Prof. Giudici Giancarlo
Dr. Giraudo Emanuele

Dissertation by:
Pantanella Federico Edoardo
837908

Academic Year 2015-2016

◊ *Index*

◊ *List of figures*

◊ *List of tables*

◊ *Abstract*

While the prominent role played by young innovative companies in promoting an innovation-driven economic growth is widely recognised, there is also general consensus that the beneficial effect exerted by such companies might be hampered due to the financial constraints binding them. The provision of venture capital (VC) is considered the most suitable solution to overcome these problems. Accordingly, the underdevelopment of the European VC market is alleged to be a primary cause of the performance gap between US and EU innovative start-ups.

In order to remedy these deficiencies, the intervention of policy makers is strongly advocated. In this perspective, the Italian government has recently developed a first and comprehensive policy scheme directly targeting innovative start-ups, that is Law No. 221/2012. In particular, among the various facilitations envisaged by Law 221, some are specifically designed to favour innovative start-ups' access to external debt (Government-guaranteed bank loan program) and equity (fiscal incentives for VC investments; equity crowdfunding platforms).

The overall objective of the present study is to investigate the determinants of Italian innovative start-ups' investment, with a particular emphasis on the effects stemming from accessing VC and guaranteed bank loans.

Results suggest two relevant facts. First, both external equity and debt capital are found to positively impact on innovative start-ups' investment rates, thus providing early evidence of public intervention success. Second, the amount of guaranteed bank loan turns out to be surprisingly uncorrelated with company investment rates. A possible interpretation of this unexpected outcome, even if not yet corroborated by a thorough analysis, is that the access to the CGF opens up further possibilities for the recipient companies, in line with a possible "certification effect".

Sommario

Sin dai primi anni del nuovo millennio, i capi di stato europei hanno deciso di compiere una serie di passi concreti volti alla creazione di un'economia europea più dinamica. A tale riguardo, nel 2000 l'Unione Europea ha approvato la "Strategia di Lisbona", un programma di riforme inteso a gettare le basi per consentire all'Unione di "diventare l'economia basata sulla conoscenza più competitiva e dinamica del mondo". Successivamente, nel 2010, è stata stilata un'altra strategia di sviluppo decennale, denominata "Europa 2020". Come definito dall'Unione Europea, Europa 2020 è una "strategia europea per una crescita intelligente, sostenibile e solidale".

L'impegno profuso dai paesi europei al fine di promuovere un'economia dinamica, basata sull'innovazione, può essere visto come una risposta alla tesi secondo cui le ragioni del minor sviluppo economico dei paesi dell'Unione rispetto agli Stati Uniti siano da ricercare nel divario esistente tra economia europea e statunitense in termini di innovazione. In particolare, numerosi autori hanno individuato nella mancanza di nuove imprese high-tech innovative una delle maggiori cause del profondo gap che divide Europa e Stati Uniti per quanto riguarda la crescita e l'innovazione (Philippon e Vèron, 2008; Veugelers, 2009; Grilli, 2014).

Per porre rimedio a questa situazione – e nel pieno rispetto delle direttive sottoscritte da Europa 2020 – nel dicembre del 2012, il governo italiano ha definito un dettagliato pacchetto di misure (Decreto Legge n. 179/2012, successivamente convertito nella Legge n. 221/2012) direttamente finalizzato a favorire la nascita e lo sviluppo di start-up innovative. Sebbene la nuova entità legale (definita "start-up innovativa italiana") creata dal governo italiano mostri specificità proprie, in generale essa presenta caratteristiche simili a quelle di particolari categorie di aziende largamente studiate nella letteratura esistente, quali le NTBF (new technology-based firms) e le YIC (young innovative companies).

In particolare, dalla letteratura empirica in materia emerge un diffuso consenso riguardo al profondo impatto che le start-up innovative esercitano nel favorire la

prosperità e la crescita economiche. Più specificamente, il ruolo primario delle neonate imprese innovative come motore propulsivo di uno sviluppo economico basato sull'innovazione risulta strettamente connesso alle loro peculiarità: piccole dimensioni, recente nascita e focalizzazione su tecnologia e attività di R&S.

Come evidenziato nel Capitolo 2 della presente tesi di ricerca, è parere comune che le aziende con una maggiore "R&D intensity" mostrino migliori risultati in termini di innovazione: da molti studi (es. Griliches, 1958) emerge che le spese in R&S hanno un impatto diretto e significativo sul benessere economico. Inoltre, le attività di R&S possono avere anche un impatto indiretto sull'innovazione: più un'azienda acquisisce conoscenza attraverso l'attività di ricerca e sviluppo, maggiore risulta la propria "capacità di assorbimento" (Cohen and Levinthal, 1990) e, quindi, la propria abilità nello sfruttare fonti di conoscenza esterne (Allen, 1977; Mowery, 1983). Dunque, anche se non necessarie, le attività di R&S vanno ben oltre la semplice creazione di un prodotto o un servizio innovativo, in quanto possono favorire in vari modi il processo di innovazione e, in effetti, l'intensa focalizzazione delle start-up high-tech sulla R&S offre una prima incontrovertibile conferma del ruolo da esse giocato nel promuovere il contesto macroeconomico.

Inoltre, è stata prestata particolare attenzione alla relazione esistente tra la dimensione di un'impresa e le sue capacità innovative: il lungo dibattito scaturito al riguardo dai celebri "Mark I" (1934) e "Mark II" (1942) schumpeteriani non è riuscito ad individuare un esito univoco (Cohen and Levin, 1989; Lerner 2010). Tuttavia, nonostante il fatto che gli studi sull'impatto della dimensione di un'impresa sul suo livello generale di innovatività abbiano prodotto risultati disomogenei, molte analisi (es. Veugelers, 2009) hanno evidenziato come le aziende di ridotte dimensioni superino quelle di grandi dimensioni quando si parla di innovazione radicale. Dal momento che l'innovazione radicale, contrariamente a quella incrementale, ha il potere di innalzare la frontiera tecnologica di un settore economico, dando così vita a risultati senza precedenti (Leifer et al,. 2000), è possibile asserire che le aziende innovative di piccole dimensioni siano in grado di avere un impatto significativo su industrie e mercati.

Per ultimo, si ritiene che le aziende più giovani siano attori principali della creazione di occupazione, in quanto esse sono responsabili di generare un'ampia quota di nuovi posti di lavoro (Davidsson et al., 1995; Haltiwanger et al., 2013).
Dunque, essendo relativamente piccole, giovani e focalizzate su attività di R&S, le start-up innovative sono ritenute una straordinaria e indiscutibile fonte di innovazione e crescita per l'intera economia.
Tuttavia, il termine "start-up" non è necessariamente sinonimo di successo: secondo Shane (2009), la supposta importanza delle start-up non è nulla più che una falsa credenza; infatti, il fondatore medio di una start-up è in primis interessato ad un posto di lavoro autonomo, piuttosto che alla creazione di un'azienda con grandi prospettive di crescita: di conseguenza, le start-up sono in media meno produttive delle imprese già presenti nel mercato e, quindi, il loro contributo alla crescita economica non è particolarmente rilevante.
Al di là del fatto che Shane nella sua analisi si riferisce alle start-up in generale, non specificamente a quelle innovative, le sue argomentazioni sono utili a sottolineare che solo un ristretto numero di start-up di particolare successo possiede le potenzialità per promuovere la crescita e lo sviluppo economico. Per questa ragione, un'attenta analisi dei fattori che risultano determinanti ai fini della crescita delle start-up è un compito estremamente importante che i decisori politici non possono esimersi dall'assolvere per designare leggi efficaci, in grado di favorire le aziende che presentano le maggiori potenzialità. In linea generale, i principali driver di crescita di un'azienda possono essere suddivisi in tre categorie: quelli relativi alle caratteristiche individuali (ovvero al capitale umano dell'azienda), quelli riguardanti le peculiarità dell'azienda (per esempio, strategia e beni capitali) e quelli legati a fattori esterni (relativi all'industria, alla localizzazione e ai rapporti con altre organizzazioni).

Tirando le somme di quanto detto finora, la progressiva affermazione di un consistente gruppo di start-up innovative è ritenuta veicolo fondamentale di una crescita economica basata sull'innovazione. Tuttavia, le start-up innovative sono particolarmente esposte ad una seria problematica, universalmente riconosciuta dai

ricercatori (Martin e Scott, 2000), ovvero il sottoinvestimento. Ovviamente, questa problematica rappresenta una minaccia rilevante – in particolar modo se ci si riferisce ad investimenti in R&S – agli occhi delle istituzioni, poiché gli effetti benefici che le start-up innovative dovrebbero produrre per il sistema economico potrebbero essere inferiori alle aspettative (Schneider and Veugelers, 2010). Gli studi economici hanno individuato due motivazioni fondamentali per cui l'intervento pubblico si rende necessario per supportare le start-up innovative nel breve termine (Colombo e Grilli, 2006): la presenza di spillover (in relazione agli investimenti in R&S) e le imperfezioni dei mercati finanziari.

La teoria secondo cui gli spillover sarebbero un fattore determinante del fatto che le imprese private investono in R&S meno di quanto desiderabile in ottica sociale è supportata dal mondo accademico senza eccezioni (1986; Nelson e Romer, 1996; Lerner, 2002).

Il concetto di spillover delle attività di R&S va di pari passo con quello di appropriabilità, ovvero la capacità di un'impresa innovatrice di acquisire e trattenere i profitti generati dalla sua attività di ricerca innovativa, a discapito delle altre aziende. Poiché solitamente le start-up high-tech operano per svariate ragioni in condizioni di scarsa appropriabilità, il tasso di rendimento sociale degli investimenti in R&S appare inferiore del relativo tasso privato (vedi Hall, 2002; Martin and Scott, 2000). Dal momento che le aziende decidono quanto investire tenendo in considerazione unicamente il tasso di rendimento privato, alcuni progetti (desiderabili da un punto di vista sociale) non saranno intrapresi, oppure lo saranno, ma con tempistiche non ottimali o su scala ridotta (Jaffe, 1996).

La seconda fondamentale causa di sottoinvestimento per le start-up innovative – di particolare interesse ai fini di questo studio – è relativo alle imperfezioni dei mercati finanziari.

L'efficienza dei mercati finanziari è di assoluta importanza al fine di permettere un'allocazione ottimale delle risorse finanziarie: quando si verificano imperfezioni nei mercati finanziari (mercati finanziari inefficienti), i capitali interni ed esterni all'azienda non sono più perfetti sostituti (Gertner et al., 1994). In conseguenza di tali "frizioni", per perseguire opportunità di investimento profittevoli, le aziende

si affidano in modo particolare al capitale interno (Revest e Sapio, 2012). Seguendo questo ragionamento, se le disponibilità personali dei soci fondatori o i profitti generati sono insufficienti, alcuni progetti innovativi non saranno intrapresi per il semplice fatto che le finanze esterne sono eccessivamente costose (Aghion et al., 2009). Negli ultimi decenni, gli studiosi hanno individuato molte possibili cause delle imperfezioni dei mercati finanziari, che minano le possibilità delle imprese di accedere a fondi esterni e, quindi, generano ulteriore sottoinvestimento. Eppure, la maggior parte dei problemi scaturisce da asimmetrie informative tra imprenditori e investitori. In particolare, quando chi investe ha meno informazioni di chi prende le decisioni (ovvero i manager), i capitali esterni (sia di rischio che di debito) hanno un costo maggiore, oppure vengono limitati, come conseguenza di problematiche relative a selezione avversa e azzardo morale (Carpenter e Petersen, 2002a; Hubbard, 1998; Stiglitz e Weiss, 1981). È importante sottolineare che, nonostante le imperfezioni dei mercati finanziari scaturite da asimmetrie informative limitino varie tipologie di impresa (Hubbard, 1998), esse sono particolarmente dannose per gli investimenti in R&S, data la maggiore incertezza che accompagna tali progetti. Non a caso, le aziende che soffrono maggiormente a causa delle limitazioni di finanze esterne sono generalmente di piccole dimensioni, recente fondazione e operanti in ambito tecnologico. In altre parole, NTBF (Carpenter e Petersen, 2002a). Date queste premesse, risulta chiaro come la struttura del capitale di una start-up innovativa eserciti un impatto decisivo sulle decisioni in termini di investimenti. In particolare, studi meno recenti hanno teorizzato l'esistenza di una "scala gerarchica" (Myers e Majluf, 1984) o "gerarchia finanziaria" (Fazzari et al., 1988). Poiché il costo marginale del debito è maggiore di quello dei capitali interni, infatti, le aziende andranno alla ricerca di capitale di debito o di rischio esclusivamente quando le disponibilità interne si saranno esaurite. In altre parole, quando la domanda per gli investimenti è bassa, le imprese faranno affidamento sul capitale interno a disposizione. Quando la domanda per gli investimenti raggiunge livelli maggiori, le aziende passeranno al capitale di debito e, in ultima istanza, a quello di rischio – il cui costo è maggiore (Fazzari et al., 1988). I primi studi in questo campo hanno quindi identificato il

capitale di debito come la risorsa preferenziale di capitale esterno, in quanto presenta minori costi rispetto al capitale di rischio e consente ai manager di mantenere diretto controllo sulle proprie aziende (Peneder, 2008).

Ciò nonostante, in contrasto con l'ipotesi di "gerarchia finanziaria", secondo numerosi studi di più recente realizzazione il capitale di rischio (venture capital, VC) è il candidato più adatto a ridurre le limitazioni finanziarie delle NTBF. Infatti, il VC è considerato da studiosi e professionisti la migliore "medicina" per far fronte alle imperfezioni dei mercati finanziari che limitano lo sviluppo delle start-up high-tech (Carpenter e Petersen, 2002a; Lerner, 2002).

Chiaramente, la principale forma di supporto garantita dai *venture capitalist* è costituita dall'iniezione di capitali all'interno dell'azienda supportata. In tal senso, recenti studi hanno dimostrato come, ove si tratti di start-up innovative, il capitale di rischio mostri numerosi vantaggi rispetto al capitale di debito. Ciò è dovuto al fatto che le principali caratteristiche del VC sono adatte a ridurre, almeno in parte, le asimmetrie informative alla base del costo differente che hanno per le NTBF le risorse finanziarie interne ed esterne. In primo luogo, i professionisti che lavorano in fondi di VC tendono ad avere competenze maggiori e più specifiche, soprattutto in campo tecnologico, che permettono loro di valutare al meglio progetti high-tech promettenti e abilità dei proponenti (Audretsch e Lehmann, 2004). In secondo luogo, al contrario delle banche, gli investitori privati non richiedono un collaterale come garanzia contro la selezione avversa: dal momento che le NTBF generalmente mancano di beni collateralizzabili, questo fattore aumenta senza dubbio i vantaggi relativi al VC. Terzo, aumentare il capitale di rischio di un'azienda non aumenta le probabilità di "dissesti" finanziari, come invece accade per il capitale di debito (Carpenter e Petersen, 2002a). Quarto, i *venture capitalist* acquisiscono quote societarie delle aziende in cui investono e, dunque, ne condividono profitti e rischi. Questa peculiarità offre alcuni vantaggi: primo, i fondatori della start-up non hanno l'onere di ripagare il debito e i suoi interessi; secondo, i *venture capitalist* hanno importanti incentivi a fornire alle aziende controllate ogni genere di risorsa utile a favorire la piena espressione del loro potenziale innovativo (Bertoni, Colombo e Croce, 2010).

Un ulteriore beneficio apportato dal VC è la cosiddetta funzione di "certificazione". In breve, i fondi di VC possono sfruttare la propria reputazione per segnalare al mercato finanziario la qualità delle aziende supportate e facilitare il loro accesso ad ulteriori finanziamenti esterni (Revest e Sapio, 2012).

Oltre ai benefici strettamente finanziari, i *venture capitalist* possono anche esercitare una funzione di "coaching", offrendo alle aziende scelte un'assistenza che va sensibilmente oltre l'alleggerimento dei vincoli finanziari. A tal proposito, le aziende di VC generalmente offrono servizi di consulenza strategica, finanziaria e networking (vedi Grilli, 2014 per un'indagine della letteratura al riguardo). Per quanto riguarda quest'ultimo, i *venture capitalist* possono estendere la propria lista di contatti alle aziende controllate, permettendo loro di avere accesso ad un ampio spettro di benefici, sia in termini di beni materiali che immateriali.

Dunque, in base a quanto detto finora, due fondamentali prerequisiti della scelta di investire in ambito innovativo – ovvero incentivi e capitali – potrebbero mancare alle le start-up innovative a causa di problematiche relative agli spillover delle attività di R&S e alle imperfezioni dei mercati finanziari.

Al fine di permettere a tali imprese di esprimere a pieno il proprio potenziale innovativo, l'intervento pubblico si rende quindi necessario. In particolare, esistono due linee di azione che le istituzioni dovrebbero perseguire nel breve termine. Da un lato, vi è la necessità di implementare piani di incentivazione appropriati per compensare i disincentivi provocati dagli spillover di R&S. Dall'altro lato, l'accesso a risorse finanziarie esterne deve essere facilitato, in particolar modo nelle prime fasi di vita delle piccole imprese.

Ai fini del presente studio, quest'ultima linea di azione è oggetto di particolare attenzione. Infatti, l'obiettivo di questa ricerca è quello di fare luce sulla relazione tra la struttura di capitali delle start-up innovative e la loro politica di investimenti. In particolare, questa analisi darà la possibilità di raccogliere delle prime evidenze riguardo alla bontà della Legge n. 221, introdotta in Italia nel dicembre 2012. Infatti, tra i vari sussidi messi a disposizione delle start-up innovative italiane, la Legge 221 prevede anche un accesso facilitato al capitale esterno, sia di debito che di rischio. Per quel che riguarda il primo, la Legge offre alle start-up innovative la

possibilità di avere un accesso preferenziale al Fondo Centrale di Garanzia. In quanto a capitale di rischio, investitori esterni e *venture capitalist* possono godere di un regime fiscale agevolato per gli investimenti in start-up. Dunque, il fine principale della presente ricerca è quello di capire se le start-up innovative italiane siano o meno in grado di convertire le sopramenzionate agevolazioni in tassi di investimento maggiori. A tal riguardo, al fine di raccogliere maggiori elementi che potranno risultare utili per suggerire possibili miglioramenti legislativi, nel presente studio vengono presi in considerazione altri possibili driver di investimento e vengono fornite ulteriori osservazioni riguardo all'impatto del capitale umano delle start-up sulle dinamiche di investimento.

Per quanto riguarda le analisi econometriche effettuate, sono stati costruiti due dataset di dati panel.

Il primo contiene una moltitudine di dati finanziari (fino al 2014) riguardanti 2526 delle 3006 start-up innovative iscritte alla sezione speciale del Registro delle Imprese al giorno 8 dicembre 2014, mentre il secondo, che contiene oltre ai dati finanziari informazioni aggiuntive riguardanti l'esperienza educazionale e professionale dei soci di ciascuna start-up, è limitato a 230 aziende.

A causa dell'esiguo numero di osservazioni disponibile per ciascuna impresa, il modello econometrico implementato si configura come un modello panel statico, stimato tramite una regressione GLS – random effects.

In totale, l'analisi è composta da tre modelli, suddivisi in due categorie; la prima (composta dai modelli 1.1 e 1.2), basata sul dataset più ampio (2526 aziende), è focalizzata allo studio delle dinamiche di investimento delle start-up innovative in relazione ai finanziamenti esterni.

La seconda categoria (composta dal solo modello 2), basata sul dataset più ristretto (230 aziende), è di fatto una versione aumentata del modello 1.1, che include ulteriori variabili che rappresentano l'esperienza accademica e manageriale dei soci.

I risultati ottenuti dalla prima categoria di modelli conferma le aspettative secondo cui accedere a capitale di debito o di rischio ha un impatto positivo (e statisticamente significativo nel caso del VC) sul tasso di investimenti delle

aziende. Sorprendentemente, per quanto riguarda il capitale di debito, l'ammontare del prestito ricevuto non sembra avere alcun effetto sulle decisioni di investimento delle start-up. Una possibile spiegazione di questo risultato inaspettato è che il Fondo di Garanzia apra nuove possibilità per le aziende che vi accedono, in linea con un possibile "effetto certificazione" documentato per altre fonti di finanziamento (i.e. VC), su cui però non c'è evidenza diretta.

Per quanto riguarda le altre variabili, i modelli 1.1 e 1.2 indicano che le start-up esibiscono maggiori tassi di investimento nei primi anni di vita, suggerendo che esse non sono poi in grado di mantenere una crescita costante nei successivi anni. Inoltre, le start-up innovative del sud Italia investono più delle altre, grazie all'introduzione di misure ad hoc volte a promuovere la loro crescita.

Infine, il modello 2 evidenzia inaspettatamente che le start-up aventi almeno un socio con precedente esperienza manageriale investono sistematicamente meno delle loro controparti.

Executive Summary

Since the beginning of the new millennium, European Heads of State have decided to take concrete steps towards the creation of a more dynamic European economy. In that respect, in 2000 the European Union launched the Lisbon Strategy (or Lisbon Agenda), a set of policies aimed at laying the foundations in order *"to become the most dynamic and competitive knowledge-based economy in the world".* In 2010, another decennial development plan ("Europe 2020") has been approved: as defined by the European Union, Europe 2020 is a "European strategy for smart, sustainable and inclusive growth".

The efforts spent by European countries in order to promote a dynamic economy based on innovation should be interpreted as a reaction to the argument that the reason for the EU countries' lower economic development in respect to US has to be found in the innovative performance gap between US and EU economies. In particular, several authors certified the lack of innovative, technology-intense new ventures as one of the main causes of the gap in terms of innovation and growth between Europe and USA (Philippon and Vèron, 2008; Veugelers, 2009; Grilli, 2014).

In order to remedy this situation – and in full compliance with the Europe 2020 guidelines – in December 2012, the Italian government outlined a comprehensive, systematic and detailed package of measures (Decree Law No. 179/2012, successively converted into Law No. 221/2012) directly aimed at favouring the birth and growth of innovative start-ups. Even though the new legal entity (defined as "Italian innovative start-up") created by the Italian government shows peculiar features, by and large it presents traits and characteristics similar to specific classes of firms which have been widely studied in the extant literature, such as new technology-based firms (NTBFs) and young innovative companies (YICs).

In particular, the empirical literature on this theme resulted in a widespread consensus on the profound impact that innovative start-ups have in fostering economic growth and prosperity. More specifically, the prominent role played by

innovative newborn firms in boosting economic development based on innovation is tightly connected to their main features: being small, young and having a strong focus on R&D activities and technology.

As highlighted in Chapter 2, companies with greater R&D intensity are alleged to show greater performance in terms of innovation: as demonstrated by several studies (e.g. Griliches, 1958), R&D expenditures have a direct and significant impact on economic welfare. Moreover, R&D activities might also have an indirect positive effect on innovation: the more a company generates internal information through R&D, the greater its "absorptive capacity" (Cohen and Levinthal, 1990) and, thus, its capability to benefit from external sources of related knowledge (Allen, 1977; Mowery, 1983). In sum, even if not necessary, R&D activities go well beyond the generation of an innovative output and can therefore favour the enterprises' innovation process in multiple ways. As a matter of fact, the intense commitment of high-tech start-ups to R&D offers a first unquestionable corroboration of their role in fostering the macroeconomic environment.

However, even more attention has been paid on the relation between firm size and innovation: the resulting long debate, ignited by Schumpeterian Mark I (1934) and Mark II (1942) failed to provide a clear result (Cohen and Levin, 1989; Lerner 2010). Nevertheless, albeit evidences of a "size effect" on the overall innovation level of a firm are mixed, several studies (e.g. Veugelers, 2009) documented that small firms can outclass larger ones when dealing with radical innovations. As radical innovation, conversely to incremental innovation, is able to move upward the technological frontier of an industry, thus originating unprecedented performance levels (Leifer et al., 2000), it is possible to assert that innovative small firms generally have a marked impact on markets and economies.

Finally, newborn companies are found to be leading characters of new employment generation, accounting for a disproportionate share of net job creation (Davidsson et al., 1995; Haltiwanger et al., 2013).

Therefore, being at the same time relatively small, young and R&D-focused, innovative start-ups are supposed to be an extraordinary and unquestionable source of innovation and growth for the whole economic environment.

However, "start-up" does not necessarily mean success: according to Shane (2009), the alleged importance of newborn ventures is nothing but a false myth; indeed, the average founder of a start-up is primarily interested in self-employment rather than the creation of a high-growth firm: as a result, start-ups have lower productivity, on average, than incumbent companies and thus their contribution to economic growth is far from outstanding. Aside from the fact that Shane refers to start-ups in general, not specifically to innovative ones, his claims help to underline that only a narrow subset of high-potential newborn companies has the possibility to boost economic growth and development. For this reason, a deeper understanding of young companies' growth determinants and key success factors is a crucial task for policy-makers, in order to design effective legislations able to favour this group of valuable ventures. By and large, firm growth drivers may be classified in three main categories: individual-specific (i.e. related to firm human capital), firm-specific (e.g. firm strategy, capital assets) and external (related to the industry, location and links with other organisations) factors.

In sum, the emergence of a wide pool of innovative start-ups is supposed to be a crucial vehicle of innovation-based economic growth. However, innovative start-ups are severely exposed to a problematic pitfall, on which researchers reached an almost universal consensus (Martin and Scott, 2000), that is underinvestment. Clearly, this issue represents a serious threat in the eyes of policy makers – especially if R&D investments are concerned – since the positive effects that innovative start-ups are supposed to convey to the economic system might be lowered (Schneider and Veugelers, 2010). Economic researches have picked out two central rationales for institutions to intervene and support innovative start-ups in the short run (Colombo and Grilli, 2006): the presence of spillovers (related, in particular, to R&D investments) and capital market imperfections.

The argument that spillovers are a crucial agent of the fact that private ventures invest less than what socially desirable in R&D is supported by academics without exception (Teece, 1986; Nelson and Romer, 1996; Lerner, 2002). The concept of R&D spillover goes together with the one of "appropriability", namely the ability

of an innovator to capture the benefits engendered by its innovation, to the detriment of other firms. Due to the fact that, for a number of reasons, high-tech start-ups generally operate in a weak appropriability scenario, the social rate of return on R&D investments is found to be greater than the private rate of return (see Hall, 2002; Martin and Scott, 2000). Since companies decide their investment level only considering the private rate of return, some desirable projects (from society's point of view) will not be run, or they will be run with a wrong timing or on a smaller scale (Jaffe, 1996).

A second fundamental cause of innovative start-ups underinvestment – of great relevance to the extent of this study – is related to capital market imperfections.

The efficiency of capital markets mechanisms is of fundamental importance to guarantee an optimal allocation of financial resources: when capital markets imperfections emerge (inefficient capital market), external and internal capital are no longer perfect substitutes (Gertner et al., 1994). As a consequence of these "frictions", companies will strongly rely on internal funds to follow on profitable investment opportunities (Revest and Sapio, 2012). By this argument, if the personal wealth of founders or the company's profits are insufficient, some innovative projects will not be undertaken simply because external finance is too expensive (Aghion et al., 2009). In the last decades, scholars acknowledged several possible causes of the capital markets "frictions" which undermine a company's ability to access external funds and consequently spawn an additional underinvestment gap. Yet, most of the problems arises from information asymmetries between entrepreneurs and external investors. In particular, when lenders are less informed than managers, both external equity and debt are found to be rationed or expensive, as a consequence of adverse selection and moral hazard issues (Carpenter and Petersen, 2002a; Hubbard, 1998; Stiglitz and Weiss, 1981). It is worthwhile to clarify that albeit capital markets imperfections generated by information asymmetries might limit many forms of businesses (Hubbard, 1998), they predominantly hamper R&D investment because of the great uncertainty surrounding technological projects. In fact, companies which suffer the most from capital constraints are usually small, young and operating in

technology-intensive sectors. In other words, NTBFs (Carpenter and Petersen, 2002a). Under these circumstances, it is clear that the capital structure of an innovative start-up has a decisive impact on its investment behaviour. In particular, early studies theorised the existence of a "pecking order" (Myers and Majluf, 1984) or "financing hierarchy" (Fazzari et al., 1988). Since the marginal cost of debt is higher than the one of internal finance, indeed, companies will turn to debt or equity finance only when internal funds (e.g. founders' personal wealth, company's retained earnings) are exhausted. In other words, when investment demand is low, ventures will rely on internally available capital. For increased levels of investment demand, firms will switch to debt and eventually to external equity – which is found to be more expensive (Fazzari et al., 1988). Thus, past studies identified debt financing as the commonly preferred source of external financing, since it is less expensive than external equity and it allows managers to maintain control over their companies (Peneder, 2008).

Nonetheless, in contrast with the pecking order hypothesis, several recent works support the empirical evidence that venture capital (VC) is the most suitable candidate to alleviate NTBFs' financial constraints. Indeed, private VC is considered by both academics and practitioners as the best suited candidate to address the capital market imperfections constraining young high-tech firms (Carpenter and Petersen, 2002a; Lerner, 2002).

Clearly, the most direct form of support provided by VC firms to innovative start-ups is represented by the injection of external equity. In this respect, recent studies have demonstrated that equity finance has several advantages over debt finance when high-tech ventures are concerned. This is due to the fact that VC peculiar characteristics are meant to offset – at least partially – the information asymmetries which are the primary causes of the gap between internal and external finance for NTBFs. First, VC firms are likely to possess greater technological and context-specific expertise, which allows them to better evaluate promising high-tech projects and the entrepreneurial skills of the proponents (Audretsch and Lehmann, 2004). Second, conversely to banks, equity investors do not require a collateral to mitigate against adverse selection: since NTBFs generally lack of collateralisable

assets, this doubtlessly increases the advantages of VC. Third, increasing the level of equity in a company will not increase the likelihood of financial distress, as debt finance does (Carpenter and Petersen, 2002a). Fourth, VC investors take an equity stage in the ventures they fund, sharing profits and risks with them. This peculiar governance structure provides some advantages: first, firm founders are not required to pay back a loan and/or the related interests; second, VC investors have huge incentives to provide portfolio firms with all the resources they might need in order to fully express their innovative potential (Bertoni, Colombo and Croce, 2010).

A further benefit provided by VC is the so-called "certification function". In a nutshell, VC firms can leverage on their reputation to signal the quality of a financed firm and smooth their access to outside capital (Revest and Sapio, 2012). Besides financial-related benefits, VC investors may also provide a "coach" function, offering to the selected companies an assistance which goes well beyond the financial constraints alleviation. To this extent, VC companies are alleged to provide strategic consultancy services, financial management and networking (see Grilli, 2014 for a literature survey on this topic). As far as the latter is concerned, VC investors may extend their business contacts list to portfolio firms, allowing them to access to a wide set of opportunities, both in terms of tangible and intangible assets.

According to what seen so far, due to the issues related to R&D spillovers and capital market imperfections, two fundamental pre-requisites of the decision to invest in innovation – namely incentives and capital – could be missing for innovative start-ups.

Therefore, in order to support them to fully express their innovative potential, public policy intervention is largely advocated. In particular, there are two compelling lines of action that institutions should follow in the short run.

On one hand, disincentives provoked by R&D spillovers have to be offset by proper incentive schemes. On the other hand, access to external finance needs to be facilitated, especially for young and small companies in their early stages.

To the extent of the present study, this latter line of action is under the spotlight. Indeed, the goal of this research is to shed light on the relation between innovative start-up capital structure and investment behaviour. In particular, this will offer the possibility to provide early evidence of the effectiveness of Law No. 221, introduced in Italy in December 2012. Indeed, among the various aids designed to support Italian innovative start-ups, Law 221 also envisages a favoured access to both debt and equity capital. As for the former, the Law allows innovative start-ups to enjoy a facilitated access to the Central Guarantee Fund. As for the latter, fiscal incentives for venture capitalists and outside investors investing in such start-ups will be provided. Therefore, the main purpose of the present research is to investigate whether Italian innovative start-ups are able to "convert" the abovementioned privileged access to external equity and debt capital into greater investment rates. While doing this, other possible investment determinants are analysed in order to have more elements to suggest potential future policy directions to be pursued. Secondarily, further remarks concerning the impact of start-up human capital on investment behaviour are offered.

In order to run the econometric analyses, two unbalanced panel datasets have been built. The first contains extensive financial data, up to 2014, for 2526 out of the 3006 innovative start-ups registered to the dedicated special section of the Business Register as of December 8th 2014. On the other hand, the second, which complements firms' financial information with hand-collected information about shareholders' educational and professional background, is limited to 230 firms.

Due to the limited number of observations available for each company, the applied econometric framework is configured as a static panel model, estimated through a GLS-random effects estimator.

Overall, the analysis includes three models divided in two categories: the first one (models 1.1 and 1.2), based on the larger dataset, is focused on studying innovative start-up investment dynamics in relation to external financing.

The second category (i.e. model 2), leveraging on the smaller sample, is an augmented version of model 1.1, which includes additional variables controlling for shareholders' managerial and academic experience.

Results stemming from the first category of econometric analyses confirm the intuition that the access to external equity and debt finance has a positive (and statistically significant for equity capital) impact on firm investment rates. Interestingly, as far as debt capital is concerned, the received loan amount does not have any impact on start-up investment behaviour. A possible interpretation of this unexpected outcome, even if not yet corroborated by a thorough analysis, is that the access to the CGF opens up further possibilities for the recipient companies, in line with a possible "certification effect".

Among the other results, models 1.1 and 1.2 indicate that younger start-ups show greater investment rate, suggesting that innovative start-ups are not able to sustain a steady growth over their early years. Moreover, innovative start-ups in the South of Italy are found to invest more than others, thanks to tailored policy schemes promoting their growth.

To conclude, model 2 unexpectedly highlights systematically lower investment rates for start-ups with at least one shareholder having previous managerial experience.

1. Italian innovative start-ups

1.1 Italian innovative start-ups: what are they?

In the last decade, the term "start-up" has become incredibly popular and widespread even outside the business landscape. In the early 2000s, with the dramatic growth of Internet and Information Technology-related sectors, a huge number of newborn companies quickly reached outstanding performances and results, drawing public opinion's and researchers' attention.

Initially, the term "start-up" was used to indicate this particular set of ventures. Very soon, however, thanks to the intense pervasiveness of IT across several industries, it acquired a wider and more generic meaning, ending up with being used in the common jargon to describe every small and young business.

As a consequence, several different definitions of "start-up" emerged in the last years, making difficult to identify a univocal, concise and incontestable definition of what a start-up is. In this paragraph, the definition provided by the U.S. Small Business Administration (SBA) will be taken as reference, since it is general and it can be considered trustworthy.

According to the SBA, a start-up is "a business that is getting off the ground, typically technology-oriented and with a clear growth potential".

The aim of this analysis, however, is focused on a specific category of start-ups, defined by the Italian law as "Italian innovative start-ups" ("start-up innovative italiane). The "*Decreto-legge 18 ottobre 2012, n. 179",* which will be analysed in detail in Chapter 7, identifies a number of characteristics that Italian companies must have in order to gain the title of "innovative start-up".

Of these, the most salient are:

1. It has been operating for less than 5 years;
2. Starting from its second operative year, the total annual value of production is not above 5 million euros;

3. Its main aim is to develop, produce and commercialise innovative products or services with high-technological value;
4. It has not been founded as a result of companies' merge, acquisition or spin-off;
5. It meets at least one of the following three requirements (5.1, 5.2 and 5.3):
    5.1. R&D expenditures are equal to or greater than 15% of the maximum between total cost and total value of production;
    5.2. At least one third of the employees/collaborators possesses a PhD title, or it is carrying out a doctoral research or has carried out no less than three years of certified research activity (in private or public research institutes); or also, at least two thirds of the workforce have got a Master of Science degree;
    5.3. It has the legal ownership of an industrial or biotechnological invention, or of a topography of semiconductor products, or of a new vegetable variant;

Once given a summarised view of the main traits of Italian innovative start-ups (ISUPs, henceforth), it is important to underline that there is a lack of studies and researches focused on this specific category of newborn companies. Evidently, this is due to the fact that Italian innovative start-ups have been conceived less than 4 years ago; moreover, this class of companies is restricted to the Italian landscape, thus resulting in a narrower interest by the scientific community.

Nevertheless, the body of literature concerning young and high-tech firms and their peculiarities, strengths and weaknesses is extremely large. In particular, most of the studies refer to very well-known and widely studied clusters of companies, called New Technology-Based Firms (NTBFs), Young Innovative Companies (YICs) and Gazelles.

In the next paragraph, the definitions of these kinds of businesses will be presented, focusing the attention on the principal similarities and differences among them.

1.2 NTBFs, Gazelles, YICs and ISUPs: a comparison

Among the abovementioned classes of companies, the first definition appeared in the economic researches is the one of NTBFs.

Specifically, this nomenclature has to be attributed to Cooper, Arnold C. (1971), who described the mechanisms and conditions underlying the emergence of new, technologically-based firms in the San Francisco Peninsula.

According to Cooper's words, a NTBF is defined as "a company which emphasizes Research and Development or which places major emphasis on exploiting new technical knowledge".

As Cooper's definition seems to be generic and lacks specificity, many authors claimed that the term "NTBF" has been actually coined by the Arthur D. Little Group.

Indeed, in a report comparing US, German and UK young technological ventures (Little, 1977), they defined a NTBF as a company with the following features:

- Established for less than 25 years, by a group of individuals (not as a subsidiary of an existing company);
- Based on potential invention or having technological risks substantially higher than the average firm;
- Founded with the aim of exploiting an invention or technological innovation;

Nonetheless, several definitions and understandings of what a NTBF actually is have emerged in literature over time, reinforcing the belief that outlining a unique meaning of this concept is a cumbersome task[1].

In that respect, a multitude of scholars underlined the complexity of understanding what "new" stands for. First, because it is not always simple to clearly establish when a firm should be considered new (Cooper, 1971). An example is that of an earlier low-performing company, which suddenly improves its performances thanks to the entrance of new shareholders/managers: can this business be considered "new", even if the actual founding occurred many years before?

[1] A comprehensive review of the different definitions of NTBFs is offered by Cunha et al., 2013.

Second, it is far from easy to tell whether "new" is to be referred to the technology, the firm or both (European Commission, 1996).

In this regard, a more "restrictive" view argues that only new companies, which are adopting new technologies to develop new industries, should be labelled as NTBFs (Shearman and Burrell, 1988). This perspective is in contrast with a wider definition of NTBFs, which essentially places them on an equal footing to high-technology SMEs (Butchart, 1987; European Commission, 1996; Storey and Thether, 1998).

In comparison to the "restrictive" view of NTBFs, the concept of high-tech SMEs has less stringent constraints in terms of company's newness and nature of its technological activities (Schneider and Veugelers, 2010): as a matter of fact, many SMEs in high-tech industries simply leverage on innovations already present in the marketplace (Delapierre et al., 1998).

By and large, the differences between NTBFs and high-tech SMEs can be resumed as follows: on one hand, NTBFs are technology-led, have simple organisational frameworks and provide few products to an unstable customer base; on the other hand, high-tech SMEs are market-oriented, have more complex organisational structures and serve a well-established customer base (Shearman and Burrell, 1988).

Even if the aforementioned views have clear differences, many scholars relied on the broader definition of NTBFs, due to the difficulty of gathering data about company's age and nature of innovative activities.

In the end, regardless of the different definitions and perspectives, researchers agree on some fundamental features owned by NTBFs: they have a growth rate higher than the average; they are young and/or operate in technology-intensive industries (Almus et al., 1999; Storey and Tether, 1996; Czarnitzki and Delanote, 2013).

The second cluster of businesses that can be somehow related to Italian innovative start-ups, although their presence is quite rare in the Italian context, is constituted by the so-called "Gazelles".

Essentially, accelerated growth pace and limited age are the two characteristics that enterprises defined as "Gazelles" must have; according to the "Manual on Business Demography Statistics" provided by Eurostat, every company established for no longer than 5 years and growing with an annual rate (in terms of turnover or number of employees) higher than 20% over a three-year time lapse can be considered "Gazelle".

Nonetheless, some authors (e.g. Schneider and Veugelers, 2010) argued that, regardless of the age, fast growth is the only determinant of "Gazelles". However, what all academics agree on is that "Gazelles" are not necessarily building their competitive advantage on innovation or high technologies, as demonstrated by Hölzl (2008) for the European case.

In recent years, great emphasis has been put on "Young Innovative Companies" (YICs) (Veugelers, 2008; Schneider and Veugelers, 2010). Differently from NTBFs and - to some extent - from Gazelles as well, for this category of firms a definite and widely accepted definition does exist: in the new aid framework for R&D development drafted by the European commission in 2006, guidelines for public support to YICs are provided.

In this document, YICs are described as having small size (less than 250 employees), being young (less than 10 years) and spending at least 15% of its operating expenses on R&D.

In literature, few studies have been run in order to deeply analyse similarities and differences between NTBFs, Gazelles and YICs. One of these is the econometric analysis carried out by Czarnitzki and Delanote (2013), which highlighted how YICs have higher growth rate in respect to NTBFs[2].

The aim of this paragraph was to encompass the different definitions of NTBFs, Gazelles and YICs, in order to check whether Italian innovative start-ups can be considered a counterpart of them or not.

[2] In this paper, authors intend the adjective "new" as referring to the age of the company rather than the nature of its technologies. With this arrangement, they consider NTBFs as having same size and age of YICs, but a less strict "R&D" criterion (higher than 0% rather than 15%).

As highlighted in Table 1, Gazelles can be related to Italian innovative start-ups only in terms of age.

Nevertheless, it is interesting to note that NTBFs and YICs seem to be complementary in describing Italian innovative start-ups.

In the definition of YICs it is possible to find indications and restrictions in terms of age, size and R&D intensity as in Italian innovative start-ups; on the other hand, the primary focus on innovative high-tech goods and the independency in the company's foundation are commonly shared by NTBFs and Italian innovative start-ups.

Table 1 – A comparison between NTBFs, YICs, Gazelles and Italian innovative start-ups (ISUPs)

	NTBFs	*YICs*	*Gazelles*	*ISUPs*
Age	≤ 25 years	≤ 10 years	≤ 5 years	≤ 5 years
Size	/	≤ 250 employees	/	Total value of production ≤ 5 mln
Focus	Based on invention/high technological risk	/	/	Innovative products/services with high-tech value
Foundation	No spin-off/ no M&A	/	/	No spin-off/ no M&A
R&D	/	At least 15% of operating expenses	/	At least 15% of Max (total cost, total value of production)
Growth	/	/	≥ 20%	/

2. The importance of innovative start-ups as a means of economic development

In the end of Chapter 1, the principal characteristics of innovative start-ups (age, size, technological intensity, etc.) have been presented.
In Chapter 2, these characteristics will be deeply analysed, with the purpose of evaluating their role in determining the increasing salience of new, high-technology firms. In other words, we will attempt to figure out which advantages an innovative start-up can convey thanks to its limited size, newness and strong focus on technological change.
The aim of this chapter is to highlight the reasons why young innovative companies captured the attention of both researchers and policy makers in the last decades, by emphasising how some of their features are actually supposed to significantly contribute to the overall economic growth.

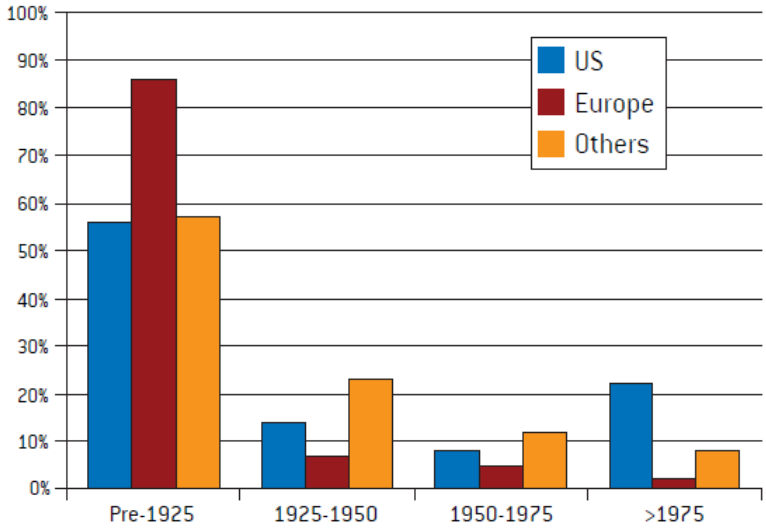
2.1 R&D, innovation and economic growth: a strong connection

Since the beginning of the new millennium, European Heads of State have decided to take concrete steps towards the creation of a more dynamic European economy. In that respect, in 2000 the European Union launched the Lisbon Strategy (or Lisbon Agenda), a set of policies aimed at laying the foundations in order *"to become the most dynamic and competitive knowledge-based economy in the world".*
In 2010, another decennial development plan ("Europe 2020") has been approved: as defined by the European Union, Europe 2020 is a "European strategy for smart, sustainable and inclusive growth". Research and innovation are placed at the centre of the Europe 2020 strategy (Horizon 2020). This includes the headline objective of increasing spending on R&D to 3% of GDP by 2020.
Here, a first evidence of the correlation between R&D and growth can be noticed: a higher intensity in Research and Development could increase the knowledge

pool, favouring the emergence of a multitude of innovations and, accordingly, enabling economic dynamism and growth.

Not surprisingly, several authors certified the lack of NTBFs as one of the main causes of the gap in terms of innovation and growth between Europe and USA (Philippon and Vèron, 2008; Veugelers, 2009; Grilli, 2014). In Figure 1 (Veugelers, 2009), it is possible to appreciate how the percentage of young (i.e. instituted after 1975) innovation-leading companies is remarkably higher in US than it is in Europe.

Figure 1 – Share of leading innovators by age cohort[3]



Source: Veugelers (2009)

2.1.1 R&D expenditures: a fundamental input of (technological) innovation

The large majority of economists and academics (e.g. Hölzl, 2008; Cohen and Levin, 1989) supports the idea that technological progress, R&D and innovation play a pivotal role in fostering economic growth and prosperity.

In their "*The second machine age*" (2014), Brynjolfsson and McAfee claim that a technological innovation (i.e. the invention of the steam engine) outclassed every

[3] "Leading innovators" are defined as the largest firms in terms of both market capitalisation and R&D spending.

previous event, such as wars, empires, philosophies, religions, in triggering and influencing human progress[4].

As a matter of fact, the compelling correlation between technological innovation and economic growth has been recognised long before 2014: classical political economists, such as Ricardo, Smith and Marx, put the accent on the impact that technical progress has on productivity improvement. In this connection, an outstanding example is the one of the notorious pin factory showed by Adam Smith.

Nonetheless, technological change theories achieved an important breakthrough in the 1950s thanks to Abramowitz (1956) and Solow (1957), who first tried to quantify this relationship.

In the previous centuries, economists dealt with economic growth (and productivity in particular) as if it were a matter of augmenting the productive inputs (e.g. capital, labour). Banally, it is possible to obtain a higher output out of a process by merely increasing the level of inputs. Abramowitz (1956) assessed both the output (in terms of products/services produced) and the inputs (mainly labour force and capital) of the US economy from 1870 to 1950. Thanks to this analysis, he pointed out that only 15% of the output growth could be justified by the input growth: the residual 85% output increase (similarly, Solow came up with a percentage around 87.5%) gives an indication of how much productivity can be boosted by technical change.

Indeed, this residual increase in output is due to technological innovations within the process itself, which allow getting more output from the same inputs (Lerner, 2010). Although later studies estimated a narrower fraction of growth stemming from technological progress, its direct impact on economic growth is widely recognised.

[4] To demonstrate it, authors refer to the work of Ian Morris ("*Why the West Rules—For Now", 2010).* In this book, Morris drafts a "social development" curve (namely, "a group's ability to master its physical and intellectual environment to get things done), noticing that it perfectly traces out over time the human population curve. In correspondence of the steam engine invention, both curves bent by almost 90 degrees.

Moreover, technological progress has also an indirect effect on growth: in fact, it also affects the input accumulation (Nelson and Romer, 1996). Without technical advance, both human and physical capital accumulation would be hampered and this would ultimately lead to an economic impasse.

A second wave of studies focused the attention on R&D expenditures: once recognised the powerful tie between technological innovation and growth, it remained to be discovered how much investments in R&D could spur technological advance and therefore be active actors of economic growth.
In this field, the work of Griliches (1958) acquired notable exposure: focusing on the agricultural sector (specifically, on "hybrid corn"), he demonstrated that the benefit-cost ratio of research activities was around 7,[5] with an IRR around 40%.
From that moment on, a multitude of similar studies, targeting both primary and secondary sectors, obtained comparable results[6].

Thus, for the most part, past researches confirm that R&D spending has a direct impact on economic growth and affluence, even though estimates of the entity of this impact may vary from research to research.
However, this is not the sole source of benefits that companies can draw from thanks to Research and Development activities.
Indeed, albeit internal knowledge generated through R&D is a key factor in the innovation process, also external knowledge does play a crucial role.
That is why a fundamental ability that businesses should have is what is defined as "absorptive capacity" (Cohen and Levinthal, 1990): this term indicates a firm's ability to leverage on external knowledge to feed its innovative activities.
However, how to acquire "absorptive capacity"?

[5] As Griliches (1992) explains, this result was wrongly interpreted as a 700% rate of return of public investment in hybrid corn research. Actually, he rather "computed current and future consumer surplus flows, discounted them back to the present, and compared them to the cumulated research cost".
[6] A complete review of the results of similar studies is offered by Griliches (1992) and attached in the Appendix.

Cohen and Levinthal (1990) indicates three main possibilities:

1. Personnel training is a direct way to increase a company's ability to assimilate and use external knowledge.
2. Being involved in production activities, firms tend to become highly endowed in evaluating the potential of new information and exploit it (Rosenberg, 1982; Abernathy, 1978).
3. Gathering prior internal knowledge allows to better exploit external knowledge.

This last point engenders a meaningful implication: the more a company generates internal information through R&D, the higher will be its capability to benefit from external sources of related knowledge (Allen, 1977; Mowery, 1983).
As it will be deepened in Chapter 4, the appropriability issue acutely affects knowledge: concisely, it means that it is generally a complex task for a company to prevent its own knowledge from being used by others.
In this scenario, absorptive capacity acquires even greater relevance: for this reason, in some situations, firms may decide to invest in R&D primarily to improve their absorptive capacity (in order to exploit external information), rather than to develop internal knowledge to be used for innovation (Rosenberg, 1990).

Some may argue that investing in R&D is not the only input of innovation: from the Community Innovation Surveys, indeed, it emerges that only 55.2% of innovative firms runs R&D (Mohnen and Roller, 2005).
Doubtless, this argument is legitimate. Yet, R&D activities seem to be the key to accomplish synergies in the complementary use of different possible inputs (e.g. innovative investment in plants, licenses, consultancy), as verified on a sample of over 3000 Italian manufacturing companies by Catozzella and Vivarelli (2014).
This result offers another evidence of the fact that, even if not necessary, R&D activities go well beyond the generation of an innovative output, and can therefore favour enterprises' innovation process in multiple ways.

Nonetheless, several factors may accrue or reduce the need for a business strategy focused on R&D: to cite an example, Hölzl (2008) found out that the importance of R&D depends on the geographical location of a company. In fact, he demonstrated that in Europe, R&D and innovation appear to be more relevant for Gazelles in countries close to the technological frontier rather than countries far from it [7].

2.1.2 R&D as a measure of innovation

The lack of a suitable yardstick to assess the impact of new knowledge on firm innovative performances represented a major obstacle faced by researchers. Strictly speaking, how to measure innovation? By and large, innovation measures can be classified as input-related measures and output-related measures.

Examples of output-related measures are technical experts' analyses or the number of patents owned. The former is exposed to subjectivity and specificity of the results, which could be hardly fruitful outside the scope of that specific technology or innovation (Griliches, 1992). Additionally, the output of some industries (e.g. Health, Aerospace, Defence) is based on input measures and therefore it cannot be successfully used to assess productivity improvements (Griliches, 1979).

The problem may even be more critical when consumer products are concerned: in this case, the benefits a company can exploit from an innovation are strictly dependent on market structure and competition intensity.

Several problems, as well, may arise using patents as a proxy of the innovative output of an industry or a company (Cohen and Levin, 1989): in fact, only the minority of patents is actually used to protect significant innovation; moreover, a huge number of potential innovations are very difficult to patent (e.g. software).

[7] Continental countries (Austria, Germany, Luxembourg, Belgium, Sweden and Finland) belong to the country group close to the technological frontier.
Southern Europe (Italy, Portugal, Greece and Spain) and new Member States (Slovenia, Slovakia, Estonia, Hungary, Czech Republic, Lithuania and Latvia) are considered far from the technological frontier.

For these reasons, input-related measures are most commonly used: among them, measuring the R&D expenditures gained particular salience. Nonetheless, also this measure is not immune to possible bias.

Undeniably, R&D operations cannot precisely reflect all the efforts a firm spends on innovation: a significant share of them is made outside formal R&D activities, besides the fact that many small firms do not run formal R&D operations (Cohen and Levin, 1989).

In addition to that, R&D expenditures may require years before related benefits can be noticed (Griliches 1979).

The R&D department of a company could be involved in several projects and could develop knowledge that can be exploited in many products. Companies might benefit from these innovative products in different periods of time and through different channels. For these reasons, quantifying returns on R&D investments might be an incredibly difficult and time-expensive activity.

As it has been shown in Chapter 1, R&D intensity is one of the criteria adopted to define Italian innovative start-ups. On the other hand, this sub-paragraph highlighted a series of issues peculiar to this measure, which have to be seriously taken into consideration when trying to quantify the value of an innovation.

Nevertheless, to the extent of this study, what matters the most is the evident set of advantages that investments in R&D can provide companies with: Research and Development can play a pivotal role in supporting the emergence and growth of innovative start-ups and thus, indirectly, in fostering the evolution of the overall economy.

This is a fundamental step in understanding why the birth of innovative young firms may significantly impact on economic growth. Adopting a very linear (and general) perspective, it is possible to assert that innovative start-ups, thanks to their acute R&D focus, can emerge as considerable drivers of innovation and technical progress; these latter, in turn, are widely recognised as key contributors of the economic growth.

2.2 Small firms and innovation

In the previous paragraph, evidences and contributions of the tangible link between R&D, innovation and economic growth have been encompassed.

As a matter of fact, the intense commitment of high-tech start-ups to Research and Development offers a first unquestionable corroboration of their role in fostering the macroeconomic environment.

Nonetheless, even higher interest has been raised by the scientific community on the relationship between firm size and innovation potential.

In this paragraph, it will be investigated whether the smallness of a company (high-tech start-ups in particular) could engender additional advantages for the economic system or not.

2.2.1 Firm size and innovation: a long-lasting debate

The fundamental basis of the debate regarding the relationship between firm size and innovation goes back to the seminal work of Joseph Alois Schumpeter, who in different periods of his life proposed two contrasting visions of the economic development theory, traditionally known in literature as Mark I and Mark II.

Schumpeter's Mark I claimed that technological progress is the result of a continuous process of newborn ventures' entry into the market. In this view, young small firms are seen as the leading characters of the innovative process: they enter into the marketplace, bringing in new products, processes and services; in this way, new innovative companies are capable of replacing the old firms (incumbents) and ensure technological dynamism and development (Schumpeter, 1934).

The neo-Schumpeterian vision (Schumpeter, 1942) offered an opposite version of the story: according to Mark II, the capitalistic system, characterised by the presence of large oligopolistic companies, can guarantee higher innovative performances.

Indeed, large firms can exploit economies of scale in the R&D activities and can rely on higher internal funds to finance the risk attached to such activities[8].
By and large, the experimental literature has interpreted Schumpeterian legacy as the belief that there is a positive correlation between firm's size and innovation (Cohen and Levin, 1989).

In the following years, dozens of researchers have tried to test the validity of the abovementioned argument.
Cohen and Levin (1989) carried out an exhaustive analysis of the most prominent studies on the relationship between size and innovation. They noticed that, until the early 1980s, most of the researches displayed an overall consensus on a positive correlation between the two variables (e.g. Mansfield, 1964; Grabowski, 1968; Soete, 1979; Link, 1981).
Nonetheless, later studies questioned the consistency of these results. Some authors showed that it is the business unit's size – rather than the company's size – to positively impact on the R&D intensity and, therefore, on innovation (Scherer, 1984; Cohen et al., 1987). Others found out that the "size effect" is triggered only after a certain size threshold: in other words, R&D intensity first decreases and then increases – as firm size rises (Bound at al., 1984; Cremer and Sirbu, 1978).
It clearly emerges that the most suitable proxy to define the results of these articles is "inconclusiveness": over time, scholars failed in converging towards a consistent and univocal result (Cohen and Levin, 1989; Lerner 2010; Schneider and Veugelers, 2010).
However, it is important to underline which are the main advantages, in terms of innovation potential, that – according to the body of literature – large and small firm could have.
The advantages of large firms are:

- Possibility to enjoy economies of scale and scope in R&D activities.

[8] As one can notice from this argument, Schumpeter was one of the first scholars to understand that new firms particularly suffers from capital market imperfections. In Chapter 4, the relevance of this issue will be highlighted.

- Greater availability of internal funds to finance R&D activities.
- Higher market power, helpful in reducing the risk related to innovation.
- Possibility to spread the fixed cost of innovation over a wider products' portfolio.
- Higher development of complementary competences and assets (e.g. marketing) that could increase the returns on R&D expenditures.

The advantages of small firms are:

- Higher control over innovation activities.
- Greater speed in catching up with opportunities.
- Higher flexibility in research activities as well as in implementing innovations.
- Less bureaucratisation of R&D activities.
- Higher possibility – for scientists and entrepreneurs – to catch the benefits stemming from an innovation.
- Higher potential to introduce in the marketplace disruptive/radical innovations.

The expression "last but not least" perfectly fits in this case: indeed, this latter advantage (i.e. higher likelihood of generating radical innovations) plays a fundamental role in determining the relevance of high-tech start-ups, as it will be deepened in the next sub-paragraph.

2.2.2 Radical innovation: when "small" is better

In the recent literature, the smallness of high-tech firms is considered as a crucial factor for macroeconomic growth and performances (Brouwer, 1998) as well as for the European innovative potential (Moncada-Paternò-Castello, 2011).

It may seem that this claim stands in contrast to what has been previously elucidated, that is the evidence that an unambiguous relationship between firm size and innovation does not exist. However, this is not the whole story: apart from the entity of innovative activities, the type of innovation matters as well (Schneider and Veugelers, 2010).

Among the several different types and classifications of innovation, the most prominent dichotomy distinguishes between *radical* and *incremental* innovation.
Due to the multitude of scholars who spent efforts on this topic, several definitions of radical innovation emerged in literature. As showed by Slocum and Rubin (2008), radical innovations are the ones that incorporate new engineering principles and technologies, creating a fertile ground for future technological developments (Ahuja and Lampert, 2001). Conversely to incremental innovations, which are based on improvements in existing products, technologies and processes, radical innovations are able to move upward the technological frontier of an industry, originating unprecedented performance levels (Leifer et al., 2000).
For these rationales, it is possible to assert that radical innovation – more than incremental – has a profound impact on companies, markets and economies.
This line of reasoning is strictly connected to the concept of "creative destruction" popularised by Schumpeter: new firms can subvert competition in existing markets, create new ones, generate truly innovative technologies; with their "disruptive force", they can replace incumbents and profit from a temporary monopolistic position.

Some authors suggest that a greater level of innovation can be obtained as a result of a combined effort of both small and large firms: the former, indeed, are meant to produce radical innovation which the latter may follow up and build on with their incremental innovation (Baumol, 2002). This view offers a twofold indication: on one hand, in order to improve the innovative performances of an economic system, radical innovation is a *conditio sine qua non*; on the other hand, it gives a critical information about the role of firm's size in innovation.
In point of fact, the literature agrees on attributing to small new firms the higher potential for radical innovations, whereas large established firms usually tend to focus on incremental innovation (Slocum and Rubin, 2008; Henderson and Clark, 1990; Tushman and Anderson, 1986).
As demonstrated by Henderson (1993), this distinction has two main causes.

First, large firms have, generally, less incentive to produce radical innovation when compared to small new companies: indeed, profits stemming from a radical innovation would cannibalise the existing revenue streams of incumbents (Reinganum, 1983)[9].

Second, large firms are found to have a lack of abilities in generating radical innovations. In fact, incremental innovations tend to strengthen the competitive position of large old firms, because they leverage on their existing core competences; but when it comes to radical innovations, they actually destroy existing competences, making them redundant (Tushman and Anderson, 1986; Henderson and Clark, 1990).

Accordingly, small new companies are the primary means of radical innovation, which could give rise to new markets (Schneider and Veugelers, 2010).

Indeed, small firms have no existing market power or skills to safeguard: the only way they have to enter in well-established industries is to create something completely different (Slocum and Rubin, 2008).

Many studies confirm the prominent role played by small firms when radical innovations are concerned. For example, Acs and Audretsch (1988) drafted a list of fundamental innovation of the 20th century, highlighting how small new firms were accountable for approximately half of them.

Baumol (2002) carried out an analogous analysis, focusing on US small firms: a sample of his findings, reported by Veugelers (2009), is showed in Figure 2.

[9] The cannibalization effect identified by Reinganum is exactly what Arrow (1962) defined as "replacement effect". According to this theory, companies able to innovate can enjoy temporary extra-profits: small new entrants would fully capture these profits, whereas incumbents would partially cannibalize the extra-profits they already have.
The only difference with Arrow's theory is that this latter was referred to innovation in general, rather than radical innovation.

Figure 2 – Major innovations by small

Major innovations by small US firms in the twentieth century		
Air conditioning	High-resolution CAT scanner	Optical scanner
Biomagnetic imaging	Hydraulic brake	Pacemaker
Polaroid camera	Kidney stone laser	Quick-frozen food
Electronic spreadsheet	Microprocessor	Soft contact lenses
Heat sensor	Magnetic resonance scanner	Two-armed mobile robot

Source: Veugelers (2009)

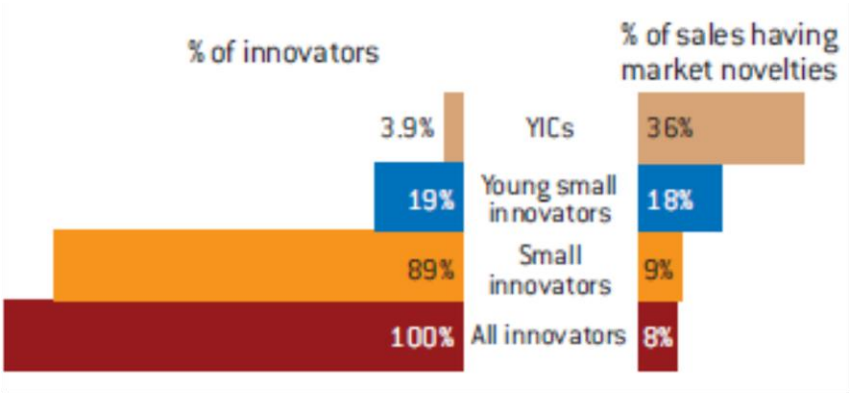
The aim of sub-paragraphs 2.2.1 and 2.2.2 was to support the thesis according to which the size of a firm is an important determinant of its innovative performance: if – as showed in sub-paragraph 2.2.1 – the evidences of the "size effect" on the overall innovation level of a firm are mixed, sub-paragraph 2.2.2 clearly demonstrated how small firms can outclass larger ones when dealing with radical and disruptive innovations.

If combined with the results of paragraph 2.1 (i.e. efforts and focus in R&D activities improve a company's potential in innovation), this means that young innovative companies – being both small and R&D-intensive – could be considered as an extraordinary and unquestionable source of innovation for the whole economic environment.

The results of a study realised by Veugelers (2009) on a sample of German companies push in this direction.

Even if small in numbers and size, YICs have 2.4 times higher sales of new or substantially improved products than other types of innovators. When it comes to radical innovations ("market novelties"), sales are even 5 times higher (see Figure 3).

Figure 3 – YICs: a rare but important source for radical innovations



Source: Veugelers (2009)

2.3 Firm size and employment generation

While size proved to be closely connected to the innovative traits of companies, much has been said about the prominent role played by small businesses in terms of employment creation.

In point of fact, the widespread perception that small firms are key resources for employment growth has been probably the primary motive that conveyed policy makers' attention towards SMEs.

Since the influential work of Birch (1979, 1981), many studies converged on the same verdict: small companies contribute disproportionally to net job creation (Baldwin and Picot, 1995; Storey, 1994; Brinkley 2008). In particular, net job creation is obtained as the difference between gross job creation (i.e. total employment gains) and gross job destruction (i.e. total employment losses) (Henrekson and Johansson, 2010).

It is worth noting that this does not mean that small firms possess an employment base larger than bigger companies: as pointed out by Birch (1979), few large companies (defined "elephants") still retain a large employment share; despite that, elephants spawn a few new jobs.

Conversely, smaller ventures more than compensate for their greater failure rate with their ability to start up and rapidly grow: for this reason, the major providers of new employment tend to be small (Birch, 1981).

Needless to say, not all young and small companies show growth rates higher than the average and generate a disproportioned share of new jobs: indeed, the vast majority of small enterprises (the so called "Mice") does not succeed in successfully expanding its business during its lifecycle and, despite determining a tangible share of gross job creation, its contribution to the net job creation is far from outstanding. Rather, it is just a narrow set of small, young, fast-growing companies (i.e. Gazelles[10]) which engender a substantial share of new jobs.

In conclusion, former studies agreed on the evidence that even if large companies hold the majority of the overall employment base, small newborn firms generate most of the new jobs or – at least – their share of net job creation is much greater than their share of employment base (Davidsson et al., 1995).

One may think that the two abovementioned arguments are one against the other: if small companies are the main contributors to the net job creation, their share in total employment should enlarge over time and, sooner or later, they should overcome larger ones in terms of overall employment base.

Actually, here a "classification" problem arises: when fast-growing SMEs exceed a certain threshold in the number of employees[11] because of their widening, they are re-categorised as large companies in the statistics (Brinkley, 2008).

However, these results have not been unchallenged over time.

For one thing, different authors suggested that the role played by small enterprises in the job creation process has been overestimated due to various methodological pitfalls. The most prominent representatives of this stream of criticism are Davis et al. (1996), who highlighted the "regression fallacy" issue, i.e. the fact that temporary fluctuations in size systematically bias estimates in favour of small firm job creation (Davidsson et al., 1995).

To better explain the meaning of the "regression fallacy", an example would help.

[10] The term "Gazelle", presented in Chapter 1, was indeed coined by David L. Birch (1979).

[11] Different thresholds are adopted in different studies to discriminate small and large companies. One of the most used limit in literature is 250 (i.e. companies with more than 250 employees are considered large).

Let's assume to study the behaviour of a company with 200 employees (at Year 1) over a 3-year period. The size boundary between small and large firms is set at 250 employees. The company under investigation will behave as follows: it will grow up to 300 employees at Year 2, but then it will regress to 200 employees at Year 3. As it is easy to compute, the net job creation over the focus period is null (eventually, the company's employment base at Year 3 is equal to the one at Year 1), but the yearly oscillation produces a job growth rate of 50% between Year 1 and Year 2 and of -33% between Year 2 and Year 3. With the traditional base-year classification, the entire share of the created jobs (100 new jobs generated between Year 1 and Year 2) is ascribed to small firms, because at Year 1 the company is labelled as "small"; on the other hand, the entire amount of destroyed employment (100 jobs lost between Year 2 and Year 3) is imputed to large firms, because the company is "large" at Year 2. Consequently, this boundary-crossing effect will ultimately bias the econometric results, overvaluing the contribution of small companies to employment generation.

Even though academics agree on the correctness of this remark, further studies demonstrated that biases due to the "regression fallacy" – even if present – were negligible and did not lead to qualitative change of the conclusions. As explained by Davidsson et al. (1995), only a small fraction of job variations involve companies close to the size threshold and, furthermore, temporary fluctuations in size are in fact relatively seldom.

More recent studies indeed confirm that the inverse relationship between size and net job growth still holds, even implementing more consistent firm size classification methods in order to avoid the "regression fallacy" (Haltiwanger et al., 2013; Neumark, Wall and Zhang, 2011).

If the important role of small businesses in new employment generation is widely recognised in literature, it is arguable whether it is their limited size to award them this peculiarity or else.

In other words: small companies produce a great share of new jobs, but is it simply because of their smallness? Apparently, it is not.

The newness of a company seems to be a much more decisive predictor of its ability to create jobs and wealth (Davidsson et al., 1995; Olofsson et al., 1986).
Haltiwanger et al. (2013) found out that, when controlling for firm age, the relationship between firm size and net job growth not only disappears, but it may even reverse as a consequence of the higher exit rates of small businesses.
The results of this study, carried out on a sample of US companies, point out that young firms show high rates of both job creation and destruction. In particular, this latter aspect is caused by the higher likelihood of exit from the market: within 5 years from the foundation, around 40% of the new jobs created by start-ups vanishes due to firm exit.
A key factor that tips the scales in favour of young firms is the effect engendered by firm births, which undeniably lead to high rates of gross and net job creation.
Since newborn companies tend to be small, it is simple to understand why other studies documented an inverse relationship between firm size and job creation.
Henrekson and Johansson (2010) confirm that the newness of a company is more important than size when job creation is concerned.
In their comprehensive survey, they analyse the results of several studies and researches on this field, pointing out that a few rapidly growing companies – i.e. Gazelles – are responsible for a disproportionate share of net employment growth.
The notion that Gazelles are the main actors of the new jobs generation is certainly not new (see Birch, 1979), but it helps to connect the dots of what has been said so far. Indeed, while all surveyed studies report that Gazelles tend to be younger on average, results about size are ambiguous: even though small firms are overrepresented among Gazelles, large Gazelles are relevant job creators as well.

The main conclusion of this sub-paragraph is that Gazelles do play a pivotal role in the job creation process (e.g. Hölzl and Friesenbichler, 2010; Brinkley, 2008).
Consequently, since most of the Gazelles are relatively young, the newness of a business is recognised as a crucial predictor of net employment creation.
On the other hand, smallness is not a fundamental feature of job creators: not by chance, Gazelles are not necessarily small, but they can be of all sizes.

Nevertheless, another aspect to be considered is firm births. The effects of this latter – intrinsically tied to newness and smallness (newborn firms are young by definition and small on average) – on net job creation is not negligible.

Obviously, not all the start-ups will become Gazelles. Most of them will leave the market (Haltiwanger et al., 2013), others will remain small ("Mice").

Nonetheless, the entry of many new firms (Mice) is at least of equal salience as the net employment contribution of fast-growing firms (Gazelles).

Moreover, the continuous entry of new firms in the market is a necessary condition to ignite an effective creative destruction process, which enables some high-potential companies to attract resources from inefficient ones and spread (Henrekson and Johansson, 2010). This is to say that, in general terms, without Mice the emergence of Gazelles would be hampered.

3. Key success factors of innovative start-ups

As deeply highlighted in Chapter 2, scholars and policy-makers have get high-tech start-ups into the limelight as they are presupposed to matter more than others in triggering states' long-term economic development.
Nonetheless, recent studies started questioning such belief, reporting empirical evidences of the average poor performances of this kind of ventures.
To this regard, it is worth mentioning the painstaking analysis of Scott Shane in its "*Illusions of Entrepreneurship: The Costly Myths that Entrepreneurs, Investors and Policy Makers Live By*"[12] (2008), which earned him the Global Award for Entrepreneurship Research in 2009.

According to Shane, the alleged importance of newborn ventures is nothing but a false myth; indeed, the average founder of a start-up is primarily interested in self-employment rather than the creation of a high-growth firm: as a result, start-ups have lower productivity, on average, then incumbent companies and thus their contribution to economic growth is far from outstanding. Statistics report that the average start-up survives no longer than 5 years.
Therefore, governments should refrain from incentivise people to start a new business from scratch. In fact, instead of entering in industries with high growth potential, the typical entrepreneur picks low entry barriers-industries, which offer a facilitated access but higher competition and failure rate as well (Johnson, 2004). As a consequence, institutions that foster the generation of small businesses are likely to provide incentives to the typical unsuccessful business.
Moreover, individuals more likely to respond to government incentives are the ones with a lower opportunity cost, such as unemployed, which are found to have lower performances than employed workers in launching new businesses.

[12] Note that Shane's research is focused on start-ups in general, not YICs or NTBFs.

Finally, Shane criticises the popular perception that start-ups create employment[13], putting the accent on their greater job destruction rate. In addition to that, jobs created by start-ups are known as offering lower wages and job security.

Shane's argumentations might seem to be discordant with the results exposed in Chapter 2, but – aside from the fact that Shane refers to overall start-ups, not innovative ones – they actually share a common idea: only a narrow subset of high-potential newborn companies has the possibility to boost economic growth and development.

For this reason, a deeper understanding of young companies' growth determinants and key success factors is a crucial task for policy-makers, in order to design effective legislations able to favour this group of beneficial ventures.

While firms' growth is certainly positive from institutions' perspective (e.g. job generation), it is less clear whether it should be considered a goal from the companies' point of view. Indeed, along time economists have identified a long-list of both advantages (e.g. benefits in terms of economies of scale, market power, reputation, investment capacity, etc.) and disadvantages (e.g. loss of managerial control, more rigid organisational structure, slower decision-making process, etc.) related to it. Nonetheless, benefits generally outclass downsides and therefore growth is supposed to be a yearned goal for start-ups (Balboni et al., 2014).

The whole academic research about growth drivers stems from the attempt to argue against the "Gibrat's law", or "law of proportional effects" (Gibrat, 1931), which asserts that company growth is essentially random (Sutton, 1997). In particular, Gibrat sustained that growth rates are independent of firm size.

Even though half a century of empirical analyses evidenced several irregularities which discredit Gibrat's theory (Ranikko, 2012), Gibrat's model had the merit of fostering scholars to find systematic determinants of firm growth (Coad and Hölzl, 2012). Accordingly, several explanations of the different growth patterns

[13] See paragraph 2.3

undertaken by high-tech start-ups can be found in literature and emphasis has been put on various growth determinants. However, it is arduous to foresee which companies will show a faster and effective growth, because firm growth is a highly idiosyncratic process (Grilli, 2014).

In other words, despite many different factors have proved to be statistically significant, a comprehensive interpretation of company growth has not been proposed yet due to the great variance in the growth rates not only between one firm and another, but within individual firms as well (Coad and Hölzl, 2012).

In the following paragraphs, the most prominent growth drivers identified in previous studies will be listed according to three fundamental categories: individual-specific, firm-specific and context-specific drivers.

3.1 Individual-specific growth drivers

Individual characteristics and behaviours have raised much of attention from researchers as far as firm growth is concerned. As it can be spotted, this vision stands in contrast with the classical economic theory, which considers economical agents' rational behaviour as a given fact.

More specifically, although different categories of individuals (e.g. managers, employee) can propitiate the success of a company, most of the studies claims that it is the human capital of founders to have a determining impact on company growth.

Albeit evidences of a similar (and lower) effect have been found for non-innovative start-ups, this primarily applies to high-tech and innovative start-ups (Cooper and Bruno,1977; Storey and Tether, 1996; Almus et al., 1999).

Indeed, due to the acute uncertainty encompassing high-tech sectors, a bunch of "complementary context-specific knowledge"[14] is necessary to effectively take advantage of a business opportunity. Theoretically, a rapid way to acquire this knowledge is by hiring employees who own the required competences;

[14] According to Colombo and Grilli (2010), examples of such knowledge are marketing, technical and managerial competences.

unfortunately, this clashes with the acknowledged difficulties that companies have in attracting highly-skilled human resources during their start-up phase.
Moreover, these competences could be more effectively exploited and protected if individuals who possess them are part of the founding team and thus control a stake in company's future earnings (Colombo and Grilli, 2005).

For these reasons, newborn firms' resources are likely to coincide with founders' competences. Consequently, YICs founded by entrepreneurs with greater human capital are supposed to enjoy significant competitive advantages thanks to their unique capabilities (Cooper and Bruno, 1977).
A variable repeatedly used to measure the level of knowledge of NTBFs is consequently the founding team's size: ventures founded by a group are likely to take over multiple complementary skills and expertise, more than the ones founded by single persons; therefore, they have a greater growth potential (Storey, 1994).
Notwithstanding that literature generally supports this argument (Zucker et al., 1994; Ranikko, 2012), the evidence connected to the impact of founding team size on growth is weak (Colombo and Grilli, 2005). For instance, Almus et al. (1999) do not detect any statistically reliable corroboration of this hypothesis. Kiederich and Kraus (2009), despite finding a strong relationship between founding team size and NTBFs' success, report that this result is not uniform across industries.
More accurate studies went deeper in the assessment of founders' knowledge; in particular, great emphasis has been put on founders' educational and professional background. These factors are indeed powerful predictors of the firms' ability to effectively adapt to changes in technology and business dynamics (Cunha et al., 2013), being crucial to provide the new firm with the most suitable strategies (Balboni et al., 2014).
In particular, a distinction should be made between "generic" and "specific" knowledge (Becker, 1975). The former concept indicates competences which cannot be directly deployed in the new business, usually absorbed through education and work experience in industries different from the one in which the new venture is operating.

As far as education is concerned, a broad consensus suggests that it has a significant positive effect on firm growth (Storey, 1994; Coad and Hölzl, 2012; see also Westhead and Cowling, 1995 for the UK case).

Colombo and Grilli (2005) claim that education in economic and management sciences have positive effects on firm growth, as well as studies in technical and scientific fields (with a weaker relationship, but still significantly positive).

Moreover, the conjoint presence of these two kinds of educational background produce strong positive synergies.

Synergies are found also by Almus et al. (1999), which assert that ventures established by entrepreneurs with business skills have not a noteworthy superiority; nevertheless, if combined with the presence of a technical degree, they are correlated to higher annual growth rates.

Apparently, statistics seem to be aligned with these results. As reported by the European Commission (1996), the level of educational accomplishments in the founding team of NTBFs is noticeably higher than the average population, or than founders of other kinds of start-ups. In the same direction, Storey and Tether (1996) notice that an increasing share of NTBFs' founders owns a PhD in scientific or technological fields. This information is tightly related with the concept of absorptive capacity introduced in Chapter 2: indeed, a company's absorptive capacity depends also on the absorptive capacities of its members (Cohen and Levinthal, 1990). Consequently, although business and managerial competences are a necessary ingredient of NTBFs success, possessing advanced technological knowledge is crucial in order exploit advanced technologies (Storey and Tether, 1996).

For what regards generic work experience, its effect on firm growth is found to be negligible (Colombo and Grilli, 2005).

In sum, generic human capital seems to bring advantages in terms of company growth, even if some studies claim that the abovementioned relationship is weak.

What appears to be relevantly more decisive is the contribution exerted by specific human capital (Ganotakis, 2012; Grilli, 2014).

This latter encompasses all that expertise matured in the same industry in which the new business is operating, which can be thus immediately exploited to support company's performances. Widely used proxies of specific knowledge are the number of years of prior experience in a specific industry, managerial experience in the same or in a different industry and former experience in launching new businesses.

Given that most of founders' capabilities have been acquired in their prior work experience (Cooper, 1971), if the new venture operates in a related business it will be able to fruitfully exploit its founding team's competences (Colombo and Grilli, 2005). Therefore, companies which can leverage on individuals with strong industry-specific expertise are likely to seize advantageous business opportunities and make the most suitable decisions to ensure growth and success (Shane, 2000; Colombo and Grilli, 2010).

Another important driver of new firm growth is constituted by managerial capacities (Coad and Hölzl, 2012). Although Storey (1994) found evidences of positive affection of prior managerial experience on firm growth, Colombo and Grilli (2005) sustain that there is not a direct impact. However, the authors notice that the correlation underlined by previous studies might be due to an "indirect" relationship: individuals with greater former managerial experience are more likely to attract external finance, and therefore to offer higher growth chances to their start-ups.

Finally, the salience of marketing-related skills raised mixed results as well. Again, Storey (1994) detected a positive influence on small business growth, whereas Colombo and Grilli (2005) highlighted a negligible role, unless they are supported by the contemporary presence of technical, industry-related competences.

All the evidences listed above reinforce the argument that companies settled up by entrepreneurs with greater human capital can benefit from this considerable pool of knowledge and exploit it in order to successfully grow. This view is generally acknowledged in literature as "capability effect".

Anyhow, a counterposed argument known as "wealth effect" challenges the "capability effect", holding that it is not a matter of competences, but of capital.
Indeed, previous studies documented a positive relation among individuals' human capital and wealth (Colombo and Grilli, 2005). In this perspective, since entrepreneurs with greater human capital are wealthier on average, companies can leverage on a larger availability of internal funds and, for this reason, they show higher growth rates.
To this extent, it is meaningful to briefly anticipate one of the basic starting points of this thesis – which will be deepened in Chapter 4 – i.e. that access to external finance is extremely hampered for NTBFs and new ventures in general. It follows that internal capital is a factor that plays a tremendously important role in the business dynamics of start-ups.
As one may understand, determining whether the positive effects of human capital on small company growth is originated by wealth or capability effect has important policy implications, since clearly the policy-actions needed would be different.
Colombo and Grilli (2005) provide a key to the reading of this dichotomy, that is focusing on the nature of the human capital of founders.
As reported above – indeed – they found for example that the years of education in technical and managerial fields produce positive effects in respect to growth. If "wealth effect" were dominant, this result should have not emerged, since the wealth is not supposed to vary according to the fields of study of individuals.
In other words, whether founders have an educational background in business sciences or art history, their personal wealth should not change in general terms.
Consequently, these results offer the evidence that the "capability effect" is the main driver behind the relationship between human capital and firm growth.
Moreover, the "capability effect" may contribute to offset the negative financial condition which newborn firms are exposed to. Indeed, it is also awarded with an "indirect" effect on firm growth, i.e. that entrepreneurs with greater human capital have a higher probability to attract venture capital investments.
Venture capitalists are more likely to support companies whose managers have a consolidated managerial experience or an educational background in economics

and management (Colombo and Grilli, 2010). On the same line, Audretsch and Lehmann (2004) found that the likelihood of receiving capital by venture capitalists is positively related to the degree of human capital of the board of directors (indicated by the number of board members who have a PhD or teach at university).

Finally, another individual-related factor that has gathered the attention of researchers due to its alleged impact on growth is managerial motivation and ambition (Cunha et al., 2013).

Indeed, growth is not necessarily the primary objective of founders or managers. Firm growth presupposes, indeed, changes to the way managers run their business: if these changes are aligned with their initial goals, then managers/founders will likely demonstrate a positive attitude towards growth (Wiklund et al., 2009).

By and large, the great majority of studies detected a positive relationship between the growth of a firm and the presence of managerial motivation, positive attitude and determination in pursuing growth (Storey, 1994; Baum et al., 2001; Wiklund et al., 2009; Kiederich and Kraus, 2009). Conversely, Stam and Wennberg (2009) claim that managerial growth aspirations are significantly related to firm growth in low-tech industries, but not in high-tech ones. Especially in these latter, managerial motivation has a positive and significant impact on growth only when combined with company's competences and knowledge (Wiklund and Shepherd, 2003).

3.2 Firm-specific growth drivers

In the following paragraph, the focus will be placed on two pillars at the basis of NTBFs' success: business strategy and funds availability.

As underlined in paragraph 3.1, the individual attitudes and characteristics of entrepreneurs do have a noticeable impact on a firm's strategy and – to a lesser extent – on capital assets as well. Nonetheless, forasmuch as these two growth drivers (i.e. strategy and capital) can be intended as characteristics of the company itself, they have been classified as firm-specific factors.

3.2.1 The role of strategy in spurring firm growth

One of the most relevant determinants used in literature to justify the differences in growth rates among companies is business strategy (Balboni et al, 2014). As suggested by Kaplan et al. (2009), having effective strategies is even more important that having the best individuals to execute them.

Clearly, the strategic orientation of a company is closely connected to the individual traits of its entrepreneurs, especially as far as start-ups are concerned.
In particular, some specific entrepreneurial attitudes are recognised as being guarantors of superior growth performances: innovation, risk-aversion and proactiveness. These three dimensions are considered the main constituents of the so-called Entrepreneurial Orientation (EO), a concept formerly introduced by Miller in 1983 and currently widely popular among researchers (Covin and Lumkin, 2011). As noticed by Wiklund et al. (2009) companies which show a pronounced EO are more likely to outperform competitors, thanks to their ability to launch new products and technologies (innovation and risk-aversion), create first-mover advantages and exploit marketplace opportunities (proactiveness).
Moreover, these advantages could be even more beneficial for small firms, which may lack the market power and assets necessary to implement other business strategies, such as cost-leadership (Wiklund, 1999).
Since EO is found to require consistent investments (as discussed in Chapter 2, innovation does not come for free), it should guarantee long-term benefits in order to be sustainable. To this regard, a two-year period study by Wiklund (1999) highlights that the benefits in terms of growth (sales, employment and market value) in the second year are even higher than the ones generated after 12 months.

While entrepreneurial orientation outlines a relatively general strategic attitude of a company, several studies identified a number of more specific strategic actions that seem to be correlated with higher growth and better performances.
For example, tangible attention has been given to market strategy and positioning, considered fundamental growth drivers (Storey, 1994; Siegel et al., 1993).

More specifically, innovative start-ups offering a diversified portfolio of products/services are found to be more successful (Almus et al., 1999).
Moreover, the timing of market entry severely influences NTBFs' growth pattern (Kiederich and Kraus, 2009).
Another strategic decision that could offer opportunity to grow is internationalisation (Kiederich and Kraus, 2009): it can indeed improve the financial conditions of newborn ventures (Oviatt and McDougall, 1996; Robson and Bennett, 2000) and generate extra-sales useful to pay back R&D investments of high-tech companies (Preece et al., 1998). On the other hand, internationalisation may imply higher risks due to the investments needed to implement it. Since NTBFs have a constrained access to debt capital, they might be forced to rely on external equity; the consequences could be higher risk of takeovers and loss of entrepreneurial control (Kiederich and Kraus, 2009).

To conclude, since knowledge is a critical element for innovation (Cohen and Levinthal, 1990) and therefore a contributor to NTBFs' success, knowledge acquisition and management can be considered a key success factor of high-tech young ventures. In this scenario, an effective and reactive information system could properly support both internal communication and business strategy (Beaver, 2001).

3.2.2 Capital resources and firm growth

As it has been anticipated in paragraph 3.1, the financial constraints of NTBFs is a well-documented issue that newborn high-tech companies have to face, especially in Europe (Grilli 2014; Wiklund et al., 2009).
As it is easy to guess, financial capital is a fundamental resource for companies: it can be readily translated into other assets (Wiklund et al., 2009); it can be used to sustain the operations and the business as a whole; it can offer a suitable buffer against any kind of risk event (Castrogiovanni, 1996).
Therefore, financial capital is as an essential asset for companies' growth and performance (Bambford et al., 1997; Wiklund et al. 2009), both at the beginning

of firms' operations (Castrogiovanni, 1996) – when cash flows are likely to be negative – and during subsequent stages (Grilli 2014).

For these reasons, it can be argued that ventures which are able to collect capital are expected to outclass competitors and have a privileged access to growth.

On one hand, start-ups may rely on the personal wealth of their owners – i.e. the "wealth effect" depicted in paragraph 3.1.

On the other hand, another basic stream to gather capital is external finance: in particular, venture capitalists are alleged to suffer less than other sources of external capital (e.g. banks) from the capital market imperfections that complicate NTBFs' access to external finance.

Much has been inferred about how can start-ups attract venture capital – and external financing in general – but it is interesting to note that the two growth drivers previously identified are of great interest to external financiers: individuals' human capital (see paragraph 3.1) and company's strategy.

As far as the latter is concerned, Castrogiovanni (1996) found a positive relationship between pre-start-up planning, amount of external finance and venture's survival. It means that new ventures that draft a detailed strategic plan before entering the market are more likely to hoard external funds and, thanks to the higher amount of external funds raised, have better survival prospects.

3.3 External growth drivers

The third macro-group of small firm growth drivers is represented by external factors. The relation between contextual drivers and company's growth has been analysed under several perspectives (Balboni et al., 2014; Ranikko 2012): in the following lines attention will be given to three sub-sets of growth variables, i.e. variables related to the industry, the location and the relationship with other organisations.

3.3.1 Industry and firm growth

Several studies investigated whether growth possibilities are uniformly distributed among industries or whether some specific industries have peculiar features that favour or hamper firm growth. Empirical evidences seem to suggest that this second assumption is mainly truthful: thus, it is argued that some sectors offer a greater room for development than others (Balboni et al., 2014).

A comprehensive survey of existing literature on this issue is provided by Coad (2007). First, some industries have inherent performance advantages because of their innovation pace: mature industries offer a limited number of market opportunities, whereas high-tech sectors present greater growth potential due to their innovative dynamism (Coad, 2007).

Second, firm growth is expected to be related to some structural features of an industry, such as minimum efficient scale (MES), concentration and competition. To this regard, Audretsch (1995) concludes that as long as there is a gap between firm size and MES, firms have an incentive to grow; accordingly, a positive relationship between industry's MES and firm growth is found.

While Geroski and Toker (1996) report that market concentration is positively correlated with firm growth, results concerning competition seem to be more ambiguous: despite finding that a company's growth is negatively related to rival firms' growth, Geroski and Gugler (2004) observe that the degree of competition is not always affecting firm growth.

Finally, as it might look logic, industry growth rate has a positive effect on small ventures' growth (Audretsch and Mahmood, 1994).

3.3.2 Location and firm growth

Despite the fact that in the past decades locational aspects have been generally neglected in micro-economic studies regarding firm growth (Audretsch and Dohse, 2007), the socio-economic characteristics of the local environment is known as being an important contributor of firm performances (Storey, 1994; Colombo and Grilli 2006), both in terms of profitability and growth (Balboni et al. 2014).

On a national scale, scholars emphasised the function of local institutional factors, such as legislations and public promotion programmes, in fostering or hampering growth (Almus et al., 1999; Balboni et al., 2014): for instance, Djankov et al. (2006) found that companies grew more successfully in countries with effective financial and labour regulations.

In addition to that, the macroeconomic conditions of the hosting country have an impact on the companies operating within its borders, as noted by Coad (2007) who asserted that firm growth rates are positively related with the GDP of the home country.

From a regional perspective, great attention has been raised around the "agglomeration" effects, i.e. benefits available in geographically concentrated areas (Almus et al., 1999). More specifically, Storey (1994) concluded that firms in accessible rural areas accomplish higher growth than their counterparts in remote rural areas. Benefits stemming from making business into well-infrastructured areas era experienced by NTBFs as well (Colombo and Grilli, 2005). But which are, more precisely, the benefits engendered by the agglomeration effect? According to the seminal work of Marshall (1890), they can be distinguished in three types: labour market pooling, non-traded inputs[15] and knowledge spillovers. Doubtlessly, knowledge externalities benefits are the ones which reached the highest notability in the academic landscape (Audretsch and Dohse, 2007). Many authors underlined the greater advantages in terms of economic performance (Audretsch and Dohse, 2007), survival chances (Raz and Gloor, 2007) and access to otherwise unavailable inputs (Witt, 2004), which are consequences of an efficient knowledge turnover (see also Balboni et al., 2014; Colombo and Grilli, 2006; Almus et al., 1999 for more detailed analyses of the existent literature on the topic). On the other hand, location and proximity facilitate knowledge dissemination – tacit knowledge in particular (Jaffe, 1989). Indeed, conversely to the cost of spreading information, the costs of transmitting knowledge increases as long as distance grows (Audretsch and Dohse, 2007).

[15] A good or a service is "non-tradeable" if it cannot be sold far from the place where it is produced or delivered.

In conclusion, a further element associated to the relevance of location and knowledge externalities is represented by the proximity to technological incubators, such as university science parks. Several studies claim that the location in a science park can be considered as a critical success factor for NTBFs (Colombo and Grilli, 2006), as it provides linkages with important suppliers, customers and researchers (Kiederich and Kraus, 2009) and it promotes the exchange of ideas (Lindelof and Lofsten, 2004).

Moreover, firms located nearby science parks are found to grow more than their competitors, thanks to the support received in R&D activities (Lofsten and Lindelof, 2005) and the increased reputation (Westhead and Batstone, 1998).

This latter growth driver (i.e. proximity to science park) related to the company's location offers the appropriate connection to the last key success factor that will be analysed, that is the link to external organisations.

3.3.3 Innovative start-up growth: the importance of building relationships with external organisations

According to the Resource-Based View theory, a company's growth is predominantly dependent on the resources it has at its disposal (Penrose, 1959).

In paragraph 3.1 the main component of the firm's internal resources has been analysed, i.e. the human capital of founders/entrepreneurs. Since, especially in the start-up period, NTBFs are not likely to be endowed with all the necessary assets to sell their goods on the market (Grilli, 2014), a critical growth enabler is their ability to gain access to external resources. Therefore, building fruitful relationships with external entities might be a necessary condition to newborn firms' survival (Teece, 1986).

As mentioned in the previous sub-paragraph, one type of such "incubators" is what is called public research organisations (PRO), which includes universities and other public research institutes. Apart from the already-cited alleged advantages which can be provided by PROs (e.g. ideas' sharing, R&D, business contacts), a further aspect to be considered is the PROs' sponsorship function. To this extent, Colombo, Grilli and Piva (2006) reported that PROs can offer a helpful broker

information and endorsement function in favour of NTBFs, in order to gain privileged relations with venture capitalists or large companies.

A second type of external supporting organisations is represented by (usually large) firms. Despite the fact that their primary assisting role is related to commercial activities, they can also be an important source of technological alliances, such as PROs are (Grilli, 2014).

By and large, empirical results confirm the positive effects which external organisations can exert on "incubated" companies (Almus et al., 1999; Colombo and Grilli, 2006), especially when they are small and young and therefore needier of support and resources.

Wiklund et al. (2009) made a lists of several studies which spotted a positive correlation between the existence of inter-organisational networks[16] and small business growth.

As far as strategic technological alliances are concerned, Colombo et al. (2009) found that they are beneficial to the NTBFs' growth: this is due to the fact that strategic alliances can support small companies to reduce their need of financial and human capital, increment their manufacturing and logistic competences and increase their innovative potential (Forrest, 1990).

The aim of this chapter was to offer a snapshot of the main key drivers of innovative start-ups' growth. However, it is important to clarify that the literature regarding (small) firm growth is absolutely extensive and this chapter is not meant to be an exhaustive and detailed analysis of the existing empirical knowledge about this field of study. Rather, only the growth contributors which either raised higher attention of the academic world (e.g. founders' human capital) or have been considered as particularly relevant to the extent of this thesis (e.g. financial capital) – or both – have been mentioned.

[16] Inter-organisational networks are defined by Wiklund et al. (2009) as strategic alliances between small firms and external organisations, such as universities, small companies and large corporations.

4. A serious impediment to innovation: the underinvestment problem

In Chapter 2, the main reason for alleging the pivotal role played by young high-technology firms in promoting economic progress has been deeply justified.
In fact, this study focuses on Young Innovative Companies (YICs), specifically on Italian innovative start-ups, whose predominant trait, as the label suggests, is – or at least should be – innovation. Moreover, a fundamental enabler of YICs' innovative performances is their intense focus on R&D activities (see paragraph 2.1).
However, the R&D market is subjected to a problematic pitfall, on which researchers reached an almost universal consensus (Martin and Scott, 2000): private firms may underinvest – from a social point of view – in Research and Development. Clearly, this issue represents a serious threat in the eyes of policy makers, since the positive effects that innovative start-ups are supposed to confer on the economic system might be lowered (Schneider and Veugelers, 2010).
Although the causes of underinvestment in innovation vary from industry to industry (Martin and Scott, 2000), economic researches have picked out two central rationales for institutions to intervene and support innovative start-ups in the short run (Colombo and Grilli, 2006): the presence of spillovers and capital market imperfections.

4.1 R&D spillovers and appropriability

The argument that spillovers are a crucial agent of the fact that private ventures invest less than what socially desirable in R&D is supported without exception by academics (Teece, 1986; Jaffe, 1996; Nelson and Romer, 1996; Lerner, 2002).
In order to fully appreciate the "mechanism" and the logic of this view, it is useful to start from the concept of "spillover" in relation to R&D activities.

An R&D spillover occurs when the economic benefits stemming from R&D investments are not fully captured by the innovating firm (the one that makes the investment), but also by other economic entities (e.g. other firms, customers).

In order to explain the way through which this "spillover gap" between private and social return is created, Jaffe (1996) identifies three main effects: pure market spillovers, pure knowledge spillovers and interaction between the two of them.

When a firm innovates, it generates new knowledge which leads to improved products or higher process efficiency. Due to market competition dynamics, the benefits related to these improvements will be shared among the firm (in terms of profit) and customers (in terms of higher quality or lower cost). Therefore, the innovating firm will not catch all the economic benefits generated by its innovation. This first "spillover gap" is due to pure market spillovers.

On the other hand, pure knowledge spillovers arise because the knowledge generated by the innovating firm can be beneficial to other firms operating in different markets: the resulting benefits (for firms and customers in other markets) contribute to widen the gap between innovator's return and social (total) surplus.

As one may note, this latter spillover is not particularly negative for the innovator by reason of the fact that it is not affecting its own profits. Unfortunately, this circumstance does not hold when market and knowledge spillovers are combined: other firms in the same market of the innovator might come out with similar products or services, to the detriment of the innovator's return.

A hefty number of studies documented the presence and influence of R&D spillovers (Lerner, 2002). One of the most noticeable seminal works in this literature – already mentioned in Chapter 2 – is provided by Griliches (1958), who estimated a 40% rate of return from R&D investments in the hybrid corn sector.

Pay attention to the fact that this rate does not refer to a private return; rather it measures the social rate of return, since the entity undergoing the investment fails in catching all the benefits stemming from it.

What is important to underline is that the difficulty for an innovating firm to fully enjoy the benefits related to its investments should not be underestimated. In many cases indeed, spillovers do not simply reduce the innovator's advantages: a

company that invest in innovation might even turn out to be disadvantaged in respect to its competitors. This scenario is generally referred to as “first mover disadvantage”, in opposition to the well-known concept of “first mover advantage”, i.e. that a company launching a new product or service before its competitors is alleged to obtain significant competitive advantage.

Multiple examples of these dynamics are shown by Teece (1986). Particularly interesting are the cases of EMI (Electrical Musical Industries Ltd.) and RC Cola. The former was a British company responsible for the invention of the CAT (computerized axial tomography) scanner. Despite the initial success of EMI CAT scanner, 8 years after its launch the company exited from that market.

The latter was the first beverage firm to introduce cola in cans and diet cola; the reason why probably no one knows this company is that industry giants, such as Pepsi and CocaCola, immediately imitated these innovations and appropriated all the benefits.

However, in order to understand who is going to benefit from innovation, several factors should be taken into consideration. To this extent, in his pioneering article “*Profiting from technological innovation: Implication for integration, collaboration, licensing and public policy*”, Teece (1986) presented a framework built on three basic “market winners”: appropriability regime, dominant design paradigm and complementary assets.

The first concept to be examined is “appropriability”, namely the ability of an innovator to capture the benefits engendered by its innovation, to the detriment of other firms. So far, it has been claimed that a company’s investment in R&D may be beneficial to other firms, even in different industries. Is this argument realistic? The answer is “yes”, and the logic behind it is closely tied to the notion of “public good”. In economics, every good can be characterised by two dimensions: rivalry in use and excludability from consumption. A good is rival if it cannot be consumed by more than one individual at a time. On the other hand, a non-rival good can be used simultaneously by multiple individuals. However, this does not imply that everyone is allowed to consume it without the permission of the owner.

If the owner of the good has the power to prevent others from consuming it, a good is said to be "excludable"; otherwise, it is labelled as "non-excludable".

By crossing these two dimensions, four categories are outlined: private goods are rival and excludable; public goods are non-rival and non-excludable. The two remaining categories are represented by rival and non-excludable goods and non-rival and excludable goods.

According to Nelson and Romer (1996), the new knowledge generated by R&D activities belongs to this latter category. Indeed, even if non-rival, knowledge can be potentially excludable. Nevertheless, excluding others from using the knowledge owned by a firm is far from being easy and might entail relevant costs (Aghion et al., 2009). Even if it is possible to protect – to some extent – the created knowledge, it is nearly impossible to keep secret tacit knowledge about successful or unsuccessful approaches (Jaffe, 1996). What is more, trade secrets can be an effective protection method when process innovation is concerned (Teece, 1986); on the other hand, the implementation of the new knowledge into visible products will disclose that it is possible to somehow obtain that results (Aghion et al., 2009).

As confirmed by Teece (1986), patents hardly ensure perfect appropriability for a number of reasons: patents could be "invented around" at low costs; in addition, they are not effective with process innovation and the legal costs to enforce them could be incredibly high. However, the type and the effectiveness of legal protections vary considerably across industries (Levin et al. 1984), since it depends on the nature of the technology itself. For this reason, Teece (1986) identifies a dichotomy between "tight appropriability regime" (i.e. technology easy to protect) and "weak appropriability regime" (i.e. technology difficult to protect).

The second concept under scrutiny is the one of "dominant paradigm design", firstly introduced by Utterback and Abernathy, 1975). The basic rationale is the following one: typically in technological markets, especially in presence of relevant network externalities, a single design emerges outclassing all the others.

What is relevant is that the competition dynamics before and after the emergence of a dominant design are completely altered. In the so called "pre-paradigmatic stage", companies compete essentially on designs. Then, after an incubation

period, the design that better meets customers' needs will "win the market": at this point ("paradigmatic stage"), all the players in the industry will be obliged to adhere to the dominant design's features and, accordingly, the competition will switch from design to a new set of variables (e.g. process innovation, economies of scale, economies of learning, etc.).

Finally, the third determinant of a company's success in innovation is constituted by complementary assets, such as marketing capabilities, efficient manufacturing operations, distribution facilities and any other tangible or intangible assets a company needs to successfully commercialise its products or services.

The three pillars above mentioned are useful to ascertain whether is going to be the innovating firm or a follower to profit from innovation.

In fact, in a "tight appropriability" scenario the innovator will be almost certainly able to transform its innovative knowledge into profits. Even in case the innovator lacks complementary assets or it enters the "pre-paradigmatic" stage with a brilliant product concept but the wrong design, the reliable protection mechanisms available in such a regime will provide him with the necessary time to acquire those assets or perform the required market tests to identify the right design.

Unfortunately, in the large majority of the situations, the innovator will deal with a "weak appropriability" regime: in this case, its chance to reap the rewards of its efforts are consistently lower.

During the "pre-paradigmatic" stage, unless the innovators operates very close to its customers and/or in an industry where prototyping costs are relatively low (so to enter the market with a design aligned to customers' needs), its probability to possess the dominant design is much lower than followers' one, which can build on the design introduced by the innovator in order to improve it.

Even if the innovator's design emerged as industry's dominant design, the road to success is still rather long. In this scenario, owning complementary assets is absolutely necessary to catch the benefits from R&D efforts. An incumbent firm will be therefore more likely to possess the proper assets to successfully follow the innovator and win the entire pie. The above mentioned case of RC Cola is a good example of this circumstance.

At this point, it should be crystal clear why firms might be reluctant to invest a conspicuous amount of money on innovation. Indeed, while the first implementation of new knowledge (at the expense of the innovator) is generally expensive, since it comprises the cost of its generation (Aghion et al., 2009), further uses can be carried out at limited costs (at the expense of the followers). Even if not completely negligible[17], the cost sustained by the followers to exploit external knowledge created by the innovating firm (e.g. training costs, cost of acquiring new information, etc.) can only mitigate – but not eliminate – the underinvestment problem (Hall and Lerner, 2010).

In conclusion, the "appropriability" issue is claimed to severely hamper private investments in innovation. Aiming at maximising their own interest, firms will invest in R&D an amount of resources which try to balance the costs and the expected profit of an R&D project, taking into consideration the great uncertainty surrounding both of them. Since the social rate of return is found to be greater than the private rate of return[18], the overall private investment in R&D will inevitably be lower than is desirable from a social perspective (see Jaffe 1996; Lerner 2002; Hall, 2002; Aghion et al., 2009; Martin and Scott, 2000). In other words, provided that companies decide their investment level only considering the private rate of return, some desirable projects (from society's point of view) will not be run, or however they will be run with a wrong timing or on a smaller scale (Jaffe, 1996).

Interestingly, some scholars (Anderson et al., 1997; Baldwin and Scott, 1987; Fudenberg and Tirole, 1987) pursued an opposite line of reasoning, suggesting the existence of an "overbidding problem" as opposite to the "appropriability" one. They claim that, rather than underinvestment, there is actually the possibility of an overprovision in R&D; this is due to the fact that the competition ignited by a new innovation in the market would lead companies to invest more in order to

[17] As reported by Hall (2002), previous studies (Levin et al., 1987; Mansfield et al., 1981) found that imitating a new technology could cost up to 70% of the costs borne for the original invention.
[18] A survey of previous studies offered by Griliches (1992) results in a rough estimation of the gap between social and private rate of return. Namely, the social rate seems to be around 50-100% of the private rate.

outperform competitors. However, the empirical evidence shows that, even if existing, the "overbidding" problem is not able to offset the negative (from a social point of view) effect created by spillovers.

Finally, it is possible to assert that the issue of R&D spillovers largely limits the innovative potential of companies, especially in high-tech sectors.
This problem acquires an even higher salience to the extent of this study due to the fact that small and young companies are claimed to suffer even more from appropriability issues. As seen in the first part of this paragraph, indeed, complementary assets are crucial to a company that wants to extract value from its innovation. Since small and young ventures, conversely to large incumbents, are less likely to possess the necessary complementary assets, they will therefore face higher difficulties in appropriating the returns from innovation (Teece, 1986; Veugelers, 2009). In addition to that, they may also lack market power to successfully defend their intellectual property (Lerner, 2002).

4.2 Capital market imperfections

In paragraph 4.1, the negative effects engendered by spillovers and the associated incomplete appropriability have been identified as a primary cause of underinvestment in R&D.
Unfortunately, this issue does not come alone: even in case weak appropriability concerns are solved through the enforcement of patents or trade-secret regulations, it could still be arduous or expensive to finance R&D investments with external capital (Hall and Lerner, 2010). The rationale that, when there is no coincidence among who makes the investment decision and who finances it, a wedge (often large) appears between private rate of return and external cost of capital. Nonetheless, capital markets failures have become a truly hot topic in economic and finance research in recent years (e.g. Jaffee and Russel, 1976; Fazzari et al., 1988; Storey and Tether, 1996; Hubbard, 1998; Hall, 2002).
The efficiency of capital markets mechanisms is of fundamental importance to guarantee an optimal allocation of financial resources: in a utopian scenario of

perfect capital markets, all investments would be financed solely in relation to their own merits (Peneder, 2008). In other words, there would be no difference between internal and external funds, since all finance channels would have the same cost (Bertoni, Croce and Guerini, 2015). Nonetheless, when capital markets imperfections emerge, external and internal capital are no longer perfect substitutes (Gertner et al., 1994). As a consequence of these "frictions", companies will strongly rely on internal funds to follow on profitable investment opportunities (Revest and Sapio, 2012). By this argument, if the personal wealth of founders or the company's profits are insufficient, some innovative projects will not be undertaken simply because external finance is too expensive (Aghion et al., 2009). In the last decades, scholars acknowledged several possible causes of the capital markets "frictions" which undermine a company's ability to access external funds and consequently spawn an additional underinvestment gap. Yet, most of the problems arises from information asymmetries between entrepreneurs and external investors. In particular, when lenders are less informed than managers, both external equity and debt are found to be rationed or expensive, as a consequence of adverse selection and moral hazard issues (Carpenter and Petersen, 2002a; Hubbard, 1998; Stiglitz and Weiss, 1981). It is worthwhile to clarify that albeit capital markets imperfections generated by information asymmetries might limit many forms of businesses (Hubbard, 1998), they predominantly hamper R&D investment because of the great uncertainty surrounding technological projects. In fact, as it will be deepened in sub-paragraph 4.2.2, companies which suffer the most from capital constraints are usually small, young and operating in technology-intensive sectors (Lerner, 2002). In other words, NTBFs (Carpenter and Petersen, 2002a; European Commission, 1996).

4.2.1 Informational asymmetries: adverse selection and moral hazard

The term "adverse selection" refers to market dynamics in which unwanted results occur when buyers and sellers have access to different information. In particular, the outcome of this market failure is that only "bad" products or services will be traded in the marketplace. The most famous example of this market process is the

so-called “lemons problem” outlined by Akerlof (1970). Suppose that 100 car owners want to sell their used cars and 100 buyers are willing to purchase one. Half of the cars on sale are low-quality automobiles (“lemons”, henceforth) and the other half are good cars. Lemons’ owners would accept €1,000 for their car, while good cars’ owners will not accept less than €2,000; on the other hand, buyers are willing to pay no more than €1,200 for a lemon and €2,400 for a high-quality car. As one may notice, if every buyer could tell a lemon from a good car, every car could be sold and the market would reach an efficient outcome. However, because of the fact that, conversely to the car owner, the buyer has not full information about the car’s quality, the actual outcome of the market transaction will deviate from what desired. Specifically, since the buyer knows that a car can be either a lemon or a good car with the same probability, he will offer no more than the expected value of the average car ($0.5 \cdot 1{,}200 + 0.5 \cdot 2{,}400 = €1{,}800$). However, this offer price is lower than the minimum selling price of good cars (i.e. €2,000) and thus only lemons will be sold on the market. In the long-term, only lemons’ seller will remain on the market, with the consequence that buyers will offer no more than €1,200 to buy a used car.

The essential rationale underlying this example is that sellers with greater information about an asset will be reluctant to accept a disadvantageous offer from a less-informed buyer (Fazzari et al., 1988). Interestingly, this argument is still valid as far as R&D and innovation investments are concerned. Indeed, the firm is very likely to have better information than lenders about the likelihood of success and the riskiness of a specific project or technology (Hall and Lerner, 2010; Carpenter and Petersen, 2002a; Peneder, 2008). Due to the difficulty to credibly transfer this knowledge to the investors, these latter will charge a higher cost of capital (“lemons’ premium”) to cover the risk of picking a lemon (Hall, 2002) or, alternatively, they will ration the credit to reduce adverse selection (Stiglitz and Weiss, 1981).

The adverse selection problem holds for both debt and external equity markets. Indeed, since external investors are not able to ascertain the quality of a company, they will value it as the average population. Accordingly, the cost of external

equity faced by high-quality ventures will include this lemons' premium (Myers and Majluf, 1984).
Analogically, the difficulty of banks to distinguish between good and bad borrowers will make the interest rates increase and the loan size reduce (Jaffee and Russel, 1976). As a consequence, only high-risk companies will accept the high interest rates and remain in the market, whereas good ones will be discouraged.

As it has been shown, adverse selection is a problem of hidden information, since buyers do not know – before the transaction takes place (ex-ante) – as much as sellers. On the other hand, moral hazard can be defined as an ex-post asymmetric information problem, due to hidden action – and not information.
Indeed, moral hazard occurs in a transaction when the party with more information, about its actions or intentions, has a tendency or incentive to behave inappropriately from the perspective of the party with less information.
In modern ventures, a principal-agent problem may often arise because of the frequent separation between management and ownership. In such a situation, it is rather difficult for external financiers to control the behaviours of entrepreneurs (Colombo and Grilli, 2010), especially in the highly-uncertain high-tech industries (Lerner, 2002). Thus, the risk of opportunistic behaviour on the side of managers becomes considerable. In particular, this entrepreneurs' opportunistic behaviour appears in many forms. First, managers might spend efforts and money on activities which maximise their own benefits but not shareholders' ones (Hall and Lerner, 2010). For example, they could invest to smarten the office (Lerner 2002) or to expand the firm beyond the efficient scale, rather than generate profits (Peneder 2008; Aivazian et al., 2005). As inferred by Jensen and Meckling (1976), this type of agency cost can be limited by leveraging the company in order to decrease the free cash flow at managers' disposal. However, this leveraging strategy could reduce a company's chances to undertake positive growth projects (Aivazian et al., 2005) and empirical evidence confirms that it is not particularly suitable in R&D-intensive sectors (Hall, 2002).

Moreover, managers may exert less efforts than expected from investors (Peneder, 2008) or – if risk averse – they could avoid to undertake R&D investments which would raise the riskiness of the firm (Hall, 2002).

On the contrary, debt finance could alter the incentive structure of a firm, giving managers greater room for pursuing high-risk investments to the detriment of investors (Colombo and Grilli, 2007; Lerner, 2002).

The ultimate consequence of moral hazard is, therefore, a lower willingness of external finance sources to provide firms with the necessary capital (Jensen and Meckling, 1976).

4.2.2 Why do high-tech start-ups suffer more from capital market imperfections

As a matter of fact, a plethora of studies supports the argument that for high-tech start-ups the access to external finance is tougher than for other ventures (e.g. Hall 2002; Carpenter and Petersen, 2002a). This result is due to several aspects tightly bounded to the main features of NTBFs: small size, youngness and high-technology intensity. This sub-paragraph is meant to shed light on the most relevant among them.

As it has been widely recognised, small firms are usually charged with higher interest rates[19] and also have higher likelihood to be rejected by banks. By and large, this is due to the fact that smaller businesses have a greater attached risk from lenders' point of view. Indeed, start-ups (and small firms in general) present a sensibly higher default rate than large corporations (Westhead and Storey, 1997). Among them, the ones active in high-tech industries are perceived as even riskier in terms of bankruptcy risk (Westhead and Storey, 1997; Peneder, 2008, Veugelers 2009), also because their value in case of default is extremely low due to the lack of collateralised assets (Revest and Sapio, 2012). This issue is even more severe if one notices that small start-ups are likely to have a shortage of internal funds (Schneider and Veugelers, 2010), since their cash-flow in the first years is limited or even negative (Peneder, 2008; Brown et al., 2009). What is more, small firms

[19] Storey (1995) reports that interest rates on external finance for small firms are on average higher by 2% in respect to larger companies.

have to face very high transaction cost connected to debt and equity finance (Revest and Sapio, 2012; Asquith and Mullins, 1986; Peneder, 2008).

In conclusion, the long-standing theory that small companies' growth is hindered by the combined effect of scarcity of internal funds and difficulty to raise external financing (see Carpenter and Petersen, 2002b for a review of this literature) finds confirmation among recent studies. In addition to that, it is important to underline how this issue has been exacerbated by the 2008 financial crisis (Veugelers, 2009; Moncada-Paternò-Castello et al., 2014 for the EU case).

When dealing with R&D investments, the hampered access to external finance suffered by small firms turns out to be even more accrued, since the informational gap between investors and entrepreneurs is intensified by the greater uncertainty surrounding this kind of projects (Revest and Sapio, 2012). As a consequence, combining the disadvantages of riskier projects and small scale, young innovative firms are even more affected by financial constraints (e.g. Schneider and Veugelers, 2010; Lerner 2002; Hall, 2002; Carpenter and Petersen, 2002a; Westhead and Storey, 1997).

Overall, the reasons why lenders perceive R&D investments as riskier can be grouped in three main rationales. First, ex-post information asymmetries (moral hazard) are intensified by the complexity for external parties to monitor ongoing R&D investments (Revest and Sapio, 2012). Indeed, high-tech ventures are found to have considerable room for replacing low-risk investments with high-risk ones, in respect to low-tech companies (Carpenter and Petersen, 2002a). Second, adverse selection is magnified the more the technology is sophisticated (Colombo and Grilli, 2010). As far as innovative and technologically complex projects are concerned, outside investors may lack the ability to fully understand the technology (European Commission, 1996; Revest and Sapio 2012; Carpenter and Petersen, 2002a; Pender 2008) and the resulting insecurity will be translated in greater perceived risk. Third, R&D projects own a significant degree of uncertainty. In particular, there is high uncertainty regarding the output of the project (Hall, 2002), especially when it is based on basic research activities

(Aghion et al., 2009). Moreover, R&D investments are often related to the design of products or services that have not reached the market yet: in such a scenario, additional uncertainty will be engendered by the high variability of the project duration and of the market response to the novelty (European Commission, 1996; Westhead and Storey, 1997; Aghion et al., 2009).
Finally, the last element of uncertainty is related to the investment's returns[20].

As one may argue, there are specific elements able to relax a company's financial constraints, namely collaterals, track record and signalling practises. Unfortunately, such elements are not suitable for NTBFs.
Indeed, R&D investments provide limited or null collateral value, as they are predominantly intangible or firm-specific (Carpenter and Petersen, 2002a). Moreover, as already mentioned, small and young firms typically lack of "collateralisable" assets and have a short track record (Revest and Sapio, 2012; Colombo and Grilli, 2007; Hall, 2002; Schneider and Veugelers, 2010; Peneder, 2008).
Finally, due to the appropriability problem discussed in paragraph 4.1, innovating firm would face a consistent risk in revealing information about their innovative activities to external investors (Carpenter and Petersen, 2002a). Therefore, the quality of the signal they could give to financiers will be extremely reduced (Bhattacharya and Ritter, 1983).

4.3 The impact of capital structure on firm investments

Drawing the conclusions of what discussed in paragraph 4.2, recent studies provide an overwhelming support to the thesis that innovative start-ups' underinvestment is aggravated by internal and external financial constraints, especially when high-tech – or innovative, more in general – projects are concerned.
Being this study aimed at investigating the relationship between Italian innovative start-ups' investment and access to different forms of external finance, it is central

[20] Mansfield et al. (1977) found that R&D projects have a success probability of 27% only.

to review the main results of the literature about firm's investment and capital structure.

The starting point of this field of study traces back to the well-known Modigliani-Miller theorem (1958), which claims that a firm's market value is not affected by its capital structure in perfect capital markets. Therefore, under the hypothesis of efficient financial markets, a company's investment decision will be independent of financial factors as liquidity, leverage or dividends payments.

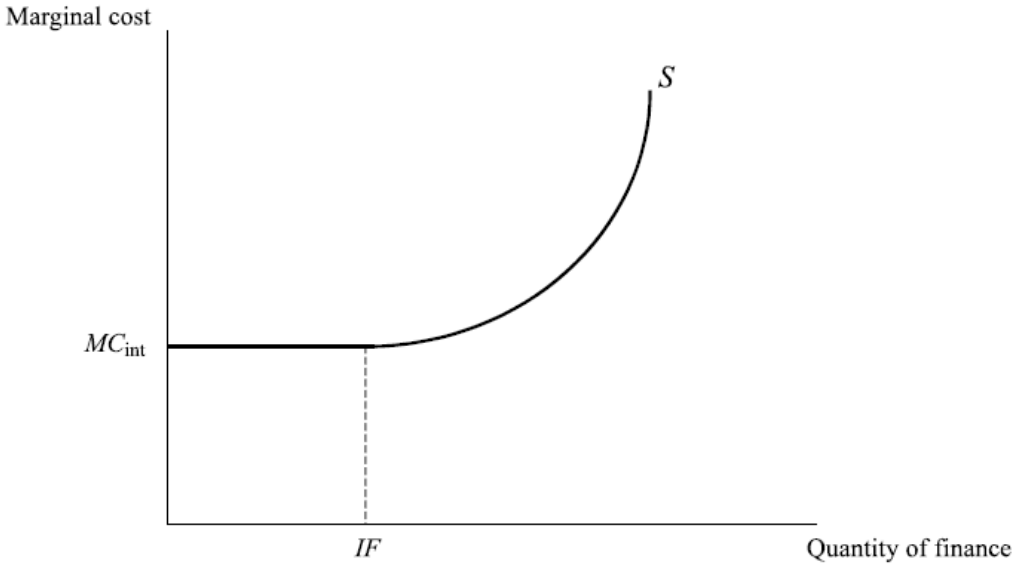
In other words, every project with a positive NPV is financed and the sources of finance – either internal or external – are perfect substitutes.

In line with Modigliani and Miller's results, Hall and Jorgenson (1967) laid the foundation of the neoclassical theory of investments, where internal financial factors (e.g. cash flows) do not impact on firm's optimal decision (Bertoni, Colombo and Croce, 2010).

Nonetheless, several scholars have raised doubts on this argument (Hall and Lerner, 2010). As a matter of fact, the hypothesis of frictionless capital markets can be suitably applied to mature corporation with well-known prospects; on the other hand, all the factors analysed in the previous paragraph (for one thing, informational asymmetries) create substantial capital market imperfections for high-tech ventures and, consequently, a wedge between the cost of new debt or equity finance and the opportunity cost of internal funds. Therefore, internal and external capital are not perfect substitutes for innovative start-ups and, accordingly, their investment choices will be affected by financial factors (Fazzari et al., 1988). The cost difference between internal and external finance is well explained in Figure 4. As one may note, the supply of finance curve will be constantly equal to the marginal opportunity cost of internal capital (MC_{int}) up to IF (i.e. the quantity of available internal capital). From that threshold on, the schedule will have an upward slope: this section of the curve – indeed – represents the supply of debt capital, which comes with higher costs; the greater the capital market imperfections, the steeper the S curve (Fazzari et al., 1988). For high level of financing required (i.e. higher financial leverage), the curve will tend to an asymptote, which embodies the extreme scenario of credit rationing (Colombo and

Grilli, 2007), i.e. when creditors are not willing to provide capital beyond a certain quantity.

Figure 4 – Supply of debt finance curve



Source: Carpenter and Petersen (2002a)

As the supply of capital curve is upward-sloping, one may expect that firms will follow a "pecking order" (Myers and Majluf, 1984) or "financing hierarchy" (Fazzari et al., 1988).

Since the marginal cost of debt is higher than the one of internal finance, indeed, companies will turn to debt or equity finance only when internal funds (e.g. founders' personal wealth, company's retained earnings) are exhausted.

In other words, when investment demand is low, ventures will rely on internally available capital, at the expense of extra-dividends. For increased levels of investment demand, firms will switch to debt and eventually on external equity – which is found to be more expensive (Fazzari et al., 1988; Peneder, 2008). Several studies provide confirmation to the "financing hierarchy" intuition. Brealey and Meyers (2000) found that US nonfinancial companies' investments during the 1990s have been financed at 90% by internal funds. Carpenter and Petersen (2002a) claim that the average company holds nearly all of its profits and makes a relatively little use of external finance. Colombo and Grilli (2007) report that only

22% of the sampled Italian NTBFs relied on bank loans at start-up time, whereas only 15 firms out of 386 accessed to private equity.

Thus, past studies identified debt financing as the commonly preferred source of external financing, since it is less expensive than external equity and it allows managers to maintain control over their companies (Peneder, 2008).

Nonetheless, researches focusing on technology-intensive firms offer a different perspective. Hall (2002) found that debt is not a suitable source of finance for investments in Research and Development. Likewise, venture capital is alleged to be the primary source of external finance among Finnish SMEs (Hyytinen and Pajarinen, 2003). Carpenter and Petersen (2002a) state that debt contract is not appropriate for high-tech firms, especially for those projects with great asset specificity and low collateral value.

Moreover, additional debt capital would increase the company's leverage, with important consequences in terms of investment possibilities. First, the cost of debt capital can hastily rise as long as leverage increases (Carpenter and Petersen, 2002a). Second, Aivizian et al. (2003) report a negative correlation between leverage and firm's investment, supporting the argument that debt capital reduces the incentives for entrepreneurs to undertake positive NPV projects whose benefits would not be fully captured by shareholders (Myers, 1977).

In line with this literature, many authors hold that equity finance has several advantages over debt for NTBFs (e.g. Hall, 2002; Carpenter and Petersen, 2002a). For instance, Hogan and Hutson (2005) offer empirical evidence that Irish software companies were ready to lose part of their ownership and control in order to raise external equity and pursue innovative goals.

While the greater effectiveness of private venture in supporting firm's growth will be analysed in full details in the next chapter, the predominance of internal finance is in fact undeniable. To this regard, a huge dispute emerged regarding the relationship between a firm's investment and its cash flow (as a proxy of internal finance). The conventional wisdom supports the thesis that the more a company is financially constrained – internally or externally – the less its investment level. In particular, the investments of a firm facing a greater cost of external capital (steep

supply of finance curve) should be more sensitive to cash-flow fluctuations (Investment-Cash-Flow sensitivity, henceforth ICFS). Indeed, as the cost disadvantage of gathering external capital increases, firms will predominantly use internal funds to finance their investments. As claimed by Fazzari *at al.* (1988), when a financially constrained firm has nearly exhausted its low-cost internal capital, it will show a strong relationship between investments and cash flow or other liquidity measures.

This result found large support by several following studies. For example, Carpenter and Petersen (2002a) identified a slightly greater than a dollar-for-dollar correlation between growth and internal finance for companies which make no use of external capital. On the other hand, the small subset of companies heavily relying on external equity showed a much weaker relationship. Moreover, ICFS is greater for companies that distribute less dividends[21] (Fazzari et al., 1988).

Nonetheless, the rationale that stricter financial constraints imply greater ICFS is too simplistic (Bertoni, Croce and Guerini, 2015).

A first stream of critiques does not question the correlation between investment and cash flow, rather it raises doubt on its interpretation: some authors claim that cash flow is not only a proxy for internal funds, but also for investment opportunities (see Hubbard, 1998 and Carpenter and Petersen, 2002b for a detailed review). This controversy is emphasised by the difficulty to build a solid proxy for investment opportunities (Gilchrist and Himmelberg, 1995); given that many researchers adopted different methodologies to control for investment opportunities, results are mixed and an overall consensus has not been reached. In any case, this possible bias is less severe for NTBFs, since investment opportunities for this type of ventures are likely to be related to the quality and innovativeness of their ideas, rather than to cash flows (Bertoni, Colombo and Croce, 2010).

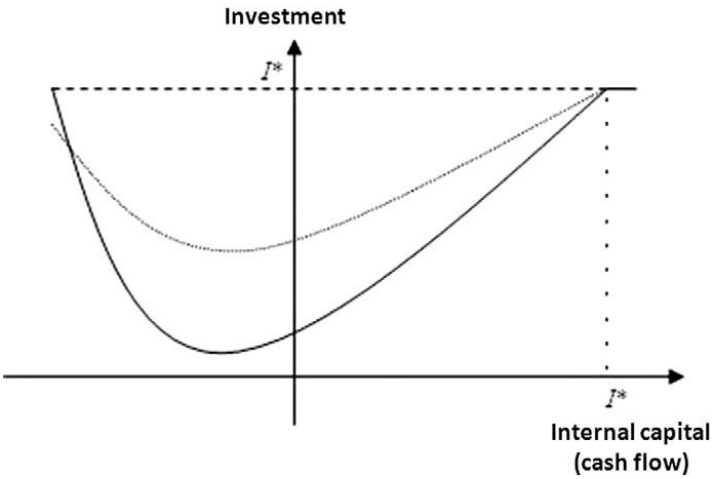
Nonetheless, the most important critique to Fazzari et al. (1988)' argument raises doubts on the I-CF relationships. This opposite stream, guided by Kaplan and

[21] Dividends' payout is used as a proxy of weaker financial constraints, since a firm with low availability of internal and external finance will likely retain most of its earnings (Fazzari et al., 1988).

Zingales (2000, 2009) shows that firms with extreme financial constraints exhibit a lower – and not higher – ICFS than those with less financial constraints.

Allayannis and Mozumdar (2004) noticed that by excluding companies with negative cash flows from the analysis, results of Kaplan and Zingales (2000, 2009) converge with what hold by Fazzari et al. (1988). Consistent with these conclusions, Cleary et al. (2007) build a debt-financed investment model that refines Kaplan and Zingales' theory. Under reasonable hypotheses[22], they found that the relationship between internal capital and investment is U-shaped (Figure 5). The convexity of the Investment Curve (IC) increases as external financing constraints are greater; accordingly, if internal and external funds were perfectly substitutes, the IC would coincide with the optimal investment level (horizontal dotted line, I*). In other words, the U-shaped curve confirm the evidence that financially constrained companies invest less than the optimal level.

Figure 5 – U-shaped investment curve



Source: Bertoni, Croce and Guerini (2015)

The main intuition explaining the U-shaped relationship between internal finance and investments goes as follows. For high level of internal capital, results in Fazzari et al. (1988) are confirmed (i.e. ICFS is positive). Indeed, as cash flow decreases, a company would ask for a larger loan to maintain the same level of

[22] 1) external finance is more expensive than internal funds; 2) the cost of external capital is endogenously determined; 3) investment is scalable.

investment. This larger loan would expose the company to a greater risk of default and consequent liquidation losses. For this reason, it would be convenient for it to ask for less debt capital, reducing default risks, and undertake cheaper projects with lower payoffs. When internal capital is at low levels, the firm will need larger external capital and thus it will face a great liquidation risk. Due to the higher probability of default, the investors will be more willing to accept a narrower repayment in order to allow the firm to make a bigger investment, whose related higher payoffs could improve the company's ability to pay back its debt. As a result, for sufficiently low levels of internal capital, ICFS will be negative.

In order to make this explanation more easily understandable, the original example proposed by Cleary et al. (2007) is reported, as follows.

Consider a firm with internal funds W that can choose between two mutually exclusive investment projects. Project A requires an investment of 8 and leads to revenues of 29 or 5 with equal probability. Expected revenue is 17 and thus the expected profit from the investment 9. Project B is smaller; it requires an investment of 6 and leads to revenues of 19 or 5 with equal probability. Expected revenue is 12 and the expected profit 6. Hence, A is the first-best project.

If $W < 8$, the first-best investment cannot be financed internally. The firm can either finance project B internally (if $W \geq 6$), or it can raise additional funds from an investor to finance project A. Raising funds may be costly: we assume that if the firm defaults on its promised repayment it is liquidated, and its shareholders lose a non-transferable future benefit worth 12.

Suppose the firm has internal funds W=4. Then financing project A requires external funds of 4, whereas financing project B requires external funds of 2. With either project, the external funds required are less than the lowest possible revenue (namely 5), which means the firm can repay with certainty. Thus, debt is risk free, and the firm's optimal project is A.

Now suppose that W=2. Again, both projects can be financed using external funds, but project A is no longer risk free. To finance project A, the firm needs to raise 6,

which may exceed the firm's revenue. The investor breaks even at a promised repayment of 7, since then he gets 7 if the firm's revenue is 29, and the entire revenue of 5 otherwise. The firm's profit is 29 – 7 = 22 plus the future payoff of 12 if revenue is high (totalling 34), and zero if it is low, since the firm then loses both its revenue and its future profits. The expected profit thus is 17. Project B, on the other hand, can still be financed with risk-free debt since the required loan of 4 can be repaid with certainty.

The expected profit is 1/2 · (19 - 4 + 12) + 1/2 · (5 - 4 + 12) = 20, which exceeds the total profit from project A. Thus, while the larger project A leads to a higher current profit, the expected liquidation loss makes it less attractive than project B.

Now suppose that W=0. Both projects remain feasible using external funds, but both entail a risk of default. With project A, the firm borrows 8, and the investor breaks even at a promised repayment of 11. The firm is liquidated with probability 1/2, and its expected payoff is 1/2 · (29 - 11 + 12) = 15. With project B, the firm borrows 6, and the investor breaks even at a promised repayment of 7. The firm's expected payoff is 1/2 · (19 - 7 + 12) = 12, which is less than the expected payoff from project A.

Thus, although both projects are feasible in all three cases, the firm prefers the smaller investment with intermediate levels of internal funds (it is easy to show that the range is $W \in [1, 3)$), and the larger investment with either high or low internal funds. In other words, investment is a U-shaped function of internal funds.

On an empirical perspective, Cleary et al. (2007) were the first to testify a negative relationship between internal funds and investments for a significant sub-sample of firms. As suggested by previous studies, this effect is obtained largely for firms whose cash flows are negative.

5. Venture capital and innovative start-ups

As depicted in the previous chapter, availability of capital acts as a sword of Damocles hanging above new innovative ventures. In contrast with the pecking order hypothesis introduced by Myers and Majluf (1984), several recent works support the empirical evidence that venture capital (VC, from now on) is the most suitable candidate to alleviate NTBFs' financial constraints.

VC is defined by Kortum and Lerner (2000) as an "equity or equity-linked investments in young, privately held companies, where the investor is a financial intermediary who is typically active as a director, an advisor, or even a manager of the firm". Usually, VC funds are created by institutions or individual investors with great financial availability, willing to invest in young ventures with the aim of increasing their value. Eventually, the equity managers monetise from this investment by selling the firms or taking them public in order to liquidate them (Hall and Lerner, 2010). The tangible positive results obtained by the American VC system[23] contributed to raise attention on the impact exerted by VCs on innovation through the support provided to NTBFs, giving rise to specific institutional programs aimed at encourage the development of an effective and flourishing VC industry.

5.1 The gap between US and EU venture capital markets

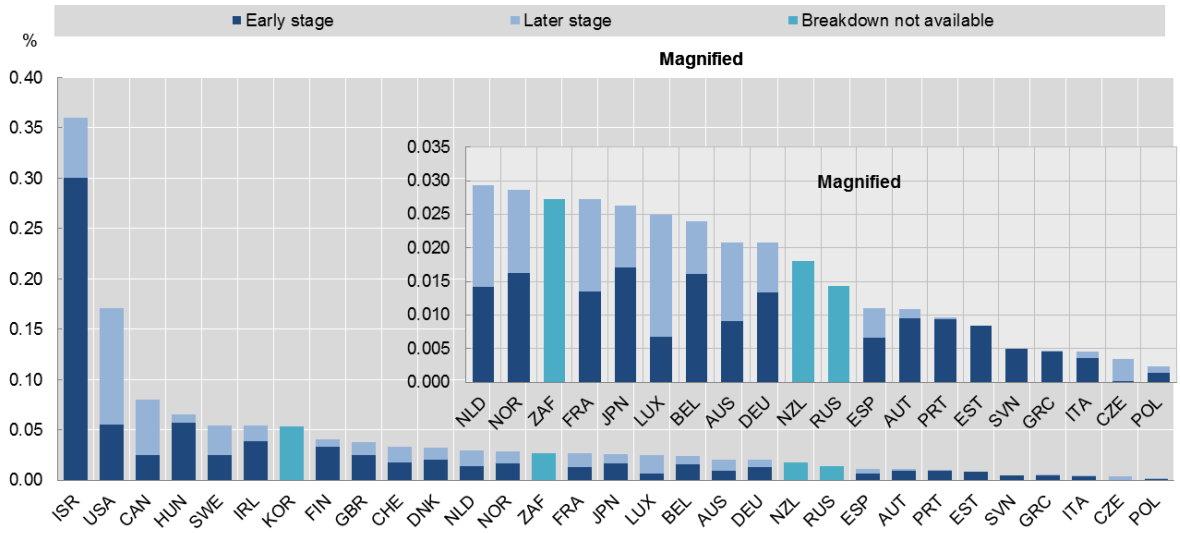
The US VC market has a long history behind, as its birth dates back to 1946, when the first VC firm (American Research and Development, ARD[24]) was founded. As observed by Gompers and Lerner (2001), the US VC industry increased dramatically in the late 1970s and, after a significant flexion in the mid-1980s due to overinvestment and low-skilled venture capitalists' entry in the market, it started

[23] As reported by Bygrave and Timmons (1992), several examples of successful US high-ventures (e.g. Intel, Cisco, Sun Microsystems, Apple) have received VC support during their start-up phase.

[24] ARD was a publicly traded closed-end fund, i.e. a shared fund which raises capital by selling shares to external investors and allows share owners to sell their shares to other investors. In the following years, other VC governances emerged, such as VC limited partnerships and Small Business Investment Companies.

growing again in the 1990s as a consequence of several factors, such as the emergence of pension funds, the incredible success of VC-backed start-ups (e.g. eBay, Yahoo!, etc.), the "explosion" of IPOs' activity in the market and the tremendous diffusion of ICTs. The Nineties proved to be a fertile ground for VC industry expansion in Europe as well. However, since the European equity financing activities towards high-tech start-ups were nearly inexistent up to that period, the prevalence of VC in financing NTBFs has remained much less developed[25]. The deficits of European VC system in respect to the US one are still considerable nowadays: as exhibited in Figure 6, in 2012 all EU countries reported a level of investments as a proportion of GDP lower than the US one.

Figure 6 – Venture capital investment as a percentage of GDP (2012)



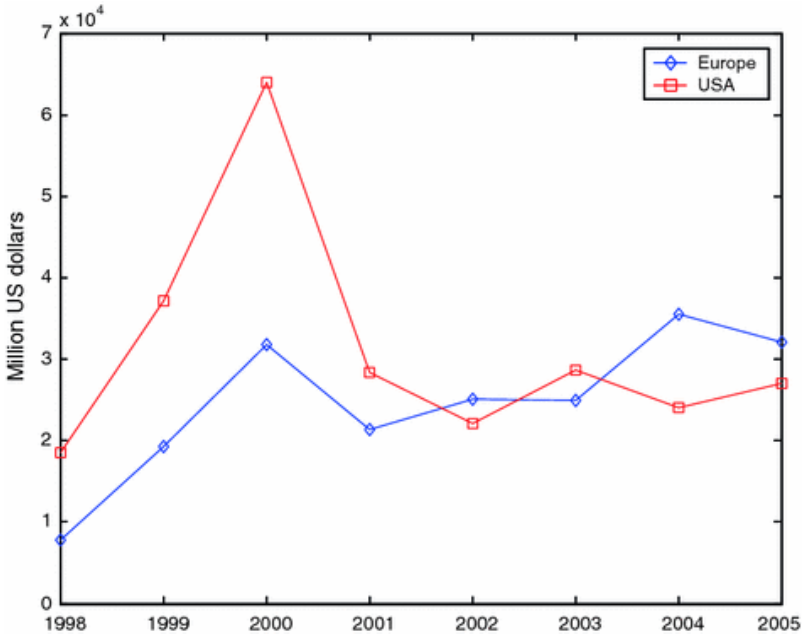
Source: Moncada-Paternò-Castello et al. (2014)

However, Europe as a whole sector has reached US for what concerns the total VC investment amount (see Figure 7 in the next page). Even though this evidence reflects the efforts spent by EU institutions in order to strengthen its VC market, it does not imply that EU VC industry is as effective as US one. First, this "catch-up" in the level of investments has not been a uniform process over Europe, but it

[25] To this extent, Colombo and Grilli (2007) report that in the 1988-1992 period the percentage of VC investments made in favour of NTBFs in their early stage decreased from 20% to 16% in Europe, whereas it rose in US from 60% to 76%. Other evidences of this "VC gap" between EU and US are provided by Dimov and Murray (2001).

was primarily provoked by the fast growth of VC investments in UK (Revest and Sapio, 2012), whose financial system – as it will be soon explained – is different from the majority of EU countries. Second, the "quality" of VC players in the European context is likely to be lower than their US counterparts. In this direction, Grilli (2014) observes that the experience of EU venture capitalists is considerably lower than US VC firms[26].

Figure 7 – VC funds invested in US and EU countries (1998-2005)



Source: Revest and Sapio (2012)

Moreover, more relevant to the extent of this study is the amount of VC disbursements allocated to young firms. From this perspective, Hall (2002) claims that there is much to be done in order to bridge the US-EU VC gap, since the share of VC invested in start-ups in 1996 was 27% in US and only 6.5% in Europe.

Given that the thinness of UE VC segment is widely identified as one of the main reasons of the relatively low performance of EU countries in favouring the emergence of NTBFs (Bertoni and Croce, 2011), it is not surprising that European governments in last years have been eager to replicate the success of US VC industry (Kortum and Lerner, 2000). But which are the causes of the EU-US gap?

[26] In this analysis, VC firms' experience is proxied by the number of funds under their control.

Many scholars focused the attention on the different institutional environment among these two areas. US, together with UK, is a prototype of the market-system, whereas most of the European countries, such as Germany and Italy, are representatives of the bank-based system (Hall and Soskice, 2001). The differences between these two economic systems are emphasised by Rajan and Zingales (2001), who claim that VC is a solution able to provide both the solid incentives for entrepreneurs typical of stock markets and the monitoring function characteristic of bank-centred systems. Nonetheless, the access to seed and start-up equity finance is sensibly constrained in bank-centred financial systems (Colombo and Grilli, 2007; Lumme et al., 1993; Audretsch and Lehmann 2004). A first possible explanation of this empirical evidence is the poor growth of pension funds in bank-based economies (Revest and Sapio, 2012). A second rationale, which received great support in literature (e.g. Revest and Sapio, 2012; Philippon and Veròn, 2008), is the presence of a strong IPO market, by and large unavailable in economies dominated by banks (Hall and Lerner, 2010). Indeed, an effective stock market is fundamental to foster the proliferation of new ventures, since it permits successful entrepreneurs to take back the control on their companies (Hall 2002) and it offers to external investors a vibrant exit market, allowing them to finance new start-ups (Hall, 2002; Hall and Lerner, 2010; Philippon and Veròn, 2008).

5.2 Role and impact of VC on innovative start-ups

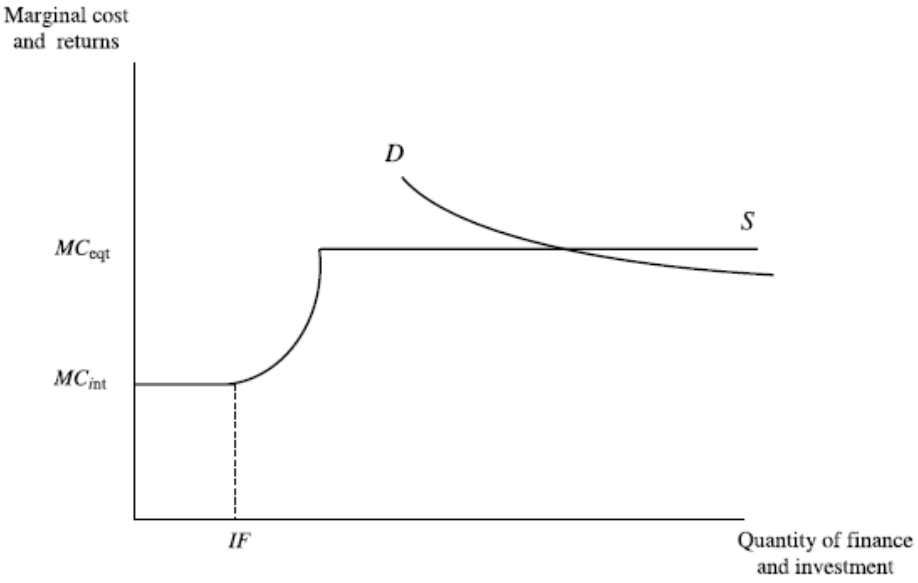
By and large, private VC is considered by both academics and practitioners as the best suited candidate to address the capital market imperfections constraining young high-tech firms (Carpenter and Petersen, 2002a; Lerner, 2002). The reasons at the basis of this argument can be divided into financial and non-financial.

5.2.1 VC's financial support

Clearly, the most direct form of support provided by VC firms to innovative start-ups is constituted by the injection of external equity. In this respect, recent studies

have questioned the classical pecking order hypothesis, by demonstrating that equity finance has several advantages over debt finance when high-tech ventures are concerned. This is due to the fact that VC peculiar characteristics are meant to offset – at least partially – the information asymmetries which are the primary causes of the gap between internal and external finance for NTBFs. When introducing the new share issue, the supply of capital curve presented in the previous chapter modifies as shown in Figure 8.

Figure 8 – Supply of external finance curve



Source: Carpenter and Petersen (2002a)

Indeed, after a certain amount of finance, debt capital becomes more expensive than external equity (horizontal portion of the S curve, corresponding to the marginal cost MC_{eqt}) due to its upward slope. What remains to be investigated is why equity finance is less subject to capital market frictions than debt finance.

First, since VC firms generally focus on specific industries (Gompers, 1995), they are likely to possess greater technological and context-specific expertise, which allows them to better evaluate promising high-tech projects and the entrepreneurial skills of the proponents (Audretsch and Lehmann, 2004; Amit et al., 1998). What is more, business plans of the proposed firms are deeply scrutinised (Lerner, 2002).

Second, conversely to banks, equity investors do not require a collateral to mitigate against adverse selection: since NTBFs generally lack of collateralisable assets, this doubtlessly increases the advantages of VC. Third, increasing the level of equity in a company will not increase the likelihood of financial distress, as debt finance does (Carpenter and Petersen, 2002a). Fourth, VC investors take an equity stage in the ventures they fund, sharing profits and risks with them. Due to this peculiar governance structure, firm founders are not required to pay back a loan and/or the related interests. This aspect could make the difference for NTBFs in their early phase, when profits are low or even absent and thus servicing a loan could be extremely harmful from an economic perspective (European Commission, 1996). Furthermore, a much more important consequence of the nature of VC contracts is that VC investors have huge incentives to provide portfolio firms with all the resources they might need in order to fully express their innovative potential (Bertoni, Colombo and Croce, 2010). For this reason, VC firms are active partners of the financed ventures (Grilli and Murtinu, 2014). In particular, VC investors closely monitor portfolio firms with a number of effective tools that help them in overcoming information agency issues. For instance, their greater monitoring function is facilitated by the venture capitalists' presence in the firms' board of directors and by the daily contacts hold with firms' managers.
In addition to that, investments staging is another powerful financial tool in order to keep control on portfolio firms (Hall, 2002; Gompers, 1995). In fact, since funds are disbursed in stages, entrepreneurs will have to act in line with VC investors' expectations if they want to obtain additional capital (Lerner, 2002).

Investment staging offers the possibility to introduce a second financial-related benefit provided by VC: the certification function. In a nutshell, VC firms can leverage on their reputation to signal the quality of a financed firm and smooth their access to outside capital (Carpenter and Petersen, 2002a; Revest and Sapio, 2012). Then, what is the link between investment staging and certification effect? As noted by Bertoni, Croce and Guerini (2015), the different effects of initial and follow-on VC investment rounds can be used to understand the magnitude of the

certification function. Indeed, while they are comparable in terms of amount of funds injected, they significantly differ in terms of information. In other words, the decision to provide a firm with a follow-on investment round is based on a much more tangible perception of a company's actual quality and, therefore, it is much more informative about the value of a firm. Since econometric results show that follow-on rounds have a much greater impact on the convexity of a NTBF's investment curve (a proxy of financial constraints) than initial investment rounds and that the amount of injected finance does not significantly affect the investment level, it follows that certification function is the predominant way through which VCs relax NTBFs' financial constraints (Bertoni, Croce and Guerini, 2015).

5.2.2 VC's non-financial support: the coaching function

The financial literature supports the argument that there are two possible explanations of the positive performances obtained by VC-backed ventures, directly related to two possible functions exerted by venture capitalists.

On one hand, VC firms may simply act as "scouts": thanks to their superior expertise and experience, they have greater skills to effectively sort high-potential ventures and support them with the necessary capital. Essentially, VC investors would merely pick winners in the marketplace. In such case, the only support a company would receive from VC investors would be related to finance.

On the other hand, VC investors may also provide a "coach" function, offering to the selected companies an assistance which goes well beyond the financial constraints alleviation. To this extent, VC companies are alleged to provide strategic consultancy services (e.g. HR management, marketing, planning, etc.), financial management and networking (see Grilli, 2014 for a literature survey on this topic). As far as the latter is concerned, VC investors may extend their business contacts list to portfolio firms, allowing them to access to a wide set of opportunities, both in terms of tangible and intangible assets.

As a matter of fact, VC firms are likely to carry out both the "scout" and the "coach" functions; however, only a few studies have investigated which is the dominant function among the two. Baum and Silverman (2004) provide some

evidence that VC teams in Canada are mainly interested in ventures to which they could bring additional value (coaching function). Similar results are obtained by Colombo and Grilli (2010) on a sample of Italian NTBFs.
In conclusion, even if the literature on the topic is far from extensive, the coaching function seems to be of great relevance in explaining the positive effects of VC on innovative start-ups. In line with this argument, Grilli (2014) claims that – at least in Europe – academics have not found evidences of solid sorting mechanisms between venture capitalists and portfolio start-ups.

5.2.3 The impact of VC: evidences of the greater performances of VC-backed firms
The wideness and heterogeneity of the studies regarding private equity makes it difficult to draft a clear picture of the influence of VC on NTBFs performances and therefore – indirectly – on economic growth. In the rest of this sub-paragraph the main results obtained by VC-backed ventures will be briefly reported, with a particular emphasis on innovative performances (for further references, see EVCA 2013).

Until the 2000s, there was little systematic research on the correlation between VC and innovation (Dimov and Murray, 2001). The first steps in this direction were aimed at studying the correlation between VC activity and technological innovation, proxied by patenting rates[27]. In this field, Kortum and Lerner (2000) verified that 1$ of VC is able to foster patenting on average more than three times in respect to traditional corporate R&D, studying a cross-industry sample of US firms between 1983 and 1992. A similar study in the EU context, carried out by Popov and Roosenboom (2009) and focusing on the period between 1991 and

[27] Despite of the possible problems stemming from using patenting patterns as a proxy of innovation (see sub-paragraph 2.1.2), the number of patents is still widely recognised as a relatively effective proxy for innovation activity (EVCA, 2013). In addition to that, Lerner et al. (2011) claim that patents generated by VC-backed firms are likely to have greater economical relevance.

2004, found that 1€ of equity finance could be even 9 times more powerful to innovation than the same amount invested by a non-VC backed company[28] [29].

One of the advantages guaranteed by venture capitalists in terms of innovation is a reduction in the time-to-market, particularly for innovating firms (Hellmann and Puri, 2000). Finally, Mollica and Zingales (2007) provide evidence that private equity capital is a determinant of greater innovation, rather than the opposite (i.e. that venture capitalists "pick" more innovative ventures).

Other studies shifted the focus on the relation between VC and other economical dimensions, such as company profits, growth and survival.

A research from Ernst & Young (2012) shows that VC generates an increase of the average EBITDA per employee by app. 7%. Similar results are obtained by Cressy et al. (2007) for the UK case, where VC-backed firms are found to have a higher operating profitability (up to 8.5%) than non-private equity firms.

Empirical evidence supports the thesis that VC is positively related to firm growth, measured in terms of productivity (Davis et al., 2014), sales (Grilli and Murtinu, 2015) and employment (Engel, 2002). What is more, the positive relationship between VC and growth goes beyond a firm's boundaries: indeed, industries where VC funds have been active in the previous 5 years experience faster growth patterns (Bernstein et al., 2010).

To conclude, private equity is also likely to lead to considerable enhancements in company survival. For example, Thomas (2010) claims that the failure rate of VC-backed ventures could be even 50% lower than their non-VC backed counterparts.

Despite all the positive aspects underlined in this section, VC dynamics clearly have some problems and limitations as well. First, the issues stemming from information asymmetries which – as explained above – are mitigated by VC but not completely solved. Second, the fact that the business ownership needs to be shared with external investors is usually not easily accepted by entrepreneurs

[28] The strength of the impact varies across industries; in particular, the strongest correlation has been found in the Bio-tech industry.

[29] Also this study uses granted patents as proxy for innovation.

(European Commission, 1996). Divergences may emerge for example about the exit strategy, as VC investors tend to be more willing to go public than entrepreneurs. Third, administrative and transaction costs (e.g. screening costs) are considerably high for high-tech start-ups (Carpenter and Petersen, 2002a), and may lead VC funds to invest in more mature companies. Fourth, VC firms usually have a limited intervention scope, as they focus only on a narrow set of industries (Lerner, 2002). A further limitation is related to the localness of VC's sphere of action: an analysis on a sample of EU high-tech ventures performed by Grilli (2014) suggests that around 30% of VC investments is made between an investor and an investee whose locations are far less than 10 km from each other. When greater distances are concerned, the effectiveness of VC may be significantly limited, especially because monitoring activities would be severely hampered.

In conclusion, it is important to underline that, even if VC could be beneficial to NTBFs under many perspectives, the most likely result of a VC investment is modest success, if not failure (Lerner, 2002). However, this outcome is determined by the extreme difficulty to operate in high-tech industries: to this extent, as traditional financiers (e.g. banks) are much more likely to fail, VC firms have proved to be the best option for innovative businesses.

5.2.4 Venture capital market: a heterogeneous sector

Until now, VC investors have been analysed as if they were a homogenous category, but in reality VC firms may have very different organisational forms – especially in the EU context. VC firms may differ in terms of objectives, target companies, competences and governance structure; accordingly, the effects engendered by different types of VC on portfolio firms are naturally expected to be different. As far as private venture capital is concerned, the most studied distinction is the one between corporate VC (CVC) and independent VC (IVC). The former is essentially a spin-off of a parent company aimed at managing an investment fund. The latter is an independent management firm controlling a number of funds provided by external investors (institutional and/or individual). Conversely to CVC, where the parent company maintains a relatively high control

on the investment decisions, the outside investors of an IVC are limited partners and do not actively participate in the management decisions. Even though CVC – differently from IVC – can provide the investee firms with access to parent companies assets, most of the "effect differential" between the two forms of VC is a consequence of their different objectives and organisational dynamics.

First, CVC firms are likely to have not only financial objectives, but also strategic ones, such as the opening of a "technology window" on the innovative technologies developed by NTBFs. For this reason, they could limit the capital injection to the minimum level necessary to develop such technologies. Moreover, it also follows that CVC teams might be not particularly interested in the company's overall performance. Second, the parent company's commitment to CVC's activities is often limited, with consequent poor incentive schemes for its CVC business unit.

For this reason, CVC firms are alleged to possess weaker scouting and monitoring skills and, thus, they are supposed to deal less effectively with ex-ante and ex-post information asymmetries' issues. Finally, CVC investments are also related to a greater risk of appropriability hazards, as parent companies often own all the necessary complementary assets to fully exploit investee firms' technologies (Dushnitsky, 2007).

All these arguments support the theory that IVC organisations outperform CVC investors, at least for what concerns the alleviation of financial constraints.

Indeed, while IVC financing is found to reduce the ICFS of the financed ventures (Bertoni, Croce and Guerini, 2015), CVC-backed companies still show a positive ICFS, which indicates their low efficacy in reducing investees' financial limitations (Bertoni, Colombo and Croce, 2010)[30].

On the other hand, explaining the different impact of CVC and IVC on portfolio companies' growth requires a further analysis. By and large, both CVC and IVC-backed firms are found to fosters firm sales growth on the long-term perspective.

[30] It is important to clarify that a greater and positive ICFS does not mean that a company's investment level is lower. In fact, despite the differences of IVC and CVC-backed firms in the ICFS, both groups exhibit a higher investment level in comparison with non VC-backed firms.

Nonetheless, the growth patterns of investee firms seem to be different dependently on the type of investors. A possible cause of this imbalance is the so called "grandstanding attitude" hypothesised by Gompers (1996), i.e. the propensity of ICV firms to take actions which signal their capabilities to potential outside investors. Indeed, due to the high search costs faced by external investors and the frequent information asymmetries about the VC managers' capabilities, ICV firms have significant incentives to grandstand. On the contrary, the presence of the parent company results in a reduction of these grandstanding incentives for CVC firms.

Since sales growth is traditionally acknowledged as an indicator of business success, especially for newborn firms, IVC companies will be likely to push portfolio firms to grow in the short-term, in order to use these immediate results as a certification for their ability. Bertoni, Colombo and Grilli (2013) provide results that confirm this argument: on a sample of 531 Italian NTBFs, they noticed that while long-term sales growth trajectories of IVC and CVC-backed firms are comparable, they considerably differ in the short-term, as IVC-investments on sales growth materialise immediately after the first financing round.

So far, the term VC has been intended only referring to private players. However, in the VC market, public players are also considered. In this "public" subset of VC firms, government venture capital (GVC) funds detain a substantial presence, particularly in Europe. As explained by Grilli and Murtinu (2014), GVCs are funds managed by a firm which is completely possessed by governmental bodies. Such funds differ from indirect governmental programs aimed at supporting the supply of VC funds privately managed (e.g. Yozma program in Israel) and from public subsidies which provide assistance to innovative start-ups (e.g. grants). Conversely, GVC represents an institutional "hands-on" approach, with the purpose of complementing the supply of private VCs by directly entering into the VC market. In a literature survey on GVCs, Grilli et al. (2014) identify the main differences in respect to IVCs.

First, albeit IVCs and GVCs share the same primary goal, that is fostering the growth of investee firms, the underlying reasons may differ: GVCs' mission is (or should be) to exploit NTBFs' growth as a vehicle of macro-economic development; on the other hand, IVCs benefit from their portfolio companies' growth as it increases the probability of an IPO or a more attractive trade sale (Chemmanur et al., 2011). Second, GVCs are likely to have less effective monitoring mechanisms and – in general – lower capabilities than their private counterparts. To this regard, the performance-related bonuses characterising the contractual agreements of IVC's managers – but absent in CVC funds – are supposed to make skilled managers more willing to join the private VC segment, rather than the public. Accordingly, GVCs' performances in their coaching function could suffer; moreover, information asymmetry problems would be more acute. Third, IVCs are found to be more risk-averse than GVCs (Auerswald and Branscomb, 2003): in fact, IVCs tend to prefer more mature and solid firms, whereas GVCs, acting from a social perspective, are more likely to back riskier high-tech firms.

In sum, the general features of GVCs are expected to result in a lower efficacy of this type of public VC support in respect to private VC forms such as IVCs.

Empirical results are aligned with these expectations: for example, Grilli and Murtinu (2014) found that GVC organisations do not convey any significant effect on company growth, whereas this relationship is documented for IVC investments. GVCs are reported to positively influence growth only when they act together with private VCs. Similar results are obtained also by Grilli et al. (2014). However, this second article evidences that a public "hands-on" approach is still valuable for high-tech ventures in their early stages: for these type of firms, in fact, GVCs plays an important beneficial role. As a matter of fact, this last result offers confirmation to the above mentioned argument that public VC firms have higher interest than private ones to invest in businesses surrounded by greater uncertainty and risk.

6. Public intervention

As highlighted in Chapter 2, young innovative start-ups are widely reputed a powerful means to foster economic growth and prosperity. The promotion of successful high-tech start-ups gained particular relevance in Europe, as several scholars and institution representatives stated that the lower emergence and development of European innovative ventures are the primary causes of the performance gap in respect to US economy. With this in mind, the European Union has recently launched various development plans (e.g. "Europe 2020"), built around the belief that pursuing innovation is the most suitable path towards economic growth. However, pursuing innovation may not be the most suitable decision from a firm's perspective: indeed, due to the issues related to R&D spillovers and capital market imperfections, two fundamental pre-requisites of the decision to invest in innovation – namely incentives and capital – could be missing. Therefore, in order to support NTBFs to fully express their innovative potential, public policy intervention is largely advocated. In particular, there are two compelling lines of action that institutions should follow in the short run.

On one hand, disincentives provoked by R&D spillovers have to be offset by proper incentive schemes. On the other hand, access to external finance needs to be facilitated, especially for young and small companies in their early stages, and particularly in those industries where the VC system is less active.

6.1 Public policy's set of instruments

As one could imagine, the two above-mentioned short-term rationales for public intervention also require different policy actions. Accordingly, Peneder (2008) categorises the main policy instruments in the ones providing incentive to invest in R&D and those favouring access to financial resources; sub-paragraphs 6.1.1 and 6.1.2 will report the most widely used policy tools maintaining this categorisation.

6.1.1 Incentives to invest in innovation

Public policy instruments designed to raise incentives for private investment in innovation can be further distinguished in fiscal incentives and direct funding of targeted expenditures.

Fiscal incentives represent all those subsidies which allow firms to reduce their tax expenses and they could assume many forms. First, companies can be allowed to deduct current R&D expenditures from their taxable income; in addition to that, some countries give firms the possibility to implement an accelerated depreciation[31] of R&D equipment[32]. Second, companies may have the opportunity to deduct an additional percentage of innovation expenses from their tax base. A third possibility are tax credits allowing ventures to detract a definite percentage of the targeted expenditures from their tax liabilities. Fourth, companies with no taxable income could be awarded with an "innovation premium": this latter incentive is specifically designed for companies which generate low or null profits (very common for high-tech start-ups), for which the traditional fiscal subsidies would not be beneficial. The final instrument is an alternative taxation base, where R&D rebate can be detracted from the employer's part of the wage tax and social security contribution of R&D-staff.

Alternatively, as far as direct funding is concerned, classical examples are grants and public loans at low interest rates. In some cases, loans can be conditionally reimbursable, i.e. repayable just in case the related innovation comes to be successful.

Albeit both fiscal incentives and direct funding share the same objective, several differences emerge between these two categories of public support. First, direct funding is a form of "selective" subsidy, whereas fiscal incentives are "automatic". This distinction is related to the scope of intervention of a given public subsidy: indeed, "automatic" forms of public aids can be undertaken by every company satisfying specific pre-requisites; conversely, "selective" subsidies give

[31] With the term "accelerated depreciation" is intended any income tax method of depreciation that allows higher deductions in the first years of an asset's lifecycle.

[32] Some regulations allow to include in "R&D equipment" even the facilities used for research activities.

institutions more room to deliberately select which project to sustain. The greater efforts in the implementation of "selective" instruments are therefore paid back by a higher possibility to discriminate among projects, for example deciding to support those with the highest spillovers. Moreover, while fiscal incentives can be implemented only by political entities empowered to make personalised tax regulations, direct subsidies can be issued by any local, national or supranational authority.

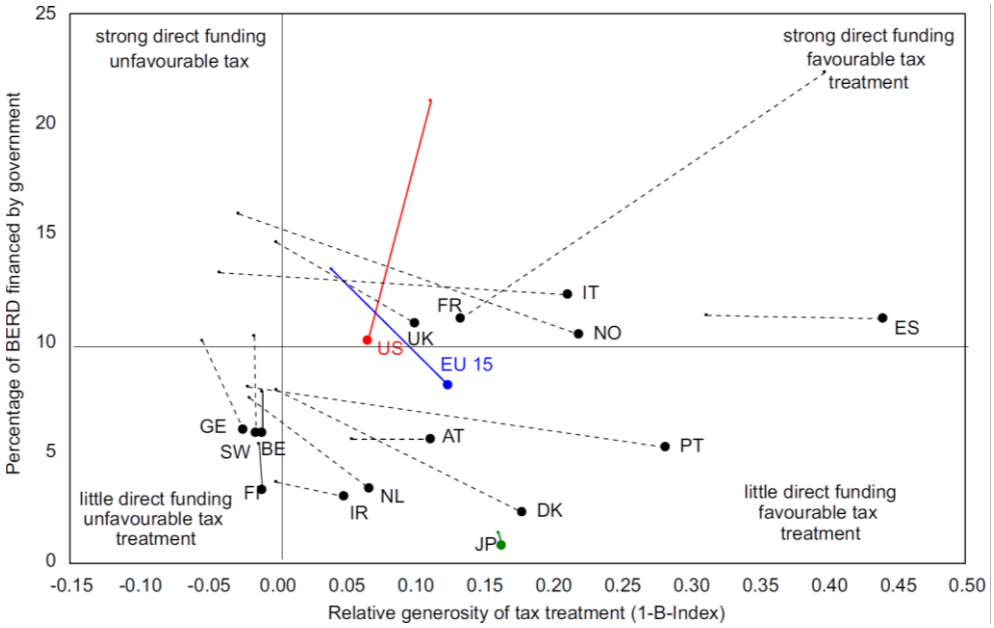
However, despite these differences, both types of public support are found to be positively related to R&D (Guellec and Van Pottelsberghe de la Potterie, 2003). More specifically, this study also shows that direct and indirect subsidies are substitutes, since increasing the munificence of one instrument leads to a lower effect of the other. Therefore, the best solution is constituted by a coordinated approach, in which the optimal balance between direct and indirect instruments is strictly related to the peculiar context, purpose and priorities of national innovation policies (Peneder, 2008). Figure 9 clearly exhibits the variety of combinations[33] of the two classes of public subsidies across different nations.

On the vertical axis, there is the share of business R&D expenditures funded by the government as a proxy of the amount of direct subsidies; the horizontal axis, instead, is represented by the intensity of fiscal incentives, proxied with the indicator *1 – B-Index*, where *B-index* is computed as "the income before tax needed to break even on one dollar of R&D outlay".

In spite of a general heterogeneity in the policy combination of different states, it is possible to notice a general trend of shifting from direct subsidies towards fiscal incentives, with few exceptions (e.g. France). A possible explanation of this trend is the growing public concern about the higher cost of direct funding subsidies in respect to fiscal incentives.

[33] These combinations are represented in a dynamic way, as they outline the "path" of each country obtained by two distinct observations, respectively in year 1991 (small dot) and 2002 (big dot).

Figure 9 – Aggregate trends for direct vs. indirect financial incentives



Source: Peneder (2008)

6.1.2 Favouring access to financial resources

In order to cope with capital market imperfections, the fan of instruments available for policy makers is made of three main support initiatives: direct funding of targeted firms (e.g. high-tech start-ups), fiscal incentives for financers in specific classes of assets and incentivation of capital markets via e.g. equity programs and guarantee schemes.

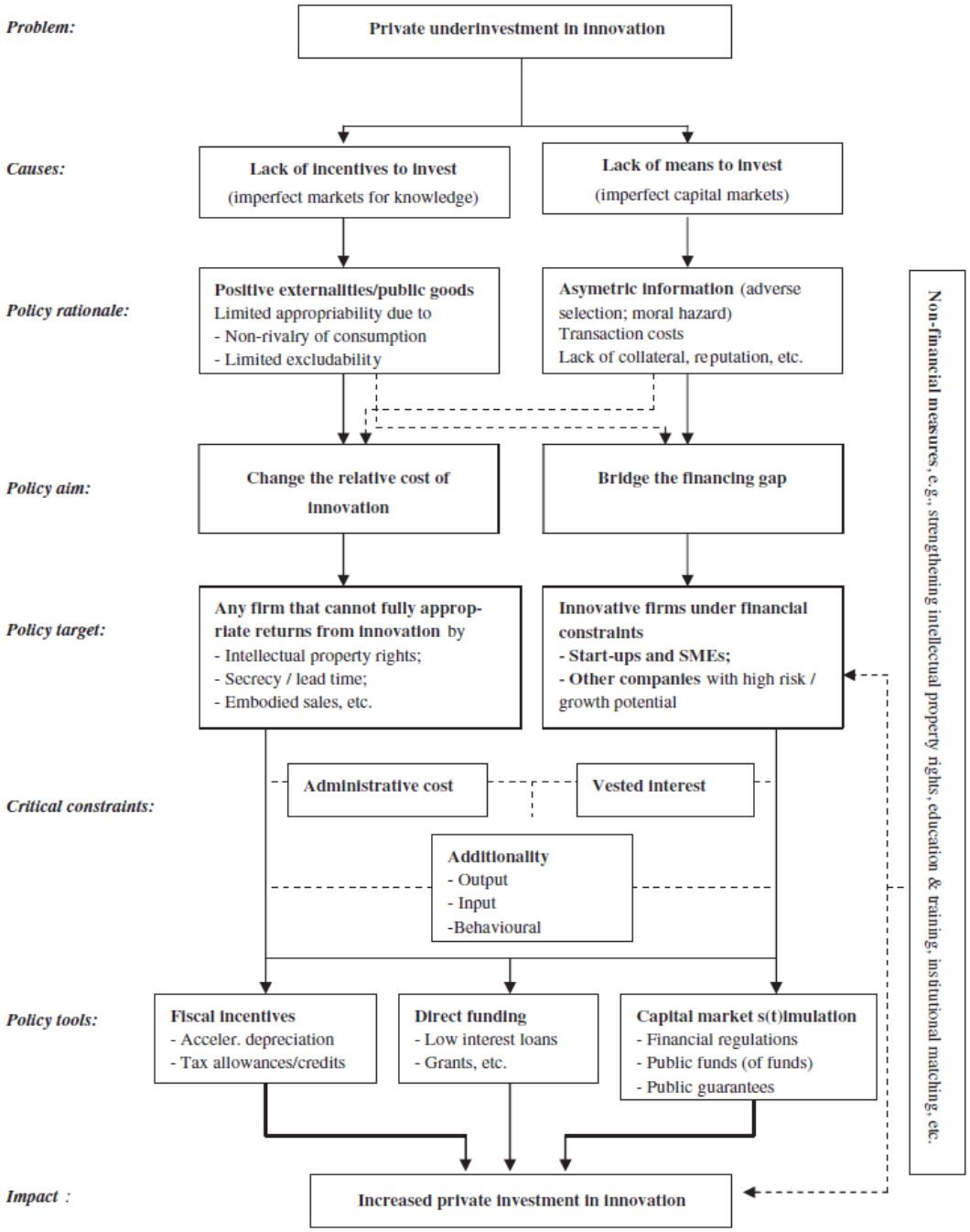
While direct funding offers in this case only a limited support, as it will probably be unable to back the emergence of fast-growing start-ups pursuing radical innovations, what governments should do is to mobilise private resources. For example, public policy could offer fiscal incentives to VC investors conditional to the supply of capital to targeted ventures. Alternatively, policy makers might substitute private investors with its own equity program, meant to provide equity either directly to entrepreneurs or indirectly through private VC firms. Lastly, public support could be delivered by means of guarantees[34], in case private actors do not provide appropriate insurance against project failures.

[34] While loan guarantees are common in most countries, equity guarantees – particularly suitable for low-experienced investors to operate in riskier market segments – have been developing in recent years.

This notwithstanding, guarantees raise two main problems: first, the expected increasing moral hazard, due to the riskier investment profile; second, the issue of undertaking the risk of investments that would have been made anyway.

As a summary of what described so far, Figure 10 shows a comprehensive visual map of the policy options to finance innovation.

Figure 10 – A policy map to finance innovation



Source: Peneder (2008)

6.1.3 Complementary policy interventions: the importance of contextual factors

Even though – as seen – a plethora of public support instruments is available for policy makers, the economic outcomes of public programs aiming at fostering innovation by backing R&D investments are likely to be disappointing if such programs fail to consider some fundamental economic contextual factors (Aghion *et al*., 2009). In other words, the implementation of a successful public support scheme for R&D investments cannot forgo the parallel design of complementary policy interventions. For instance, Aghion and Howitt (2005) found that R&D support strategies are rather ineffective when insufficient attention is paid to side factors such as education and training, competitive arena, macroeconomics and labour market. In the rest of this sub-paragraph, the importance of these contextual factors will be highlighted.

As far as education is concerned, the connection with technical advance and innovation is rather straightforward. As underlined by Romer (2000), increasing R&D expenditures is only one of the inputs of innovation, and therefore it is not sufficient to ensure fast growth without a satisfactory presence of the other innovation inputs. This is a fundamental aspect: even a well-designed support plan for R&D will fail if the education system does not guarantee a proper number of scientists and engineers.

The role of education in supporting NTBFs is a central theme also in the policy suggestions of Storey and Tether (1996). In a survey of the most important forms of support to NTBFs in Europe in the 1980s and 1990s, three out of the five identified are directly related to the education system: science parks, relationships with universities and PhDs supply.

Science Parks are physical areas supported by industry-university collaborations, whose main aim is fostering the formation and development of knowledge-based businesses. In particular, science parks facilitate the interaction between companies and university, allowing academics to commercialise their ideas in a suitable location, stimulating research links between large corporations and university departments and creating a fertile environment for small businesses to

develop their radical innovations. Even if NTBFs incubated in science parks do not exhibit significantly greater performances in terms of growth and survival then their "independent" counterparts, Westhead and Storey (1994) claim that science parks in UK are found to stimulate the emergence of high-tech ventures that would have not been established outside, thus stimulating the local economic development. The number of science-parks in Europe has remained scant until 1990s, when some countries, UK in particular, tried to replicate the successful example of US tech-parks. Not by chance, UK is nowadays the first European country for number of science parks (63), followed by France (60); in Italy, however, the count stops at 6[35]. Nonetheless, science parks are not the only way for businesses to exploit collaboration with universities. Indeed, in the last decades an increasing trend of strengthening the links between universities and private companies emerged. Nonetheless, these links are found to be stronger between the academic world and larger companies; thus, incentivising more extensive relations with SMEs could represent a reasonable policy action.

Moving to the individual level, the percentage of NTBFs' founders owning a science or technology-based PhD has increased strikingly as well. On one hand, this trend supports the idea that as long as technology becomes more sophisticated, highly-educated individuals are more and more important to fully develop and manage such technologies, especially when high-tech skills are combined with business experience. In this regard, it is fundamental for public policy to incentivise the "entrepreneurial option" amongst these individuals, in order to ensure that an appropriate fraction of them will try to commercialise their ideas launching new businesses rather than keeping on working in basic research activities.

Secondly, other contextual factors to take into consideration are competition, macroeconomic aspects and labour market. For one thing, a fair competition in the

[35] AREA Science Park, Bioindustry Park Canavese, San Raffaele Biomedical Science Park, Science Park Raf, Technoparco del Lago Maggiore, Technopolis Novus Ortus (IT).
A full list of European science parks is available at *http://www.unesco.org/*.

market has great positive effects on innovation, as documented by several authors. Low entry barriers could provide a twofold beneficial effect: on one hand, they allow new firms to bring their innovative ideas into the market place; on the other hand, incumbents' creativity and innovation efforts are stimulated. A reduced, or even absent, market competition is thus likely to severely reduce the effectiveness of R&D subsidies. Moreover, private R&D expenditures are particularly sensitive to macroeconomic fluctuations. In recession periods, when retained earnings are lower and the failure risk greater, companies will likely reduce the level of investments in uncertain R&D projects which entail high sunk costs. Consequently, policies able to sustain private innovative activities during economic downturns are convenient.

Finally, the labour market: a prerequisite for an efficient destructive creation process is labour market flexibility, which allows to minimize the cost of dismissing employees.

In conclusion, a dimension that has raised little attention in literature – but could have a consistent impact on NTBFs prosperity – is the culture of failure.

Indeed, as discussed at the beginning of Chapter 3, encouraging more people to become entrepreneurs could have negative – rather than positive – consequences on economic growth (Shane, 2009). Conversely, the social surplus would be maximised if the institutional landscape could be able to scope its incentives towards those innovative businesses with great potentialities. As a matter of fact, the empirical evidence suggests that failure is the most likely outcome of high-tech entrepreneurship. For this reason, another aspect that policy makers should not overlook is the reduction of both administrative and cultural burdens related to failure. As noticed by Grilli (2014), only a restricted number of European states have recently implemented regulations concerning bankruptcy. What is more, the main focus has been posed on rescuing ventures with high default risk rather than easing a rapid second business opportunity for those entrepreneurs who ran into

failure[36]. However, reducing the burdens of business failure is not only a matter of regulations. Indeed, it has to be followed by a drastic cultural change, in order to prevent failure to be considered as a "death sentence". An example of policy action aimed at favouring a new positive attitude towards failure is offered by the "Singapore case" analysed by Lerner (2010), which will be presented in the second part of this chapter. In particular, Singaporean institutions created specific awards for failed entrepreneurs, with the purpose of encouraging risk-taking.

To sum up, this sub-paragraph has shown how many contextual factors matter when dealing with innovation. Therefore, direct R&D subsidies result ineffective if not surrounded by accurate complementary policies which create a suitable arena for developing innovations.

6.2 How to design a policy intervention

As inferred by Colombo and Grilli (2006), policy schemes can be classified according to four basic criteria: main objective, main instrument, evaluation method and main target group. The main policy instruments have already been analysed. Moreover, this study's scope is restricted to policies whose main objective is supporting R&D investments. Thus, this paragraph aims at examining the remaining two dimensions, namely evaluation method and main target group.

6.2.1 Policy's evaluation method: automative vs selective schemes

As anticipated in the previous paragraph, policy schemes can adopt automatic or selective measures to evaluate applicants. An automatic subsidy provides financial support to any applicant satisfying the requirements indicated by the law. Contrarily, in selective schemes, applicants are in competition with each other and those who pass a careful evaluation by expert committees are awarded with financial assistance. The distinction between automatic and selective support schemes is central with regard to NTBFs. First, selective subsidies represent a

[36] Data from MICREF database indicate that in the period 2000-2011, in Europe have been launched 88 policy legislations to foster the creation of start-ups, but only 28 to enable a rapid second start after business failure.

powerful tool to reduce information asymmetries: on one hand, the competition among applicants will foster information sharing between firms and institutional experts; on the other hand, NTBFs will be more incline to communicate sensitive information, as public investors raise lower appropriability risks than private ones. Second, accessing to selective subsidies could generate a significant certification effect (Lerner, 1999), signalling to other stakeholders the quality of the scrutinised NTBF. Since NTBFs are acknowledged to severely suffer from adverse selection problems, this certification effect could hugely impact on their likelihood to access to external debt or equity and to establish strategic alliances with well-established firms in the market. In addition to that, selective forms of subsidies may prevent possible problems which frequently arise with automatic schemes. For example, the high risk of opportunistic behaviour from the recipient firms, which may label some expenses as "R&D-related" while they are actually related to other business activities. Also, private ventures are likely to use tax credits (the most common form of automatic subsidy) to first finance projects with the highest private rate of return (David et al., 2000), rather than the ones with the broadest gap between social and private returns – which should be the primary target of public policy.

Nonetheless, selective policies may also have peculiar pitfalls, which might reduce their effectiveness. For one thing, the high application opportunity costs could discourage firms from entering the program. Secondly, applicants could carry on lobbying activities to influence the selection, incurring in influence costs stemming from entrepreneurs focusing on unproductive activities (Milgrom and Roberts, 1990). What is more, the selection process itself is exposed to various possible bias, which will be further analysed in sub-paragraph 6.3.3.

Despite these possible negative events, the extant literature supports the claim that selective policy measures provide greater results when NTBFs are concerned.

Colombo, Grilli and Murtinu (2011) found that the effect of R&D policy interventions on firms' total factor productivity growth is positive and statistically significant only when they rely on a competitive selection of proponents. Conversely, automatic subsidies, even if very popular in the Italian context, are not alleged to foster firm productivity growth. In line with these results, Colombo,

Giannangeli and Grilli (2013) claim that the most relevant variable to consider is firm age: while neither selective nor automatic R&D subsidies have a considerable impact on mature NTBFs' employment growth, younger high-tech ventures benefit from selective interventions. This result provides support to the certification effect hypothesis: for newborn and young companies, subject to significant information asymmetries and lacking a consistent track record, obtaining a public selective subsidy could be of great help to signal their quality to the market.

6.2.2. A successful example of selective subsidy: the SBIR program

The SBIR program, acronym of Small Business Innovation Research, is a famous example of selective public intervention, as it provides selected R&D-intense ventures with financial awards delivered in subsequent stages.

The SBIR program joints public and private efforts in order to provide grants to finance private R&D projects. In particular, the government authorised every federal agency with yearly research expenses higher than $100 million to set aside 1.25% of these expenditures as awards for small businesses. In 2015, this percentage accounted for 2.9%, growing to 3.2% by 2017[37].

In this perspective, the government is alleged to act as an entrepreneur, by funding socially beneficial innovative investments which otherwise would have not been funded due to the greater uncertainty (Link and Scott, 2010). Overall, the declared objectives of the SBIR program are:

- To foster technological innovation
- To use small businesses to meet Federal research and development needs
- To encourage the participation of minorities and disadvantaged individuals in technological innovation
- To enhance private sector commercialisation of innovations stemming from Federal R&D.

[37] Source: SBIR Program Overview Presentation, available at *https://www.sbir.gov/about/about-sbir.*

The program, originally launched in 1982, has been modified and renewed several times over the years. However, the main purposes and the fundamental structure have remained unchanged. In particular, the award scheme is articulated in three subsequent phases. The objective of phase I is to assess the feasibility and commercial potential of an innovative idea. For this aim, SBIR phase I awards are set at $150,000 for 6 months. On the other hand, SBIR phase II awards are capped at $1,000,000 for 2 years: these awards, eligible only for firms which have obtained phase I awards[38], are meant to further develop the proposed research, ideally leading to a new commercialised product or service.

Businesses needing additional funds can rely on phase III awards. However, this last phase is not financed by the SBIR program; rather, some federal agencies may provide follow-on investment rounds. Currently, 12 federal agencies have joined the SBIR program and the amount of subsidies supplied is around $2.0-2.5 billion per year. In last years, several successful high-tech ventures, such as Symantec, Qualcomm and iRobot, received fundamental support from this program.

6.2.3 Policy's target: vertical vs horizontal schemes

A further dimension which plays an important role in determining the effectiveness of a policy intervention is its specific focus or target. In particular, public subsidies can assume two forms: "vertical" and "horizontal". Unlike horizontal subsidies, vertical ones are designed for a specific class of companies (as far as R&D subsidies are concerned, vertical subsidies are intended as regulations specifically targeting high-tech start-ups or innovative SMEs).

In a broad and comprehensive analysis of public policy measures in Italy, which will be further analysed in the last paragraph of this chapter, Colombo and Grilli (2006) conclude that every form of general-purposes horizontal policy is ineffective in supporting Italian high-tech ventures. An incisive public intervention should predominantly target companies with great potential and strictly constrained by market imperfections. For this reason, a more customised (vertical)

[38] However, from 2014, the Department of Defence, the National Institutes of Health and Education are allowed to make awards even to ventures which have not passed through phase I.

approach, able to better take into consideration the peculiarity of NTBFs could be needed.

However, vertical subsidies clearly pose problems in terms of more severe information asymmetries – both adverse selection and moral hazard.

That is why indirect intervention schemes, delegating selecting and monitoring functions to specialised entities, are probably more effective. Therefore, a viable solution could be to favour the development of efficient technology incubators and VC markets, in order to facilitate high-tech ventures' access to the essential inputs they need.

Martin and Scott (2000) take the "vertical approach" argument to extremes. They claim that the underlying forces leading to private underinvestment in innovation differ from industry to industry. Indeed, each sector has peculiar innovation modes, which will result in peculiar innovation failures: in order to address them, public policy will need to deploy different forms of support.

In intermediate good industries (e.g. Software), the main innovation mode is the development of high quality products serving as inputs in related downstream sectors. The main innovation failures in those markets are the high financial transaction costs faced by SMEs and the low appropriability related to general purpose technologies. In such arena, the government should make funds available to SMEs, allowing them to launch innovative products and fostering incumbents to do the same as a result of the weaker entry barriers. However, given that public institutions typically lack of proper screening and monitoring skills, direct grants, debts or equity financing should be avoided. Conversely, public policies should adopt an indirect approach, supporting private institutions such as venture capitalists.

On the other hand, dual sectors where firms innovate in order to adapt products and processes industrialised in upstream sectors to their own business needs (e.g. Agriculture) have different challenges. In order to support these industries to afford the expenses of keeping up with the technological frontier, institutions should deliver services acting as open technical repositories accessible by private firms, such as cooperative industrial research organisations.

For what concerns those few – but fundamental – industries developing complex systems (e.g. Aerospace, Electronics, Telecommunication) the most critical issues are the great cost and risk related to R&D investments. To this regard, policy makers should outline a competition policy to foster R&D cooperation and, if needed, they should also consider to provide direct subsidies in the early phase of cooperative activities. In some of these industries, a considerable source of innovation market failure is related to the development of a common paradigm for infrastructural technology. In this case, the significant network externalities could generate a "standards war", whose results could lead many companies to failure. Public bridging entities investing in infrastructural technologies would fill a critical gap in such situations.

Finally, when innovation is closely linked to basic research (e.g. Biotech, Pharmaceuticals), institutions should favour the transmission of scientific contents and knowledge from academic research to the private sector. In order to promote and strengthen formal and informal connections between companies and university researches, science parks could be a suitable solution.

6.3 Effective public support to innovative start-ups: a complex task

As it clearly emerges from the analysis carried out so far, designing an effective public policy in support of R&D investments and innovative start-ups is undeniably an extremely complex task, due to the great number of endogenous and exogenous factors to be managed.

For this reason, quite often the outcome of a public intervention in the innovation field deviates from what desired. Accordingly, the purpose of this paragraph is to shed lights on the most frequent and critical pitfalls which public subsidies may incur in.

6.3.1 Substitution and deadweight effects

A first risk, generated by public interventions supporting new firms' foundation, is that of disturbing and delaying the natural competition mechanisms. The two

main negative results of this distortion are well-known in literature as "substitution" and "deadweight" effects. In order to explain the way through which these effects could be engendered, the logical steps identified by Santarelli and Vivarelli (2002) will be taken as a point of reference. In particular, a useful starting point is the model of "noisy selection" introduced by Jovanovic (1982), which offers a simplified view of the entry and post-entry behaviour of new ventures. According to this model, start-ups do not know in advance which will be their cost function, but they will only discover it in the early phases of their operations, as long as they advance in their learning curve. In other words, newborn firms acknowledge their actual efficiency level only after they start operating in the marketplace. At that point, the best firms will grow and prosper, whereas inefficient ones will likely exit the market. Especially in high-tech industries, the assumption that entrepreneurs have only a rough idea of their future profitability before starting their business is absolutely sensate.

In this scenario, by moving downwards companies' cost function, public intervention will alter the market selection mechanism and – in so doing – could cause relevant distortions. Indeed, since the natural market selection is delayed, less efficient companies have the possibility to remain in the market as long as the subsidy's positive effect will counterbalance their low performances. Therefore, a public intervention aimed at fostering new firms' entry will likely to result in higher entry rates, but also a correspondent increasing failure rate when the subsidy ceases in operation. From this perspective, a subsidy could prove itself not only useless (because efficient firms would have not needed it, while non-efficient ones will eventually exit the market anyway), but also harmful (as less efficient ventures are allowed to stay in the market more than they would have without public support). In the former case, the policy intervention generates a deadweight effect: most of the recipients would have realised their potential even without the institutional aid and, thus, the policy measure does not add any benefit to the as-is situation. In the latter case, a substation effect arises: "bad" companies, destined to leave the market in any case, remain active longer at the expenses of more efficient potential entrants.

For the industrial policy, there are two viable alternatives to limit these problems: either changing the target of the subsidy (from potential entrants to already established ventures) or restricting the scope of the intervention, making the incentives conditional on some measures of efficiency.

6.3.2 Crowding-out effect

A second possible pitfall, specific of direct R&D support schemes, is the so called "crowding-out" effect, i.e. the possibility that institutions, due to information asymmetries or poor policy design, finance R&D investments that would have been undertaken even without public aid. Indeed, in order to demonstrate the effectiveness of public support programmes, it is essential that the principle of additionality is fulfilled. In other words, in a successful R&D support scheme, public funds stimulate a greater R&D effort, rather than simply substitute private expenditures.

A large body of empirical research has tried to disentangle whether R&D subsidies complement or substitute private R&D financing, but the dispute is still open. From a theoretical perspective, both hypotheses are supported (Garcia-Quevedo, 2004). On one hand, public R&D subsidies lowering private R&D marginal cost could be a stimulus for ventures to assign more resources to innovative projects; on the other hand, private companies could "free ride" on innovation, using public funds to finance R&D activities that would have been privately funded anyway.

One of the most comprehensive literature survey, conducted by David et al. (2000), claims that there is an overall prevalence of studies refusing the "crowding out" hypothesis, despite various methodological issues. Even if empirical results are far from unanimous (Zuniga-Vicente et al., 2014), most of more recent studies support the argument that "crowding out" effects are not significant. However, the above mentioned results hold for average companies. On the contrary, the only few studies investigating the impact of public policies on innovative start-ups cast more than one doubt on the success of direct policy funding. For example, Schneider and Veugelers (2010) found that even though R&D subsidies lead on average to

greater innovative performances of the recipient companies, this result is not detected on YICs.

6.3.3 Selective subsidies: the problem of a fair selection

Until now, the entire analysis of public policy measures has been built on an implicit assumption, namely that policy makers act in the interest of the public community. Unfortunately, political class' interests often deviate from social interests in practise. In other words, politicians might seek to provide subsidies in a way that benefits themselves and create political consensus (Colombo and Grilli, 2006). According to Lerner (2002), these distortions – which are strictly related to selective subsidies – can assume different forms.

For instance, politicians could supply funds to politically-connected companies simply to increase their profitability. Another possibility is that institutions provide selective subsidies to firms with high likelihood of success, even if they would not actually need public funds. This sort of "conscious deadweight effect" allows politicians to claim credit for the company's success even if public aid played a negligible role in it.

Even in case policy makers are willing to act in behalf of the people, another reason to be cautious about government intervention results is that they can simply get it wrong. To this regard, Lerner (2010) noticed that more competent public programmes are likelier in wealthier states, characterised by an English legal tradition and heterogeneous populations.

A further possible bias in selective subsidies occurs when the members of the selection committees are influenced by the reputation of the applicants, rather than the actual quality of the project under scrutiny. In particular, as previous awards significantly affect a firm's reputation, there is a strong risk that firms that already received a selective subsidy in the past will be much more likely to obtain a new subsidy. In this scenario, there are high risks that screening committees will become "prisoners" of the former assignees of R&D subsidies, which could be selected just thanks to their reputation, rather than after a fair assessment of their

current quality. The resulting persistence in funds allocation has generally been considered as a negative bias of the selection process and a form of inefficiency of selective R&D interventions. In order to assess the relevance of this issue, Antonelli and Crespi (2013) adapt to research policy the concept of "Matthew effect" – used in sociology to describe a situation where who already has status possesses greater chances to gain more, whereas who has not status generally struggles to obtain more. In particular, most of the antecedent studies focused on a negative – or "vicious" – Matthew effect, i.e. when public funds are provided to already awarded companies even if they actually reduced their commitment to R&D after obtaining previous subsidies. However, the authors claim that also a positive (or "virtuous") type of Matthew effect exists, when the provision of subsidies targets firms that have used prior public funds to effectively scale up their R&D operations. In this case, the Matthew effect would improve public policy's performances, as a consistent assessment method (i.e. awarding companies which successfully exploited previous public financing) would be adopted in place of the arbitrary criteria commonly used in absence of a precise evaluation strategy.

Empirical results, obtained on a sample of Italian firms, confirm the existence of a positive allocation persistence in the Italian context, which supports public authorities in "picking the winners", i.e. selecting companies with enhanced innovative performances.

6.4 Public policy: some examples

In conclusion to this chapter, some examples of implemented policy programs will be analysed. First, the relevance of public programs fostering high-tech start-ups growth will be highlighted through a comparison between two countries which underwent completely different policy paths, namely Jamaica and Singapore.

Second, the successful case of the Yozma Venture Capital, an Israeli VC support program, will be presented. Finally, in order to prepare the way for the analysis of the Law 221/2012 (Chapter 7), a review of the Italian industrial policy context will be provided.

6.4.1 The impact of public policy: the different paths of Jamaica and Singapore

As noticed by Lerner (2010), Jamaica and Singapore are two relatively small countries, with less than 5 million residents. Nonetheless, from an economic perspective, they are drastically different: while in 2006 Singapore's GDP per capita accounted for $31,400, the same figure in Jamaica was $4,800. What is interesting to note is that in the early years of their history, both countries had nearly the same wealth conditions: in 1965, pro capita GDP was $2,850 for Jamaica and $2,650 for Singapore. Moreover, they both were British colonies, they had a central port and both counties' institutions had a marked capitalistic attitude. How to explain the current gap in the economic prosperity of these two states? The answer is an interplay of several factors: while Singapore was able to establish an open and corruption-free economy, based on focused investments on infrastructures, education system and independent wealth funds, Jamaica severely suffered from political and (consequent) economic instability, also due to the hefty public debt and violence which hampered the implementation of a consistent long-term economic policy.

Focusing on Singapore, it is possible to assert that most of the initial growth can be attributed to effective macroeconomic policies, political stability and other factors; however, entrepreneurship initiatives represented a crucial ingredient in stimulating growth in the following years. In particular, the government has implemented a broad range of policies to develop a solid entrepreneurial sector, such as public funds meant to attract external VC investors in Singapore, direct subsidies for targeted technologies, incentives for biotech researchers to move to the city-state, encouragement of potential entrepreneurs (e.g. awards for failed entrepreneurs).

Conversely, entrepreneurial activities in Jamaica have to face several barriers and, as a result, only a small percentage of early-stage entrepreneurial businesses is converted into mature enterprises. Some of these barriers are highlighted in the World Bank's 2008 analysis (International Finance Corporation, 2010a).

First, in terms of easiness to comply with tax regulations (measured by both fiscal costs and administrative burdens related with complying with the tax code),

Jamaica is ranked 170th out of the 178 scrutinised countries. Since access to external finance is particularly arduous for NTBFs, a limited available internal capital due to high tax obligation could represent a strong deterrent for business growth. Conversely, in this particular ranking, Singapore owns the 2nd position (International Finance Corporation, 2010b).

Second, Jamaica is ranked 108th for what regards the cost of registering property (as a percentage of the value of the property). As a consequence of the high cost of registering property, fewer people register their holdings, which means less secure property rights. Because of this, entrepreneurs without a firm legal title to property will be probably unable to borrow against this holding from a bank: the final outcome, in this case also, is a reduction in the resources available to grow.

6.4.2 Public intervention and VC market: Yozma Venture Capital

In his analysis, Lerner (2010) also presents some examples of successful public support schemes for young high-tech companies.

Among these, the Yozma Venture Capital Ltd., a $100 million fund established in 1992 in Israel, merits a great deal of attention. The main aim of this fund, fully owned by the Israeli government, was to attract foreign venture capitalists' financial resources, expertise and network of contacts, in order to stimulate the development of an effective domestic VC market. Indeed, in 1992 there was a single VC firm operating in the state, despite the abundance of skilled entrepreneurs working on innovative technologies. However, these latter preferred to rely on debt finance rather than equity, because of the immaturity of the Israeli VC market and the overall scepticism to sell equity to external parties. Unfortunately, given the difficulty for NTBFs to obtain bank loans, most of the entrepreneurial activities at that time were failing to develop and market their products.

To fill this gap, foreign investors were given the possibility to obtain matching funds from Yozma (usually $8 million of a $20 million fund). Further incentives were provided in case the projects proved successful: in fact, venture capitalists

had the opportunity to buy back the government share within 5 years, with an interest rate around 5-7% of the initial value.

What is more, the bureaucratic burdens to join the program were sensibly lowered, allowing external investors to have an easy access to public support. Together with these financial incentives, a critical feature of the Yozma program was represented by its legal structure, built on the US model (e.g. limited partnership) in order to make it suitable for foreign VC investors.

The results of the Yozma Venture Capital went well beyond the most optimistic expectations: ten VC groups, coming from US, Japan and Western Europe, exploited the opportunity offered by the Israeli government, achieving outstanding returns and stimulating the appearance of larger follow-on funds.

Ten years after the program launch, the ten initial Yozma groups were managing $2.9 billion of Israeli funds and the overall VC market was made of 60 different VC organisations, managing around $10 billion.

6.4.3 The Italian public policy context

Before 2012, when Law 221/2012 became a reality, there were not any direct or indirect large-scale public supports in Italy explicitly targeted to innovative start-ups (Colombo, Croce and Guerini, 2013). Indeed, the only policy partially oriented towards NTBFs was Law 297/1999, whose purpose was to favour the emergence of academic start-ups. On the contrary, the general tendency of Italian governments in the 1990s and early 2000s was either to implement horizontal schemes directed to all companies, or to support specific industries, or to focus on young small firms regardless of their operating sector.

Following the classification introduced by Colombo and Grilli (2006) – already mentioned in paragraph 6.2 – it is possible to identify four dimensions related to public subsidies: main objective, evaluation method, main instrument and main target group. In particular, out of the 28 policy measures that provided some kind of financial support to Italian NTBFs up to 2003, there is no predominance of a specific evaluation method, as both automatic (16) and selective (12) subsidies

have been delivered[39]. For what regards the main instrument, albeit direct forms of subsidies, such as financial contributions, have been generally preferred to fiscal benefits (respectively 20 and 14 schemes), more recent public interventions have been increasingly based on tax incentives. In terms of targeted companies, statistics provide support to the argument that Italian institutions favour horizontal schemes targeting all types of firms (17), rather than focusing on stimulating entrepreneurship and SMEs (11). Finally, most of the policy programs put in place aims at supporting general-purpose investments – such as equipment, new plants and employment – rather than focusing on R&D activities. In the next page, Figure 11 summarises the results reported by Colombo and Grilli (2006).

A similar evaluation of the Italian industrial policy context, offered by Colombo, Croce and Guerini (2013), analyses policy objectives from a different perspective. In particular, while the authors agree on the secondary role played by policies supporting R&D and innovation (responsible for the 22% of the subsidies provided to private companies between 2000 and 2003), they noticed that the primary goal for Italian policy makers was to sustain businesses located in the South, where the worse economic and social conditions reflect the need of public intervention.

In particular, policy interventions targeting the Italian "Mezzogiorno" in the period 2000-2003 accounted for almost half (46%) of the total number of subsidies awarded to private firms.

[39] However, in the early 2000s it is possible to observe a clear tendency towards automatic support schemes.

Figure 11 – Taxonomy of Italian industrial policy

Number of the national scheme		1329	1089	902	46	696	26	44	64	113	318	346	11	317	215	488	17	236	451	95	341	140	196	266	449	297	185	388	383
Year of implementation		'65	'68	'76	'82	'83	'86	'86	'86	'86	'87	'88	'89	'91	'92	'92	'93	'93	'94	'95	'95	'97	'97	'97	'97	'99	'00	'00	'01
Main Objective	R&D Investments		X		X							X		X								X	X			X			
	General-purpose investments	X		X		X				X	X		X		X		X	X	X	X				X	X			X	X
	Depressed areas						X	X	X							X					X						X		
Evaluation Method	Automatic	X				X					X			X	X		X		X		X	X	X	X	X	X	X	X	X
	Selective		X	X	X		X	X	X	X		X	X			X		X		X									
Main Instrument	Fiscal benefits or incentives		X				X							X	X		X		X		X	X	X	X	X	X		X	X
	Financial contributions	X	X	X	X	X	X	X	X	X	X	X	X		X	X		X		X	X		X			X	X		
Main Target Group	All firms	X	X	X	X		X			X		X	X			X	X	X	X		X	X				X		X	X
	New entrepreneurship or SMEs					X		X	X		X			X	X					X			X	X	X		X		

Source: Colombo and Grilli (2006)

7. Law 221/2012: a specific support to innovative start-ups

As underlined in sub-paragraph 6.4.3, until short time ago there was not any vertical public policy directly targeting NTBFs in Italy. This condition drastically changed in October 2012, thanks to the proclamation of the Decree Law No. 179/2012 (also known as "Decreto Crescita 2.0"), subsequently converted into Law No. 221/2012 (named "Ulteriori misure urgenti per la crescita del Paese") and come into force starting from 18th December 2012. In this perspective, the Law 221/2012 represents an important turning point for Italy, since for the first time a comprehensive, systematic and detailed package of measures aimed at favouring birth and growth of innovative start-ups has been introduced in the Italian policy context.

From a political point of view, the establishment of the technocratic Monti cabinet (2011-2013) offered the perfect conditions for the emergence of such policy; indeed, the Law 221/2012 is coherent with the goals of the governmental economic agenda, "Programma Nazionale di Riforma 2012" [40], where integration among UE countries and compliance with the "Europe 2020" program are seen as the only viable way to come out of the 2008 financial crisis. In particular, as explained in Chapter 2, the "Europe 2020" agenda predicates a "smart, sustainable, inclusive growth" with greater coordination of national and European policies. Therefore, with this goal in mind, the Ministry of Economic Development set up a task force composed by 12 experts, in order to produce ideas, incentives and concrete proposals to boost Italian economic growth. The output of these efforts is represented by the report "Restart, Italia!", published in September 2012, which constitutes the backbone of the Decree Law 179/2012.

Among all the policy measures discussed in the statutory law, the entire Section IX (Article 25-32) is dedicated to birth and development of Italian innovative start-ups. The overall rationale of the new provisions is elucidated in Article 25 of the Decree: supporting sustainable growth, technological development, new

[40] http://ec.europa.eu/europe2020/pdf/nd/nrp2012_italy_it.pdf

entrepreneurship and employment, particularly among young individuals. At the same time, the instructions in Section IX are meant to contribute to the emergence of a new entrepreneurial culture and to a context able to spur innovation, together with a greater social mobility and attractiveness of Italy in the eyes of foreign talents, companies and funds.

Before starting the analysis of the main elements of Law 221/2012, it is important to underline that its legislative text has been subject to frequent updating; for example, the Law Decree 76/2013 (also known as "Decreto Lavoro") simplified the requirements for companies to be included in the section dedicated to innovative start-ups and benefit from the related special provisions. Therefore, the following analysis will use as a reference the current legal text; however, the most important modifications occurred will be signalled in the notes.

7.1 Italian innovative start-ups: definition and prerequisites

7.1.1 Prerequisites

The definition of Italian innovative start-up (henceforth, ISUP) is characterised by a set of well-defined criteria, primarily related to factors such as ownership, age, revenues, purpose and innovativeness of the start-up under scrutiny.

As specified in Art. 25, an ISUP is an Italian-based limited company (including cooperatives), whose shares or representative shares are not listed on a regulated market or on a multilateral trading system. Moreover, in order to get access to the special section of the Business Register of the Italian Chamber of Commerce for ISUPs, a company must possess a number of "cumulative" requirements, plus at least one of the "alternative" ones.

The "cumulative" requirements are:

a) They are owned directly by natural persons, who control the majority (i.e. at least 51%) of the company's shares and voting rights.
b) They are 5 years old or younger[41].

[41] Initially, the maximum age for being included in the special section of the register was set at 48 months (4 years). More recently, the Law 33/2015 has increased the maximum working period to 5 years.

c) They are located in Italy, or in a EU country or in nations sharing the deal on the European economic area, as long as they have a subsidiary or a productive branch in Italy.
d) Starting from the second year of activity, the total yearly production value is not greater than 5 million Euros.
e) They do not pay dividends.
f) Their exclusive or prevailing business purpose is the development, production and commercialisation of innovative goods or services of high technological value.
g) They have not been established from companies' mergers, corporate splitting or as a result of a corporate divestiture or a corporate branch.

Moreover, firms must also satisfy at least one of the three following alternative criteria, aimed at determining their innovative nature:

h_1) R&D expenditures account for at least 15% of the highest value between cost and production value[42].

h_2) At least one third of the employees (or any kind of collaborators) must have a PhD title (or they are enrolled in a PhD program), or they possess a degree and have been working in certified research activities for at least three years; alternatively, at least two thirds of overall labour force have a M.Sc. degree title.

h_3) The company has the legal ownership of an industrial or biotechnological invention, or of a topography of semiconductor products, or of a new vegetable variant.

Companies established before the conversion of the Law Decree into Law (i.e. 18th December 2012), and in possess of the above listed pre-requisites, can have access to the ISUP section if they submitted a certification of their compliance with the

[42] The minimum R&D expenditure was initially set at 20%, until Law 99/2013 reduced this threshold to 15%.

selection criteria within 18th February 2013. In such case, they can benefit from the program for a variable period, depending on their age: i.e. 4 years if they are 1 or 2 years old, 3 years if they are 3 years old and 2 years if they are 4 years old.

In parallel with the delineation of ISUPs, the Law 221 also defines another special entity, namely "certified start-ups incubator". In this regard, incubators are defined as limited companies providing services to support birth and development of innovative start-ups. In order to be considered as certified incubators, firms need to own specific facilities and equipment to support innovative start-ups (e.g. spaces for research or testing activities, meeting rooms, ultra-wide band, etc.), have recurrent partnerships with universities and public research organisations and a deep expertise in supporting innovative newborn ventures.
As ISUPs, certified incubators benefit from sources of assistance such as fiscal credit, simplified business start-up, exoneration from the stamp duty and facilitated access to the Central Guarantee Fund.

7.1.2 The access to the special section of the Business Register

In order to be registered in the special section dedicated to ISUPs, companies are required to self-certificate their compliance to the peculiar requirements characterising ISUPs or certified start-ups incubators. As soon as the self-certification (in electronic format) is presented, a company is automatically labelled as ISUP or certified incubator, and its basic information (e.g. founding date and location, business purpose, shareholders list, contacts, etc.) are downloaded on the Chamber of Commerce website. In addition to that, companies mandatorily have to update such information every 6 months and provide a new self- certification of compliance within 30 days from the yearly approval of the budget. If this is not done, the company will be excluded from the special section within 2 months.
Such registration procedure has a twofold rationale: on one hand, administrative costs for the admission process are extremely lowered, as the government is asked to simply supervise ex-post the veracity of those statements; on the other hand, this

allows a transparent management and provision of information about ISOPs, that are web-based and freely accessible by any interested third party.

7.2 Law 221/2012: a wide menu of instruments

Registered firms benefit from a great number of supporting provisions, gradually extended since 2012, intended to foster a protected setting for their initial growth. In this paragraph, the most relevant provisions will be divided in different groups according to their main purpose.

1. Reduction of start-up phase burdens (Art. 26):

- Since, during its first years of activity, a start-up is likely to generate low or null revenues while incurring in relatively high start-up costs, ISUPs can extend by one year[43] the period within which they are obliged to pay back a business loss, when this latter is greater than one third of the corporate capital.
- ISUPs constituted as Ltd firms have the possibility to independently determine shareholders' rights, by creating special categories of shares deprived of voting rights or with non-proportional voting rights.
- Both ISUPs and certified incubators are exonerated from stamp duty, administrative fees for the registration to Business Register and annual fee in favour of the Chamber of Commerce.
- The Law Decree 3/2015 ("Investment compact") has established that ISUPs can edit their Articles of Association in electronic format and sign them with electronic signatures. In order to do so, the Article of Association must be compliant to the standard model attached in the Decree Law.

2. Remuneration through capital-participation instruments (Art. 27):

- ISUPs and certified incubators can enjoy the benefits of a favourable fiscal regime related to the provision of capital-participation instruments. In

[43] For other companies, this period lasts until the end of the following fiscal year.

particular, the income deriving from the provision of financial incentive plans based on stock options, shares or similar titles to administrators, employees, collaborators and suppliers will not be part of the taxable income.

3. Tax credit for hiring highly-qualified personnel (Art. 27-bis):

- As other types of companies, also ISUPs and certified incubators benefit from a tax credit equal to the 35%[44] of the hiring cost for permanent contracts destined to highly-qualified personnel[45], as established by the Decree Law 83/2012. However, for ISUPS and certified incubators tax credit is conceded in a priority way and for apprenticeship contracts as well.

4. Flexibility in the use of short-term employment contracts and the payment of salaries (Art. 28): ISUPs can enjoy tailored employment regulations which allow for a greater operative flexibility, particularly in the early phase.

- In fact, it is possible for them to stipulate fixed-term contracts lasting from 6 to 36 months. After 36 months, these contracts can be extended only once, for a maximum of 12 additional months. At the end of this 48-month period, usually characterised by great risk, a contract will become permanent.
- Besides a minimum wage level (fixed), employees' compensation is primarily made by a variable component, which could be related to factors such as company's efficiency or profitability, employee's productivity or other parameters agreed by the two parties (employer and employee).

5. Incentives to invest in ISUPs (Art. 29):

- For the years 2013, 2014, 2015 and 2016, fiscal incentives are available for natural or legal persons investing in ISUPs. This beneficial fiscal exemption is valid for both direct and indirect investments that are kept for at least 2

[44] For a maximum yearly amount of €200,000 per venture.

[45] Highly-qualified personnel are represented by i) individuals owning a PhD title or ii) individuals possessing a Master Degree in technical or scientific field, employed in R&D activities.

years. In particular, individuals can deduct 19% of their investment in ISUPs from their taxable income, for a maximum of €500,000. As far firms[46] are concerned, the deductible percentage rises to 20%, with a maximum of €1.8 million.

- If the above mentioned investments are focused on social vocation ISUPs or ISUPs developing and commercialising high-value tech products or services in the energetic field, the fiscal deductions rise to 25% and 27% of the invested amount, respectively for individuals and companies.

6. Support in capital raising (Art. 30):

- ISUPs are authorised to gather capital through crowdfunding platforms[47]. Thanks to this permission, ISUPs are allowed to gather equity capital through online platforms, monitored by Consob ("Commissione Nazionale per le Società e la Borsa"). In particular, this institute has the duty to protect the interest of non-professional investors.
- ISUPs can have a simplified and no-cost access to the Central Guarantee Fund for small and medium enterprises. This public fund has been created by the Ministry of Economic Development, partially built on European financing, with the aim of supporting SMEs, for which access to bank loans is particularly difficult due to the lack of collateral. In particular, SMEs might substitute the traditional (and expensive) guarantees with a public guarantee to obtain funds from banks, leasing organisations and other financial intermediaries. The public guarantee can cover up to 80% of the financing, with a maximum total sum of €2.5 million. This limit is related to the guaranteed amount, whereas there is no ceiling on the financing amount. The access to the Central Guarantee Fund is not conditional on the sector in which a company operates: indeed, companies from every industry – with the exception of financial organisation – can apply for the guarantee.

[46] ISUPs themselves, together with OICRs ("Organismo di Investimento Collettivo del Risparmio") and other ventures investing mainly in ISUPs are excluded from the fiscal benefits.

[47] Until January 2015, ISUPs were the only Italian legal entities enabled to adopt this innovative financing channel. With the Investment compact, this right has been extended to innovative SMEs as well.

As the implementation of the Law generally requires some time, the "fast track" access to the Central Guarantee Fund has been adopted since May 2013.

7. Support to internationalisation (Art. 30):

- ISUPs are included among the recipients of the services offered by the ICE-Agency, a public institution aimed at promoting Italian companies' internationalisation. In particular, this authority provides various forms of assistance, such as legal, corporate, fiscal, real-estate and contractual consultancy. Moreover, the ICE-Agency designs initiatives to put in contact innovative start-ups and potential investors and allows supported firm to participate at no-cost to the main international fairs and events related to their business.

8. Exemptions from bankruptcy law or "fail-fast" (Art. 31):

- The Law offers unsuccessful ISUPs the possibility to exploit a set of procedures aimed at alleviating and speeding-up the failure process, in order to allow entrepreneurs to easily and quickly restart a new business after a failure. Moreover, after 12 months from the beginning of the liquidation process, information related to shareholders are no longer publicly available, but they can only be accessed by judicial authorities: in this way, the reputational burdens caused by a business failure will have a reduced impact on entrepreneurs' image.

7.3 Innovative start-ups in 2016: main features and early results

As anticipated in the Introduction, the main purpose of this study is to evaluate the effectiveness of the Law 221/2012 in favouring ISUPs' investments. In particular, the focus will be put on the correlation between access to external finance and firm investments. However, before building and presenting the econometric models, it

is worthwhile to get a snapshot of the ISUPs currently operating in Italy and show some first evidences of public policy's effectiveness.

7.3.1 Descriptive statistics of the current ISUPs population

In order to encompass the main characteristics of Italian companies currently registered in the special section of the Business Register reserved to ISUPs, it will be referred to the official report on innovative start-ups published by the Chamber of Commerce (data elaborations updated to July 2016, 1st [48]).

Since its launch in October 2012, the ISUP program has obtained greater and greater visibility, as a result of the steadily increasing number of companies accessing the special section. In particular, at the end of June 2016 the number of registered ISUPs was equal to 5943, with a consistent growth of 9.27% in respect to the previous trimester. As showed in Table 2, this growth trend is confirmed looking at data related to the second part of 2015[49].

Table 2 – Number of companies registered to the special section of the Business Register.

	3rd trimester 2015	*4rd trimester 2015*	*1st trimester 2016*	*2nd trimester 2016*
No. of ISUPs	4704	5143	5439	5943
% variation in respect to the previous trimester	+10.7	+9.3%	+5.8%	+9.3%

Source: elaboration on data from startup.registroimprese.it

Therefore, even if ISUPs still represent a minority (0.38%) among the overall Italian capital companies' population, their number is increasing on average by more than 100 units per month.

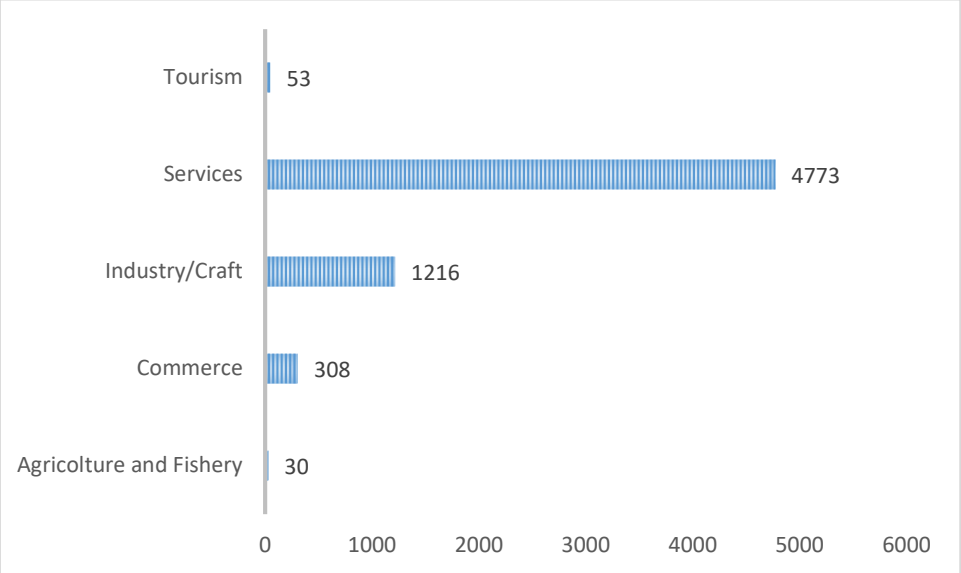
Out of the total number of ISUPs registered until October 2016, 12th the 74.6% operates in the Service industry (the prevailing businesses are software

[48] The report is available online at *http://startup.registroimprese.it/report/2_trimestre_2016.pdf*.

[49] Moreover, a more recent statistic (updated at 12 October, 2016) shows that the number of ISUPs is still increasing, as in that date it accounts for 6399 (+ 7.7% from June 2016).

manufacturing & IT consultancy, 30%; and R&D activities, 15%) whereas the 19% of them is active in Industry/Craft macro-sector (the main activities are machineries and electronic goods manufacturing). Figure 12 exhibits the distribution of ISUPs according to the macro-sectors in which they operate[50].

Figure 12 – Distribution of ISUPs by ATECO economic sector

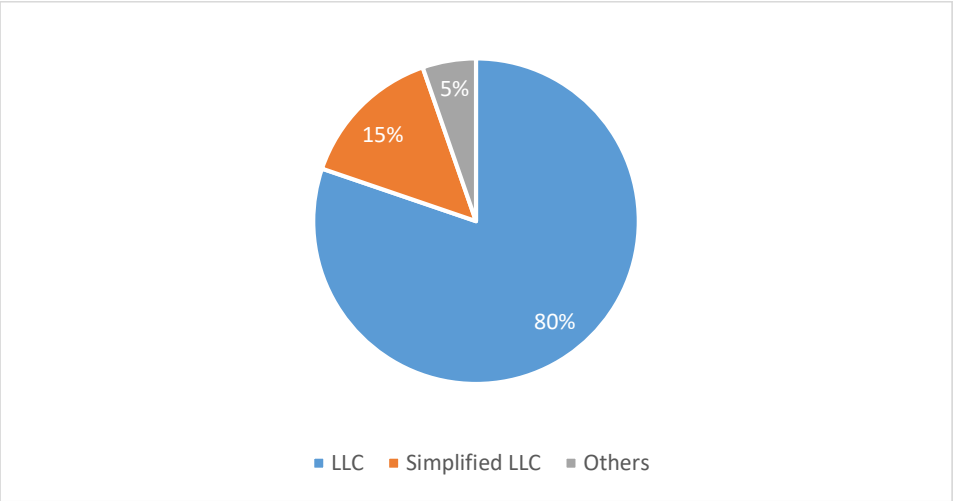


Source: elaboration on data from startup.registroimprese.it

For what regards the legal nature of ISUPs (see Figure 13), there is a significant predominance of limited liability companies (LLCs), which constitute the large majority of registered ISUPs (80%), followed by Simplified LLC (15%). Other legal status account for the remaining 5%[51]. As a matter of fact, LLC is by far the most suitable legal status for small and young companies as ISUPs (with no distinction between the different LLC forms, they account for the 96.7% of the total number of ISUPs), whose capital size is relatively narrow (the 86.7% of ISUPs has a capital size lower than €50,000; the 62.37% even below €10,000).

[50] For 19 ISUPs out of the 6399 registered up to the 12 October 2016 a classification is not available.
[51] Among other legal status, the most representatives are: cooperative (2.02%), LLC with a single shareholder (1.78%) and Ltd (1.14%).

Figure 13 – ISUPs' legal status



Source: elaboration on data from startup.registroimprese.it

The exponential birth of innovative start-ups also affected Italian employment rate. In particular, at the end of the first trimester of 2016, 8193 individuals are employed in ISUPs (+25,58% in respect to December 2015). Obviously, the constraints in terms of size and age does not allow ISUPs to reach comparable performances in terms of employees' number with the average capital company (3.48 employees on average vs 14.31).

Table 3 – Number of employees of ISUPs (1st trimester 2016)

	Overall capital companies	*ISUPs*
Mean value	14.31	3.48
Median value	3	2
No. of firms with employees	577,627	2,356
No. of total employees	8,267,626	8,193

Source: startup.registroimprese.it

Nonetheless, it is interesting to note how ISUPs show a greater average number of shareholders in respect to the average capital company (see Table 4).

Table 4 – Number of shareholders of ISUPs (2nd trimester 2016)

	Overall capital companies	*ISUPs*
Mean value	2.6	3.97
Median value	2	3
No. of firms with shareholders	1,445,311	5,801
No. of total shareholders	3,756,199	23,045

Source: startup.registroimprese.it

As a matter of fact, the above mentioned data support the hypothesis that, conversely to what happens for the average firm, a greater part of ISUPs' shareholders is directly involved in a company's activities.

As far as ISUPs geographical distribution is concerned, Lombardia is the Italian region hosting the higher number of ISUPs (21.6%), followed by Emilia Romagna (11.8%) and Lazio (10.1%), as shown by the ranking provided in Table 5. However, if the number of ISUPs in a given region is compared to the number of capital companies in the same region (regional density), the most relevant incidences can be found in Trentino-Alto Adige (1 ISUPs per 100 capital companies), Marche (0.73%) and Friuli-Venezia Giulia (0.62%).

Table 5 – Regional distribution and density

Region	*No. of ISUPs*	*% on the overall number of ISUPs*	*% on the overall number of capital companies in the region*
Lombardia	1285	21.62	0.40
Emilia-Romagna	703	11.83	0.63
Lazio	601	10.11	0.23
Veneto	450	7.57	0.38
Piemonte	387	6.51	0.53
Campania	370	6.23	0.24
Toscana	330	5.55	0.32
Marche	282	4.75	0.73
Sicilia	276	4.64	0.30

Table 5 - continued

Puglia	222	3.74	0.27
Trentino-A.A.	191	3.21	1.00
Sardegna	155	2.61	0.45
Friuli-V.G.	146	2.46	0.62
Abruzzo	139	2.34	0.42
Calabria	136	2.29	0.41
Liguria	101	1.70	0.32
Umbria	91	1.53	0.43
Basilicata	46	0.77	0.43
Molise	21	0.35	0.31
Valle d'Aosta	11	0.19	0.49

Source: startup.registroimprese.it

Also when dealing with provinces, there is a marked distinction between absolute number of ISUPs (Table 6) and provincial density (Table 7). As for the former, Milano (14.7%) leads the top 10 ranking, followed by Roma (8.8%) and Torino (4.9%).

Table 6 – Provincial distribution (top 10 provinces)

Province	*No. of ISUPs*	*% on the overall number of ISUPs*
Milano	874	14.71
Roma	520	8.75
Torino	291	4.90
Napoli	190	3.20
Bologna	178	3.00
Modena	145	2.44
Firenze	139	2.34
Trento	134	2.25
Bari	114	1.92
Padova	112	1.88

Source: startup.registroimprese.it

On the other hand, the most salient cities in terms of provincial density are Trento (1.35 ISUPs per 100 capital companies), Trieste (1.25%) and Ascoli Piceno (1%). As one may note, only four provinces (Trento, Torino, Bologna and Modena) appear in the top 10 ranking for both absolute number of ISUPs and density.

Table 7 – Provincial density (top 10 provinces)

Province	*No. of ISUPs*	*% on the overall number of capital companies in the province*
Trento	134	1.35
Trieste	50	1.25
Ascoli Piceno	61	1.00
Ancona	107	0.99
Macerata	55	0.71
Torino	291	0.71
Pordenone	41	0.71
Ravenna	54	0.68
Bologna	178	0.67
Modena	145	0.67

Source: startup.registroimprese.it

A last interesting element to spot is related to the innovative resources owned by ISUPs. In particular, in is worthwhile to analyse which of the three alternative pre-requisites regarding innovation are satisfied by ISUPs: in other words, how many ISUPs accessed the program because they respect the 1st, the 2nd or the 3rd criterion[52]. The first criterion (related to a minimum threshold of R&D expenditures) is by far the most frequently possessed, as 4,112 out of 6,399 ISUPs respect it. Moreover, 1,824 companies meet the second requisite (related to employees' education and experience) and only 1,278 the third (related to patents). Albeit most of the registered ISUPs (i.e. 5,605) possess only one of the three criteria, more than 540 ISUPs respect two of them. Finally, a set of 175 companies, particularly rich in terms of innovative inputs – meet all the three pre-requisites.

7.3.2 Early evidences of public policy results

In this sub-paragraph, some first evidences of the results carried out by the Decreto Crescita 2.0 and the recipient ISUPs are shown.

[52] A complete description of the 3 alterative selection criteria has been provided in Paragraph 7.1.

An analysis performed by "Il Sole 24 Ore"[53] in April 2016, provides sensible information about the magnitude of the policy intervention under scrutiny.

In particular, in 2013, 844 natural or legal persons have invested app. €28.2 million in start-ups. More specifically, €14.5 million have been provided to 338 start-ups by natural persons, who have benefitted of €2.9 fiscal allowances for their efforts. Similarly, legal entities have financed 126 start-ups with app. €13.7 million, corresponding to almost €3 million of reduced taxable incomes.

Significant data also emerge from the report[54] regarding ISUPs and Central Guarantee Fund drafted by the Ministry of Economic Development. In the last three years (September 2013 - September 2016), the Central Guarantee Fund has guaranteed 1,987 financings to 1,239 ISUPs, accounting for €490.4 million (and a guaranteed related-value greater than €384 million). The average value of the guaranteed financings towards ISUPs is equal to €246,804, while the average duration of such financings is 54.8 months.

In addition to that, VC investments in the period 2013-2014 have grown by 208% in respect to 2011-2012, even if the overall amount is still considerably low if compared with other European countries (0,002% of GPD).

In conclusion, it is useful to underline some figures – stemming from 2014 financial documents[55] – that testify ISUPs' main economic performances.

The average production value for ISUPs accounts for €114,000, while average assets are equal to €214,000: nevertheless, these figures are significantly unbalanced among companies, as half of the innovative start-ups produced less than €21,303 in 2014 and has assets lower than €62,000.

As predictable – due to the high investment costs required in their early phases – the majority (56.5%) of ISUPs produced losses in 2014, whereas the remaining 43.5% registered a budget surplus. As exhibited in Table 8, the main profitability indicators are negative for ISUPs. However, when focusing only on companies

[53] http://www.diritto24.ilsole24ore.com/art/avvocatoAffari/mercatiImpresa/2016-04-06/la-situazione-4-anni-decreto-crescita-20-e-vigenti-incentivi-sostegno-innovazione-144432.php

[54] Downloadable at: http://www.economyup.it/upload/images/10_2016/161013163355.pdf

[55] These data refer to the 2860 ISUPs for which 2014 balance sheet is publicly available.

generating profits, both ROI and ROE are sensibly greater for ISUPs than for the average capital company. A same dynamic is also true for both financial independence[56] and "added value to production value" ratio.

Table 8 – Main financial indicators

	ISUPs		*Average capital company*	
	total	*only profitable ones*	*total*	*only profitable ones*
ROI	-0.12	0.10	0.02	0.02
ROE	-0.28	0.21	0.03	0.03
Financial independence	0.36	0.28	0.36	0.36
Added value/production value	0.15	0.33	0.21	0.21

Source: startup.registroimprese.it

[56] Computed as "equity to asset" ratio.

8. Research hypotheses and data analysis

8.1 Research hypotheses

The overall objective of this study is to investigate the determinants of Italian innovative start-ups' investment behaviour. In particular, primary attention is paid on the capital structure of a company: since constraints in accessing external debt and equity capital have been identified by the extant literature as one of the main causes of start-ups' underinvestment, it is possible to expect that ISUPs with greater internal funds availability will likely invest more than others. Therefore, the following research hypothesis is derived:

H1: Innovative start-ups with a larger pool of internal capital resources will show greater investment rates.

Moreover, those start-ups able to obtain external capital, in the form of debt or equity, will have an additional source to finance their investment in respect to those which do not access external capital. Therefore:

H2: ISUPs having VCs among their shareholders will have greater capital resources. In addition to that, VC firms will exert a "coaching" function that will provide guidance to the invested firm. For such reasons, VC-backed ISUPs will invest more than their non-backed counterparts.

H3: ISUPs receiving government guaranteed bank loans will enjoy additional debt capital which can be exploited to follow up with investment opportunities.

H4: Since the amount guaranteed by the Central Guarantee Fund is – to some extent – proportional to the bank financing amount – the greater the guaranteed amount, the higher the debt external finance injected into the start-up. Accordingly, firms benefitting from higher guarantees will show greater investment rates.

Since a privileged access to equity and debt capital is one of the main prerogatives of Law 221, these arguments also offer the opportunity to put in place a first review of the initial effectiveness of supplied public subsidies in spurring ISUP's investments.

8.1.1 Additional evidences: human capital and investments

Since founders' human capital has been identified in literature as one of the main key success factors of innovative start-ups, it is interesting to check whether it also affects ISUPs' investment decisions.

In particular, start-ups' expertise and competences are alleged to coincide with its founders'/shareholders' knowledge and skills. Since investment opportunities for start-ups are likely to depend on their business idea and the innovativeness of their incubated technologies, companies with greater human capital are expected to better follow up with fruitful investment opportunities and, thus, invest more than others. Accordingly:

H5: companies which have one or more shareholders with previous managerial experience are expected to exploit such greater managerial competences to implement most suitable and effective strategies. Therefore, they will be able to spot and pursue the best investment opportunities: as a result, these firms will invest and grow more than their counterparts.

H6: companies which have one or more shareholders with a previous active role in a university (research fellow, researcher, associate professor, full professor) are supposed to leverage on more innovative technologies or processes. Moreover, they are likely to have a facilitated access to university assets, such as academic human capital, facilities and business network.

Thus, these firms will invest and grow more than their counterparts.

8.2 Database construction

The data used in this research study have been drawn from one main dataset, which collects all the available financial information regarding the entire set of Italian innovative start-ups registered in the special section of the Business Register up to December 8th 2014. For this reason, the number of companies which the main econometric models are based on is lower than the current number of Innovative start-ups active in the Italian landscape (6399, on October 12th 2016): at the end of 2014, indeed, the Italian innovative start-ups' figure was 3006. Starting from this dataset, two data samples have been built in order to carry out the present study: the "large" and the "small" sample.

8.2.1 Data collection: the large sample

The first sample (large sample, henceforth) is basically constituted by all the start-ups belonging to the main datasets for which the most relevant financial documents (i.e. balance sheet and income statement) were publicly available.

Out of the 3006 innovative start-ups belonging to the main dataset, 2526 (84.1%) companies with full-financial information have been included in the large sample. For these selected companies, it has been possible to obtain information coming from all the financial documents published from their birth year to 2014 (included), in order to build a consistent unbalanced panel[57] data sample.

Indeed, even though the samples construction has been "freezed" in October 2016, unfortunately the majority of the start-ups in the dataset had still not deposited any data regarding the year 2015 up to that moment. For this reason, the most recent data in the sample trace back to 2014.

The main source which data collected in the large sample stem from is AIDA ("Analisi Informatizzata Delle Aziende"), a comprehensive database – offered by "Bureau Van Dijk" – which makes available a great number of financial information on Italian companies. General (e.g. ID, business name, administrative

[57] Panel – or longitudinal – data refers to multi-dimensional data containing observations of different statistic entities (individuals, firms, etc.) over multiple time periods. In unbalanced panel data, differently from balanced panels, the number of time periods observed may vary over different entities (i.e. companies).

headquarters, business activity, etc.) and financial information about companies have been complemented with macroeconomic indicators (e.g. GDP growth, infrastructural index, etc.) on regional or national scale, which have been sourced from Eurostat (ec.europa.eu/eurostat), Istat (www.istat.it) and Istituto Guglielmo Tagliacarne (www.tagliacarne.it).

Finally, the large sample has been enriched with information related to the raising of external capital, in the form of both debt and equity capital.

As far as debt capital is concerned, information about the bank loans guaranteed by the Central Guarantee Fund for small and medium enterprises indicates for each company whether it accessed to the guarantee or not; in addition to that, information about the guaranteed amount and the year in which the guarantee has been provided has been collected for all those start-ups which benefitted from this instrument.

For what concerns equity capital, a specific check made on the shareholders of all the start-ups in the large sample (source: Telemaco, the official datastore of the Business Register) allowed to identify the presence of VC firms in a company's shareholder list. In case of positive feedback, the year of entrance of the VC organisation among the shareholders' team has been recorded.

8.2.1 Data collection: the small sample

The second sample ("small sample", from now on) is a subset of the large one, which provides a great number of additional information regarding the human capital of start-ups' shareholders. Specifically, for each of the start-ups included in the large sample, personal information – mostly related to the role in the company, education and previous work experience[58] – about both former and current shareholders has been hand-collected. For this data collection work, the main source has been LinkedIn, a widely diffused social network gathering information

[58] For each shareholder, the following information have been collected: name, surname, fiscal code, age, entry and exit (if any) dates in the firm, percentage of shares owned (both current and entry shares), educational details (PhD, master, bachelor), work experience (divided according to the business sector and the specific activity performed), previous role in a university and previous experience as business founder (distinguishing between ISUPs and other legal entities).

about past and current educational and professional experiences. Further information, mainly regarding a shareholder's history within the company (shares, role, entry and exit dates, etc.) – but educational and professional backgrounds when not available on LinkedIn – are derived from Telemaco.

The logic behind human capital data collection is the one to progressively enlarge the small sample until it actually matches the large one. To this extent, different master's candidates (E. Girelli, S. Melchionda, F.E. Pantanella and D. Sesana), have collected data for the small sample, focusing on some particularly relevant business sectors, that are manufacturing, software, R&D, telecommunications and publishing (books, periodicals and software).

Overall, the shareholder's team of the 1224 innovative start-ups operating in the abovementioned business sectors have been encompassed. This resulted in the survey of 4330 shareholders' profiles, even if complete data have been found and registered only for 1560 of them.

To the extent of this study, the small sample including human capital information will be used to check whether managerial and academic experience may have an impact on a start-up's investment rate and, by and large, as a robustness check for the results obtained in the large sample's econometric analyses. Accordingly, only the start-ups with information about shareholder's managerial and academic background have been selected to build the small sample: as a result, this latter is actually composed of 230 innovative start-ups (9.1% of ISUPs in the large sample).

8.3 Descriptive statistics of the large sample

As anticipated in the previous paragraph, the large sample is a longitudinal dataset containing both general (e.g. business name, ID, year of foundation, number of shareholders/employees, etc.) and specific financial information about 2526 companies, out of the 3006 registered to the special section of the Business Register for innovative start-ups up to December 2014. Even though the number of innovative start-ups is steadily increasing since then (the special section currently counts app. 6500 companies), Table 9 confirms that the large sample's

composition, from a geographical perspective, is actually very representative of the current (updated to July 2016) ISUPs population.

Table 9 – Number of ISUPs across regions: a comparison between large sample and current population

Region	*No. of ISUPs (large sample)*	*% on the overall number of ISUPs (large sample)*	*% on the overall number of ISUPs (July 2016)*
Lombardia	562	22.3	21.6
Emilia-Romagna	289	11.5	11.8
Lazio	248	9.8	10.1
Veneto	200	7.9	7.6
Piemonte	177	7.0	6.5
Campania	130	5.2	6.2
Toscana	178	7.1	5.5
Marche	108	4.3	4.7
Sicilia	82	3.2	4.6
Puglia	103	4.1	3.7
Trentino-A.A.	106	4.2	3.2
Sardegna	72	2.9	2.6
Friuli-V.G.	78	3.1	2.5
Abruzzo	38	1.5	2.3
Calabria	46	1.8	2.3
Liguria	43	1.7	1.7
Umbria	28	1.1	1.5
Basilicata	15	0.6	0.8
Molise	12	0.5	0.3
Valle d'Aosta	9	0.4	0.2

Source: elaboration on data from startup.registroimprese.it

Other evidences of the overall correspondence between ISUPs population as of December 8th 2014 and the current one (2016) are provided in Table 10 (number of employees), Table 11 (number of shareholders), Figure 14 (macroeconomic sector), Figure 15 (legal status) and Table 12 (main financial figures). By and large, such figures suggest that results obtained from the large sample analysis would be still consistent and significant for the 2016 ISUPs population.

Table 10 – Number of employees of ISUPs: a comparison

	ISUPs (large sample)	*ISUPs (1st trimester 2016)*
Mean value	3,06	3.48
Median value	2	2
No. of firms with employees	1,047	2,356
No. of total employees	3,205	8,193

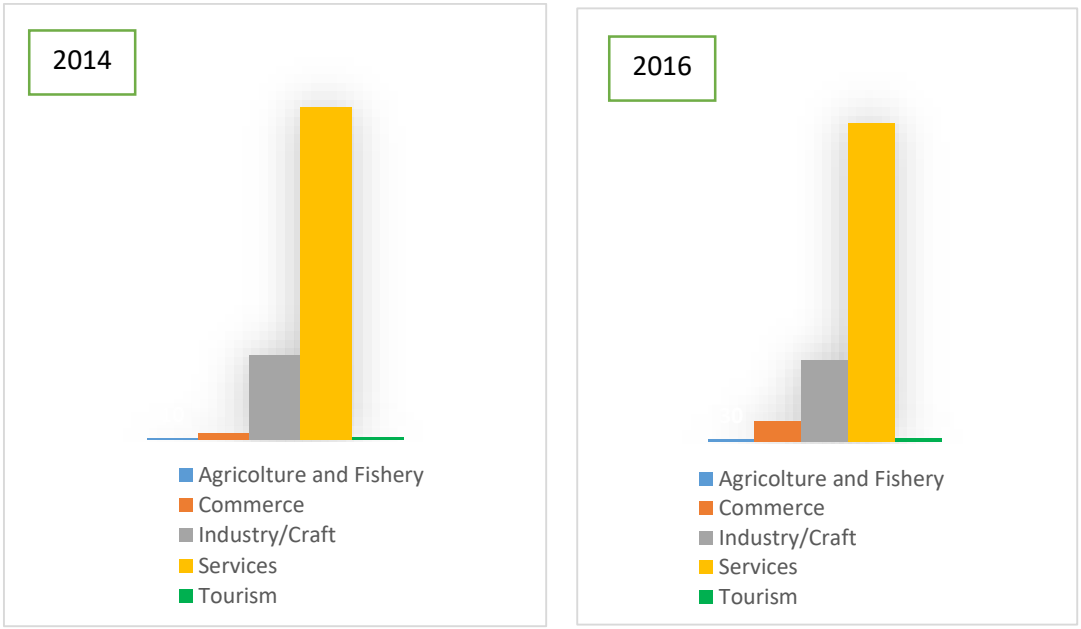
Source: author's elaboration

Table 11 – Number of shareholders of ISUPs: a comparison

	ISUPs (large sample)	*ISUPs (2nd trimester 2016)*
Mean value	4,76	3.97
Median value	3	3
No. of firms with shareholders	2,150	5,801
No. of total shareholders	10,244	23,045

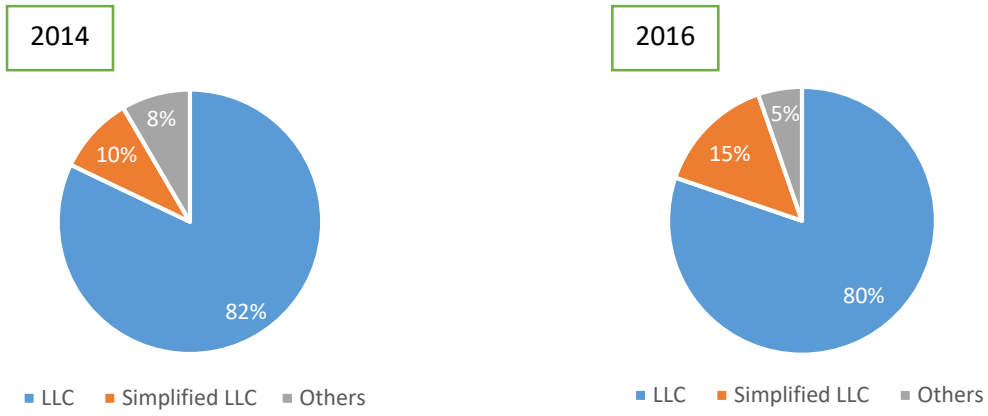
Source: author's elaboration

Figure 14 – ISUPs distribution by ATECO economic sectors: a comparison



Source: author's elaboration

Figure 15 – ISUPs legal status: a comparison



Source: author's elaboration

Table 12 – Main financial indicators: a comparison

	ISUPs (large sample)		*ISUPs (2nd trimester 2016)*	
	total	*only profitable ones*	*total*	*only profitable ones*
ROI	-0,75	0,11	-0.12	0.10
ROE	-0,89	0,37	-0.28	0.21
Financial independence	0,08	0,40	0.36	0.28
Added value/production value[59]	0.09	0.34	0.15	0.33

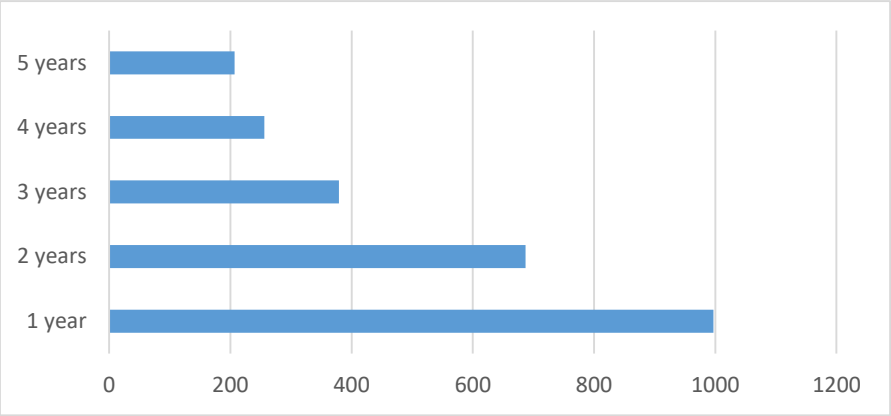
Source: author's elaboration

Focusing on the large sample characteristics, it is configured as an unbalanced panel, meaning that the number of observations is not fixed for each company. In particular, it ranges from 1 to 5: this means that, while for some start-ups only the 2014 financial documents are available, financial data since 2010 have been

[59] In order to compute the mean value of the "added value to production value" ratio for the large sample, a number of strong outliers, significantly biasing statistics, has been omitted from the computation. In particular, a value x has been considered as a "strong outlier" if $x > Q_3 + 3(Q_3 - Q_1)$ or $x < Q_1 - 3(Q_3 - Q_1)$, where Q_1 and Q_3 are, respectively, the first and the third quartiles.

registered for some other entities in the large sample. Figure 16 offers a snapshot of this circumstance: the 2526 start-ups in the sample (horizontal axis), have been divided according to the number of observations available (vertical axis).

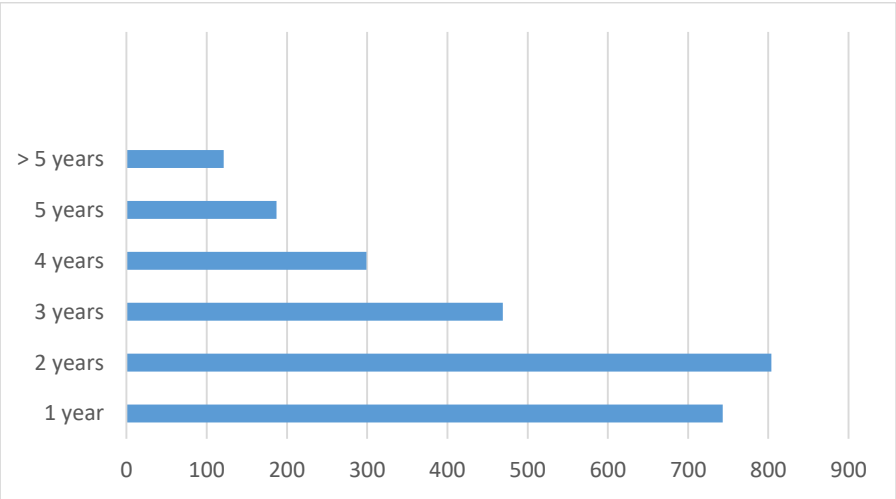
Figure 16 – Number of observations per company (large sample)



Source: author's elaboration

As shown in Figure 16, a large majority of start-ups (66.7%) deposited financial documents only in 2014 (1 year) or in both 2014 and 2013 (2 years). This figure can be easily explained by looking at the age[60]of the sampled start-ups (Figure 17).

Figure 17 – ISUPs' distribution by age (large sample)



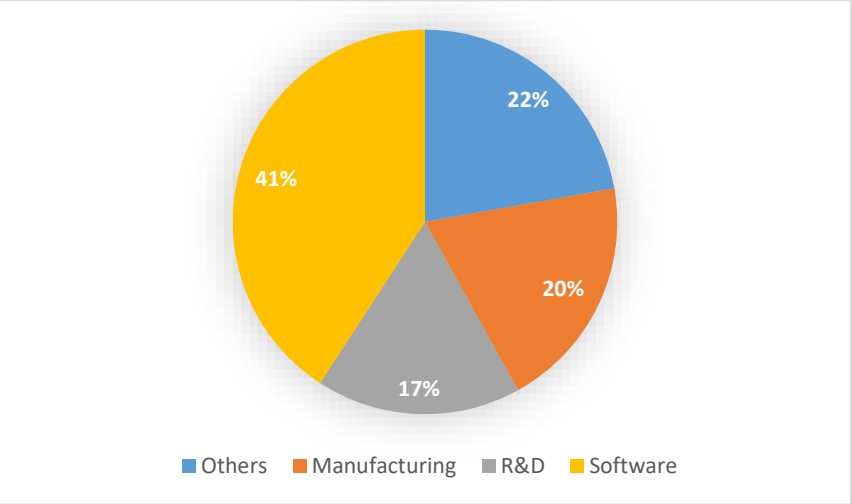
Source: author's elaboration

[60] The age of a company has been set at 1 if the year of observation corresponds to the year of foundation, 2 if the observation is made the successive year to the foundation's year, and so on.

Indeed, almost the 80% of the start-ups belonging to the large sample are younger than 3 years.

Finally, Figure 18 provides a classification of start-ups in terms of macro-sectors[61]: the three most represented business industries in the large sample are software (41%), manufacturing (20%) and R&D (17%). Overall, other generic service industries account in sum for 22% of the ISUPs in the sample.

Figure 18 – ISUPs' distribution by economic sector (large sample)



Source: author's elaboration

From now on, different pie charts will be used to get some insights into the main financial figures of ISUPs in the large sample. The financial data used to draft these graphs are all referring to the last year of observation for companies in the sample, i.e. 2014.

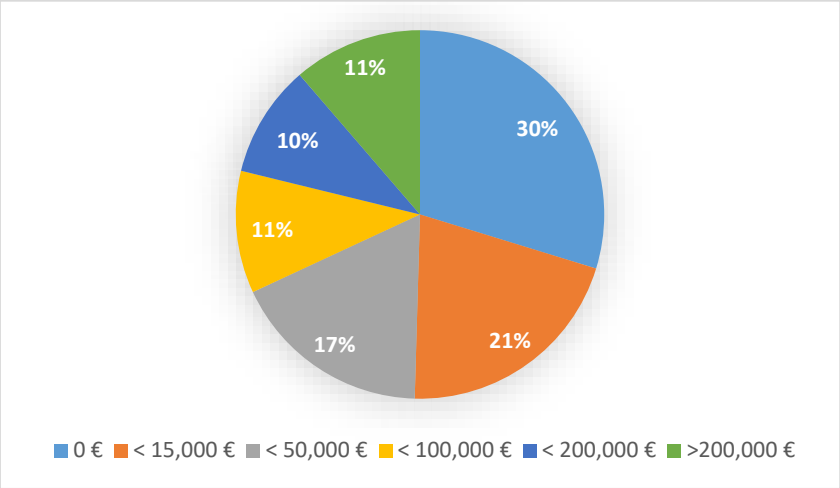
First, Figure 19 and Figure 20 report information (i.e. sales and fixed assets) which could be used to ascertain the average size of ISUPs in the large sample.

As far as sales are concerned, the average value is 108,565 €. However, Figure 19 demonstrates how, regardless of this mean value, almost one third (30%) of start-ups in the sample actually did not sell anything in 2014. Therefore, it is very likely that the average sales value is actually biased by a limited number of outliers (the

[61] Differently from Figure 14, in Figure 18 the "service" sector is broken down in order to highlight its most relevant sub-sectors (i.e. R&D and Software).

highest value is 5,125,451 €). According to this evidence, it is possible to assert that the average ISUP has a low (or even null) sales level, coherently with the relatively young age of such companies.

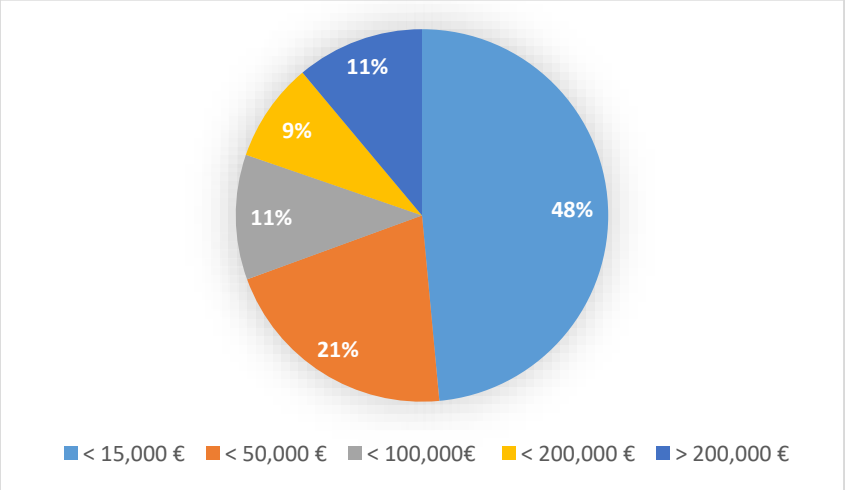
Figure 19 – ISUPs' distribution by sales (large sample)



Source: author's elaboration

Figure 20, which exhibits the level of fixed assets owned by ISUPs, provides additional evidences of the limited size of the average start-up, as almost half of them (48%) possesses fixed assets for less than 15,000 €.

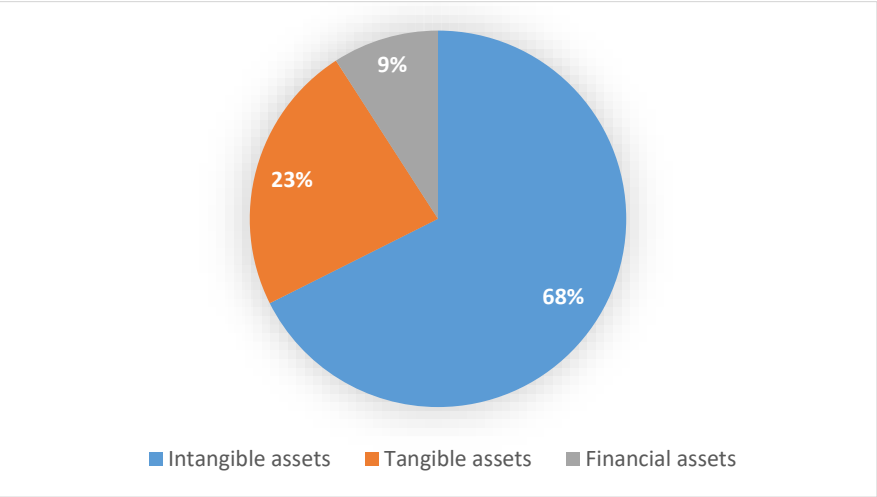
Figure 20 – ISUPs' distribution by total fixed assets (large sample)



Source: author's elaboration

What is more, these fixed assets are mainly constituted by intangible fixed assets (see Figure 21). This occurrence is perfectly in line with what has been discussed in the literature review: by and large, young and small companies lack collateralisable assets. Moreover, as R&D expenditures are classified among intangible assets according to the Italian law, it is totally reasonable to report high levels of intangible assets among ISUPs.

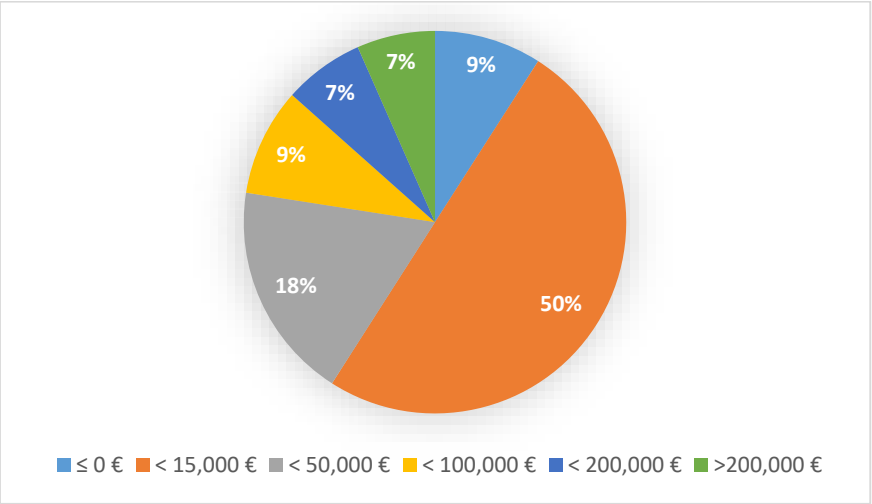
Figure 21 – ISUPs' fixed assets: intangible, tangible and financial (large sample)



Source: author's elaboration

Data related to investments (net of depreciation) are aligned with what has been said so far. As highlighted in Figure 22, a remarkable percentage (9%) of ISUPs did not invest (or even disinvested) in 2014. Furthermore, half of the companies in the sample invested less than 15,000 €.

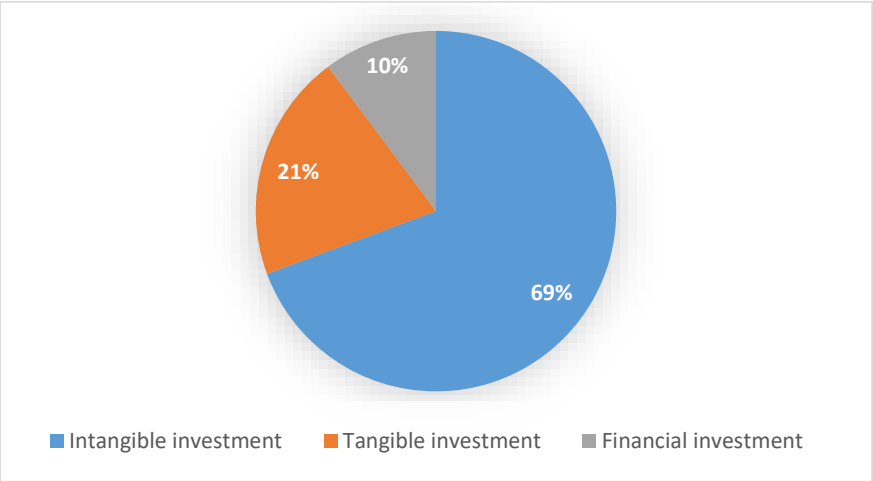
Figure 22 – ISUPs' net investments (large sample)



Source: author's elaboration

When distinguishing between intangible, tangible and financial investments, the correspondent pie chart (Figure 23) basically matches the profile assumed by the one related to ISUP-owned fixed assets (68% intangible, 23% tangible and 9% financial).

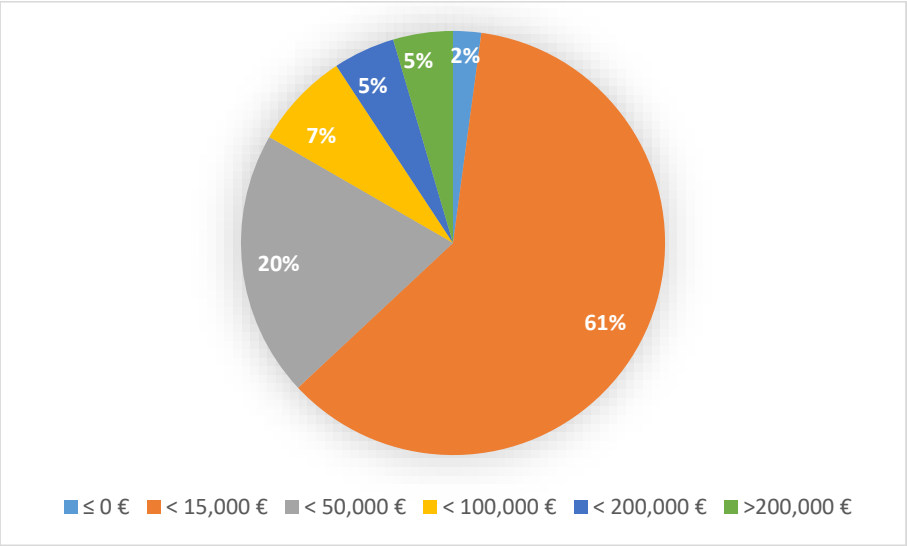
Figure 23 – ISUPs' net investments: intangible, tangible and financial (large sample)



Source: author's elaboration

As discussed in Chapter 4, one of the most acute constraints to a start-up's investment is represented by internal capital shortages.

Figure 24 – ISUPs' cash and cash equivalents (large sample)

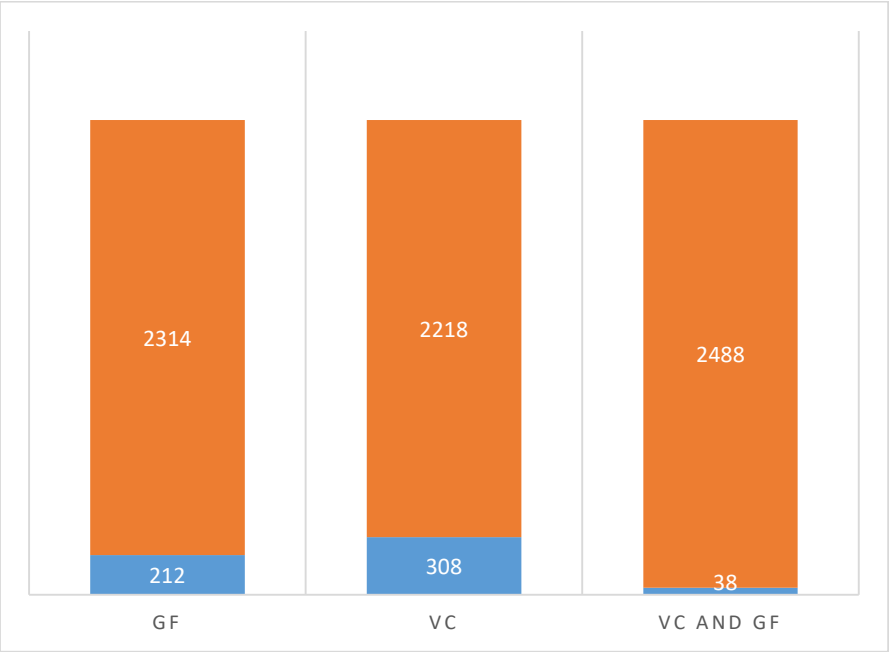


Source: author's elaboration

Figure 24 exhibits the distribution of ISUPs according to cash and cash equivalents (cash on hand, cheques and deposit accounts), used as a measure of internal capital. From this pie chart two interesting facts emerge. First, as expected the average start-up owns a relatively low amount of cash. Second, liquidity seems to be closely related to the level of investments. 63% of the ISUPs (including companies with no cash at all) in the large sample holds less than 15,000 €, as 59% (including companies not investing at all) invests less than 15,000 €. Similarly, percentages are almost equal for the remaining classes of liquidity (and the corresponding investment classes). Clearly, this reasoning is simply based on rough comparisons: the possible correlation between cash and investment in the large sample's ISUPs needs to be confirmed running econometric analyses.

Nonetheless, the low levels of internal liquidity make particularly worthwhile to show how many companies in the sample got access to external equity and debt capital. To this purpose, Figure 25 shows in blue the number of ISUPs which obtained a guarantee from the Guarantee Fund (GF), external equity from a VC company or both.

Figure 25 – ISUPs' access to GF and VC (large sample)



Source: author's elaboration

As it can be easily understood, only a small fraction of firms in the sample has been able to access external capital. More specifically, only 8.4% of the ISUPs received a guarantee, while 12.2% has a VC organisation in its shareholders' list. Accordingly, only 1.5% of the sampled companies obtained both forms of external finance. However, the scant results in terms of external finance provision should not be interpreted as a low effectiveness of the Law 221. As a matter of fact, the reported data are limited to a restricted time period (2 years), as the Law entered into force in December 2012 (and the facilitated access to the CGF for ISUPs became reality starting from May 2013) and this analysis does not consider the years after 2014.

8.4 Descriptive statistics of the small sample

The small sample is a subset of the large one, which is enriched with additional information about its shareholders. More specifically, it is drawn from the 1224 innovative start-ups belonging to a subset of business industries (manufacturing, software, R&D, telecommunication and publishing), which have been chosen as worthy of further analyses. However, given the difficulties in obtaining complete

information about all the surveyed shareholders, only a restricted fraction of companies has been inserted in the small sample. In particular, out of the great number of information gathered about ISUPs' human capital, two of them has been selected to create two corresponding dummy variables, considered of particular interest to the extent of this study. Therefore, the selection process of the 230 ISUPs composing the small sample is directly related to the nature of these two variables. More in detail, the two variables related to shareholders' human capital are dummies which are equal to 1 when a start-up has at least one shareholder with previous managerial experience (for the first dummy) or a previous role in a university (for the second dummy). For this reason, it was not necessary to consider only start-ups with full available information about all its shareholders: as long as a shareholder is found to have previous managerial (or academic) experience, his/her company is automatically selected and marked with a dummy's value equal to 1. Conversely, when no shareholders with previous managerial (or academic) experience are found for a specific ISUP, it is selected (with dummy's value equal to 0) only if there is full information about the entire shareholders' list. In other words, when a company has not full information regarding the entire shareholders' team, it is included in the sample only if it has at least one shareholder with managerial (or academic) experience. In the opposite case, the start-up is excluded from the sample as it is still possible that one of the shareholders whose data are missing actually had previous managerial (or academic) experience. A final screening procedure allowed to select only those companies to which a value (0 or 1) has been assigned for both variables. Thus, for every of the 230 ISUPs in the small sample it is known with certainty:

1) Whether it has at least one shareholder with previous managerial experience or not.
2) Whether it has at least one shareholder with previous academic experience or not.

By and large, descriptive figures concerning ISUPs do not move away from what emerged in the large sample analysis.

In Table 13, a comparison of the regional distribution of companies belonging to the two samples is provided. Overall, no significant differences emerge, as the largest variation (-3.7%, in Lazio) is relatively low.

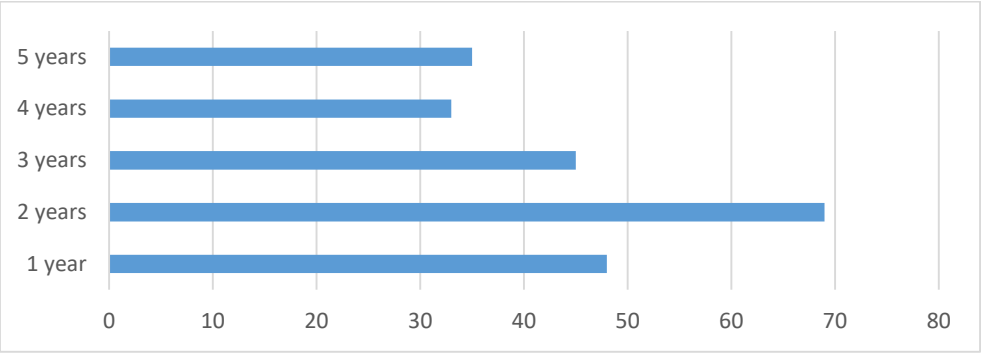
Table 13 – Number of ISUPs across regions: a comparison between small and large samples

Region	*No. of ISUPs (small sample)*	*% on the overall number of ISUPs (small sample)*	*% on the overall number of ISUPs (large sample)*
Lombardia	52	22.6	22.3
Emilia-Romagna	24	10.4	11.5
Lazio	14	6.1	9.8
Veneto	15	6.5	7.9
Piemonte	20	8.7	7.0
Campania	17	7.4	5.2
Toscana	24	10.4	7.1
Marche	6	2.6	4.3
Sicilia	7	3.0	3.2
Puglia	10	4.3	4.1
Trentino-A.A.	11	4.8	4.2
Sardegna	4	1.7	2.9
Friuli-V.G.	7	3.0	3.1
Abruzzo	0	0.0	1.5
Calabria	4	1.7	1.8
Liguria	5	2.2	1.7
Umbria	5	2.2	1.1
Basilicata	3	1.3	0.6
Molise	1	0.4	0.5
Valle d'Aosta	1	0.4	0.4

Source: author's elaboration

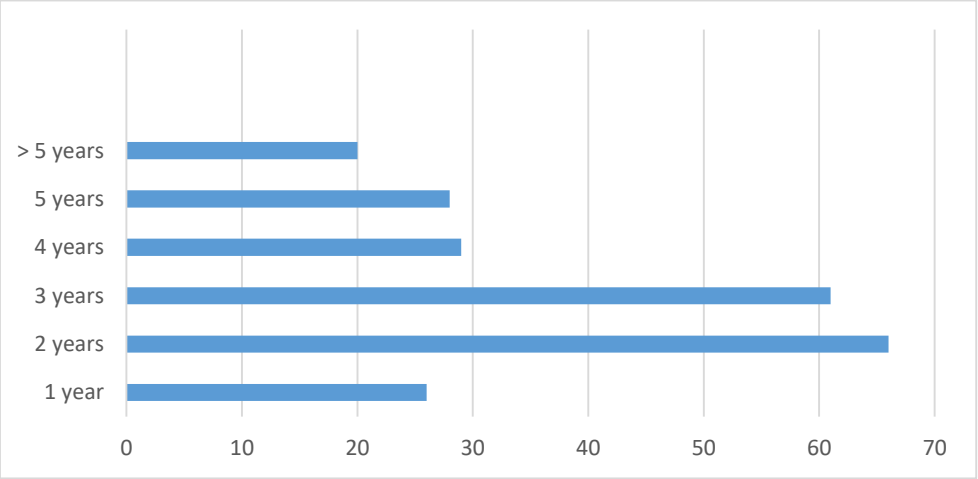
On the other hand, data shown in Figure 26 denote a general increase in the number of observations per company. In particular, the fraction of companies with a single observation in time is considerably lower in the small sample than in the large one.

Figure 26 – Number of observations per company (small sample)



Source: author's elaboration

Figure 27 – ISUPs' distribution by age (small sample)

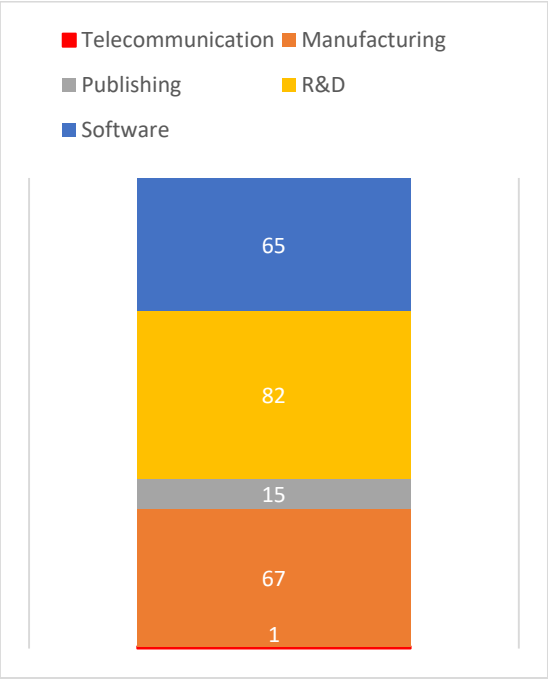


Source: author's elaboration

Once again, this variation seems to be directly dependent on the age of ISUPs in the sample: not by chance, the number of 1-year old companies is sensibly lower than in the large sample (Figure 27). However, it is important to underline how focusing on companies with a greater number of observations is even more consistent from an econometric perspective, as the investment behaviour patterns can be more precisely analysed.

Finally, Figure 28 reports the distribution of companies in the small sample across business sectors.

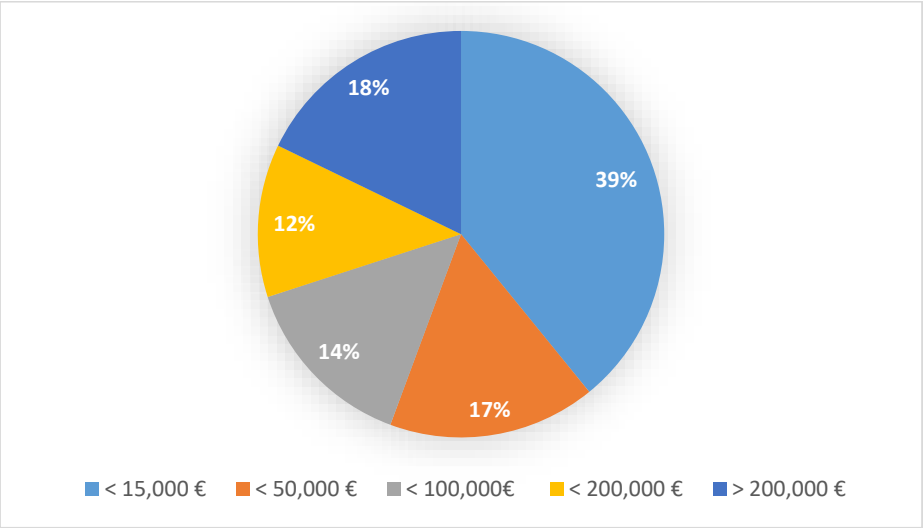
Figure 28 – ISUPs' distribution by macro-economic sector (small sample)



Source: author's elaboration

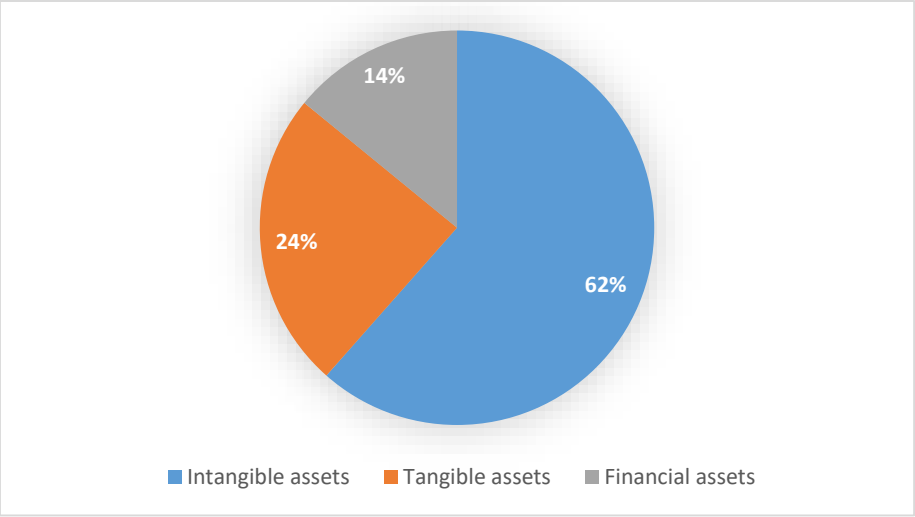
For what concerns the main financial figures, the small sample proves to be quite representative of the large one once again. The only sensible differences might be noticed when considering fixed assets (Figure 29), sales (Figure 31) and liquidity (Figure 32). Indeed, for all these financial items the highest-value category embraces a larger share of ISUPs, to the detriment of the lowest-value one: this difference in respect to the large sample, albeit not particularly significant, can be explained by the averagely greater age of ISUPs in the small sample. Older companies are indeed supposed to possess greater fixed assets, leverage on higher sales volume and have available a noteworthy amount of internal capital. As for fixed assets, despite of the abovementioned discrepancies in respect to the large sample, the share of intangible, tangible and financial assets (Figure 30) is nearly the same as the one reported for the large sample.

Figure 29 – ISUPs' distribution by total fixed assets (small sample)



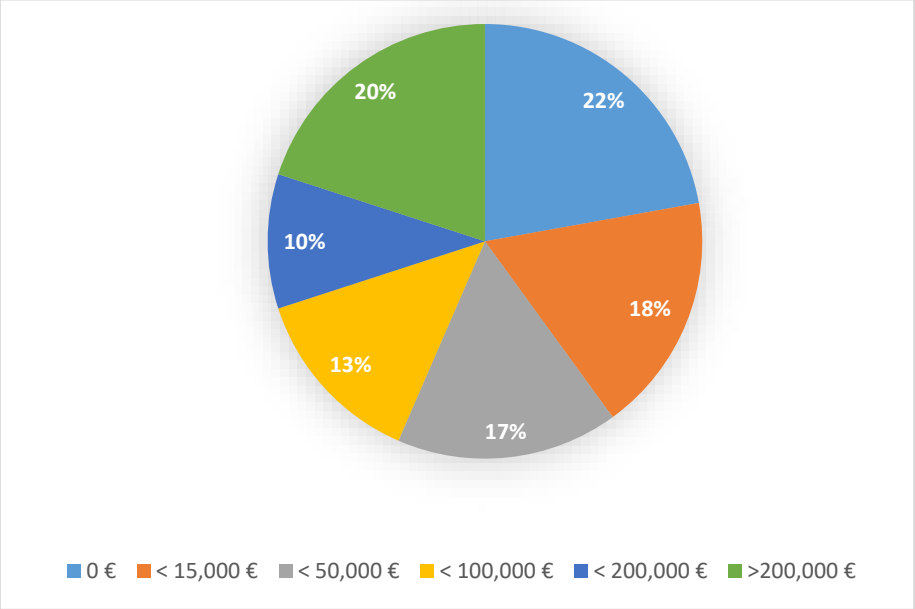
Source: author's elaboration

Figure 30 – ISUPs' fixed assets: intangible, tangible and financial (small sample)



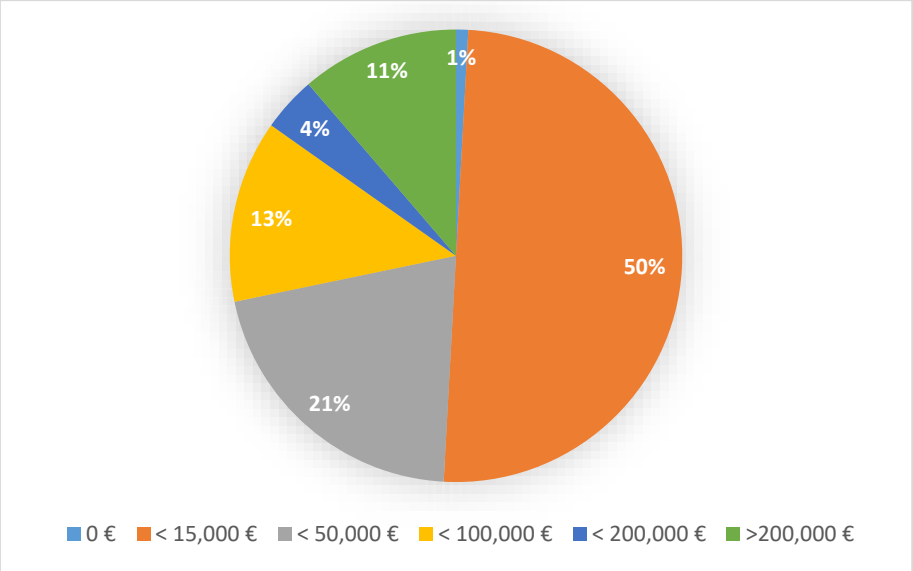
Source: author's elaboration

Figure 31 – ISUPs' distribution by sales (small sample)



Source: author's elaboration

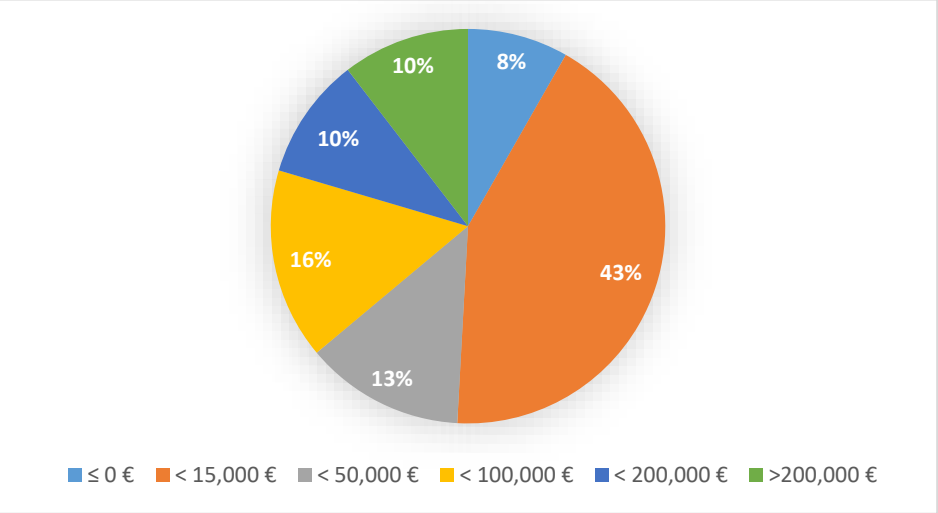
Figure 32 – ISUPs' cash and cash equivalents (small sample)



Source: author's elaboration

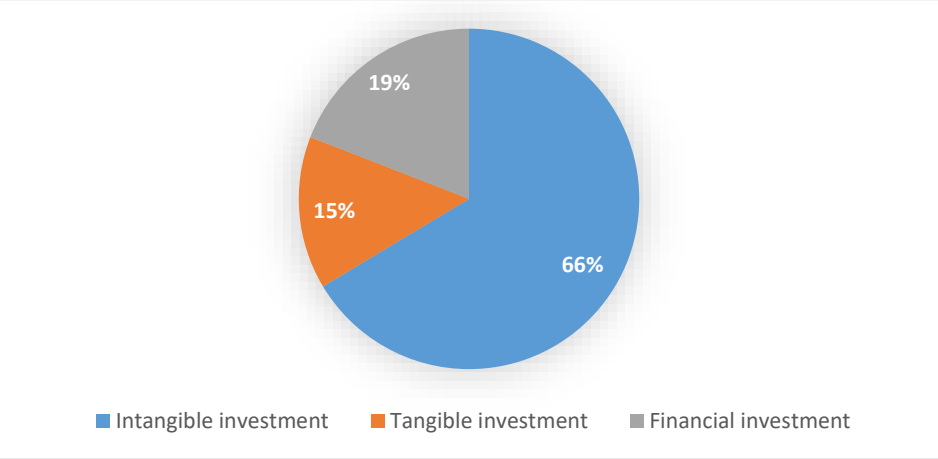
As far as net investments are concerned, Figure 33 and 34 outline an overall correspondence with data stemming from the large sample.

Figure 33 – ISUPs' net investments (small sample)



Source: author's elaboration

Figure 34 – ISUPs' net investments: intangible, tangible and financial (small sample)

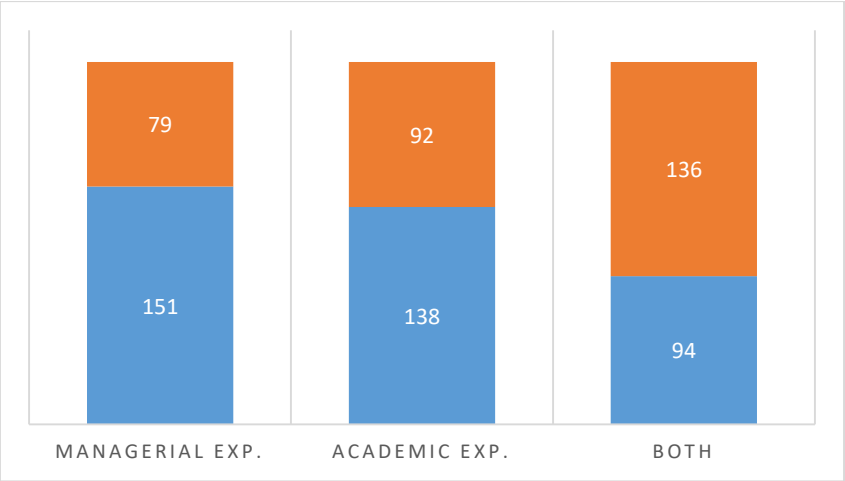


Source: author's elaboration

As clarified above, the small sample is characterised by the information about the presence (or absence) in each start-up of at least one shareholder with previous managerial or academic experience. Figure 35 reports the number of ISUPs (in blue) that can rely on shareholders with managerial and/or academic background. As a consequence of the small sample selection criteria– addressed at the beginning of this paragraph – the shares of companies whose shareholders have

previous managerial experience (65.7%), academic experience (60%) and both (40.9%) are relatively high.

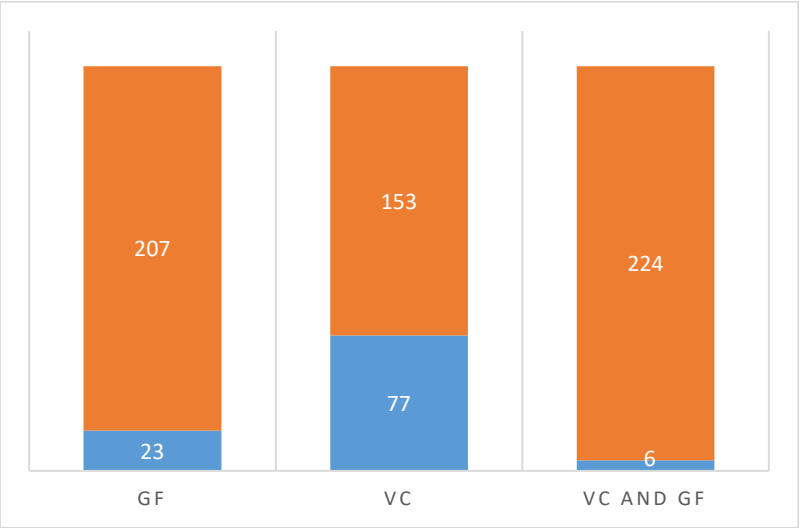
Figure 35 – ISUPs with at least one shareholder with managerial/academic experience or both



Source: author's elaboration

In conclusion, Figure 36 shows the number of ISUPs which obtained a guarantee from the Guarantee Fund or received the support of VC organisations. While the first figure (access to GF) is absolutely aligned with the correspondent value of the large sample, in the small sample there is a greater percentage of VC-backed firms (33.5% vs 12.2%). Albeit this difference could be ascribed to mere fortuity, a possible explanation is that companies which can leverage on a greater human capital – such as better managerial capabilities – are also able to exert a greater appeal in the eyes of venture capitalists, resulting in a higher likelihood of attracting external VC funds.

Figure 36 – ISUPs' access to GF and VC (small sample)



Source: author's elaboration

9. The econometric analysis

9.1 Studying investment behaviour: the choice of the model

9.1.1 Static and dynamic models

As highlighted in paragraph 4.3, in the last decades firm investment behaviour has become a truly hot topic. In particular, the great majority of the studies investigating this issue (e.g. Fazzari et al., 1988; Kaplan and Zingales, 2000; Cleary et al., 2007; Colombo, Croce and Guerini, 2013) has focused on analysing the relationship between internal capital and investments, defined as ICFS (Investment-Cash Flow Sensitivity).

In general, the models adopted in this research stream include cash flow metrics – used as a proxy for availability of internal finance – among the independent variables. Nonetheless, this occurrence generates a serious econometric issue, as cash flow is likely to raise a problem of endogeneity, which could severely bias the estimates. Indeed, besides being a measure for internal capital, cash flow is also alleged to be related to investment opportunities. If this is the case, a significant and positive relationship between cash flow and investment could not consistently certify a correspondent correlation between internal capital and firm investments, as this positive relation might be actually due (in part, at least) to favourable investment opportunities incurred in by the surveyed companies.

In order to avoid this methodological pitfall, scholars experimented different ways to control for unobservable investment opportunities.

A first solution, frequently adopted in the early literature, is based on the inclusion in the model of firms' marginal Tobin's q, with the aim of capturing investment opportunities effects. Nevertheless, the use of this variable led to unsatisfactory empirical performances, as it is particularly difficult to estimate (even theoretically impossible for unlisted firms, as ISUPs) and it is also based on hypotheses which are unlikely to be met (Hubbard, 1998).

Therefore, in the more recent literature some alternative approaches emerged, such as ECM, Euler equation and sales accelerator models (see Bertoni et al., 2012 for further references on studies based on such econometric frameworks).
Even though conceptually different, all these models have a common feature: they make use of the lagged dependent variable among the covariates. For this reason, such models are defined as "dynamic models" (1).

$$(1) \qquad y_{it} = \rho y_{i,t-1} + x'_{it}\beta + \varepsilon_{it}$$

By and large, dynamic models bring additional criticalities to the design of an effective estimation methodology, as the lagged dependent variable is allegedly correlated with the error term, thus leading to endogeneity biases. For this reason, traditional estimators such as pooled ordinary least squares (OLS), fixed-effects and random-effects are rather ineffective when dynamic models are concerned, since they are cause of serious biases (Bond et al., 2001).
To solve this issue, it is customary to resort to the Generalised Method of Moments (GMM) estimation (Bertoni, Croce and Guerini, 2012). More specifically, most of the econometric models applying the GMM to dynamic panel data relies on a 2-step system-GMM estimation with finite-sample correction, also known as "Arellano-Bover/Blundell-Bond" estimation. This relatively recent estimation procedure is supposed to reduce endogeneity-related biases by using lagged levels and lagged differences of the endogenous covariates as instruments for first-differences and levels equations.
Unfortunately, running a GMM estimation is not a viable option because of the nature of the dataset available for this study. In fact, the number of observations (*T*) for each company in the large sample ranges from 1 to 5, with an average value of 1.97. With such a narrow set of data, it would not be possible to use the efficient instruments which GMM estimator are based on. Indeed, since these instruments are often constituted by lagged values of the covariates (two-period lagged values are the minimum required to run such models), the amount of companies with a sufficient number of observations would be extremely low. What is more, as some

of the variables in the model (including the dependent one) present a lagged metric (lagged fixed assets) as a denominator, the number of available observations would be further reduced[62].

For these reasons, all the models analysed in this study are static. Of course, a prerogative of this choice is to identify possible measures to reduce the potential endogeneity related to internal capital metrics, as well as to control for investment opportunities: the adopted measures will be explained in the next paragraph, when the models variables will be presented. Nonetheless, the abovementioned problems are likely to be less severe for NTBFs: indeed, investment opportunities for high-tech start-ups are likely to depend – especially in their early years – on the quality of their business ideas and the innovative potential of the technologies being developed, rather than being related with cash flows (Bertoni, Colombo and Croce, 2010).

9.1.2 Static models: pooled OLS, fixed effects and random effects

In order to analyse a panel static model, there are three possible estimators: pooled OLS, Fixed-Effects (Within-Group) and Random-Effects.

The easiest approach is represented by pooled OLS, in which all the observations from N cross-sectional entities and from T time periods are pooled. Then, the estimates are obtained by using ordinary least squares methodology. Despite its simplicity, such estimate is based on the assumption that every cross-sectional unit (i.e. every company in the sample) has the same time-invariant intercepts and slope coefficients. However, due to the large heterogeneity across industries and across companies in the same industry, from a theoretical perspective is reasonable to hold that investment behaviour will likely differ from firm to firm and across time. In order to control for this unobservable firm "individual effect", in this study the approach of Cleary (1999) and Aivazian et al. (2005) was followed, i.e. to resort to Fixed or Random Effects estimators. As pooled OLS, both these approaches still hold the assumption of equal slope coefficients across individuals; nonetheless,

[62] For example, 3-year lagged fixed assets are necessary to compute the 2-period lagged dependent variable. Thus, only companies for which 4 observations are available could be valuable for the analysis.

they allow for the variation in the intercepts. In this way, such estimates are characterised by a twofold variability, both across time and across sections (i.e. individuals). This variability can be interpreted assuming that the error term in the model is the sum of three components:

$$\varepsilon_{it} = \mu_i + \lambda_t + \nu_{it}$$

where μ_i (individual effect) accounts for the effects of those omitted variables that are constant across time but do change across individuals, λ_t which controls for variable that equally affects all the cross-sectional units but are specific to each time period; finally, ν_{it} represents the residual idiosyncratic shocks. By and large, the most frequently used estimators consider only the individual heterogeneity (μ_i): such estimators are also known as "one way" Fixed/Random Effects. In such cases, the estimator to be applied in order to calculate the model coefficients is chosen on the basis of the hypotheses formulated around the nature of the individual effects factor (μ_i).

If the individual heterogeneity is assumed constant over time for every cross-sectional unit, the correspondent estimator is called "Fixed Effects"; on the other hand, "Random Effects" estimator holds that individual effects vary across time according to a certain probability distribution.

Starting from a general regression equation (2):

(2) $$y_{it} = \alpha + x'_{it}\beta + (\mu_i + \nu_{it})$$[63]

Under the hypothesis of fixed effects, the model (3) is first transformed by subtracting to each observation its mean across time, in order to eliminate the fixed effects (3):

[63] This equation shows the relevant variables for a given individual *i*, for each period *t* from *1* to *T*. y_{it} and the error term are random variables; x_{it} is a k x 1-vector representing the *k* regressors; α and β are a parameter and a *k x 1*-vector of parameters, respectively.

(3) $$y_{it} - \bar{y}_i = (x_{it} - \bar{x}_i)'\beta + (v_{it} - \bar{v}_i)$$

Then, the model (3) is estimated with OLS.

Conversely, random effects models assume that the individual intercepts are randomly distributed around a mean value (α), with individual random fluctuations assumed to have an expected value of 0 and a fixed variance. In other words, the individual heterogeneity is distributed as a random variable with mean E[μ_i] = 0 and variance E[$\mu_i{}^2$] = $\sigma_\mu{}^2$. In order to obtain the best linear unbiased estimates for this model, it is again necessary to transform it and then apply the OLS methodology. The particular technique put in place for RE models is generally known as Feasible Generalised Least Squares (FGLS).

In particular, the model (2) will first undergo a quasi-differencing transformation (or "quasi-time demeaning"), i.e. it will be subtracted to each observation θ-times its mean across time (4):

(4) $$y_{it} - \theta\bar{y}_i = (1 - \theta)\alpha + (x_{it} - \theta\bar{x}_i)'\beta + (1 - \theta)\mu_i + (v_{it} - \theta\bar{v}_i)$$

Therefore, while the within-group transformation subtracts the mean values (for each unit, across *T* time periods) from each correspondent variable, the FGLS transformation subtracts just a fraction (θ) of such mean value, which depends on the variances of both error components and on T. Indeed:

$$\theta = \sqrt{\frac{\sigma_v^2}{\sigma_v^2 + T\sigma_\mu^2}}$$

As one may easily note, for θ = 1, the FGLS-RE estimate perfectly matches the FE-Within-Group method.

In order to estimate model (4), it is necessary to calculate the variances of the error components (σ_v^2 and σ_μ^2) to compute θ. This procedure is made of three sub-steps:

1) Estimation of the model within-group (WG) (3). Then, using the residuals of the WG regression in order to compute σ_v^2.

2) Estimation of the model between-group (BG), i.e. $\overline{y_i} = \overline{x_i}'\beta + (\overline{\varepsilon_i})$. Then, using the residuals of the BG regression in order to compute σ_ε^2.
3) Given that $\sigma_\varepsilon^2 = \sigma_\mu^2 + \frac{\sigma_v^2}{T}$, calculate σ_μ^2.

At this point, it is possible to apply a OLS regression to model (4).

In addition to that, the model (4) also highlights a fundamental aspect: contrary to FE models, in RE the individual effects are not eliminated by the transformation. Accordingly, RE models require the assumption of uncorrelation between unobservable individual effects and regressors, otherwise the estimates will be biased by endogeneity. Nevertheless, if sufficient evidences of the uncorrelation assumption consistency are found, RE estimator is found to produce more efficient estimates. Moreover, it allows to estimate time-invariant covariates: conversely, in FE regressions this could not be possible, as all the variables which do not vary across time periods would be "absorbed" by the fixed effects estimator and omitted by the regression's results.

9.1.3 Fitting the reality: Durbin-Wu-Hausman test

In order to test which empirical model is the most suitable to the extent of this study, the Hausman specification test (Hausman, 1978) – also called Durbin-Wu-Hausman test – will be used. Such statistical test, aimed at comparing two different models, is widely adopted in order to compare FE and RE estimates. In detail, the Hausman test is based on the idea that, if the model is correctly designed and under the hypothesis of uncorrelation between individual effects and independent variables (null hypothesis, H_0), both FE and RE estimators are consistent and their estimates should not be statistically different. On the other hand, statistical differences in the estimates could be explained by the presence of correlation among individual heterogeneity and regressors (alternative hypothesis, H_1). Therefore, if the null hypothesis is rejected, it is possible to conclude that RE estimators is inconsistent and, thus, FE models should be run.

To the extent of the models analysed in this study, the null hypothesis is never rejected at a significance level of 0.10. Therefore, from a statistical point of view, there is not significant evidence of correlation among individual effects and independent variables: for this reason, a one way FGLS-RE estimators will be used.

9.2 Model's structure and variables

In the present study, ISUPs' investment behaviour is analysed with the support of three different models, which will be shown in this paragraph.

The first model (model 1.1, henceforth) can be considered as a reference framework, as the other two models (model 1.2 and 2) are conceived as an augmented version of it. More specifically, models 1.1 and 1.2 are run using the large sample as reference dataset. On the other hand, model 2 is complemented with specific human capital variables; hence, it will rely on the small sample.

All the models built in this analysis share the same objective, that is to investigate on Italian innovative start-ups' investment behaviour, in order to spot possible relevant investment determinants. In doing so, particular attention will be paid to the role played by external capital sources (i.e. equity and debt capital) in spurring firms' investment and growth.

As it will be deepened in the Conclusions, the results of this study might be particularly important for a number of different stakeholders, in primis policy makers and entrepreneurs.

9.2.1 Model 1.1

The structure of model 1.1 is the following:

$$\frac{I_{i,t}}{K_{i,t-1}} = \alpha + \mu_i + \beta_1 \frac{CF_{i,t}}{K_{i,t-1}} + \beta_2 \frac{Sales_{i,t}}{K_{i,t-1}} + \beta_3 Age_{i,t} + \beta_4\, Leverage_{i,t-1} + \beta_5\, GDPgrowth_t + \beta_6\, Deficit_t + \beta_7\, South_i + \beta_8\, InfraGen_i + \beta_9\, InfraEco_i + \beta_{10}\, ServGen_i + \beta_{11}\, Software_i + \beta_{12}\, R\&D_i + \beta_{13}\, VC_{i,t} + \beta_{14}\, GF_{i,t} + \nu_{it}$$

In particular, the dependent variable represents a company's investment rate, computed as $\frac{I_{i,t}}{K_{i,t-1}}$, where $K_{i,t-1}$ represents the fixed assets (intangible, tangible and financial) of firm *i* at year *t-1*.

$I_{i,t}$ represents the investment of firm i at year t net of depreciation, and it is computed as $K_{i,t} - K_{i,t-1} + amortisation\ and\ depreciation$.

Hence, as amortisation and depreciation are included in the computation, the dependent variable can also assume negative values (i.e. disinvestments).

The choice of this measure of a firm's investment has been driven by the previous literature, as all the surveyed studies (e.g. Fazzari et al., 1988; Cleary, 1999; Aivazian et al., 2005; Bertoni, Colombo and Croce, 2010; Engel and Stiebale, 2014) adopted such metric.

$\frac{CF_{i,t}}{K_{i,t-1}}$ is a measure of company *i*'s liquidity at year *t*. As one may note, the cash term is then divided by the lagged fixed assets. Once again, this choice is absolutely aligned with the literature. In particular, dividing cash by $K_{i,t-1}$ provides two general advantages: first, it makes the independent variable more consistently comparable with the dependent one, which shares the same denominator; second, deflating a variable by lagged fixed assets alleviates one of the possible sources of heteroscedasticity, that is that variances of error terms are likely correlated with firm size (Cleary et al., 2007; Aivazian et al., 2005). If not corrected, this problem could engender severe biases in the coefficient estimation: as shown in the previous chapter, indeed, ISUPs in the large sample have relatively small sizes; nonetheless, sales, liquidity and fixed assets figures highlighted the presence of a small set of outliers, with values far above the average ones.

If the explanatory variable $\frac{CF_{i,t}}{K_{i,t-1}}$ has been widely used in investment analyses, various differences in how to compute the $CF_{i,t}$ metric emerged. In this study, the approach of Cleary et al. (2007), is followed: to rule out concerns of endogeneity (in particular, reverse causation), $CF_{i,t}$ is calculated as net liquid assets at the beginning of year *t.* In this way, it is also possible to use this variable as a more consistent measure of internal capital, as liquid assets at the beginning of the year

are less likely to capture the effects of unobserved investment opportunities than computations of cash inflows and outflows during the year. After all, the purpose of this study differs from most of the models built in the extant literature, whose main focus was on determining the ICFS.

$\frac{Sales_{i,t}}{K_{i,t-1}}$ is a variable which takes into consideration the sales of firm *i* at time *t.* For the same reasons exposed for the liquidity covariate, this variable has been scaled by lagged fixed assets. In literature, both measures including sales at year *t* and *t-1* are adopted. However, in order to better capture investment opportunities at year *t*, current sales are chosen, also considering that the internal capital variable is computed as the beginning-of-the-year value and, therefore, it should not capture such unobserved effects.

$Age_{i,t}$ indicates the age of firm *i* at year *t.* This metric is calculated as follows: 1 if year *t* coincides with firm *i* foundation year, 2 if year *t* is the year after the foundation one, and so on. The use of such variable could turn out to be quite relevant, since a company's investment behaviour is likely to change according to its age. Despite companies in the large sample are all relatively young, as shown in Chapter 8, some outliers are up to 7 years old: in this case, investments needs could be significantly different in respect to a newborn firm.

$Leverage_{i,t-1}$ measures the financial leverage of company *i* at year *t-1*. More specifically, the leverage is computed as $\frac{Total\ Debt}{Equity}$. Unfortunately, the available data did not allow to select only financial debts for this computation[64]. However, the metric adopted in this study is still the most frequently used to measure a company's financial structure.

Besides computational issues, it is important to control for possible differences in the investment dynamics related to the capital structure of a firm. Indeed, as

[64] Actually, a debt to equity ratio computed only considering financial debts was available in the database, However, it has not been used due to the great amount of missing values in it.

discussed in paragraph 4.3, Aivizian et al. (2003) report a negative correlation between leverage and firm's investment, supporting the argument that debt capital reduces the incentives for entrepreneurs to undertake positive NPV projects whose benefits would not be fully captured by shareholders (Myers, 1977). Moreover, increasing levels of financial leverage might disproportionally increase the cost of external debt, reducing the potential capital sources to finance investments.

$GDPgrowth_t$ and $Deficit_t$ are two variables which indicate, respectively, Italian real GDP growth and the Italian budget deficit compared to the national GDP at current market prices at time *t*. Both metrics have been sourced from Eurostat. The reason underlying the use of such variables reflects the need to control for possible effects of macro-economic conditions on firms' investment decision. Being peculiar to the entire Italian landscape, these variables vary across time but not across companies.

$South_i$, $InfraGen_i$ and $InfraEco_i$ are three variables which are related to firm *i* location. In particular, they are all computed on a regional scale and thus they vary across companies (even if they are the same for firms located in the same region) but are fixed over time.

$South_i$ is a dummy variable which is equal to 1 if company *i* is located in the South of Italy, 0 otherwise. In particular, regions belonging to the South of Italy are Abruzzo, Basilicata, Calabria, Puglia, Campania, Molise, Sicilia and Sardegna.

Historically, the North and South of Italy underwent very different economic paths. For this reason, several public subsidies targeting the Italian "Mezzogiorno" have been put in place. Accordingly, differences might arise also from a microeconomic perspective.

$InfraGen_i$ and $InfraEco_i$ are indicators of the level of infrastructure of each Italian region. Both indexes have been computed by "Istituto Tagliacarne" and refer to the latest metrics available, that are updated at 2012. The former considers all types of infrastructures, whereas the latter only takes into consideration economic ones.

The idea of controlling for firms' location is not new to investment behaviour

studies, especially when R&D investments and innovation are concerned. Shefer and Frenkel (2005) provide some references of studies finding that location plays a significant role on innovation rate, which may underlie the need for investments. In addition to that, Lynskey (2013) includes a geographical dummy in his model aiming at investigating investment's drivers.

$ServGen_i$, $Software_i$ and $R\&D_i$ are three dummies which are used to classify ISUPs by industry. In particular, $R\&D_i$, as the name suggests, identifies companies operating in the R&D sector; similarly, $Software_i$ dummy is equal to 1 for ISUPs working in the software industry. Finally, $ServGen_i$ represents all the remaining service sectors. A fourth sectorial dummy (omitted due to collinearity in the model) refers to manufacturing companies and complements the three variables just mentioned.
As one may understand, investment behaviours are supposed to consistently vary across industries: for example, in theory a manufacturing activity should have a greater level of assets than a pure service company. Therefore, controlling for it seems to be absolutely reasonable.

$VC_{i,t}$ is a dummy variable that is equal to 1 if firm *i* has been backed (in year *t* or before) by a VC organisation. In other words, $VC_{i,t}$ is equal to 0 for all those companies which do not have any VC firm among its shareholders. For those which have it, the dummy is equal to 1 from the time observation related to the year when the VC bought company shares onward.

$GF_{i,t}$ is a dummy variable whose logic is exactly the same as $VC_{i,t}$. When $GF_{i,t}$ is equal to 1, it means that firm *i* has received a bank loan guaranteed by the Central Guarantee Fund for Small and Medium Enterprises at year *t* or before.
Deepening whether VC or external debt capital impacts or not on ISUPs' investment level is of great importance to the extent of this study. Since the extant literature identified the constrained access to external financing as the main impediment to start-ups' investments, companies able to receive bank loans

(proxied by $GF_{i,t}$) and external equity (proxied by $VC_{i,t}$) should exhibit greater investment rates. Moreover, checking for a possible correlation between these two independent variables and the investment rate also offer the possibility to provide a first evaluation of the effectiveness of Law 221, as favouring ISUPs' access to external funds is one of the main aim of this public intervention.

Finally, α represents the intercept, μ_i the estimated individual effects and ν_{it} the idiosyncratic component of the error term.

9.2.2 Model 1.2

The second model (1.2) tested in this study presents the following structure:

$$\frac{I_{i,t}}{K_{i,t-1}} = \alpha + \mu_i + \beta_1 \frac{CF_{i,t}}{K_{i,t-1}} + \beta_2 \frac{Sales_{i,t}}{K_{i,t-1}} + \beta_3 Age_{i,t} + \beta_4\ Leverage_{i,t-1} + \beta_5\ GDPgrowth_t + \beta_6\ Deficit_t + \beta_7\ South_i + \beta_8\ InfraGen_i + \beta_9\ InfraEco_i + \beta_{10}\ ServGen_i + \beta_{11}\ Software_i + \beta_{12}\ R\&D_i + \beta_{13} VC_{i,t} + \beta_{14}\ GF_{i,t} + \beta_{15}\ GFAmount_{i,t} + \nu_{it}$$

In respect to model 1.1, model 1.2 just adds one variable, $GFAmount_{i,t}$, which provides additional information about the absolute amount guaranteed by the Central Guarantee Fund. In particular, as the guaranteed amount is proportional to the bank loan amount (usually the 80%), this variable can be used as a proxy for the actual quantity of debt capital received by firm *i*. Like the $GF_{i,t}$, also $GFAmount_{i,t}$ is built under a cumulative logic: this variable, indeed, represents the amount of guarantees received by firm *i* up to year *t*. Hence, $GFAmount_{i,t}$ is equal to 0 as long as $GF_{i,t}$ is equal to 0. When $GF_{i,t}$ is equal to 1, $GFAmount_{i,t}$ reports the actual amount of guarantee received up to that time period. In other words, for all those companies that received a guarantee in both 2013 and 2014, the $GFAmount_{i,t}$ at year 2014 includes the cumulative guaranteed amount obtained in 2013 and 2014.

In the model design, there were two viable options: whether to substitute $GFAmount_{i,t}$ to $GF_{i,t}$ or simply add it to model 1.1's variables. The latter alternative has been chosen: in this way, it is possible to discriminate between the effects produced by simply accessing to the GF subsidy ($GF_{i,t}$) and the ones engendered by a lower or greater amount of debt capital injected in the company ($GFAmount_{i,t}$). Conversely, in case only $GFAmount_{i,t}$ were inserted in the model, such variable would have caught both effects.

Below, Table 14 reports mean, standard deviation and 5-number summary of the variables (dummies excluded) used in model 1.1 and 1.2.

Table 14 – Model 1.1 and 1.2: variables statistics.

Variables	N. of obs.	Mean	S.D.	Quantiles				
				Min	.25	Mdn	.75	Max
$CF_{i,t}/K_{i,t-1}$	2957	3.35	9.99	-0.69	0.10	0.63	2.63	240.82
$Sales_{i,t}/K_{i,t-1}$	2957	15.03	51.61	-0.00	0.14	1.96	10.34	1233.1
$Age_{i,t}$	5567	2.37	1.30	1.00	1.00	2.00	3.00	8.00
$Leverage_{i,t-1}$	3041	2.87	34.91	-1236.3	0.24	0.92	3.16	703.73
$GDPgrowth_t$	5567	-0.96	1.13	-2.80	-1.70	-0.40	-0.40	1.70
$Deficit_t$	5567	-3.06	0.27	-4.20	-3.00	-3.00	-2.90	-2.90
$InfraGen_i$	5567	107.36	25.75	39.46	85.51	113.09	116.71	173.85
$InfraEco_i$	5567	107.26	27.36	36.63	85.85	11.99	121.89	196.76
$GFAmount_{i,t}$	5567	16776.2	1.6e+05	0.00	0.00	0.00	0.00	4.0e+06

9.2.3 Model 2

Finally, model 2 presents the following structure:

$$\frac{I_{i,t}}{K_{i,t-1}} = \alpha + \mu_i + \beta_1 \frac{CF_{i,t}}{K_{i,t-1}} + \beta_2 \frac{Sales_{i,t}}{K_{i,t-1}} + \beta_3 Age_{i,t} + \beta_4\, Leverage_{i,t-1} + \beta_5\, GDPgrowth_t + \beta_6\, Deficit_t + \beta_7\, South_i + \beta_8\, InfraGen_i + \beta_9\, InfraEco_i + \beta_{10}\, ServGen_i + \beta_{11}\, Software_i + \beta_{12}\, R\&D_i + \beta_{13}\, VC_{i,t} + \beta_{14}\, GF_{i,t} + \beta_{16}\, ManagExp_i + \beta_{17}\, AcadExp_i + \nu_{it}$$

As with model 1.2, model 2 is build adding some variables related to ISUPs' human capital to model 1.1. More specifically, the two dummy variable related to managerial and academic previous experience of ISUPs' shareholders ($ManagExp$ and $AcadExp$) – already introduced in Chapter 8, have been added to the model. In particular, both dummies are equal to 1 if company *i* has at least one shareholder with previous managerial ($ManagExp$) or academic ($AcadExp$) experience. As for this latter variable, a shareholder is considered to have previous academic experience if she/he covered an active position (as research fellow, researcher, associate professor or full professor) in an Italian or foreign university. The introduction into the econometric model of these two dummy variables allows to investigate the possible impact of shareholders' capabilities and competences on ISUPs' investment behaviour.

Table 15 shows mean, standard deviation and 5-number summary of the variables (dummies excluded) used in model 2. Statistics in this table differ from the ones reported in Table 14, since they are drawn from different datasets (i.e. large and small sample).

Table 15 – Model 2: variables statistics.

Variables	N. of obs.	Mean	S.D.	Quantiles				
				Min	.25	Mdn	.75	Max
$CF_{i,t} / K_{i,\ t-1}$	388	4.25	15.13	-0.69	0.12	0.84	3.14	240.82
$Sales_{i,t} / K_{i,\ t-1}$	388	16.19	47.36	0.00	0.18	2.00	9.21	516.60
$Age_{i,t}$	628	2.58	1.35	1.00	2.00	2.00	3.00	7.00
$Leverage_{i,t-1}$	398	3.62	13.92	-40.25	0.23	0.78	2.88	131.73
$GDPgrowth_t$	628	-0.98	1.24	-2.80	-1.70	-0.40	-0.40	1.70
$Deficit_t$	628	-3.09	0.32	-4.20	-3.00	-3.00	-2.90	-2.90
$InfraGen_i$	628	106.47	25.26	39.46	85.51	113.09	116.71	173.85
$InfraEco_i$	628	106.63	27.45	36.63	85.85	111.99	121.89	196.76

In the next page, a summary of the independent variables included in models 1.1, 1.2 and 2 is available in Table 16.

Table 16 – Independent variables: a summary

Variable	Description
Firm-specific	
$CF_{i,t} / K_{i, t-1}$	Firm beginning-of-the-period liquid assets on lagged fixed assets
$Sales_{i,t} / K_{i, t-1}$	Firm Sales on lagged fixed assets
$Age_{i,t}$	Age of the firm at time *t*
$Leverage_{i,t-1}$	Firm lagged Debt to Equity ratio
$VC_{i,t}$	One if the firm has reveived VC at year *t* or before
$GF_{i,t}$	One if the firm has reveived government guaranteed bank loan at year *t* or before
$GFAmount_{i,t}$	Cumulative amount of guarantees obtained by the firm at year *t*
Location-specific	
$DSouth_i$	One for firms located in the South of Italy
$InfraGen_i$	General infrastructure indicator of the region in which the firm is located
$InfraEco_i$	Economic infrastructure indicator of the region in which the firm is located
Sector-specific	
$Software_i$	One for firms operating in the Software industry
$R\&D_i$	One for firms operating in the R&D industry
$ServGen_i$	One for firms operating in other service industries
Macroeconomic-specific	
$Deficit_t$	Italian budget deficit compared to the national GDP at current market prices at time *t*
$GDPGrowth_t$	Italian real GDP growth rate at time *t*
Human Capital-specific	
$ManagExp_i$	One for firms with at least one shareholder having previous managerial experience
$AcadExp_i$	One for firms with at least one shareholder having previous academic experience

9.3 Econometric results

In this section, the econometric results of models 1.1, 1.2 and 2 will be presented and discussed. Furthermore, the limitations of this analysis, together with some possible future developments will be highlighted.

In the next page, Table 17 exhibits the econometric results of models 1.1, 1.2 and 2.

Table 17 – Econometric results

Random-effects GLS regression				
Coeff.	Independent Variables	Model 1.1	Model 1.2	Model 2
β_1	$CF_{i,t} / K_{i,\ t-1}$	0.1621127 (0.0402513)***	0.162132 (0.0402588)***	0.5087168 (0.0675195)***
β_2	$Sales_{i,t} / K_{i,\ t-1}$	0.1227046 (0.0076872)***	0.1226896 (0.0076899)***	-0.0257801 (0.021902)
β_3	$Age_{i,t}$	-1.539477 (0.3525237)***	-1.540265 (0.352666)***	-1.929773 (0.6183947)***
β_4	$Leverage_{i,t-1}$	-0.001237 (0.0103129)	-0.0012361 (0.0103148)	0.0232176 (0.0550384)
β_5	$GDPgrowth_t$	-0.4271856 (0.4373911)	-0.4269265 (0.437474)	-1.461672 (0.84835)*
β_6	$Deficit_t$	- 0.3211328 (3.186781)	-0.3189926 (3.187416)	-8.927145 (5.647515)
β_7	$South_i$	3.362654 (1.236725)***	3.367129 (1.237626)***	0.1646148 (1.944815)
β_8	$InfraGen_i$	-0.0428657 (0.0799471)	-0.0427936 (0.0799673)	-0.0753403 (0.1443729)
β_9	$InfraEco_i$	0.0223911 (0.0739329)	0.0223742 (0.0739495)	0.0592055 (0.1318109)
β_{10}	$ServGen_i$	-2.123035 (1.261974)*	-2.123561 (1.262267)*	0.358698 (3.566166)
β_{11}	$Software_i$	-1.936317 (1.124787)*	-1.936951 (1.125055)*	-0.8256579 (1.669575)
β_{12}	$R\&D_i$	-2.015778 (1.36138)	-2.017667 (1.361795)	-0.5988197 (1.93978)
β_{13}	$VC_{i,t}$	2.016671 (1.07972)*	2.01706 (1.079958)*	2.411906 (1.582317)
β_{14}	$GF_{i,t}$	2.740847 (1.807104)	2.848293 (2.052754)	-0.3224904 (3.331159)
β_{15}	$GFAmount_{i,t}$	/	-3.95e-07 (3.58e-06)	/
β_{16}	$ManagExp_i$	/	/	-3.40399 (1.544669)**
β_{17}	$AcadExp_i$	/	/	1.743996 (1.537722)
	N. of Obs.	2957	2957	388

Note: Standard errors in parenthesis; ***, ** and * indicate, respectively, significance levels of <1%, <5% and <10%.

9.3.1 Result interpretation: model 1.1

In general, econometric results of model 1.1, reported in Table 17, confirm most of the expectations based on the arguments highlighted in the literature review.

To begin with, the impact of the beginning-of-the-period liquidity is positive and significant at 99% confidence level. This evidence is aligned with the argument, discussed in Chapter 4, that internal capital is the preferred investment source for young innovative companies. Especially for ISUPs, which do not pay any dividend (as specified in Law 221), internal capital can be largely exploit to pursue investment opportunities and provide the company with a broader fixed assets base.

For what concerns the two independent variables of primary focus in this study (GF and VC), estimates are once again aligned with expectations. Indeed, both dummy variables have a positive coefficient (higher than 2 in both cases); furthermore, the variable related to venture capital is significant at 90% confidence level (p-value equal to 0.062); on the other hand, even if not statistically significant, the GF variable still has a relatively low p-value (i.e. 0.129). This notwithstanding, it is reasonable to hold that both VC and bank loans are a fundamental source for ISUPs to sustain their investment over time. Even if VC dummy, differently from GF, is significant at a 10% level, there is no sufficient evidence supporting the argument that equity capital is preferred over debt as external capital source for ISUPs: indeed, FG estimates has even a greater magnitude than VC one (2.74 vs 2.01); moreover, a possible impediment to the comparison of VC and GF variables emerges: while access to the CGF has been possible only starting from May 2013, the presence of VC among an ISUP's shareholders could have been spotted even in previous observed years. Hence, even if both measures are focused on the short-term, the impact of VC on firm

investment rates has been tested (at least for some of the observed firms[65]) over a longer time period.

Another variable having a positive and significant (at 99% confidence level) impact on investment rate is the one related to sales. In this study, such variable has been introduced in order to control for investment opportunities at year *t*. Therefore, a positive correlation was expected, as companies that face favourable market conditions are also likely to increase their investment level. In addition to this argument, another possible explanation of the positive impact of sales on investment is that companies – especially start-ups which generally lack of complementary assets – need to invest more in order to build a more suitable asset base to handle increased sales volumes.

Very interesting results come from the estimate of β_3, the coefficient of the explanatory variable related to firm age. Indeed, one may expect to find a positive relationship between investment rate and firm age: as long as time goes by, companies grow and are supposed to invest more and more. Clearly, this growth path could not be expected to last forever; however, as long as this analysis is focused on the early years of innovative start-ups' life (less than 5% of ISUPs in the large sample are older than 5 years), it is reasonable to think that investment should increase as companies get older. Nonetheless, a company's age exerts a negative impact, significant at 99% confidence level. In order to shed light on this apparently controversial result, Table 18 reports interesting data coming from the large sample. As a matter of fact, it is important to remember that the dependent variable does not represents net investments in absolute terms, but it is actually an investment rate that measures the yearly incremental fixed assets growth. Consequently, saying that firm age has a negative correlation with firms' investment rate does not mean that younger ISUPs invest more than older ones;

[65] In particular, for 244 out of 2526 surveyed firms, VC has been received in 2012 or earlier. Conversely, ISUPs were not allow to accesso to the CGF before May 2013.

actually, it means that younger ISUPs invest more than older ones in percentage terms relating to the beginning-of-the-year fixed assets value.

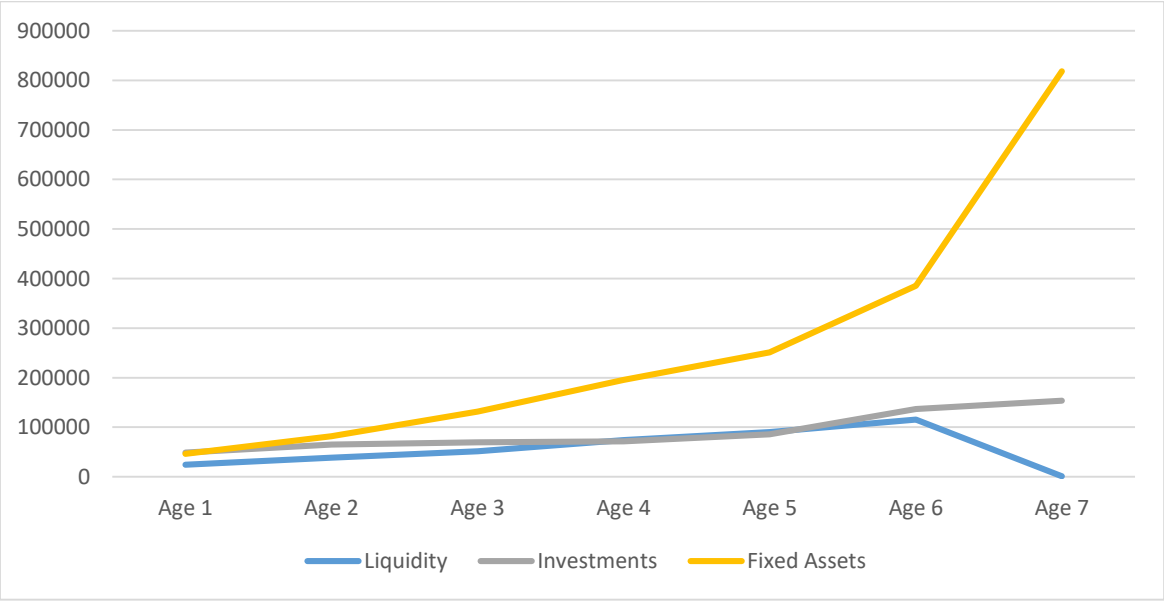
Table 18 – Average net investments, fixed assets and liquidity by firm age

Age	N. of Obs.	Net Investments	Fixed Assets	Liquidity
1	1668	48863	46343	24559
2	1782	65265	82089	38485
3	1070	69773	131319	51177
4	607	71267	195766	73827
5	308	85544	251049	90509
6	121	136790	385479	115162
7	10	153329	818341	1275

Source: author's elaboration

Data shown in Table 14 help to understand which is the ISUPs' investment behaviour in relation to firm age[66]. As it is possible to see from the table, net investments, fixed assets and liquidity all rise as long as companies get older. However, they rise at very different rates (see Figure 37).

Figure 37 – Net investment, fixed assets and liquidity growth trajectory over time



Source: author's elaboration

[66] The number of observations on which the average values of net investments, fixed assets and liquidity are computed is added in order to provide a consistency measure of reported values.

The growth trajectories of fixed assets, net investment and liquidity reported in Figure 37 offer a precise snapshot of the situation. Even if ISUPs on average increase their yearly net investments, this growth is considerably less steep than fixed assets growth: accordingly, even if ISUPs do invest more as time goes by, their investment rate decreases.

By and large, this dynamic affects most of the start-ups in their early years, which are reported to stop (or slow down) their growth after the first years of activity. This issue could be even more remarkable considering that all ISUPs in the database were still active and operative at the end of 2014.

Another considerable aspect stemming from Figure 37 is that net investments and liquidity follow basically the same trajectory over time. Of course, these figures represent only rough average data; however, if combined with the econometric results obtained so far, they support the evidence that Italian innovative start-ups grow on average along time, increasing both their investments and their pool of internal available funds. However, the pace at which their liquidity and investment levels increase are relatively low. Therefore, a facilitated access to external capital may increase the liquid resources available and play a crucial role in maintaining greater investment (and growth) rates.

Sectorial dummies give very clear indications: for all of them (R&D, Software and other services), coefficients are negative and of remarkable entity. Moreover, dummies related to software and other service industries are significant at 90% confidence level. On the other hand, R&D presents a p-value equal to 0.139, quite close to significant values. These estimates provide a consistent evidence that the fourth and complementary dummy (omitted due to collinearity), related to the manufacturing industry, has a positive and considerable impact on ISUPs' investment rate. This rationale is coherent with expectations, as tangible and intangible assets are likely to be much more important to start-ups working in the manufacturing industries rather than in the service environment.

A further result that is, to some extent, unexpected is the estimate of the geographical dummy *South*, which identifies ISUPs located in the 8 Italian regions forming the so-called "Mezzogiorno". Indeed, as the South of Italy has historically struggled to keep pace with the North in terms of economic efficiency and development, it was possible to anticipate a negative correlation with investment rate. On the contrary, the correlation is positive, remarkable (3.36) and statistically significant at 99% confidence level.

The explanation of this result is not directly related to micro-economic reasons, but is actually due to institutional factors. Indeed, in order to support the economic development of Southern regions, the Italian governments have put in place a multitude of special subsidies targeting the "Mezzogiorno". Focusing on the period of interest to the extent of this study (2010-2014)[67], the Ministerial Decree 6 March 2013 has created a fertile ground for South start-ups' investments. First, small newborn firms operating in the "Mezzogiorno" can benefit from an economic support up to 200,000€ to cover production, logistic, corporate and organisational costs in the first 4 years after their birth. Second, an additional investment program has been focusing on digital and high-tech start-ups; in this case, firms may obtain up to 200,000€ to offset investment expenditures (in plant and equipment, hardware and software, licenses, patents and certifications, design, development and testing costs, technical consultancy) together with a technical-managerial tutoring as a support during the start-up phase.

Finally, no evidence of the relation between investment and financial leverage is found. Conversely to the findings of Aivazian et al. (2005), who documented a negative relationship between leverage and firm investments, in this study the coefficient related to the leverage variable is very close to 0 and shows a significant statistical inconsistency (p-value equal to 0.905).

[67] More recently, the "Decreto Stabilità" of 2016 has introduced a tax credit (20% for small companies) for investments in machineries and equipment. This subsidy is limited to those companies located in the "Mezzogiorno".

9.3.2 Result interpretation: model 1.2

Results stemming from model 1.2 are, obviously, very close to those obtained from model 1.1. In particular, all the significant variables which have been previously discussed maintain their statistical significance at the same level of confidence.

On the other hand, what is interesting to analyse is the estimate of coefficient $\beta_{15,}$ relative to the cumulative amount of the guarantee obtained by ISUPs.

In particular, this variable is conceived as a proxy for the amount of debt capital injected into a firm thanks to the guaranteed bank loan. Indeed, Law 221 set the maximum guaranteeable amount at 80% of the debt financing: for most of the ISUPs which had access to the Central Guarantee Fund, the actual guarantee obtained was quite close to that maximum threshold (on average, 77%).

According to the widely recognised argument that financial constraints are a main source of start-ups underinvestment, a greater amount of external finance obtained through a bank loan should enable companies to invest more.

However, results of model 1.2 are not in agreement with this logic: variable *GFAmount* has a negative coefficient (nearly 0) and a p-value equal to 0.912.

Combining these results with what has been seen in model 1.1, the empirical evidence seems to suggest that accessing the Central Guarantee Fund has a positive correlation with ISUPs' investment rate, while the actual amount of supplied funds does not. Such evidence is to some extent aligned with a possible "certification effect", which has been documented and studied in relation to other financing sources, such as VC (see Bertoni, Croce and Guerini, 2015). However, it is important to underline that there is no direct evidence of the existence of a "certification effect" engendered by the CGF; therefore, further and more specific analyses should be carried out to confirm such hypothesis.

9.3.3 Result interpretation: model 2

The primary aim of model 2 was to check whether previous experience (managerial or academic) of ISUPs' shareholders has an impact on firm investment behaviour or not. Moreover, estimates coming from model 2 can be also used as a robustness check of the results presented so far.

As for this second aim, most of the most remarkable results stemming from model 1.1 and 1.2 are confirmed. In particular, both internal funds and equity capital (VC) are found to have positive and statistically significant coefficients: liquidity (as before) at a confidence level of 99%, while VC at a confidence level of 95%.

The estimate of the last variable related to capital (*GF*) is sensibly different from the previous models (negative coefficient). Since the p-value is much greater than in previous estimates (0.923 vs 0.129), it is very likely that the small sample limited size (230 companies, less than 10% of the ones analysed in the large sample) has produced inconsistency in the estimate. The same explanation can be valid for *South* and *Sales/K*, whose estimates are inconsistent with previous evidence.

Conversely, in the case of *Age*, ISUPs in the small sample behave exactly as in the large one.

For what concerns shareholders' human capital, results deviate from the expectations. More specifically, ISUPs having one or more shareholders with a previous role in university are generally associated with greater investment rates (coefficient equal to +1.74). This result would confirm the general belief that companies whose shareholders possess a high-level education can translate these superior competences into their operations, growing more than average and exploiting at best investment opportunities. Moreover, having one or more shareholders previously working in a university can likely give the start-up a preferential access to university resources, such as human capital, facilities and business contacts. Unfortunately, p-value of coefficient $\beta_{17,}$ related to the variable *AcadExp*, is too high (0.257) to confer statistical significance to this result.

On the other hand, variable *ManagExp* is significant at 10% confidence level: however, the correlation among managerial experience and firm investment rate is surprisingly found to be negative. In principle, indeed, it is reasonable to believe that having one or more shareholders with previous managerial experience could help start-ups to outline more effective business strategies and thus create greater investment opportunities. As inferred by Bertoni, Colombo and Croce (2010) high-tech start-ups' investment opportunities are, indeed, likely to be related to the

quality of their business idea and the innovative potential of the technologies being developed.

Hereafter, two possible explanations of the negative correlation between managerial experience and investment rate are presented.

The first – and perhaps easier to support – is that the estimate is not consistent as the number of surveyed firms in the sample is relatively low if compared to the ISUPs population at December 2014 (230 vs 3006).

A second possibility is that shareholders with previous managerial experience could be abler to avoid inefficiencies and huge expenditures, thus ending up with adopting a more "conservative" approach in terms of investment. This argument can be supported with some figures: limiting the analysis at year 2014, ISUPs with "managerial experience" have on average a smaller fixed assets base, invest less but they still have more revenues than their counterparts with no managerial experience. Consequently, ISUPs whose shareholders have developed greater managerial skills are also more profitable, or better "less unprofitable" (in 2014, the average ROA for those companies is -19%, while for their counterparts is -74%). Following this view, it would be possible to infer that companies with greater managerial competences in their early stages are more cautious in terms of investment, trying to limit potentially sunk cost and making the best out of a smaller asset base. Conversely, ISUPs with lower managerial skills show a more unscrupulous strategy, paying little attention to current losses; rather, they invest more with the hope to be paid back in the future.

9.4 Limitations and possible issues

In this section, the main issues and potential limitations faced during the present analysis will be encompassed. Interestingly, most of these limitations have a common denominator, that is the relatively short observation period.

Indeed, the primary aim of this research was to shed light on the effectiveness of some of the support instruments enforced by Law 221 (i.e. facilitated access to equity and debt capital). As the abovementioned law became effective in December 2012 and financial data regarding ISUPs are available up to 2014, it is

obvious that only the short-term effects of the privileged access to the Guarantee Fund on surveyed companies could be analysed. Therefore, the present study focuses its attention on investments, which is one of the few financial items which could have been tangibly impacted by the policy scheme in the short-term. However, this limitation made not possible to investigate the early effects of Law 221 on other fundamental financial figures, such as revenues or profitability. Moreover, also the long-term impact of external capital (both equity and debt) on ISUPs investment behaviour could not be empirically tested.

Another problem directly related to the narrow set of observed years is associated to the choice of the econometric model to be run in the analysis. As discussed in paragraph 9.1, the recent literature focusing on firm investments has increasingly opted for the adoption of a dynamic panel model (estimated with a GMM-SYS). However, the low number of observation per company is incompatible with a consistent GMM estimation. Besides the possible issues in controlling for unobserved investment opportunities (discussed earlier in this chapter), implementing a GMM model would have reduced the possibility of endogeneity-related biases. Indeed, in such models it is possible to classify in advance independent variables as endogenous or predetermined. In this way, potentially endogenous variables would have been estimated through the use of suitable instruments. Running a GLS-random effects model, on the contrary, leaves space to the possibility of biases related to the endogenous nature of some control variables. In particular, the estimates could have been biased by reverse causality, i.e. when the correlation between dependent and independent variable does exist, but has inverse direction (the dependent variable impacts on the independent one, rather than the other way around). Among the independent variables included in the model, reverse causality can be generated by measures of liquidity, sales and access to external capital (GF and VC). As for liquidity and sales, these variables have been widely identified in literature as the most suitable metrics to control for investment opportunities at year *t*. However, if included at year *t*, they could also become sources of reverse causality. In order to manage this trade-off, the variable related to liquidity (which is more likely to generate reverse causality) has been

included in the model with a metric (i.e. beginning-of-the-year liquid assets) specifically designed to avoid risks of reverse correlations. In doing so, there would have been no variable to properly control for investment opportunities at year *t*: to solve this issue, the variable related to sales (which is less likely, in principle, to generate reverse causality) has not been lagged, thus being able to capture the effects of investment opportunities at year *t*. However, potential biases due to reverse causality still persist – even if limited – in relation to such variable. Also variables indicating the access to equity (VC) or debt (GF) capital have a potentially endogenous nature. As a matter of fact, a firm that is facing interesting investment opportunities is more likely to look for external finance (Colombo, Croce and Guerini, 2013).

However, including such variables as 1-year lagged was not an option due to the limited time observations available in the dataset. Especially for GF, this would have made impossible to carried out consistent estimates, as the facilitated access to the CGF has been possible for ISUPs starting from May 2013: thus, not considering data from 2014 would have not been a viable option.

However, from a theoretical perspective, endogeneity for such variables should be alleviated by the nature of these metrics themselves: both VC and FG dummies, indeed, are built on a cumulative logic: they are equal to 1 if a company has received VC or GF at year *t* or before. Therefore, potential endogeneity could affect the estimates only in the observation related to the year when firm *i* actually accessed VC of GF.

A last main caveat is represented by the limited size of the small sample (230 firms out of 2526), which makes estimates of model 2 substantially less consistent than those of models 1.1 and 1.2. In this case, obtained results and related arguments should be seen as a first attempt to evaluate the impact of human capital on ISUPs investment dynamics. However, such results should be handled carefully, pending further future evidence.

To conclude, it is possible to say that, even though various sources of potential biases have been faced in this study, most of them have been solved or at least alleviated to the extent possible. Therefore, the results and the arguments

supported in this study (in particular those related to models 1.1 and 1.2) can be considered consistent and worthy of attention. Moreover, if the present study represents a first step in the ISUPs' investment behaviour analysis – with a specific connection with the support scheme offered by Law 221 – future analyses on the object of this study will likely to overcome the abovementioned limitations, as they could leverage on an extended database, larger in terms of number of period observations per firm.

Conclusions

Since the beginning of the new millennium, European Heads of State have decided to take concrete steps towards the creation of a more dynamic European economy. In that respect, in 2000 the European Union launched the Lisbon Strategy (or Lisbon Agenda), a set of policies aimed at laying the foundations in order *"to become the most dynamic and competitive knowledge-based economy in the world".* In 2010, another decennial development plan ("Europe 2020") has been approved: as defined by the European Union, Europe 2020 is a "European strategy for smart, sustainable and inclusive growth".

The efforts spent by European countries in order to promote a dynamic economy based on innovation should be interpreted as a reaction to the argument that the reason for the EU countries' lower economic development in respect to US has to be found in the innovative performance gap between US and EU economies. In particular, several authors certified the lack of innovative, technology-intense new ventures as one of the main causes of the gap in terms of innovation and growth between Europe and USA (Philippon and Vèron, 2008; Veugelers, 2009; Grilli, 2014).

In order to remedy this situation – and in full compliance with the Europe 2020 guidelines – in December 2012 the Italian government, outlined a comprehensive, systematic and detailed package of measures (Decree Law No. 179/2012, successively converted into Law No. 221/2012) directly aimed at favouring the birth and growth of innovative start-ups. Even though the new legal entity (defined as "Italian innovative start-up") created by the Italian government shows peculiar features, by and large it presents traits and characteristics similar to specific classes of firms which have been widely studied in the extant literature, such as new technology-based firms (NTBFs) and young innovative companies (YICs).

In particular, the empirical literature on this theme resulted in a widespread consensus on the profound impact that innovative start-ups have in fostering economic growth and prosperity. More specifically, the prominent role played by

innovative newborn firms in boosting economic development based on innovation is tightly connected to their main features: being small, young and having a strong focus on R&D activities and technology.

As highlighted in Chapter 2, companies with greater R&D intensity are alleged to show greater performance in terms of innovation: as demonstrated by several studies (e.g. Griliches, 1958), R&D expenditures have a direct and significant impact on economic welfare. Moreover, R&D activities might also have an indirect positive effect on innovation: the more a company generates internal information through R&D, the greater its "absorptive capacity" (Cohen and Levinthal, 1990) and, thus, its capability to benefit from external sources of related knowledge (Allen, 1977; Mowery, 1983). In sum, even if not necessary, R&D activities go well beyond the generation of an innovative output and can therefore favour the enterprises' innovation process in multiple ways. As a matter of fact, the intense commitment of high-tech start-ups to R&D offers a first unquestionable corroboration of their role in fostering the macroeconomic environment.

However, even more attention has been paid on the relation between firm size and innovation: the resulting long debate, ignited by Schumpeterian Mark I (1934) and Mark II (1942) failed to provide a clear result (Cohen and Levin, 1989; Lerner 2010). Nevertheless, albeit evidences of a "size effect" on the overall innovation level of a firm are mixed, several studies (e.g. Veugelers, 2009) documented that small firms can outclass larger ones when dealing with radical innovations. As radical innovation, conversely to incremental innovation, is able to move upward the technological frontier of an industry, thus originating unprecedented performance levels (Leifer et al., 2000), it is possible to assert that innovative small firms generally have a marked impact on markets and economies.

Finally, newborn companies are found to be leading characters of new employment generation, accounting for a disproportionate share of net job creation (Davidsson et al., 1995; Haltiwanger et al., 2013).

Therefore, being at the same time relatively small, young and R&D-focused, innovative start-ups are supposed to be an extraordinary and unquestionable source of innovation and growth for the whole economic environment.

However, “start-up” does not necessarily mean success: according to Shane (2009), the alleged importance of newborn ventures is nothing but a false myth; indeed, the average founder of a start-up is primarily interested in self-employment rather than the creation of a high-growth firm: as a result, start-ups have lower productivity, on average, than incumbent companies and thus their contribution to economic growth is far from outstanding. Aside from the fact that Shane refers to start-ups in general, not specifically to innovative ones, his claims help to underline that only a narrow subset of high-potential newborn companies has the possibility to boost economic growth and development. For this reason, a deeper understanding of young companies’ growth determinants and key success factors is a crucial task for policy-makers, in order to design effective legislations able to favour this group of valuable ventures. By and large, firm growth drivers may be classified in three main categories: individual-specific (i.e. related to firm human capital), firm-specific (e.g. firm strategy, capital assets) and external (related to the industry, location and links with other organisations) factors.

In sum, the emergence of a wide pool of innovative start-ups is supposed to be a crucial vehicle of innovation-based economic growth. However, innovative start-ups are severely exposed to a problematic pitfall, on which researchers reached an almost universal consensus (Martin and Scott, 2000), that is underinvestment. Clearly, this issue represents a serious threat in the eyes of policy makers – especially if R&D investments are concerned – since the positive effects that innovative start-ups are supposed to convey to the economic system might be lowered (Schneider and Veugelers, 2010). Economic researches have picked out two central rationales for institutions to intervene and support innovative start-ups in the short run (Colombo and Grilli, 2006): the presence of spillovers (related, in particular, to R&D investments) and capital market imperfections.

The argument that spillovers are a crucial agent of the fact that private ventures invest less than what socially desirable in R&D is supported by academics without exception (Teece, 1986; Nelson and Romer, 1996; Lerner, 2002). The concept of R&D spillover goes together with the one of “appropriability”, namely the ability

of an innovator to capture the benefits engendered by its innovation, to the detriment of other firms. Due to the fact that, for a number of reasons, high-tech start-ups generally operate in a weak appropriability scenario, the social rate of return on R&D investments is found to be greater than the private rate of return (see Hall, 2002; Martin and Scott, 2000). Since companies decide their investment level only considering the private rate of return, some desirable projects (from society's point of view) will not be run, or they will be run with a wrong timing or on a smaller scale (Jaffe, 1996).

A second fundamental cause of innovative start-ups underinvestment – of great relevance to the extent of this study – is related to capital market imperfections.

The efficiency of capital markets mechanisms is of fundamental importance to guarantee an optimal allocation of financial resources: when capital markets imperfections emerge (inefficient capital market), external and internal capital are no longer perfect substitutes (Gertner et al., 1994). As a consequence of these "frictions", companies will strongly rely on internal funds to follow on profitable investment opportunities (Revest and Sapio, 2012). By this argument, if the personal wealth of founders or the company's profits are insufficient, some innovative projects will not be undertaken simply because external finance is too expensive (Aghion et al., 2009). In the last decades, scholars acknowledged several possible causes of the capital markets "frictions" which undermine a company's ability to access external funds and consequently spawn an additional underinvestment gap. Yet, most of the problems arises from information asymmetries between entrepreneurs and external investors. In particular, when lenders are less informed than managers, both external equity and debt are found to be rationed or expensive, as a consequence of adverse selection and moral hazard issues (Carpenter and Petersen, 2002a; Hubbard, 1998; Stiglitz and Weiss, 1981). It is worthwhile to clarify that albeit capital markets imperfections generated by information asymmetries might limit many forms of businesses (Hubbard, 1998), they predominantly hamper R&D investment because of the great uncertainty surrounding technological projects. In fact, companies which suffer the most from capital constraints are usually small, young and operating in

technology-intensive sectors. In other words, NTBFs (Carpenter and Petersen, 2002a). Under these circumstances, it is clear that the capital structure of an innovative start-up has a decisive impact on its investment behaviour. In particular, early studies theorised the existence of a "pecking order" (Myers and Majluf, 1984) or "financing hierarchy" (Fazzari et al., 1988). Since the marginal cost of debt is higher than the one of internal finance, indeed, companies will turn to debt or equity finance only when internal funds (e.g. founders' personal wealth, company's retained earnings) are exhausted. In other words, when investment demand is low, ventures will rely on internally available capital. For increased levels of investment demand, firms will switch to debt and eventually to external equity – which is found to be more expensive (Fazzari et al., 1988). Thus, past studies identified debt financing as the commonly preferred source of external financing, since it is less expensive than external equity and it allows managers to maintain control over their companies (Peneder, 2008).

Nonetheless, in contrast with the pecking order hypothesis, several recent works support the empirical evidence that venture capital (VC) is the most suitable candidate to alleviate NTBFs' financial constraints. Indeed, private VC is considered by both academics and practitioners as the best suited candidate to address the capital market imperfections constraining young high-tech firms (Carpenter and Petersen, 2002a; Lerner, 2002).

Clearly, the most direct form of support provided by VC firms to innovative start-ups is represented by the injection of external equity. In this respect, recent studies have demonstrated that equity finance has several advantages over debt finance when high-tech ventures are concerned. This is due to the fact that VC peculiar characteristics are meant to offset – at least partially – the information asymmetries which are the primary causes of the gap between internal and external finance for NTBFs. First, VC firms are likely to possess greater technological and context-specific expertise, which allows them to better evaluate promising high-tech projects and the entrepreneurial skills of the proponents (Audretsch and Lehmann, 2004). Second, conversely to banks, equity investors do not require a collateral to mitigate against adverse selection: since NTBFs generally lack of collateralisable

assets, this doubtlessly increases the advantages of VC. Third, increasing the level of equity in a company will not increase the likelihood of financial distress, as debt finance does (Carpenter and Petersen, 2002a). Fourth, VC investors take an equity stage in the ventures they fund, sharing profits and risks with them. This peculiar governance structure provides some advantages: first, firm founders are not required to pay back a loan and/or the related interests; second, VC investors have huge incentives to provide portfolio firms with all the resources they might need in order to fully express their innovative potential (Bertoni, Colombo and Croce, 2010).

A further benefit provided by VC is the so-called "certification function". In a nutshell, VC firms can leverage on their reputation to signal the quality of a financed firm and smooth their access to outside capital (Revest and Sapio, 2012). Besides financial-related benefits, VC investors may also provide a "coach" function, offering to the selected companies an assistance which goes well beyond the financial constraints alleviation. To this extent, VC companies are alleged to provide strategic consultancy services, financial management and networking (see Grilli, 2014 for a literature survey on this topic). As far as the latter is concerned, VC investors may extend their business contacts list to portfolio firms, allowing them to access to a wide set of opportunities, both in terms of tangible and intangible assets.

According to what seen so far, due to the issues related to R&D spillovers and capital market imperfections, two fundamental pre-requisites of the decision to invest in innovation – namely incentives and capital – could be missing for innovative start-ups.

Therefore, in order to support them to fully express their innovative potential, public policy intervention is largely advocated. In particular, there are two compelling lines of action that institutions should follow in the short run.

On one hand, disincentives provoked by R&D spillovers have to be offset by proper incentive schemes. On the other hand, access to external finance needs to be facilitated, especially for young and small companies in their early stages.

To the extent of the present study, this latter line of action was under the spotlight. Indeed, the goal of this research was to shed light on the relation between innovative start-up capital structure and investment behaviour. In particular, this offered the possibility to provide early evidence of the effectiveness of Law No. 221, introduced in Italy in December 2012. Indeed, among the various aids designed to support Italian innovative start-ups, Law 221 also envisages a favoured access to both debt and equity capital. As for the former, the Law allows innovative start-ups to enjoy a facilitated access to the Central Guarantee Fund. As for the latter, fiscal incentives for venture capitalists and outside investors investing in such start-ups will be provided. Therefore, the main purpose of the present research was to investigate whether Italian innovative start-ups are able to "convert" the abovementioned privileged access to external equity and debt capital into greater investment rates. While doing this, other possible investment determinants have been analysed in order to have more elements to suggest potential future policy directions to be pursued. Secondarily, further remarks concerning the impact of start-up human capital on investment behaviour have been offered.

In order to run the econometric analyses, two unbalanced panel datasets have been built. The first contains extensive financial data, up to 2014, for 2526 out of the 3006 innovative start-ups registered to the dedicated special section of the Business Register as of December 8th 2014. On the other hand, the second, which complements firms' financial information with hand-collected information about shareholders' educational and professional background, is limited to 230 firms.

Due to the limited number of observations available for each company, the applied econometric framework was configured as a static panel model, estimated through a GLS-random effects estimator.

Overall, the analysis included three models divided in two categories: the first one (models 1.1 and 1.2), based on the larger dataset, was focused on studying innovative start-up investment dynamics in relation to external financing.

The second category (i.e. model 2), leveraging on the smaller sample, was an augmented version of model 1.1, which included additional variables controlling for shareholders' managerial and academic experience.

Results stemming from the first category of econometric analyses confirmed the intuition that the access to external equity and debt finance has a positive (and statistically significant for equity capital) impact on firm investment rates. Interestingly, as far as debt capital is concerned, the received loan amount does not have any impact on start-up investment behaviour. A possible interpretation of this unexpected outcome, even if not yet corroborated by a thorough analysis, is that the access to the CGF opens up further possibilities for the recipient companies, in line with a possible "certification effect".

Among the other results, models 1.1 and 1.2 indicated that younger start-ups show greater investment rate, suggesting that innovative start-ups are not able to sustain a steady growth over their early years. Moreover, innovative start-ups in the South of Italy are found to invest more than others, thanks to tailored policy schemes promoting their growth.

To conclude, model 2 unexpectedly highlighted systematically lower investment rates for start-ups with at least one shareholder having previous managerial experience.

The findings and the contents of the present analysis might be of particular interest for a number of stakeholders, in particular entrepreneurs and policy makers. The former should be aware of the opportunities offered by the Law 221 in order to overcome the main barriers to firm investments and growth.

As for policy makers, by and large the outcome of this study shows that the policy schemes aimed at favouring start-up access to external capital have been effectively spurring firm investments. Nonetheless, even though the positive correlation between VC and investment rate, conversely to what found for the Guarantee Fund, is statistically significant, it is still not possible to have clear evidence that for ISUPs equity capital is a preferred resource in respect to debt.

However, despite accessing VC and GF helps companies to reduce the financial constraints binding their investments, ISUPs are generally not able to sustain growth over time. This notion, together with the fact that, as a consequence of tailored public subsidies directly related to their investments, ISUPs in the South of Italy exhibit greater investment rates, could suggest that the original measures

provided by the Law should be complemented. In fact, this is actually what happened in September 2014, when the program "Smart&Start Italia", at first targeting only South innovative start-ups, has been extended to the rest of the Peninsula. In particular, such program put in place a 200-million-Euro fund to be supplied, with a selective mechanism, to support expenditures in fixed assets, such as machineries, equipment and licenses. Since the present analysis is restricted to the 2010-2014 period, the effects of such complementary policy have not been captured. Therefore, it would be interesting to repeat the analysis with additional year observations, taking in this way into consideration the effects of more recently implemented policies.

Besides solving most of the econometric issues described in paragraph 9.4, including in the analysis additional year observations could also provide two further suggestions for future developments of this study.

First, to understand whether VC and GF have a similar impact on company's investment or not. In this line, being able to collect information about the amount of equity provided by venture capitalists could allow a proper comparison with the guaranteed amount of debt capital studied in model 1.2.

Second, a more comprehensive view about the actual success of ISUPs (and, consequently, of Law 221) could be drafted by focusing the attention on other financial KSFs, such as profitability measures, which require a longer time span to be successfully analysed.

Appendix

Estimates of returns to R&D and R&D spillovers (source: Griliches, 1992)

1. Agriculture		*Rates of Return to Public R&D*	
Griliches (1958)	Hybrid corn	35-40	
	Hybrid sorghum	20	
Peterson (1967)	Poultry	21-25	
Schmitz-Seckler (1970)	Tomato	37-46	
	Harvester	35-40	
Griliches (1964)	Aggregate	41-50	
Evenson (1968)	Aggregate	28-47	
Knutson-Tweeten (1979)	Aggregate	45-62	
Huffman-Evenson (1991)	Crops	11-83	
	Livestock	43-67	
	Aggregate		
2. Industry		*Rates of Return to R&D*	
Case Studies			
Mansfield et al. (1977)		25	56
I-O Weighted		Within	From Outside
Terleckyi (1974)	Total	28	48
	Private	29	78
Sveikauskas (1981)		10 to 23	50
Goto-Suzuki (1989)		26	80
R&D Weighted (patent flows)			
Griliches-Lichtenberg (1988)		46 to 69	11 to 62
Mohnen-Lepine (1988)		56	28
Proximity (technological distance)			
Jaffe (1986)			30% of within
Cost functions			
Bernstein-Nadiri (1988, 1989)			20% of within
differs by industry		9 to 27	10 to 160
Bernstein-Nadiri (1991)		14 to 28	Median: 56% of within

Bibliography

Abernathy, W.J. (1978). The Productivity Dilemma. Baltimore: Johns Hopkins University Press.

Abernathy, W.J., Utterback, J.M. (1978). Patterns of Industrial Innovation. Technology Review 80(7), 40-47.

Abramowitz, M. (1956). Resource and output trends in the United States since 1870. American Economic Review 46(2), 5–23.

Acs, Z.J., Audretsch, D.B. (1988). Innovation in large and small firms: An empirical analysis. American Economic Review 78(4), 678–690.

Aghion, P., Askenazy, P., Berman, N., Cette, G., Eymard, L. (2007). Credit Constraints and the Cyclicality of R&D Investment. Evidence from France, Working Paper.

Aghion, P., David, P.A., Foray, D. (2009). Science, technology and innovation for economic growth: Linking policy research and practice in "STIG Systems." Research Policy 38(4), 681–693.

Aghion, P., Howitt, P. (2005). Appropriate growth policy: a unifying framework. The 2005 J.A. Schumpeter lecture. In: 20th Annual Congress of the European Economic Association, Amsterdam.

Ahuja, G., Lampert C. M. (2001). Entrepreneurship in the large corporation: a longitudinal study of how established firms create breakthrough inventions. Strategic Management Journal 22(6-7), 521-543.

Aivazian, V.A., Ge, Y., Qiu, J. (2005). The impact of leverage on firm investment: Canadian evidence. Journal of Corporate Finance 11(1-2), 277–291.

Akerlof, G.A. (1970). The Market for "Lemons": Quality Uncertainty and the Market Mechanism. Quarterly Journal of Economics 84(3), 488–500.

Allayannis, G., Mozumdar, A. (2004). The impact of negative cash flow and influential observations on investment-cash flow sensitivity estimates. J. Bank. Financ. 28(5), 901–930.

Allen, T.J. (1977). Managing the Flow of Technology. Cambridge, MA: MIT Press.

Almus, M., Nerlinger, E.A., Steil, F., (1999). Growth determinants of start-ups in Eastern Germany: a comparison between innovative and non-innovative firms. In: Oakey, R., During, W., Mukhtar, S.M. (Eds.), New Technology-based Firms in the 1990s. Bd. M. VI, Amsterdam, 283– 296.

Amit, R., Brander, J., Zott, C. (1998). Why do venture capital firms exist? Theory and Canadian evidence. Journal of Business Venturing 13, 441-466.

Anderson, S., Goeree, J., Holt, C. (1997). Rent seeking with bounded rationality: an analysis of the all-pay auction. Thomas Jefferson Center Discussion 283, University of Virginia.

Antonelli, C., Crespi, F. (2013). The "Matthew effect" in R&D public subsidies: The Italian evidence. Technological Forecasting and Social Change 80(8), 1523–1534.

Arrow, K.J. (1962). Economic Welfare and the Allocation of Resources for Invention. In: Nelson, R. (Ed.), The Rate and Direction of Inventive Activity. Princeton, NJ.

Asquith, P., Mullins, D.W. (1986). Equity issues and offering dilution. Journal of Financial Economics 15, 61-89.

Audretsch, D.B. (1995). Innovation and Industry Evolution. Cambridge, MA: MIT Press.

Audretsch, D.B., Dohse, D. (2007). Location: A neglected determinant of firm growth. Review of World Economics 143(1), 79–107.

Audretsch, D.B., Mahmood, T. (1994). Firm selection and industry evolution: the post-entry performance of new firms. Journal of Evolutionary Economics 4, 243-260.

Audretsch, D., Lehmann, E. (2004). Financing high-tech growth: the role of banks and venture capitalists. Schmalenbach Business Review 56, 340–357.

Auerswald, P.E., Branscomb, L.M. (2003). Valleys of death and Darwinian seas: financing the invention to innovation transition in the United States. Journal of Technology Transfer 28, 227–239.

Balboni, B., Bortoluzzi, G., Tivan, M. (2014). The Growth Drivers of Start-up Firms and Business Modelling: A First Step toward a Desirable Convergence. Management 9(2), 131–154.

Baldwin, J., Picot, G. (1995). Employment Generation by Small Producers in the Canadian Manufacturing Sector. Small Business Economics 7, 317-331.

Baldwin, W., Scott, J. (1987). Market Structure and Technological Change, Fundamentals of Pure and Applied Economics 17. London: Harwood Academic Publishers.

Banca d'Italia (2013). The new framework for the taxation of venture capital in Italy. Questioni di economia e finanza.

Banca d'Italia (2016). Innovative start-ups in Italy: their special features and the effects of the 2012 law. Questioni di economia e finanza.

Baum, J., Locke, E., Smith, K.G. (2001). A Multidimensional Model of Venture Growth. Academy of Management Journal 44(2), 292–303.

Baum, J., Silverman, B. (2004). Picking winners or building them? Alliance, intellectual, and human capital as selection criteria in venture financing and performance of biotechnology startups. Journal of Business Venturing 19, 411-436.

Baumol, W.J. (2002). The Free-Market Innovation Machine. Princeton University Press.

Beaver, G. (2001). Innovation, high technology and the new enterprise. Strategic Change 10, 421-426.

Becker, G.S. (1975). Human Capital. National Bureau of Economic Research, New York.

Bernstein, S., Lerner, J., Sørensen, M., Strömberg, P. (2010). Private Equity and Industry Performance. National Bureau of Economic Research, Inc.

Bertoni, F., Colombo, M.G., Croce, A. (2010). The effect of venture capital financing on the sensitivity to cash flow of firm's investments. European Financial Management 16(4), 528–551.

Bertoni, F., Colombo, M.G., Grilli, L. (2013). Venture capital investor type and the growth mode of new technology-based firms. Small Business Economics 40(3), 527–552.

Bertoni, F., Croce, A. (2011). Policy reforms for venture capital in Europe. In: Colombo, M.G., Grilli, L., Piscitello, L., Rossi, C. (Eds.). Science and innovation policy for the new knowledge economy. Edward Elgar, Cheltenham Glos (UK), 196-229.

Bertoni, F., Croce, A., Guerini, M. (2012). The effectiveness of public venture capital in supporting the investments of European young high-tech companies. SSRN eLibrary (217485), 1–32.

Bertoni, F., Croce, A., Guerini, M. (2015). Venture capital and the investment curve of young high-tech companies. Journal of Corporate Finance 35, 159–176.

Bertoni, F., Martí Pellón, J., Ferrer, M. (2012). The different role played by venture capital and private equity investors on the investment activity of their portfolio firms. Journal of Small Business Economics.

Bhattacharya, S., Ritter, J.R. (1983). Innovation and Communication: Signalling with Partial Disclosure. The Review of Economic Studies 50(2), 331–346.

Birch, D. (1981). Who creates jobs?. The Public Interest 65.

Birch, D. (1979). The Job Generation Process. Unpublished report prepared by the MIT Program on Neighborhood and Regional Change for the Economic Development Administration, U.S. Department of Commerce, Washington D.C.

Bond, S.R., Hoeffler, A., Temple, J. (2001). GMM Estimation of Empirical Growth Models. CEPR Discussion Paper 3048.

Bond, S.R., Meghir, C. (1994). Dynamic investment models and the firm's financial policy. Review of Economic Studies 61, 197–222.

Bound, J., Cummins, C., Griliches, Z., Hall, B.H., Jaffe, A. (1984). Who does R&D and who patents?. In: Griliches, Z. (Eds.), R&D patents and productivity. Chicago, University of Chicago, Press for the National Bureau of Economic Research.

Brealey, R., Myers, S. (2000). Principles of Corporate Finance. Boston: Irwin/McGraw-Hill.

Brinkley, I. (2008). Knowledge Economy and Enterprise: A Knowledge Economy Working Paper.

Brouwer, M., (1998). Firm Size and Efficiency: A Comment. Small Business Economics 11(4), 391-393.

Brown, J.R., Fazzari, S.M., Petersen, B.C. (2009). Financing innovation and growth: cash flow, external equity and the 1990s R&D boom. J. Financ. 64(1), 151–185.

Brynjolfsson, E., Mcafee, A. (2014). The Second Machine Age - Work, progress, and prosperity in a Time of Brilliant Technologies. W.W. Norton and Company 1, 6-9.

Butchart, R. (1987). A New UK Definition of High Technology Industries. Economic Review 400, 82-88.

Bygrave, W.D., Timmons, J.A. (1992). Venture Capital at the Crossroads. Boston, MA: Harvard Business School Press.

Carpenter, R.E., Petersen, B.C. (2002a). Capital Market Imperfections, High Tech Investment, and New Equity Financing. The Economic Journal 112(477), F54–F72.

Carpenter, R.E., Petersen, B.C. (2002b). Is the growth of small firms constrained by finance?. The Review of Economics and Statistics 84(2), 298–309.

Castrogiovanni, G.J. (1996). Pre-startup planning and the survival of new small businesses: Theoretical linkages. Journal of Management 22(6), 801–822.

Catozzella, A., Vivarelli, M. (2014). The Catalysing Role of In-House R&D in Fostering Complementarity Among Innovative Inputs. Industry and Innovation 21(3), 179–196.

Chemmanur, T.J., Krishnan, K., Nandy, D. (2011). How does venture capital financing improve efficiency in private firms? A look beneath the surface. Review of Financial Studies 24, 4037-4090.

Cleary, S. (1999). The relationship between firm investment and financial status. The Journal of Finance 54(2), 673–692.

Cleary, S., Povel, P., Raith, M. (2007). The U-Shaped Investment Curve: Theory and Evidence. Journal of Financial & Quantitative Analysis 42(1), 1–39.

Coad, A. (2007). Empirical investigations into the characteristics and determinants of the growth of firms. Doctoral dissertation. Université Panthéon-Sorbonne. Paris.

Coad, A., Hölzl, W. (2012). Firm growth: empirical analysis. Handbook on the Economics and Theory of the Firm, 324.

Cohen, W.M., Levin R.C. (1989). Empirical Studies of Innovation and Market Structure. In: Schmalensee, R., Willig R. D. (Eds.), Handbook of Industrial Organisation, 1059-1107. Amsterdam: Elsevier.

Cohen, W.M., Levinthal, D.A. (1990). Absorptive Capacity: A New Perspective on Learning and Innovation. Administrative Science Quarterly 35(1), 128–152.

Cohen, W.M., Levin, R.C., Mowery, D.C. (1987). Firm size and R&D intensity: A re-examination. Journal of Industrial Economics 35, 543-563.

Colombo, M.G., Croce, A., Guerini, M. (2013). The effect of public subsidies on firms' investment-cash flow sensitivity: Transient or persistent? Research Policy 42(9), 1605–1623.

Colombo, M.G., Giannangeli, S., Grilli, L. (2013). Public subsidies and the employment growth of high-tech start-ups: Assessing the impact of selective and automatic support schemes. Industrial and Corporate Change 22(5), 1273–1314.

Colombo, M.G., Grilli, L. (2005). Founders' human capital and the growth of new technology-based firms: A competence-based view. Research Policy 34(6), 795–816.

Colombo, M.G., Grilli, L. (2006). Supporting high-tech start-ups: Lessons from Italian technology policy. International Entrepreneurship and Management Journal 2(2), 189–209.

Colombo, M.G., Grilli, L. (2007). Funding gaps? Access to bank loans by high-tech start-ups. Small Business Economics 29(1-2), 25–46.

Colombo, M.G., Grilli, L. (2010). On growth drivers of high-tech start-ups: Exploring the role of founders' human capital and venture capital. Journal of Business Venturing 25(6), 610–626.

Colombo, M.G., Grilli, L., Murtinu, S. (2011). R&D subsidies and the performance of high-tech start-ups. Economics Letters 112(1), 97–99.

Colombo, M.G., Grilli, L., Piva, E. (2006). In search of complementary assets: The determinants of alliance formation of high-tech start-ups. Research Policy 35, 1166–1199.

Colombo, M.G., Grilli, L., Murtinu, S., Piscitello, L., Piva, E. (2009). Effects of International R&D Alliances on Performance of High-tech Start-ups: A Longitudinal Analysis. Strategic Entrepreneurship Journal 3, 346-368.

Cooper A.C. (1971). The founding of technologically-based firms. Milwaukee: The Center for Venture Management.

Cooper, A.C., Bruno, A.V. (1977). Success among high-technology firms. Business Horizons 20, 16–22.

Covin, J.G., Lumkin, G.T. (2011). Entrepreneurial Orientation Theory and Research: Reflections on a Needed Construct. Entrepreneurship Theory and Practice 35(5), 855-872.

Cremer, J., Sirbu, M. (1978). Une analyse econometrique de l'effort de recherche et developpement de l'industrie Francaise. Revue Economique, 29, 940-954.

Cressy, R., Munari, F., Malipiero, A. (2007). Playing to their strengths? Evidence that specialization in the private equity industry confers competitive advantage. Journal of Corporate Finance 13(4), 647-669.

Cunha, D., Silva, S., Teixeira, A.A.C. (2013). Are Academic Spin-Offs necessarily New Technology-Based firms?. FEP Working Papers 482.

Czarnitzki, D., Delanote J. (2013). R&D Subsidies to Small Young Companies: Should the Independent and High-tech Ones be Favoured?. 358 DRUID Conference Proceedings, Barcelona, Spain.

David, P.A., Hall, B.H., Toole, A.A. (2000). Is public R&D a complement or substitute for private R&D? A review of the econometric evidence. Research Policy 29(4-5), 497–529

Davidsson, P., Lindmark, L., Olofsson, C. (1995). Smallness, Newness, and Regional Development. Paper presented at OECD High-level Workshop on SMEs, Innovation and Employment, Washington D.C.

Davis, S.J., Haltiwanger, J., Schuh, S. (1996). Job Creation and Destruction, MIT Press.

Davis, S.J., Haltiwanger, J., Handley, K., Jarmin, R., Lerner, J., Miranda, J. (2014). Private Equity, Jobs and Productivity. American Economic Review, American Economic Association 104(12), 3956-3990.

Delapierre, M., Madeuf, B., Savoy A. (1998). NTBFs – the French Case. Research Policy 26(9), 989–1003.

Dimov, D., Murray, G. (2001). Literature Survey of Venture Capital Support Schemes in Europe, IFISE Project.

Djankov, S., McLiesh C., Ramalho, R.M. (2006). Regulation and Growth. Economic Letters 92 (3), 395-401.

Dushnitsky, G. (2007). Limitations to inter-organizational knowledge acquisition: the paradox of corporate venture capital. Working Paper. Wharton School, University of Pennsylvania.

Engel, D. (2002). The impact of venture capital on firm growth: an empirical investigation. Discussion Paper 02-02. Centre for European Economic Research (ZEW).

Engel, D., Stiebale, J. (2014). Private equity, investment and financial constraints: Firm-level evidence for France and the United Kingdom. Small Business Economics 43(1), 197–212.

Ernst&Young (2012). Branching out: How do private equity investors create value? A study of European exits.

European Commission (1996). New technology based firms (NTBFs) in Europe. University of Warwick.

European Venture Capital Association (2013). Exploring the impact of private equity on economic growth in Europe. Frontier Economics, London.

Fazzari, S. M., Hubbard, R. G., Petersen, B. C., Blinder, A. S., James, M. (1988). Financing Corporate Constraints Investment. Brookings Papers on Economic Activity 1(1), 141–206.

Forrest, J.E. (1990). Strategic alliances and the small technology-based firm. Journal of Small Business Management, July, 37-45.

Fudenberg, D., Tirole, J. (1987). Understanding rent dissipation: on the use of game theory in industrial organization. American Economic Review 77, 176-183.

Ganotakis, P. (2012). Founders' Human Capital and the Performance of UK New Technology Based Firms. Small Business Economics 39, 495–515.

Geroski, P.A., Gugler, K. (2004). Corporate Growth Convergence in Europe. Oxford Economic Papers 56, 597-620.

Geroski, P.A., Toker, S. (1996). The turnover of market leaders in UK manufacturing industry, 1979-86. International Journal of Industrial Organization 14, 141-158.

Gertner, R.H., Scharfstein, D.S., Stein, J.C. (1994). Internal versus external capital markets. NBER Working Paper Series 4776.

Gibrat, R. (1931). Les Inégalités économiques. Paris: Librairie du Recueil Sirey.

Gilchrist, S., Himmelberg, C. P. (1995). Evidence on the role of cash flow for investment. Journal of Monetary Economics 36(3), 541–572.

Gompers, P. (1995). Optimal investment, monitoring, and the staging of venture capital. Journal of Finance 50, 1461-1490.

Gompers, P. (1996). Grandstanding in the venture capital industry. J. Financ. Econ. 42, 133-156.

Gompers, P., Lerner, J. (2001). The Venture Capital Revolution. Journal of Economic Perspectives 15(2), 145–168.

Grabowski, H.G. (1968). The determinants of industrial research and development: A study of the chemical, drug, and petroleum industries. Journal of Political Economy 76, 292-306.

Griliches, Z. (1958). Research cost and social returns: Hybrid corn and related innovations. Journal of Political Economy LXVI, 419-431.

Griliches, Z. (1979). Issues in assessing the contribution and development of research to productivity growth. The Bell Journal of Economics 10(1), 92–116.

Griliches, Z. (1992). The Search for R&D Spillovers. Scandinavian Journal of Economics 94, 29–47.

Grilli, L. (2014). High-Tech Entrepreneurship in Europe: A Heuristic Firm Growth Model and Three "(Un-)easy Pieces" for Policy-Making. Industry and Innovation 21(4), 267–284.

Grilli, L., Lambruschini, V.R., Murtinu, S. (2014). Turning European new technology-based firms into "gazelles": the role of public (and private) venture capital. Industrial and Corporate Change 41.

Grilli, L., Murtinu, S. (2014). Government, venture capital and the growth of European high-tech entrepreneurial firms. Research Policy 43(9), 1523–1543.

Grilli, L., Murtinu, S. (2015). New Technology-based Firms in Europe: Market Penetration, Public Venture Capital and Timing of Investment. Industrial and Corporate Change 24(5), 1109–1148.

Guellec, D., van Pottelsberghe de la Potterie, B. (2003). The impact of public R&D expenditure on business R&D. Economics of Innovation and New Technology 12(3), 225-243.

Hall P.A., Soskice D. (2001). Varieties of capitalism: the institutional foundations of comparative advantage. Oxford University Press.

Hall, B.H., Lerner, J. (2010). The financing of R&D and innovation. In: Hall B., Rosenberg, N. (Eds), Economics of Innovation: Elsevier.

Hall, B.H. (2002). The financing of research and development. Oxford Rev Economic Policy, 35-51.

Hall, R.E., Jorgenson, D. W. (1967). Tax policy and investment behavior. American Economic Review 57, 391-414.

Haltiwanger, J.C., Jarmin, R.S., Miranda, J. (2013). Who Creates Jobs? Small vs. Large vs. Young. Review of Economics and Statistics, 347-361.

Hausman, J.A. (1978). Specification tests in econometrics. Econometrica 46, 1251-1271.

Hellmann, T., Puri, M. (2000). The Interaction between Product Market and Financing Strategy: The Role of Venture Capital. Review of Financial Studies 13, 959-984.

Henderson, R.M. (1993). Underinvestment and incompetence as responses to radical innovation: Evidence. RAND Journal of Economics.

Henderson, R.M., Clark, K.B. (1990). Architectural innovation: The reconfiguration of existing product technologies and the failure of established firms. Administrative Science Quarterly 35(1), 9–30.

Henrekson, M., Johansson, D. (2010). Gazelles as job creators: A survey and interpretation of the evidence. Small Business Economics 35(2), 227–244.

Hogan, T., Hutson, E. (2005). Capital structure in new technology-based firms. Evidence from the Irish software sector. Global Finance Journal 15(3), 369–387.

Hölzl, W. (2008). Is the R&D Behaviour of Fast Growing SMEs Different?. Evidence from CIS III Data for 16 Countries, WIFO working paper, 327.

Hölzl, W., Friesenbichler, K. (2010). High-growth firms, innovation and the distance to the frontier. Economics Bulletin 30(2), 1016-1024.

Hubbard, R.G. (1998). Capital market imperfections and investment. Journal of Economic Literature 36, 193–225.

Hyytinen, A.A., Pajarinen, M. (2003). Financial Systems and Firm Performance. Theoretical and Empirical Perspectives. Helsinki: Taloustieto,

International Finance Corporation. (2010a). Doing business: Jamaica. Retrieved May 24, 2010.

International Finance Corporation. (2010b). Doing business: Singapore. Retrieved May 24, 2010.

Jaffe, A.B. (1989). Real Effects of Academic Research. American Economic Review 79(5), 957-570.

Jaffe, A.B. (1996). Economic Analysis of Research Spillovers: Implications for the Advanced Technology Program. Washington: Advanced Technology Program, National Institute of Standards and Technology, U.S. Department of Commerce.

Jaffee, D., Russell, T. (1976). Imperfect information, uncertainty and credit rationing. Quarterly Journal of Economics 90, 651–666.

Jensen, M., Meckling, W. (1976). Theory of the firm: managerial behavior, agency costs, and ownership structure. J. Financ. Econ 3, 305.

Johnson, P. (2004). Differences in regional firm formation rates: A decomposition analysis. Entrepreneurship Theory and Practice 28(5), 431–445.

Jovanovic, B. (1982). Selection and evolution of industry. Econometrica 50, 649-670.

Kaplan, N., Zingales, L. (2009). Do Investment-Cash Flow Sensitivities Provide Useful Measures of Financing Constraints?. Qje, 112(1), 169–215.

Kaplan, S.N., Sensoy, B.A., Stromberg, P. (2009). Should Investors Bet on the Jockey or the Horse? Evidence from the Evolution of Firms from Early Business Plans to Public Companies. The Journal of Finance 64(1), 75–115.

Kaplan, S.N., Zingales, L. (2000). Investment Cash Flow Sensitivities are Not Valid Measures of Financing Constraints. The Quarterly Journal of Economics, 53, 1689–1699.

Kiederich, A., Kraus, S. (2009). Investigating new technology-based firm internationalization: The impact on performance, the process and the antecedents. International Journal of Business Research 9(2), 1-12.

Kortum, S., Lerner, J. (2000). Assessing the Contribution of Venture Capital to Innovation. The RAND Journal of Economics 31(4), 674–692.

Lee, C., Lee, K., Pennings, J.M. (2001). Internal Capabilities, External Networks, and Performance: A Study on Technology Based Ventures. Strategic Management Journal 22(6–7), 615-640.

Leifer, R., McDermott C.M., Colarelli O'Connor, G., Peters, L.S., Rice, M.P., Veryzer, R.W. (2000). Radical Innovation: How Mature Companies Can Outsmart Upstarts. Boston, Massachusetts, Harvard Business School Press.

Lerner, J. (1999). The Government as Venture Capitalist: The Long-Run Impact of the SBIR Program. The Journal of Business 72(3), 285–318.

Lerner, J. (2002). When bureaucrats meet entrepreneurs: the design of effective public venture capital programmes. The Economic Journal 112(477), F73–F84.

Lerner, J. (2010). The future of public efforts to boost entrepreneurship and venture capital. Small Business Economics 35(3), 255–264.

Lerner, J., Sørensen, M., Strömberg, P. (2011). Private Equity and Long-Run Investment: The Case of Innovation. The Journal of Finance 66(2), 445-477.

Levin, R., Klevorick, A., Nelson, N., Winter, S. (1984). Survey Research on R&D Appropriability and Technological Opportunity. Unpublished manuscript, Yale University.

Lindelof, P., Lofsten, H. (2004). Proximity as a Resource Base for Competitive Advantage: University–Industry Links for Technology Transfer. Journal of Technology Transfer 29, 311-326.

Link, A.N., Scott, J.T. (2010). Government as entrepreneur: Evaluating the commercialization success of SBIR projects. Research Policy 39(5), 589–601.

Link, A.N. (1981). Research and development in U.S. manufacturing. New York: Praeger.

Lofsten, H., Lindelof, P. (2005). R&D networks and product innovation patterns-academic and non-academic new technology-based firms on science parks. Technovation 25, 1025-1037.

Lumme, A., Kauranen, I., Autio, E., Kaila, M. (1993). New, Technology-Based Companies in Cambridge in an International Perspective. University of Cambridge Small Business Research Centre Working Papers 35 (September).

Lynskey, M.J. (2013). Determinants Of R&D Investment: Strategic And Entrepreneurial Characteristics In Japanese New Technology-Based Firms. Journal of Global Media Studies 13, 13–36.

Mansfield, E. (1963). Size of firm, market structure, and innovation. Journal of Political Economy 71, 556-576.

Mansfield, E. (1964). Industrial research and development expenditures: Determinants, prospects, and relation of size of firm and inventive output. Journal of Political Economy 72, 319-340.

Mansfield, E., Romeo, A., Villani, E., Wagner, S., Husic, F. (1977). The Production and Application of New Industrial Technology. New York: Norton.

Mansfield, E., Schwartz, M., Wagner, S. (1981). Imitation Costs and Patents: An Empirical Study. Economic Journal 91, 907-918.

Marshall, A. (1890). Principles of Economics. London: Macmillan.

Martin, S., Scott, J.T. (2000). The nature of innovation market failure and the design of public support for private innovation. Research Policy 29(4-5), 437–447.

Milgrom, P., Roberts, J. (1990). Bargaining costs, influence costs, and the organization of economic activity. In: J. Alt and K. Shepsle (Eds), Perspectives on Positive Political Economy. Cambridge: Cambridge University Press, 57-89.

Miller, D. (1983). The Correlates of Entrepreneurship in Three Types of Firms. Management Science 29(7), 770–791

Modigliani, F., Miller, M.H. (1958). The Cost of Capital, Corporation Finance and the Theory of Investment. American Economic Review 48, 261-297.

Mohnen P., Röller L.H. (2005). Complementarities in Innovation Policy. European Economic Review 49, 1431-1450.

Mollica, M., Zingales, L. (2007). The Impact of Venture Capital on Innovation and the Creation of New Businesses. University of Chicago Working paper.

Moncada-Paternò-Castello, P. (2011). Companies' growth in the EU: What is research and innovation policy's role?. Publications Office of the European Union.

Moncada-Paternò-Castello, P., Vezzani, A., Hervas-Soriano, F., Montresor, S. (2014). Financing R&D and Innovation for Corporate Growth: What new evidence should policymakers know?. Publications Office of the European Union.

Morris I. (2010). Why the West Rules—For Now: The Patterns of History, and What They Reveal About the Future. Farrar, Straus and Giroux.

Mowery, D.C. (1983). The relationship between intrafirm and contractual forms of industrial research in American manufacturing, 1900-1940. Explorations in Economic History 20, 351-374.

Myers, S.C. (1977). Determinants of corporate borrowing. Journal of Financial Economics 5, 147-175.

Myers, S.C., Majluf N.S. (1984). Corporate financing and investment decisions when firms have information that investors do not have. Journal of Financial Economics 13(2), 187-221.

Nelson, R., Romer, P. (1996). Science, economic growth, and public policy. Challenge 39(1), 9-21.

Neumark, D., Wall, B., Zhang, J. (2011). Do Small Businesses Create More Jobs? New Evidence for the United States from the National Establishment Time Series. Review of Economics and Statistics 93(1), 16–29.

OECD (2002). High-Growth SMEs and Employment. Paris.

Olofsson, D., Petersson, G., Wahlbin, C. (1986). Opportunities and Obstacles: a Study of Start-ups and Their Development. Frontiers of Entrepreneurship Research, Wellesley, MA: Babson College.

Oviatt, B.M., McDougall, P.M. (1996). New venture internationalization, strategic change, and performance: A follow-up study. Journal of Business Venturing 11, 23-40.

Peneder, M. (2008). The problem of private under-investment in innovation: A policy mind map. Technovation 28(8), 518–530.

Penrose, E. (1959). The Theory of the Growth of the Firm. Oxford: Oxford University Press.

Philippon, T., Véron, N. (2008). Financing Europe's Fast Movers. Bruegel Policy Brief 1, 1-8.

Popov, A., Roosenboom, P. (2009). Does private equity investment spur innovation? Evidence from Europe. European Central Bank.

Preece, S.B., Miles, G., Baetz, M.C. (1998). Explaining the international intensity and global diversity of early-stage technology-based firms. Journal of Business Venturing 14, 259-281.

Rajan, R.G., Zingales, L. (2001). Financial Systems, Industrial Structure, and Growth. Oxford Review of Economic Policy 17, 467-482

Raz, O., Gloor, P.A. (2007). Size Really Matters – New Insights for Start-ups' Survival. Management Science 53(2), 169-177.

Reinganum, J.F. (1983). Uncertain innovation and Persistence of Monopoly: Reply. American Economic Review 74, 243-245.

Revest, V., Sapio, A. (2012). Financing technology-based small firms in Europe: What do we know?. Small Business Economics 39(1), 179–205.

Robson, P., Bennett, R. (2000). SME Growth: The Relationship with Business Advice and External Collaboration. Small Business Economics 15(3), 193-208.

Romer, P.M. (1990). Endogenous technological change. Journal of Political Economy 98 (October (5)) 71–102.

Rosenberg, N. (1982). Inside the Black Box: Technology and Economics. New York: Cambridge University Press.

Rosenberg, N. (1990). Why do firms do basic research (with their own money)?. Research Policy (RSS).

Santarelli, E., Vivarelli, M. (2002). Is subsidizing entry an optimal policy?. Industrial and Corporate Change, Oxford Univ. Press.

Scherer, F.M. (1984). Innovation and growth: Schumpeterian perspectives. Cambridge, Mass.: MIT Press.

Schneider, C., Veugelers, R. (2010). On young highly innovative companies: Why they matter and how (not) to policy support them. Industrial and Corporate Change 19(4), 969-1007.

Schumpeter, J. (1942). Capitalism, Socialism, and Democracy. Harper and Row (reprinted 1960), New York.

Schumpeter, J., (1934). The Theory of Economic Development. Harvard University Press, Cambridge, MA.

Shane, S. (2000). Prior Knowledge and the Discovery of Business Opportunities. Organization Science 11, 448–469.

Shane, S. (2009). Why encouraging more people to become entrepreneurs is bad public policy. Small Business Economics 33(2), 141-149.

Shane, S. (2008). Illusions of Entrepreneurship: The Costly Myths that Entrepreneurs, Investors and Policy Makers Live By. Yale University Press.

Shearman, C., Burrell, G. (1988). New Technology-Based Firms and the Emergence of New Industries: Some Employment Implications, New Technology. Work and Employment 3(2), 87-99.

Shefer, D., Frenkel, A. (2005). R&D, firm size and innovation: An empirical analysis. Technovation 25(1), 25-32.

Siegel, R., Siegel, E., Macmillan, I.C. (1993). Characteristics Distinguishing High-Growth Ventures. Journal of Business Venturing 8(2), 169–80.

Slocum, A., Rubin, E. (2008). Understanding Radical Technology Innovation and its Application to CO2 Capture R&D. Interim Report 1-Literature Review. Research Showcase 01.

Soete, L.L.G. (1979). Firm size and innovative activity: The evidence reconsidered. European Economic Review 12, 319-340.

Solow, R.M. (1957). Technical change and the aggregate production function. Review of Economics and Statistics 39(3), 312–320.

Stam, E., Wennberg, K. (2009). The roles of R&D in new firm growth. Small Business Economics 33(1), 77-89.

Stiglitz, J.E., Weiss, A. (1981). Credit rationing in markets with imperfect information. American Economic Review 71, 393-410.

Storey, D.J. (1994). Understanding the Small Business Sector. London: Routledge.

Storey, D.J., Tether, B. (1996). Review of the Empirical Knowledge and an Assessment of Statistical Data on the Economic Importance of New Technology-Based Firms in Europe. Warwick Research Institute, Coventry.

Sutton, J. (1997). Gibrat's Legacy. Journal of Economic Literature 35, 40-59.

Teece, D.J. (1986). Profiling from technological innovation: implications for integration, collaboration, licencing and public policy. Research Policy 15, 285–305.

Thomas, J. (2010). The Credit Performance of Private Equity-Backed Companies In The Great Recession of 2008–2009. Available at SSRN: https://ssrn.com/abstract=1582666.

Tushman, M.L., Anderson P. (1986). Technological discontinuities and organizational environments. Administrative Science Quarterly 31, 439-465.

Utterback, J.M., Abernathy, W.J. (1975). A Dynamic Model of Process and Product Innovation by Firms. Omega 3(6), 639-656.

Westhead, P., Batstone, S. (1998). Independent technology-based firms: The perceived benefits of a science park location. Urban Studies 35, 2197-2219.

Westhead, P., Cowling, M. (1995). Employment change in independent owner-managed high technology firms in Great Britain. Small Business Economics 7, 111–140.

Westhead, P., Storey, D.J. (1997). Financial constraints on the growth of high technology small firms in the United Kingdom. Applied Financial Economics 7, 197–201.

Westhead, P., Storey, D.J. (1994). An Assessment of Firms Located On and Off Science Parks in the United Kingdom. London: HMSO.

Wiklund, J. (1999). The sustainability of the entrepreneurial orientation - performance relationship. Entrepreneurship Theory & Practice 24, 37-48.

Wiklund, J., Patzelt, H., Shepherd, D. (2009). Building an integrative model of small business growth. Small Business Economics 32(4), 351 – 374.

Wiklund, J., Shepherd, D. (2003). Aspiring for, and Achieving Growth: The Moderating Role of Resources and Opportunities. Journal of Management Studies 40(8), 1919-1941.

Witt, P. (2004). Entrepreneurs' Networks and the Success of Start-ups. Entrepreneurship and Regional Development 16(5), 391-412.

Zucker, L.G., Darby, M.R., & Brewer, M.B. (1994). Intellectual Capital and the Birth of U.S. Biotechnology Enterprises, 1–68.

Zuniga-Vicente, A.J., Alonso-Borrego, C., Forcadell, F.J., Gala, J. (2014). Assessing the Effect of Public Subsidies on Firm R&D Investment: A Survey. Journal of Economic Surveys 28, 36-67.

Sitography

https://www.sba.gov/starting-business/how-start-business/business-types/startups-high-growth-businesses

http://ec.europa.eu/competition/state_aid/reform/gber_final_en.pdf

http://europa.eu/rapid/press-release_IP-06-1600_en.htm?locale=en

http://europa.eu/rapid/press-release_IP-13-1203_en.htm

http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A52011DC0808

http://www.unesco.org/new/en/natural-sciences/science-technology/university-industry-partnerships/science-parks-around-the-world/science-parks-in-europe/

https://www.sbir.gov/about/about-sbir

http://www.sviluppoeconomico.gov.it/index.php/it/component/content/article?id=2024657

http://www.diritto24.ilsole24ore.com/art/avvocatoAffari/mercatiImpresa/2016-04-06/la-situazione-4-anni-decreto-crescita-20-e-vigenti-incentivi-sostegno-innovazione-144432.php

http://www.gazzettaufficiale.it/eli/id/2012/12/18/012G0244/sg

http://www.gazzettaufficiale.it/atto/serie_generale/caricaDettaglioAtto/originario?atto.dataPubblicazioneGazzetta=2012-12-18&atto.codiceRedazionale=12A13277

http://ec.europa.eu/europe2020/pdf/nd/nrp2012_italy_it.pdf

http://www.sviluppoeconomico.gov.it/images/stories/documenti/rapporto-startup-2012.pdf

http://www.italiastartup.it/risorse/decreto-sviluppo-e-rapporti-dal-ministro-dello-sviluppo-economico/

http://startup.registroimprese.it/report/2_trimestre_2016.pdf

http://www.economyup.it/upload/images/10_2016/161013163355.pdf