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The impact of startup quality and ecosystem factors on the Corporate Venture Capital activity across countries

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List of Abbreviations

CVC	Corporate Venture Capital
VC	Venture Capital
JVC	Victor Company of Japan
UNESCO	United Nations Educational, Scientific and Cultural Organization
OECD	Organization for Economic Co-operation and Development
WIPO	World Intellectual Property Organization
GEM	Global Entrepreneurship Monitor
GII	Global Innovation Index
GERD	Gross Domestic Expenditure on Research & Development
STEM	Science, Technology, Engineering and Mathematics
WHO	World Health Organization
MTF	Multiannual financial Framework
TEA	Total early-stage Entrepreneurial Activity

Introduction

Each country has its specificities in terms of innovation. They are often translated into consistent "industry clusters" formed by companies in a defined area. Corporations are the main engine that boost innovation, either by turning to their internal resources, such as their R&D division, or by looking at the outside world. In particular, they can invest in the external startup ecosystem, whose firms constantly develop new technologies and business models. One of the most common and rising investment practices in external firms is Corporate Venture Capital (CVC). It has grown progressively in the last years. Many large companies, from IBM to Tencent, started investing in startups through dedicated venture capital vehicles. Recent CVC trends highlight that corporate venturing is not only a strategic and financial investment means but it often expresses how a specific environment (or country) is turning towards the future by drawing the best from its most effective and innovative activities.

The following research attempts to find a connection between countries' CVC industry and the level of development of their innovation ecosystem. It concerns the relationships between companies, startups, and other factors that traditionally favour innovation. Considering national countries as a formal delimitation of different business ecosystems, the inspiring source of my study comes from the substantial differences between them in terms of startup ecosystem and CVC activity.

The work aims to answer the following questions: "Are differences across countries in terms of CVC activity due to the quality of their startups and some ecosystem factors, such as taxation, education technology? What is the relationship between these variables? How could a country leverage these factors to develop its CVC industry and bridge the gap with the global innovation leaders?". The objective is to understand how those drivers are relevant for countries to advance their innovative ecosystem led by corporations' engagement through OI and CVC. My contribution to academic research on this topic is to partially fill a gap in the literature where previous studies that associate the state of development of national CVC activity and their startup and socioeconomic ecosystems misses.

To test my hypotheses, I used a data sample from 29 countries (including 20 European and 9 non-European) that are related to the most relevant variables about startup quality, taxation, education and technology. Data refer to 2019 in order to prevent the analysis from being influenced by the recent Covid-19 pandemic. The estimation model is built through multiple linear regression.

The analysis results prove empirical evidence that startup quality is positively related to the CVC activity in a country, as well as education. Taxation and (surprisingly) the number of patents granted in a country are negatively associated with the number of CVC-backed firms (partially refuting my hypothesis H2). In contrast, patents' granting is positively related to CVC-backed funding.

In conclusion, I present an early snapshot of the effects of the Covid-19 pandemic on the CVC industry and the main implications that updated statistics had on the conclusions drawn by the empirical analysis.

Chapter 1: Corporate Venture Capital

1.1 Introduction to Corporate Venture Capital and Open Innovation

1.1.1 Innovation ecosystem

Innovation is the common practice that an organization uses to reshape, update, or reconvert its products, systems or processes creating value or redistributing it. The concept of innovation is focused on three main characteristics: newness, improvement and spread. At first, it refers to a sort of unique solution, which implies the improvement of current practices or products bringing an additional value compared to existing ones. In a business environment, building up an innovation puts companies in the position to be more competitive in their industry, and to gain an advantage over competitors. In a more generic sense, it can be seen as a means to find new solutions for existing problems, implement existing solutions for existing problems, or find new solutions for new problems. Such an approach enables companies to keep up with the times by employing their resources to increase the technological rate of their products or services and enhance the intrinsic value delivered to customers.

Each country has its specificities in terms of innovation. Businesses tend to specialize, and countries' specificities are often translated into consistent "industry clusters" formed by companies in a defined area. Clusters are a geographical concentration of specialized suppliers, service providers, organizations, commercial unions and interconnected enterprises, which compete against each other and, at the same time, collaborate in a specific industry or related industries (Porter, 1996). Usually, firms rival in price and product differentiation, but they also cooperate in acquiring supplies or performing R&D. Clusters are also strictly connected with education institutions, like universities, that help other cluster's agents enhancing new knowledge and technology, or business associations, that try to create favourable conditions to do business. Simultaneously, schools and universities are highly influenced by the cluster, and they tend to provide their students with the right preparation and know-how in that specific industry, growing a qualified labour market from which companies can draw talents and skilled workers.

Clusters typically have two components: organizations and interactions. As evidenced above, organizations include companies, cooperatives, business associations, universities, technological institutes and public offices. These interrelated organization groups are close to each other, and their geographical proximity is a key feature of the cluster. Indeed, the most important component of the cluster is the interaction between organizations. Connections can be either vertical, like the relationship between seller and buyer, or horizontal, like that between providers of the same service or users of similar technologies. They mainly consist of social relations. They allow cluster insiders to build a strong network from which every member takes advantage. These characteristics make the cluster a pool of agents whose relationship contributes to its development and evolution. According to a study run by the International Research Journal of Finance and Economics (2011),

there is a positive correlation between the Global Innovation Index[1] of a country and the level of its clusters' development. It means that innovation is favoured by the tight and continuous relationship between organizations in the same area. The mechanism implies that each company benefits from the interrelation, the technological transfer from universities and research centres, and the inspiring competition among the companies within the cluster.

The clusters' example highlights how companies' innovation process is extremely conditioned and enriched by external contaminations. For this reason, corporate innovation should be framed in the broader context of an "innovation ecosystem", namely a set of business actors, activities and artefacts which are engaged in the same political, social and economic environment, and that synergically interact with each other generating an innovative performance (Granstrand et al., 2020). The idea of an innovation ecosystem caught on in the economic literature of the last 15 years (Gomes et al., 2018). The first definition was made by the American professor Ron Adner in its article "*Match your innovation strategy to your innovation ecosystem*" published in the Harvard Business Review in 2006. Adner argued that an innovation ecosystem is an environment in which "the collaborative arrangements" between companies determine "their individual offerings into a coherent customer-facing solution", meaning that the firm's offer to the outside market is influenced by the relationships with other companies and is in line with what customers expect to satisfy their needs. To further emphasize the importance of the surrounding environment for corporate innovation, he cited the famous example of Kodak's decline in the mid-2000s, pointing out the company's inability to understand the cameras' market running towards digitalization. The economic literature on the "innovation ecosystem" topic stresses the point about the ambivalence between collaboration and competition among firms. Moore (1993) underlines that "companies … work cooperatively and competitively to support new products, satisfy customer needs, and eventually incorporate the next round of innovations". Such notion of cooperation-competition has been largely inspired by the comparison between the innovation ecosystem and the natural, biological ecosystem. In the natural ecosystems different species compete for a restricted batch of resources; being resources limited, animals of the same species tend to pool their strengths in order to ensure the survival of the whole community. A similar approach is carried out by companies that belong to the same ecosystem (or cluster). Moore firstly, in 1996, proposed the analogy between the biological world and the business world, appealing to the concept of "business ecosystems". As well as in a biological ecosystem, in a business ecosystem, each organization's behaviour, attitude and strategic move affects others and the surrounding environment. Although the literature does not unanimously agree either on the geographical borders of the ecosystem or on the type of organizations belonging to it, most scholars agree that the "social network" of ideas, opinions and information within the ecosystem has to do with the growth and the evolution of the ecosystem itself (Mercan and Göktas, 2011). The key point is that innovation activities do not only depend on elements but mainly on relations between them. An innovation ecosystem has a dynamic nature; it has an ever-changing structure.

[1] *Global Innovation Index*: annual ranking of countries by their capacity for, and success in, innovation. It is published by Cornell University, INSEAD, and the World Intellectual Property Organization, in partnership with other organizations and institutions.

One of the most classical examples of how an ecosystem is a source of innovation for a business sector is the competitive environment of video recording systems in the 1970s-1980s between Sony and Victor Company of Japan (JVC). Betamax from Sony and VHS from JVC were the two competing technological and production standards for manufacturing video cassettes and video cassette recorders (VCRs). In the mid-1970s, Sony was the first mover on the VCR market. The Japanese firm was proprietary to the Betamax standard and was initially averse to collaborate with others on Betamax development since it wanted to retain its innovation leadership position because of bad experiences in other standardization attempts for products. The second mover, JVC, replied to Sony's strategy by proactively building up a group of collaborators (i.e., Hitachi and Sharp) for licensing JVC's VHS technology. This intra-group licensing was very favourable for JVC and allowed improvements in production experience and processes across the group members. The enabling of various versions of VCRs and cassettes through generous licensing for external firms has opened up a mix of competition and collaboration between the players in the VHS innovation ecosystem. It has led to lower prices and increased value of the VHS offering over time, including an increasing quantity and variety of both hardware products and film contents adapted to the VHS format, thus guiding Betamax to become outdated. In the end, Sony was forced to give up and buy a VHS license from JVC since its Betamax standards were substituted by VHS. Hence, JVC outcompeted the market leader's first move by creating an innovation ecosystem with other business partners that were open to complementary products (or even substitutes), aiming at performing a successful technological development, along with higher sales revenues, for all the ecosystem's members.

This story is only one example of successful innovation driven by an ecosystem. Let us think also about the hospitality sector, and how tremendously the business landscape is changing. The Hilton Worldwide Holdings, one of the biggest multinationals in the hotel & resorts market, has been in existence for almost 100 years, it owns about 850,000 rooms in more than 100 countries, and has a market capitalization of $34.3 billion. However, in the last ten years, starting from scratch, the near-former startup Airbnb has surpassed Hilton's market capitalization, managing four times the number of its rooms. Airbnb understood that to innovate the way travellers think about their accommodation, a hospitality company has to see beyond the traditional schemes. What the Californian venture did is to engage all the stakeholders in its business ecosystem, letting them make their house or properties a solution for travellers. It is like Airbnb involved its potential customers (that were also house renters) to join the party, and contribute to refresh a sector that has always been quite static. Such a revolutionary business model was made possible thanks to the founders' thinking not as a company, but as an organization interacting with its surrounding environment. This mentality, open to the interconnection of the company with external subjects and organizations, is the basis of the so-called "Open Innovation", namely the ability of corporations to look over the fence and seeking for innovation from the outside.

1.1.2 Open Innovation

Open Innovation is an expression used to indicate a new R&D and investment mindset towards innovation that goes beyond traditional research within the boundaries of the company, encouraging the discovery of new products, technologies and business models in the external environment. One of the first scholars that tried to give a theoretical frame to the Open Innovation concept was Henry Chesbrough, actual executive director at Garwood Center for Corporate Innovation at Haas School of Business (Berkley, California). Traditionally deemed as "the father of Open Innovation", professor Chesbrough conceived this idea in his notorious book "*Open Innovation: The New Imperative for Creating and Profiting from Technology*". In its original definition, the notion of Open Innovation referred to "the paradigm that assumes firms can and should use external ideas … to advance their technology" (Chesbrough, 2003). The author underlined that for their technologies to progress, firms should take into consideration also external ideas and paths to market as long as internal ones. The process by which companies create value can be enriched by the participation of external subjects bringing their competencies and know-how inside the company. Such a process sometimes can result much easier and faster than develop innovations internally.

Big corporations very often tend to be "control freaks" on innovation, believing that vertical integration and millionaire spending on R&D are the only ways to gain a competitive advantage in their market. In fact, the concept of Open Innovation is set against its counterpart "Closed Innovation". This archetype holds that successful innovation requires control. Specifically, it implies the firm has to manage the whole idea generation process, as well as any other business function, like production, marketing, distribution, funding and support. What drove this idea is that, at the beginning of the 20th century, science applications were not commercialized by academic and government institutions. As a result, other corporations (often state-owned enterprises) had the product development cycle in their hands. There just was not the time to wait for the scientific community to become more involved in the practical application of science, and for many competitor companies to start implementing the production of components that were required for the final product. Therefore, the few organizations handling the product developed a relatively self-sufficient attitude, with little exchange of information with outwards companies or universities. Throughout the years, several factors contributed to paving the way to "open" the traditional innovation paradigms: the increasing availability and mobility of skilled workers, the growth of the Venture Capital market, the increasing number of external ideas and solutions, and the higher number of external suppliers for raw materials. Thanks to these drivers, a new market of knowledge was emerging; a market in which the company was not exclusively proprietary of knowledge, but in which knowledge was spread to the ecosystem around the company. It could reside in employees, suppliers, customers, competitors and universities. Particularly, since the 1980s, incumbent well-established corporations have started competing with new fast-growing organizations that were ready to find new ways to use such knowledge, making current products and services outdated. They were rising startups, whose greatest ability has been to leverage the global character of digitalization to foster their growth. This new dynamic and evolving habitat pushed scholars, but also managers, to understand that innovation can

actually be generated either by closed or open approaches. They agreed to tear down the walls of their company and stimulate the entry of external flows.

The importance of the exchange of knowledge and ideas between the company and its external environment is illustrated within Chesbrough's reformulation of the concept of Open Innovation. The economist, indeed, in the continuation of his studies, proposed a new definition, highlighting a deeper interpretation of the subject. He stated that Open Innovation consists of a "distributed innovation process based on purposively managed knowledge flows across organizational boundaries" (Chesbrough and Bogers, 2014). In his refinement, the author explained how flows of knowledge could be either knowledge inflows to the company (taking advantage of external knowledge sources through internal processes), or knowledge outflows from the company (profiting internal knowledge through external commercialization procedures) or both (combining external knowledge sources and commercialization methods). In this sense, external inflows become beneficial because of their integration with internal competencies and processes. Open Innovation is not only the way to tap into other organizations' technologies and methodologies, but it is a way to integrate and blend external influences (in terms of know-how) with those already present in focal companies so that merging the two return a value greater than the sum of the individual parts. It draws a sort of permeable organization, whose boundaries do not include only the traditional ones, but also those of the entire surrounding innovation ecosystem. This is why the concepts of "Open Innovation" and "innovation ecosystem" have some connection. As far as the literature concerns, while Moore researched business ecosystems in manufacturing around a specific sector or branch, the open model of innovation with the ecosystem theory was recently studied in various industries. In 2011, H. Traitler et all. researched and used it for their study *"Reinventing R&D in an Open Innovation ecosystem"*, stating that global Open Innovation becomes productive when alliances between organizations are based on complementary differences. Innovation partnerships should be focused on sharing knowledge so as to move to a co-development model of sustainable innovation, in which different parties contribute differently. For example, D. West et all. researched Open Innovation ecosystems in industries like the software and the food ones, showing how small firms flighted and succeeded thanks to the creation of an ecosystem that shares knowledge, encourages individuals' growth, and embeds trust among participants, such as suppliers, workers, clients and also media. In particular, they studied the case of Symbian, English software development and licensing company. The research was about the open innovation network organised around the company, which accounted for about 80 out of the 115 million advanced mobile phones sold in 2007 (Canalys, 2008). It is peculiar that Symbian did not govern its ecosystem by holding an absolute market power, conversely, it secured its competitive advantage through access to non-public information and contractual restrictions on the use of its intellectual property. Therefore, the key driver was the ability of the company to control the ecosystem through the management of information, meaning both knowledge and news that proved to be decisive to outcompete the market. Other examples can be found in many other fields, like in the telecommunication industry or the urban-tech industry. Ecosystems foster collaboration and accelerate the dissemination of knowledge by leveraging network externalities. In fact, value creation increases with each additional actor in the ecosystem, nurturing the potential of the ecosystem itself. Another example of the

successful exploitation of the ecosystem is to employ the rising "platform business model", namely the use of digital platforms to facilitate the exchange between two or more independent groups, like consumers and producers. Such a model is incredibly effective to set up an innovation ecosystem and making it work through the creation of a community, letting various players achieve a mutually beneficial purpose. In its researches, G. Parker explained the so-called "platforms revolution", describing how networked markets are transforming the economy. Nowadays, platform ecosystems are increasingly used and are driving the digital growth.

In conclusion, companies need to make the most of the surrounding environment by creating a system that connects them with those organizations which may contribute to enhance either the value delivered to customers, or their management processes, or even their portfolio with diversification investments. A common practice that companies, especially medium-large sized ones, use to meet these needs is Corporate Venture Capital, through which they participate in the capital of disruptive startups to boost their capacity to innovate and obtain competitive advantages on the market.

1.1.3 Corporate Venture Capital

Corporate venture capital (CVC) is the investment of corporate funds, directly in small but innovative or specialist firms. A large corporation typically provides monetary resources (usually in exchange for an equity stake) along with management and marketing expertise, letting the small company scale up rapidly. The reasons for the investment can be many: to innovate the corporate's core product or service through new and lean innovative solutions; to innovate the management practices or the production process; to secure access to some intellectual property rights, considered as strategic for the corporate's core business; to hire promising talents so as to increase the quality of corporate's human resources; to diversify the business portfolio by investing in high growth markets that have nothing to do with the corporate's core business; to avoid rising startups become fearsome competitors in the corporate's core market.

Different from traditional Venture Capital (VC), CVC is not an investment into startups made by an independent external fund, managed by a third party, even if the investment vehicle is funded by a single company. In CVC, the invested funds are provided by a non-specialized investment company, whose core business is usually different from finance. Therefore, CVC is not synonymous with VC, rather it is a specific subset of it. In essence, Corporate Venturing is about setting up a collaboration framework acting as a bridge between innovative external ventures and established corporations in order to drive mutual growth. These ventures are startups, especially early-stage and seed-stage ones, that come from outside the corporate.

CVC funds are characterized by a hybrid nature. The investing corporate is frequently a well-established company with structured operations and processes, and rigid bureaucratic rules placed to manage both internal and external relationships. It implies that every decision is taken by passing through a series of decision-making levels and multiple middle managers. This makes procedures within the company often slow and inflexible. On the other hand, corporate's rigidity is set against startups' agile and flexible attitude towards

both decision-making and relationships with stakeholders. Startups are characterized by the complete absence of any structure or consolidated procedures. They have very few employees, a lean and simple business model, few products or services, and neither a reputation to defend nor a binding relationship with institutions. Therefore, this cultural and organizational diversity between startups and corporates is reflected also in the organization of the corporate venture fund or division. In fact, as claimed by experts, the management of relationships between corporate and startups is one of the most difficult tasks that a CVC entity has to face. According to a report studying the corporate-startups relationships in the DACH[2] region published by McKinsey in 2020[3], 72% of interviewed startups declared not to be satisfied with their partnership with the corporate. The key reason for this data is the lack of speed and reactiveness, caused by too much bureaucracy and missing support on the corporate side. These factors reduce and slow down collaboration on data exchange or impede quick decision-making, among other things. Another pain point is the lack of transparency in decision-making owing to more complex hierarchical structures in corporates and the involvement of multiple decision-makers. Such data witness what a great challenge is to make the organizational machine work, and how much care must be provided to avoid cultural clashes and let corporate venturing investments succeed.

Moreover, another important feature of CVC is the degree to which the operations of the investing company and the startup are linked (Chesbrough, 2002). For instance, a startup with strong links to the investing company may profit from its manufacturing facilities, distribution channels, technology and brand. It can also learn the investing company's business practices to commercialize its products or services, and take advantage of its customers' network. Conversely, the company's own resources and the conventional processes might represent weaknesses rather than capabilities, especially in front of new markets or disruptive technologies. An external venture could provide the investing company with the occasion to build new and different competencies, which can even make current capabilities obsolete. The only concern is that the potential startup's contribution in terms of knowledge can be crushed by the braking impulse of a consolidated mindset and modus operandi within the company. This is the reason why housing such capabilities in a separate legal entity, like a CVC fund or division, can isolate them from internal undermining efforts. Therefore, if the venture and its processes bring positive results, the corporate can evaluate if and how to adapt its processes inspired by those of the startup.

After having discussed what are the key features of CVC, it is fundamental to analyse the main reasons that bring corporate and startups to start collaborating. Corporates may have several motivations to partner with or invest in external ventures. First of all, dealing with startups allows them to explore and study the technological progress of products and services in a very cost and time-efficient manner, which would have hardly been possible in their large and bureaucratic structure. Moreover, partnerships enable corporates to become aware of new and potentially disruptive technologies in the relative competitive environment. Corporates can also strengthen their market position by partnering with startups that either improve the corporates' existing

[2] DACH: Deutschland, Austria, German Switzerland
[3] Dörner K., Flötotto M., (2020), You can't buy love. Reimagining corporate–startup partnerships in the DACH region, *McKinsey Digital*

products (or services) or bring substitute solutions for the same market need. Furthermore, startups can update the corporate's managerial processes giving insights to managers about new ways of working, such as more agile work styles or a different work schedule. However, very sound and well-known corporates sometimes admit that startup partnerships are used also to signal innovativeness and trend awareness, and so, investing has less the goal of actual innovation but more that of making others perceive to be innovative. Last but not the least, startups can contribute to enrich the corporate's talented teams and promise them an attractive ROI over time.

As well as companies decide to partner with the most innovative emerging ventures in their business ecosystem, startups share several reasons for collaborating with companies too. In fact, startups hope a corporate partner is willing to help accelerate their growth and upgrade their reputation, so as to send a positive signal to both investors and customers. According to the McKinsey report on corporate-startup partnerships mentioned above, receiving financing is one of the key motives for startups to engage in partnerships. Although typical financing is cashed in exchange for equity instruments, some corporates prefer to lend money to startups or to grant them. Besides, startups often look for a corporate partner because they hope to become a future customer or to receive useful customer insights from it. This attitude is more frequent for early-stage startups[4] than later-stage ones (about 72% of early-stage versus 52% of later-stage startups) since they still lack a well-established customer base and revenue stream, and they are still exploring their product/market fit. This is particularly true for B2B startups since 87% of them (both early-stage and later-stage) professed it as highly important. Moreover, startups with B2B products or services tend to regard corporate partnerships as more important than B2C-focused ones (79% versus 60%). In this case, the startups' main objective is to be smoothly introduced in the industry or to the corporate's customer network by co-developing products or services (usually the startup brings the technology, while the corporate brings data and expertise). Here, the only shortcoming for B2B startups is that a strategic investment from a corporate often requires exclusivity agreements, prohibiting them from selling their products to a corporate's competitors. Such insight can explain also why B2B startups seem to be less interested in financial investment from their corporate partner than B2C ones (47% versus 71%).

At last, Open Innovation and CVC suggest that valuable ideas and technological advancement can come from outside the company, originating new horizons of investment and innovation. The CVC is an effective approach in this sense because it allows corporations to expand their professional mindset to new business models and new managerial practices. Therefore, it is of particular interest how and when this practice of corporate venturing was born, and how it has evolved to the present day.

[4] Early-stage startups are considered those with under 25 employees or less than € 1 million in revenue

1.2 History of Corporate Venture Capital

Corporate Venture Capital has grown progressively in the last years. On a global level, CVC-backed funding passed from $17.9 billion in 2014 to $57.1 billion in 2019, with an average annual growth of about 30% (CB Insights, 2020). Many large companies, from 7-Eleven to IBM, started investing in startups both directly and through dedicated venture capital vehicles. CVC funds or divisions have become a quite common feature of large corporations, even for those that do not work in R&D capital-intensive sectors like high-tech or biotechnology. Therefore, being CVC a relatively recent phenomenon, digging into its history is a way to better understand the success stories, failures, its evolution, and to better analyse the "tension" between corporate's financial and strategic goals, as well as the difficulty in competing for the best deals.

1.2.1 The origins and the first wave (1960-1977)

The origin of CVC can be traced back to the first decades of the 20th century in the U.S.A. when the first corporate giants started up their business. In 1914, Pierre S. du Pont, president of chemical and plastics manufacturer DuPont, invested in a young private automobile venture known as General Motors. Mr. du Pont had a great intuition. The shares he bought just before World War I increased their value seven-fold during the conflict since wartime needs led the demand for automobiles to grow exponentially.

After the war, the relationship between the two companies became even stronger. The chemical manufacturer acquired General Motors for both financial and strategic reasons. DuPont's board of directors invested $25 million in the car manufacturer, hoping that the cash injection would have speeded its development, and consequently would have also expanded the demand for the parent company's products (like artificial leather, plastics, and paints). Indeed, the result was outstanding. General Motors, after having become public in 1916, grew its sales by 56% annually, already had over 85,000 employees, and built its new headquarters in Detroit (CB Insights, 2020). DuPont's blended approach of combining both commercial and financial strategies behind the acquisition definitely worked and became an example for businesses willing to create more formal CVC units. The chemical company, along with other early-comers like 3M and Alcoa, was one of the pioneers of the first great era of corporate venturing. In fact, after DuPont's CVC program, the first blooming of CVC was between the late 50s' and the early 60s' until the stagflation crises in the 70s'.

This mid-century period was characterised by the prevailing spirit of American big firms to enlarge their operations and expand their business in many sectors. In part, the race for diversification was driven by the strict anti-trust enforcement by the government, to avoid large companies exercising too much control in their established market and force them to look to new profitable opportunities in other markets. Thus, for companies willing to invest, corporate venturing became a viable solution to extend the firm's reach into a

variety of different sectors and industries. But diversification was only one of the main reasons that pushed some American large corporations to became the early CVC investors. Indeed, another primary motivation was the excess liquidity not fully utilized by American industrial conglomerates. They disposed of large amounts of cash that wanted to put to productive use. This is why the first corporate venture capitalists were not the sort of companies that we traditionally associate with CVC (like high-tech or pharmaceutical companies), but were mainly industrial businesses, such as Boeing, Ford, Mobil, Singer or General Dynamic.

The two prevailing CVC models of investment were the internal and the external model. The former implied that companies invested in their employee ventures or tried to spin out their technologies in new companies. A classic case of this CVC type is 3M, whose CVC internal program produced the well-known Post-it notes. Instead, as regards the external model, corporates simply invested in external startups that were aligned to their needs or strategic objectives, as DuPont did with General Motors. An emblematic case of the first wave was that of Exxon Enterprises, a CVC vehicle founded in 1964 to exploit underutilized technologies from Exxon's corporate labs. During the 1970s, Exxon Enterprises invested in 37 ventures, about half internal and half external, and established two wholly-owned subsidiaries that respectively manufactured gasoline pumps and supplied nuclear fuel products. Although some investments could seem strange to observers, since they were not totally involved in the parent's core strategy, Exxon was praised by the media and was able to expand its activities into the computers and the communication sectors. Problems came only in the early 1980s when some negative investments on ventures with unreliable entrepreneurs implied millions of dollars in losses and pushed the company to consolidate for vertical integration and to shut down the program in 1984.

Actually, the first wave of CVC definitively declined in the mid-1970s. The oil shocks and the stagflation crisis caused the economic recession, comporting also the IPO market to drop and the American industries' availability of cash to evaporate. Anti-trust regulation eased and the frantic push to diversification gradually stopped. Moreover, in 1969, the U.S. government increased the capital gains tax, denting profits of both CVC programs and VC firms.

1.2.2 The second wave (1978-1994) and the myth of "Silicon Valley"

In the late 1970s, the crucial event that changed the history of CVC (and probably also the entire contemporary history) was the release of the first personal computers. Computers introduced epochal changes both in society and in the economy, impressing a new enthusiasm in the business community willing to be engaged in this technological revolution. While the first wave of CVC investment was characterized by the push for diversification of post-war industrial giants, in the second wave technology became closer to consumers, so access to it was a top priority for every company. The 1980s were the period in which subsequent innovations in the Information Technology (IT) industry created the myth of "Silicon Valley". Success stories such as those of Microsoft and Apple became a hymn to entrepreneurship and prompted many large companies to implement their CVC programs.

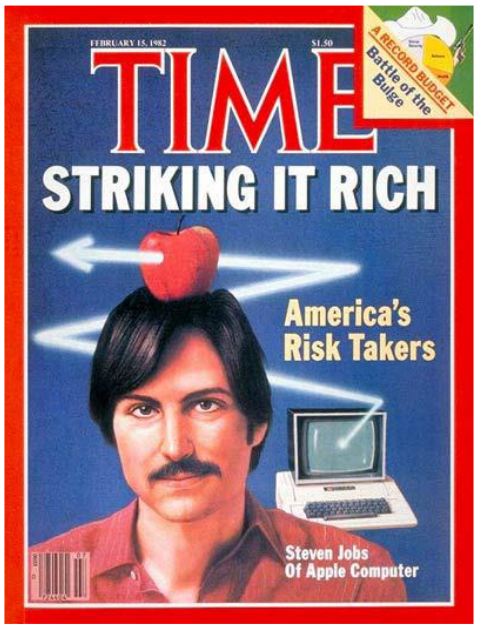

Figure 1: Cover of Time magazine, February 15, 1982, Time magazine

As often happens in history, in the early 1980s, CVC was reinvigorated by some favourable business conditions. In 1978, and then again in 1980, the U.S. government significantly reduced the capital gain tax and incentivized private investments. This manoeuvre greatly improved investors' attitude towards those investments in which the main source of profit was capital gain, like venture capital. CB Insights estimates that resources dedicated to VC grew from $2.5 billion in 1977 to $6.7 billion in 1982, of which 34% on average came from corporate investors (CB Insights, 2017). Companies employed different models in pursuing CVC programs during this period, sometimes mixing more than one strategy. Some corporations preferred to have an indirect approach, addressing their resources to independent VC funds. About 100 American companies used this tactic in 1987 and over $480 million was invested in this way in 1989 (CB Insights, 2017). Another CVC strategy was to provide capital to create a specific VC fund run by an external fund manager. This type of vehicle was known as a "client-based fund". Sometimes, companies even pooled their strengths to build together client-based funds, as AT&T, Viacom and 3M did with Edelson Technology Partners in 1984. This style became quite common in the U.S. as from 1982 to 1987 the number of this type of funds grew from 31 to 102 (CB Insights, 2017). As an alternative to these schemes, corporates could also establish traditional internally-managed CVC funds or made direct investments in external startups. Although such classical models of corporate venturing had less appeal than others during the second wave, the number of internal CVC vehicles tripled between 1982 to 1988, from 28 to 76 (CB Insights, 2017). Lastly, the fourth common approach to CVC was to financing the ideas generated by corporate employees. An example was Kodak, which employed a significant percentage of its $80 million budget for CVC to fund internally-developed projects (CB Insights, 2017).

The second wave was also the first time in which foreign companies, especially from Japan and Europe, instituted CVC programs. In 1989, Japanese corporations invested in 60 U.S.-based firms and provided 12% of total funds raised in CVC programs by U.S.-based companies. In addition, in 1990, more than 130 European

companies invested directly in European VC funds, while internally-managed CVC vehicles were still rare. Foreign competitors regarded VC and CVC as a simple means to access American technology. This was a constant for all the 1980s and 1990s. It was like both American and foreign corporations began to fear being left behind by the ongoing technological revolution. CVC was considered as a cheaper way (or at least cheaper of making acquisitions) to access it, either as a form of diversification or to expand the company's operation into adjacent product lines. However, the extreme rapidity with which many companies attempted to enter the high-tech industry or tried to improve their core products was the cause of failure for their CVC programs. Often large companies excessively rushed the invested ventures to find innovative solutions for their needs, but this just as often led many startups not to have enough time to mature and their respective corporates to abandon them too early.

1.2.3 The third wave (1995-2001) and the dot-com bubble

While the personal computer was the leading technology of the second wave of CVC, the Internet was definitely the driving force behind the third wave, whose scope and size far exceeded the previous times. According to CB Insights, over 20 new CVC units made their first investment in 2000, and about 100 CVCs did it between 1995 and 2001. The whole CVC investments in 2000 were worth approximately $17 billion and 25% of total funding to VC-backed companies. Even if U.S.A. remained the global leader of CVC, this business practice continued its process of internationalization. Between 1990 and 1999, 71% of CVC investors and 75% of ventures were located in the U.S. (CB Insights, 2017). However, we should take into account that many foreign companies set up their CVC units in America, making those data a little overrated. For instance, as we observed previously, since Japanese companies were very attracted by the opportunities offered by the U.S. market, they frequently sent their executives to work in private VC funds in which they invested; the objective was to bring information and experience back to their headquarters in Japan. Conversely, American companies used CVC units to access foreign markets and foreign technology.

This significant growth in CVC activity was in part built up on hype and enthusiasm for what was seen as "the market of the decade", namely the Internet and all products and services related to it. As it had already happened in the second wave, even in the third wave some success stories, such as eBay and Yahoo, have increased the interest in this industry. In fact, many companies that in the past ran internal R&D divisions to generate technological advancements began to regard CVC as a new and more efficient model to drive innovation. They understood that CVC was an alternative way of outsourcing (at least part of their) R&D to more agile startups. During this period, pharmaceutical companies and rising tech companies arose as the major investors, but also media and advertising firms, like Reuters or Reed Elsevier, started millionaire CVC programs. Even in Europe, the German media conglomerate Bertelsmann AG committed $1 billion to a VC fund investing in new media startups in 2000 (CB Insights, 2017).

On the other side of the moon, the accelerated growth of CVC in the 2000s also raised some of its contradictions. The main one was the "corrupt" competing environment about compensation differences between CVC units and independent VC funds. The latter were racking up huge profits during the tech boom and could afford rich salaries for their senior investors and executives. In contrast, CVC programs did not have as well-defined compensation structures because their investments were usually strategic rather than financial. As a result, they often paid their executives much less than independent VCs, generating a flight of talent in search of better remuneration.

Despite these inconsistencies, the third wave was characterized by a tight relationship between corporations and independent VCs. The main reason for it was that the VC market was overcrowded, especially in the U.S., therefore, partnerships with corporations were deemed as a great competitive advantage for VC funds (Gompers and Lerner, 2001). This kind of cooperation often went beyond mere financial logic, and sometimes had the goal to stimulate the demand in specific markets or to defend the demand for existing products by nurturing the ecosystem around them. A paradigmatic example of such a statement is the Intel Capital CVC program, remembered as one of the most successful in history. Founded in 1991, Intel Capital was Intel's corporate venture unit dedicated to centralizing the company's investments that were previously managed individually by different business units. Its purpose was not only to fill the gap in Intel's technologies but also to power the ecosystem of products that orbited the company. Intel Capital's strategy was to invest in multiple startups competing in the same market in order to stimulate emerging technologies and market sectors rather than single companies' success. For instance, in 1999, Intel instituted the Itanium 64 Fund, an internal fund that invested about $250 million in companies that generated products using its Itanium 64-bit processor. Similarly, in 2002, the company invested $150 million in companies developing products that would boost the adoption of wireless technologies laying the foundation of current Wi-Fi networks. Even if most entrepreneurs and VC funds declared to be sceptical about this strategy, the company has actually benefited from it because it has managed to focus on its long-term goals, increasing the sales of its core products. The result was that, in 2000, Intel Capital reported profits of $3.7 billion, about one-third of the company's total profits (CB Insights, 2017).

Unfortunately, the golden wave of CVC ended in the early 2000s when the dot-com bubble produced a massive drop in the stock market (Nasdaq fell 40% between March and May of 2000), enormous losses in venture-related units (about $9.5 billion in U.S. corporations in the second quarter of 2001) and many companies closed their CVC units (like Microsoft, AT&T and News Corp) (CB Insights, 2017).

1.2.4 The fourth wave (2004-today): The Unicorn Era

In the years following the dot-com bubble, CVC investments halved year after year until 2003, and then slightly resumed growth until the 2008 crisis (Figure 2). In 2012, the annual global funding from CVC-backed

deals was $8.3 billion, which was a relevant increase from the 2009 fall to $5.1 billion, but still much less than the record $16.8 billion of 2000.

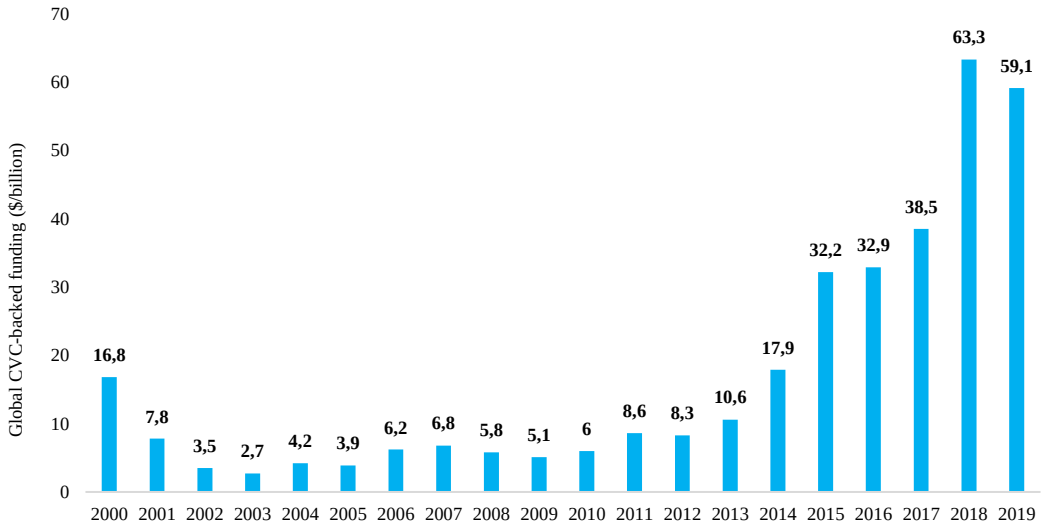

Figure 2: Annual CVC global funding trend, 2000-2019, CB Insights

For CVC investments to recover to the level of 2000, it was necessary to wait until 2014. Indeed, between 2013 and 2019, we witnessed an exorbitant 36% annual growth in CVC funding to reach the record level of $63.3 billion in 2018. CVC's incredible resurgence around this time was due to the combined rise of social media and smartphones. As evidence of this, in the last quarter of 2016, the internet and mobile phone industries attracted 63% of CVC investments (CB Insights, 2017). In addition, two other events that could have played a role (albeit marginal) are Microsoft's investment in Facebook in 2007 and the launch of Google Ventures in 2008. At that time, Microsoft bought a 1.6% share in Facebook for a total market valuation of $15 billion, helping the company to mature and to achieve a quite $300 billion market capitalization just ten years later (in 2017). On the other hand, Google Ventures often demonstrated in the last few years to have become one of the most important CVC vehicles in the world, investing in 818 startups mainly working in the mobile, software and healthcare sectors (Crunchbase, 2021).

Two other interesting statistics that give an idea of how much CVC has taken hold recently are the annual number of new CVC investors that make the first investment and the gap between the average CVC and VC deal size between 2013 and 2019.

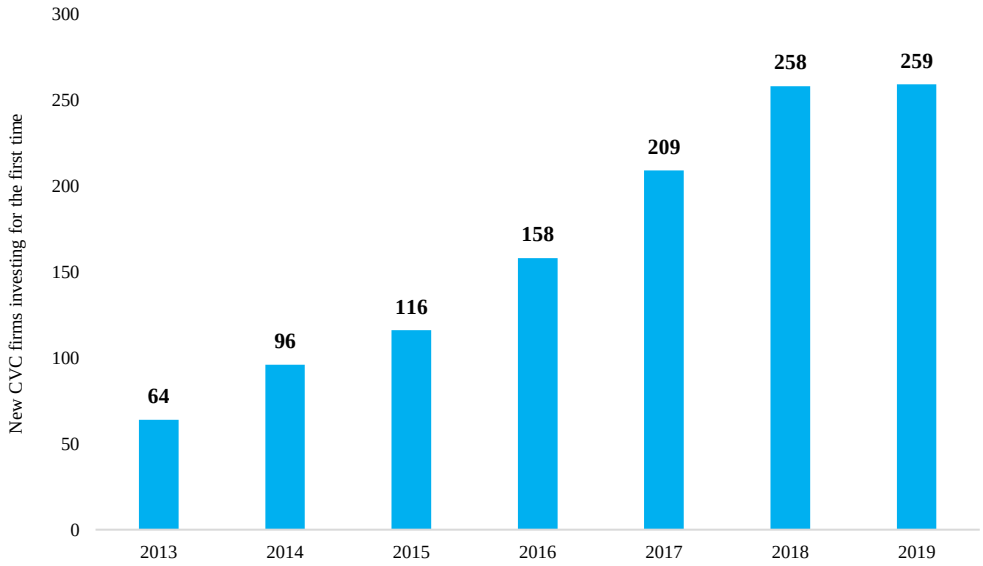

Figure 3: Annual global number of new CVC investors that made the first investment, 2013-2019, CB Insights

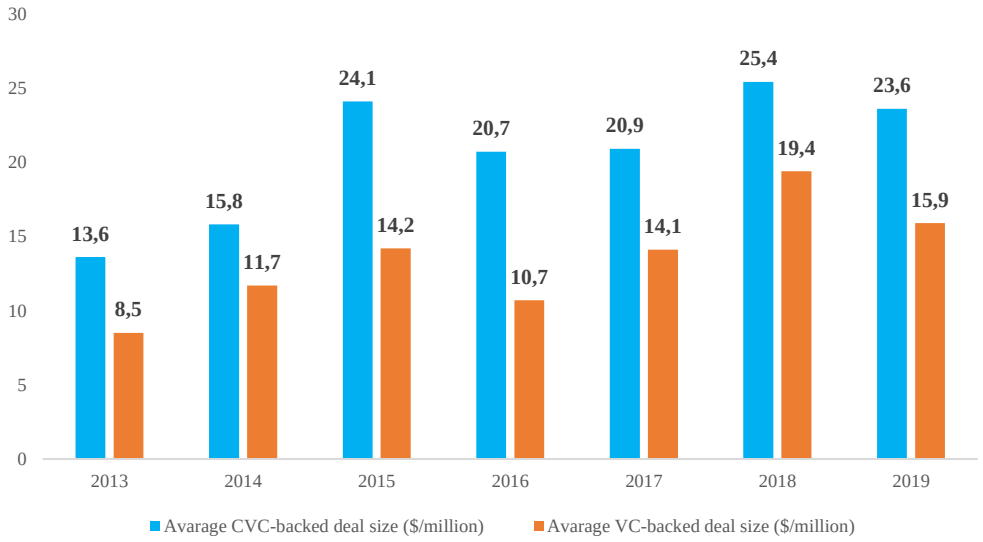

Figure 4: Annual Gap between average global CVC and VC deal size, 2013-2019, CB Insights

Figure 3 shows that the number of new CVC programs between 2013 and 2019 reported an unprecedented surge. In these 7 years, that number has grown 4 times and with an annual average growth rate of 27%, reaching 259 new CVC investors in 2019. But what is even more surprising from Figure 4 is that, in the same period, corporates invested an average of $7.1 million more in each CVC deal than in VC deals by independent funds. This data is particularly illustrative of how CVC is a “tool” and an indicator of fundamental importance for understanding the involvement of companies in the technological progress of the ecosystem around them.

Apart from the size of investments and the innovations that drove the two waves, there are some structural differences between the dot-com era and the tech boom of the 2010s. In recent years, many of the largest CVC investors are not emerging units of companies that are facing the CVC market for the first time, but rather the CVC arms of great high-tech companies, many of which have survived the last recession and are continuing

to invest, such as Intel Capital and Cisco Investments. This makes them very reactive to external stimuli and ready to capitalize on the current opportunities. CVC's other big tech investors, such as Google and Salesforce, started their funds more recently, in 2008 and 2009 respectively, but were already directly investing in the market before it overheated. For example, Salesforce has substantially increased its investments from $27 million in 2011 to over $500 million in 2017. Contrariwise, in the dot-com era, CVC was establishing as "the modern way" to invest outside the corporate's borders, and many of the companies that overlooked it did it for the first time. This is why the data shown above must be interpreted in light of these considerations.

In conclusion, recent CVC trends communicate how it is, in a sense, getting back to its origins, receiving a strong boost from the technology industry that has become predominant in the current decades. It is clear that some high-tech giants have just taken the lead. A few years ago, they were growing startups like many others, while now they are known as "unicorns", which underlines both their uniqueness and their fast-growing attitude, a characteristic that their CVC units also look for new ventures. The importance of the high-tech sector in CVC's initiatives in the 2010s has also allowed many Asian companies to establish themselves as protagonists on the global scene. The CVC market in Asia produced nearly $20 billion in CVC investments and 351 deals in 2018, of which just over half came from China (CB Insights, 2020). Vehicles such as Baidu Ventures, Tencent Investment, Alibaba Capital Partners, Fosun International, JD Capital and Haier Capital have dominated the Asian CVC market in recent years, mainly investing in the software and internet industry. The latter industry, in China, is worth over $800 billion a year in revenues and it is the face of a thriving ecosystem (Ibisworld, 2020). These statistics contribute to highlight how CVC represents not only a strategic and financial investment means but the expression of how a specific environment (or country) is turning towards the future by drawing the best from the most effective and innovative activities.

1.3 Background and research question

1.3.1 Corporate Venture Capital and differences among the countries

As discussed in the first paragraph, clusters can be assimilated into business ecosystems to some extent. The cluster is a small version of a business ecosystem, within which there are very similar economic, social and cultural conditions, which undoubtedly influence its organizations' activities. By the way, countries have these characteristics too. Companies based in the same country are subject to the same government and law; share similar basic social and economic settings, such as taxation, bureaucracy or law enforcement; they have schools and universities that are part of the same education system; they have also inherited equivalent cultural roots. For these reasons, countries can also be considered business ecosystems, but on a larger scale. All these factors relate to companies that operate within the same country, laying the foundations of that business environment, and consequently affecting their ability to adapt to technological progress and innovation. In

addition, in the last twenty years, CVC established as one of the most important innovation basins not only for companies but also for the entire national ecosystem around them.

In the following graphs, I represented the interesting link between scaleups[5] and the CVC activity in 29 countries in 2019. Data have been collected from the Crunchbase database.

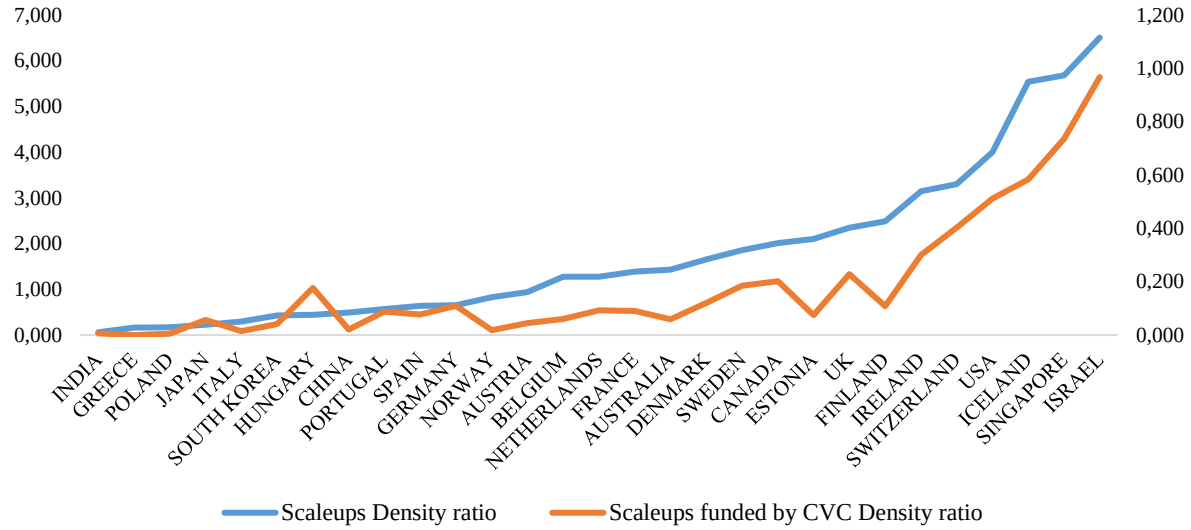

Figure 5: Scaleups density ratio[6] vs. Scaleups funded by CVC density ratio, 2019, Crunchbase

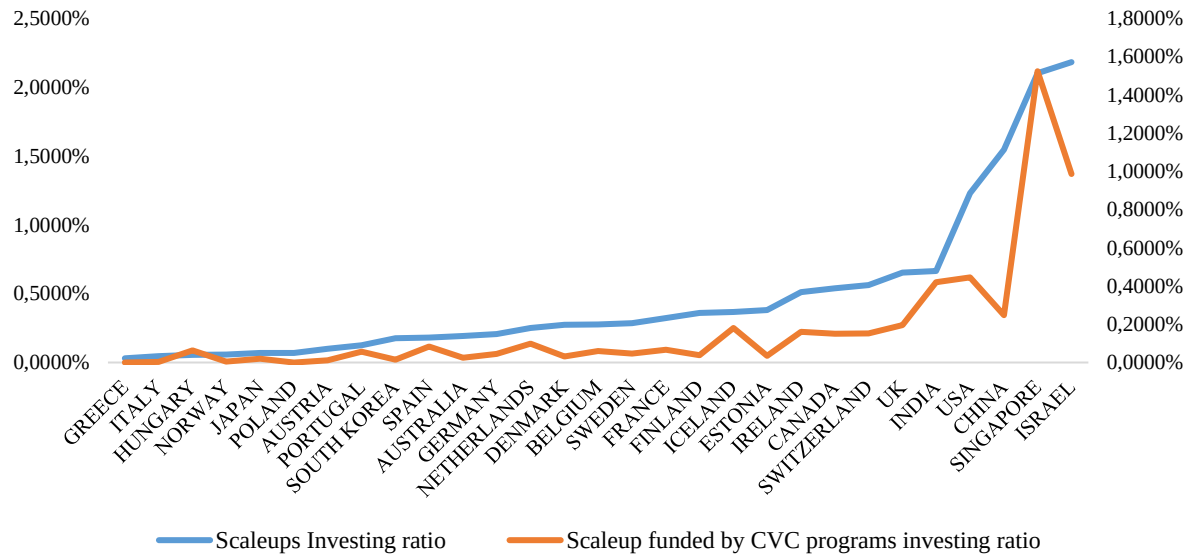

Figure 6: Scaleups investing ratio[7] vs. Scaleups funded by CVC investing ratio, 2019, Crunchbase

Figure 5 compares the total number of scaleups (based in each country) as a percentage of the population and the number of scaleups that have been (at least once) funded by a CVC investor as a percentage of the

[5] *Scaleups*: startups with more than $1 million funding raised (before December 31, 2019)
[6] *Scaleups density ratio*: number of scaleups per 100,000 inhabitants within a country
[7] *Scaleups investing ratio*: capital raised by scaleups as a percentage of thousands of dollars of GDP

population. Instead, Figure 6 compares the total capital raised by scaleups (based in each country) as a percentage of the GDP and the capital raised by scaleups that have been (at least once) funded by a CVC investor as a percentage of the GDP. As it can be noticed, in both cases the performance of a country's startup ecosystem is overall in line with the performance of its CVC activity. The trends of the scaleups density ratio and the scaleups investing ratio remain almost the same compared to the corresponding ones of the scaleups funded by a CVC investor. Thus, analysing a country's state of progress in the context of CVC reveals some information about the ability of the country to cultivate new enterprises, products and business models, that are elements of innovation and technology. Another important piece of evidence from these Figures is Italy's marginal role on the global scene. Among the selected countries, Italy has the fifth-lowest number of scaleups in proportion to its population and the second-lowest level of scaleups' funding in proportion to its GDP. This implies that its startup ecosystem is vastly underperforming its economy.

The following research would attempt to find a connection between countries' CVC industry and their state of innovation. By "state of innovation", I mean the level of development of national innovation ecosystems concerning the relationships between companies, startups, and those factors that favour their technological development, such as taxation, education or access to technology. In particular, this study is addressed to the CVC and Open Innovation industry as an expression of a model of external innovation which involves not only the individual company but also its surrounding environment. Considering national countries as a formal delimitation of different clusters on a global level, the inspiring source of my study comes from the considerable differences between them from the point of view of their startup ecosystem and CVC activity.

1.3.2 Research question

The report "*Open Innovation Outlook Italy 2020*", published by Mind the Bridge[8] in 2020, upholds that, in Italy, large companies have just begun the transition towards Open Innovation and CVC. As the report declares, "innovative firms grow twice as fast, both in employment and sales, compared to firms that fail to innovate … and Open Innovation is an investment practice that provides the possibility for startups to scale-up and for companies to access to technology" (Mind the Bridge, 2020). This observation is particularly true for Italy, where medium and large companies have been gradually losing competitiveness with regards to their international competitors, and startups struggle to develop. In 2019, the number of Italian scaleups was only 3% of the total number of scaleups in Europe[9] and they raised just 1.4% of the total funding for scaleups in Europe. Despite Italy is the second-largest manufacturing country in Europe, the gap between the top European startup ecosystems is extremely wide. The U.K.'s number of scaleups is ten-fold that of Italy, and the amount of capital employed in them is twenty-two times higher (Mind the Bridge, 2020). These data testify that Italy

[8] Mind the Bridge: American innovation advisory firm that periodically performs researches and studies on CVC and Open Innovation.

[9] This data considers European top 25 countries for the number of scaleups (UK, France, Germany, Sweden, Switzerland, Spain, Netherlands, Finland, Ireland, Italy, Denmark, Belgium, Norway, Austria, Poland, Portugal, Estonia, Greece, Iceland, Hungary, Czech Rep., Ukraine, Luxembourg, Lithuania, Romania).

still has a long way to go compared to the global innovation leaders, such as the U.S.A., China, Israel and the U.K.

The economic literature has extensively dealt with the topic of CVC and innovation. Many scholars and professors have analysed how a country manages to create the ideal conditions for constant technological development over time, how to stimulate the technological transfer between universities and companies, how the establishment of geographical clusters of companies have created innovation ecosystems and how CVC programs can somehow substitute traditional R&D corporate investments. However, based on the previous historical analysis, it has emerged that, in recent years, CVC has played an important role in interconnecting the best innovative ideas and technologies with corporations that have the commercial networks, skills and capital for their success. Therefore, the goal is to fill this analytical gap in the economic literature that associates the state of development of countries' CVC activity with the state of development of their startup and socioeconomic ecosystems.

The work aims to answer the following questions: "Apart from cultural issues, are differences across countries in terms of CVC activity due to the quality of their startups and some ecosystem factors, such as taxation, education technology? What is the relationship between these variables? How could a country leverage these factors to develop its CVC industry and bridge the gap with the global innovation leaders?". The objective of this research is to understand how those drivers are relevant for countries to improve their innovative ecosystem led by corporations' engagement in OI and CVC. In particular, this analysis can be of great value for those countries, such as Italy, whose CVC industry is still lagging behind the flourishing and dynamic environment that has been created within the leading innovation countries.

To find out the answer, I decided to analyse a set of variables that could significantly affect a country's path towards innovation and specifically determine the trust of large companies in investing in that national innovative ecosystem. In particular, I identified some dependent variables affecting the number of firms backed by CVC programs and the total funding from CVC investors within the country. On the other hand, independent variables refer mainly to:

- Quality of startups operating in the country
- Social and economic ecosystem factors

Here are the hypotheses I want to investigate:

H1. CVC activity is positively related to the quality of startups.

H2. CVC activity is positively related to some socioeconomic factors, such as education and technology, and negatively related to the level of taxation.

Figure 7 summarizes the hypotheses of this study highlighting the relevant literature that I used.

#	Type of variable	Expected impact on CVC	Literature
1	Startup quality	+	Onetti A., (2021); Dörner K., Flötotto M., (2020); Kou M., Yang Y., Chen K., (2020); Prats J., Siota J., Canonici T., Contijoch X., (2018); Peris-Ortiza M., Ferreira J., Fernandes C.I., (2018); Chesbrough H.W., Bogers M., (2014); Barro R.J., (2013); Cusumano, (2013); Mercan B., Göktas D., (2011), Traitler H., Watzke H.J., Saguy S., (2011), Bertoni F., Croce A., Colombo M.G., Pila E., (2007); Paddison O., Gyimah-Brempong K., (2006); Chesbrough H.W., (2005); Chesbrough H.W., (2003); Yiming Q., (2003); Chesbrough H.W., Tucci C.L., (2002); Kondo M., (1999); Kortum S., (1993); Solow R. (1956)
2	Education	+	
3	Technology	+	
4	Taxation	-	

Figure 7: Summary of hypothesises and related literature

Chapter 2: Quantitative analysis

In this chapter, I deal with the quantitative analysis of my study. This section is organized into two parts. The first part refers to the methodology used for the analysis, including all the preliminary information on data collection, type and selection criteria adopted. Subsequently, the variables and the statistical methods employed to build the models will be explained in detail. The second part, on the other hand, focuses more on the results of the quantitative analysis, on the practical implications that derive from it, on the limits of the model and on some conclusions to be drawn.

2.1 Methodology

2.1.1 Sample data

To examine the impact of the quality of startups and other ecosystem factors on the CVC activity across countries, I created a dataset where I included a wide range of variables on different themes. The most of data have been collected from authoritative databases that are available online on the official websites of national and international institutions, such as the United Nations Educational, Scientific and Cultural Organization (UNESCO), the Organization for Economic Co-operation and Development (OECD), the World Bank and the World Intellectual Property Organization (WIPO). Other data come from some specific sectoral organizations, mainly focused on studying the entrepreneurial ecosystem and the startups' engagement in the economy all over the world, such as the Global Entrepreneurship Monitor (GEM) and the Global Innovation Index (GII) platform. Then, a portion of data was also taken from private well-known databases, like Crunchbase, Statista and CB Insights. I have chosen these types of sources for the data-collection process because they are among the most reliable economic information, which is provided annually by national statistical departments and international organizations. They represent an absolute reference point for numerous studies or research works all over the world.

All data refer to the year 2019, except for the variables "STEMs graduates' ratio" and "GERD as a percentage of GDP", whose values are an average between those of 2017, 2018 and 2019. The decision to use data relating to or before 2019 originates from two different reasons. The first pertains to the availability of data. As of today, data after 2019 are not available for all the observed variables. In particular, for some variables more recent data from 2020 onwards are available only as estimates and not as established values. Therefore, I preferred to base my analyses on the most reliable recent data. The second reason concerns the accountability of the possible results of the analysis. As is well-known, 2020 and 2021 have been marked by a tragic economic crisis due to the Covid-19 outbreak and governments' social restrictions to avoid the virus spread. This extraordinary event has strongly influenced the economic performance of all countries and has changed the scenario in which companies operate. Therefore, to prevent my analysis from driving to conclusions that are

decisively influenced by these recent events, I preferred to carry out a study based on a "standard" situation (such as the one before the pandemic), from which more truthful results and more significant implications may emerge.

I performed my analysis on 29 observations. They consist of 29 countries, of which 20 are European and 9 are non-European. Among the non-European ones, I used the most industrialized and developing countries, including the U.S.A., Australia, Israel, Japan, India and China.

2.1.2 Variables

To analyse the relationship between the CVC activity across countries and the two macro-categories of factors (the quality of startups and the ecosystem), and to understand how a country can soar towards a more mature and conscious state of innovation, I selected a specific set of variables representing the key indicators for each category.

As dependent variables, in the analysis, I made use of the number of firms in which CVC programs invested (as a percentage of population) and the amount of funds that these firms raised from CVC investors (as a percentage of GDP). According to some reports issued by some business analytics companies and other organizations[10], the CVC activity within countries is usually evaluated by the annual number of deals between firms and CVC investors, and the related investment funds raised by the firms. Nevertheless, it must be noticed that the number of deals is not representative of the number of firms in which CVC vehicles invest every year, since one firm can potentially attract more than one deal from more than one CVC investor. Moreover, although the number of CVC deals gives an idea of the size of the transactions taking place in the related area, this size is also exhaustively represented by the total amount of funding from the CVC programs. Therefore, alongside this last variable, for my research, I preferred to use the number of companies financed by CVC investors as they embody the order of magnitude of the possible investments that these investors can make in a country. An example that clarifies my logic is about comparing two countries with the same amount of CVC funding, but with a very different number of companies involved. Obviously, of the two, the country that has a higher number of CVC-backed companies, and so a larger ecosystem of firms (especially startups) in which corporate venture capitalists invest, may have also a more vigorous CVC activity. Thus, I consider the number of firms funded by a CVC investor as a more appropriate variable for my analysis than CVC-backed deals.

Regarding the independent variables, as I mentioned in Chapter 1, I divided them into two categories: quality of startups and political and social ecosystem factors. For the first category, very little research is available in

[10] Some of the reports mentioned above are:
2020, Quinto Osservatorio Open Innovation e Corporate Venture Capital, *Assolombarda*.
2020, Open Innovation outlook Italy 2020, *Mind the Bridge*;
2020, The 2020 Global CVC Report, *CB Insights*;
2019, The next chapter for Corporate Venture Capital, *Deloitte*;

the previous literature. Indeed, the evaluation of the quality of a startup is based more on the investors' experience and repeated scouting techniques rather than on mere literary theories. However, through the few papers and business articles available about this theme, I realized how experts examine the potential of a startup to be successful. In particular, I used the approach that VC funds employ for the scouting and selection of startups. From this research, it emerged that the most important criterion of choice concerns the evaluation of the team. Beyond the psychological dynamics and teamwork skills, often the potential of a startup is evaluated through its team's level of competence, especially its founders' one. Founders' level of education is often a symptom of the quality of the work they can offer (Cusumano, 2013). Therefore, one of the variables to evaluate the quality of startups is an estimate of the number of founders who have attended university. This data was extrapolated from the total number of scaleups in each country. Secondly, venture capitalists typically evaluate both the market in which startups operate and the technology they propose. Being the evaluation of a good or bad market a more subjective choice for an investor and the deepening of this topic beyond the objectives of my research, I collected information about the scaleups' technology in each country, as another driver influencing the quality of startups. Previous literature unanimously points to the number of patents granted as the most reliable measure of a company's technological level (Peris-Ortiz et al., 2018). And therefore, as a second independent variable relating to the quality of startups, I used the number of patents assigned to scaleups in each country.

By the way, it is important to specify why in the variables just mentioned, I conducted my analysis with data about scaleups rather than startups. The logic is that scaleups are more representative of the number of startups in which investors invested more, and so, in which they have placed more trust. This would avoid considering outliers values in terms of the number of startups and would make the analysis' results more relevant to draw conclusions. The problem is that countries differ a lot in the percentage of startups that scaled up (e.g., in Italy only 23% of startups raised more than $1 million funding and can be considered scaleups; instead in France, almost 43% of startups raised more than $1 million funding). These differences across countries could adversely affect the results of the analysis. Therefore, being the size of rising startups in each country an indicator of how its startup ecosystem is able to propose winning business models and profitable organizations, I preferred to collect data about scaleups, and to use the "Scaleups-startup ratio" (the percentage of scaleups on the total number of startups in a country) as a control variable to isolate possible outlying effect. Lastly, I want to mark that the definition of "scaleup" (a startup that raised more than $1 million funding) has been borrowed from the report that inspired my whole research, namely *"Open Innovation outlook Italy 2020"* published by Mind the Bridge.

The second category of independent variables concerns the political and social ecosystem factors within each observed country. Specifically, the focus is on three sub-topics which, according to the main macroeconomics theories[11], characterize some of the underlying pillars of a country that pursues long-term economic growth:

[11] The Solow model is one of the most famous macroeconomic theory dealing with the relationship between economic growth, technology, human capital and taxation (Solow R., 1956, A Contribution to the Theory of Economic Growth, *Quarterly Journal of Economics*, Vol. 70, (1), 65-94)

taxation, education and technology. According to the recent history of the CVC, changes in government fiscal policies could incentivize or hinder large corporations to invest in external ventures. As already mentioned in Chapter 1, Paragraph 1.2, changes in corporate-related taxation in 1969, 1978 and 1980 in the U.S. determined a short-term increase or decline in the CVC activity. Thus, one of the independent variables I considered for the analysis is the corporate tax rate across countries. As for education, the representative independent variable is the percentage of students who graduated in STEM subjects in each country. Despite literature typically considers variables like the years of schooling or the total number of graduates in a certain period (Barro R. J., 2013; Paddison O., 2006), I tried to investigate the relationship between science education and CVC activity. This curiosity stems from the evaluation that more than half of the startups receiving an investment from a CVC vehicle belong to technologically advanced industries. CB Insights estimates that, in 2019, 58% of total CVC-backed funding globally was addressed to the Internet, healthcare, finance and electronics industries (CB Insights, 2021). This data confirms that corporate ventures usually prefer investing in dynamic markets where disruptive technology, and thus excellent human resources in scientific fields, creates a huge competitive advantage in favour of the most innovative companies. Finally, the technology-related variable is selected in continuity with the economic literary tradition and similar previous studies (Peris-Ortiz et al., 2018; Kou M. et al., 2020). It consists of the total number of patents granted in each country as a percentage of the population, namely one of the most common indicators of innovative activity.

To complete this research and prevent the analysis's outcomes from being influenced by other variables that are not directly studied, I used three control variables in order to isolate their effect on independent variables. Two out of three control variables are “Median age of population” and “Gross Domestic Expenditure on Research & Development (GERD) (as a percentage of GDP)”. In the previous literature, population age and R&D expenditure are employed, either as independent or as control variables, in many of the studies regarding VC, CVC and innovation in general (Kou M., 2020; Peris-Ortiz M., 2018). The motivations are simple. According to Harvard Business Review, in 2018, the average age of startups’ founders was 45 years old, but the average age at the time of founding was 31, and actually, the average age of the founders of the fastest growing startups between 2015 and 2018 was 29 (Azoulay P. et al., 2018). These data highlight that age matters when disruptive ventures are founded, and countries with a younger population can benefit from a higher percentage of people in the working age. As concerns GERD, some studies show the relationship between R&D expenditure and patents (Kondo M., 1999; Kortum S., 1993). Countries whose companies have a greater spending budget on R&D can have an advantage in both generating innovations and investing in external technologies. Therefore, it is important to keep also this variable under control, and so to carry out a more complete analysis. At last, the third control variable is the “Scaleups-startup ratio”. As already mentioned above, the differences across countries about the number of startups that were able to scale up (raise more than $1 million funding) make it necessary to isolate its possible effect on the analysis, especially when studying the annual investments by CVC investors. Although this type of control variable was not used in the previous literature, in this analysis it must be considered because of the disparity among countries both in terms of investments in startups and the total number of startups. However, this control is only significant for examining

one of the two dependent variables (the aforementioned “CVC-backed funding”). In the next paragraph, this aspect would be discussed more.

In Figure 8, there is a summary of all variables employed in the analysis, while, in Figure 9, variables’ descriptive statistics can be found.

Type	Abbreviation	Noun	Year	Description	Source Database
Dependent	CVC_firms	CVC-backed firms density ratio	2019	Number of firms in which CVC programs have invested (per 100,000 inhabitants)	*Crunchbase - World Bank*
Dependent	CVC_funding	CVC-backed funding ratio	2019	Annual funding to firms by CVC investors (as a percentage of GDP)	*CB Insights - World Bank*
Independent	Scaleups_patents	Scaleups' patents density ratio	2019	Number of patents granted per scaleup	*Crunchbase*
Independent	Founders_univ	Estimated number of founders who attended university (% population)	2019	Total number of scaleups' founders who attended university (per 100,000 inhabitants)	*Crunchbase - World Bank*
Independent	Corporate_tax	Corporate Tax rate	2019	Corporate tax rate on profits	*OECD*
Independent	STEM_graduates	Percentage of STEM graduates	average 2017-2019	Percentage of total graduates in a country that studied STEM subjects	*UNESCO*
Independent	Patents_granted	Patent granting ratio	2019	Number of patents granted in a country (per 100,000 inhabitants)	*WIPO - World Bank*
Control	Pop_Median_age	Median age of population	2019	Age that divides a population into two numerically equally sized groups	*Wikipedia*
Control	GERD	GERD as a percentage of GDP	average 2017-2019	Gross domestic expenditure on R&D (GERD) (as a percentage of GDP)	*UNESCO*
Control	Scaleups_startups	Scaleups-startups ratio	2019	Percentage of scaleups on the total number of startups within a country	*Crunchbase*

Figure 8: Summary of variables

Variables	Observations	Min	Max	Mean	Median	S.D.
CVC-backed firms density ratio	29	0,00	1,86	0,56	0,39	0,51
CVC-backed funding ratio	29	0,0%	0,4%	0,1%	0,0%	0,1%
Scaleups' patents density ratio	29	0,05	3,52	1,29	1,02	0,96
Estimated number of founders who attended university (% pop.)	29	0,00	1,37	0,30	0,18	0,36
Corporate Tax rate	29	9,0%	32,0%	23,5%	24,0%	5,4%
Percentage of STEM graduates	29	16,8%	50,0%	26,7%	25,4%	7,5%
Patent granting ratio	29	0,79	314,87	84,40	64,98	81,74
Median age of population	29	28,70	48,60	41,13	41,90	4,45
GERD as a percentage of GDP	29	0,7%	4,9%	2,3%	2,1%	1,0%
Scaleups-startups ratio	29	12,0%	57,9%	28,6%	26,8%	10,3%

Figure 9: Descriptive statistics

2.1.3 Estimation methodology

For my analysis, I used the multiple linear regression model to apply panel data and analyse the relationship between CVC activity across countries, startup quality and socioeconomic ecosystem factors. I chose this type of quantitative methodology because all variables (both dependent and independent) are continuous, meeting one of the most important conditions of a standard regression model. Furthermore, the main objective of this study is not a precise forecast, but it is to understand if the independent variables can somehow explain the dependent variables, and so to understand on which factors countries, such as the U.S., Israel, or China, should leverage to be positioned as the global innovation leaders. For this reason, more complex models, like nonlinear regression, would have been unnecessary for the scope of this study; instead, the linear regression model is accurate enough to return relevant results and draw conclusions.

Multiple linear regression requires some conditions to be met. First, we need to check the multicollinearity among the variables. Even though I constructed two different linear regression models for the two dependent variables, we can test for multicollinearity of both through the correlation matrix in Figure 10.

	CVC firms	CVC funding	Scaleups patents	Founders univ	Corporate tax	STEM graduates	Patents granted	Pop Median age	GERD	Scaleups startups
CVC_firms	1									
CVC_funding	0,65103	1								
Scaleups_patents	0,45350	0,57796	1							
Founders_univ	0,72262	0,39671	0,28601	1						
Corporate_tax	-0,49895	-0,05995	0,23405	-0,19770	1					
STEM_graduates	-0,13349	0,21872	0,15162	-0,33944	0,14873	1				
Patents_granted	0,16381	0,14037	0,58016	0,13463	0,13051	0,19994	1			
Pop_Median_age	-0,43742	-0,55384	0,01096	-0,36958	0,27830	0,12135	0,25332	1		
GERD	0,30366	0,52712	0,73812	0,15025	0,23704	0,18919	0,75874	0,00224	1	
Scaleups_startups	0,30130	0,45746	0,43017	0,30386	0,20230	0,31906	0,35984	-0,32781	0,55249	1

Figure 10: Correlation matrix

From the matrix, there is no sign of multicollinearity. The correlation coefficients among the independent variables are quite low. The only independent variable with higher correlation coefficients than others is "GERD as a percentage of GDP". In particular, it appears to be slightly correlated with "Scaleups' patents density ratio" and "Patent granting ratio". However, "GERD" is only a control variable and has the sole purpose of isolating the effect that differences in R&D expenditure across countries could have on the final results. In addition, keeping this variable as moderator, the regression model exhibits a higher R-squared, a lower standard error and independent variables show higher significance. Thus, I have decided to use it in the model anyway.

Multiple linear regression must also meet other four conditions: homoscedasticity, independence, normality and linearity. In both models, the random errors comply with the former three conditions. This assumption is

supported by the Residual plots, the Time Residual plots and the Q-Q plots available in the Appendix, from Figure A.1 to A.6. Instead, linearity could be assumed because of rather high R-squared and adjusted R-squared values, and thanks to a common experience coming from the literature that has traditionally evidenced a relevant relationship between the dependent and independent variables considered in this study.

In conclusion, I processed the collected data with STATA software version 16 (StataCorp LP, USA).

2.2 Empirical results

In the subsequent analysis, I examine whether specific startup quality determinants and some socioeconomic ecosystem factors, such as education, taxation, and technology, affect the CVC activity in a country. This research is carried out on two distinct models, which take into consideration the two dependent variables of interest. Model 1 focuses on evidencing any relationship between the aforementioned factors and the number of firms that received an investment by a CVC investor. The main purpose is to understand which factor illustrates to be more correlated with the number of firms that attract an investment from large companies' CVC divisions or funds and try to explain the results. On the other hand, Model 2 targets the link, if exists, between the independent variables and the total CVC funding within a country. The objective is, once again, to uncover any interesting association as to what produces a high or low level of CVC funding, and what recommendations can be made for those countries whose CVC business is still lagging behind that of the global innovation leaders.

2.2.1 Model 1

For Model 1, I estimated the following econometric model:

$$CVC\_firms_i = \alpha + \beta_1 Scaleups\_patents_i + \beta_2 Founders\_univ_i + \beta_3 Corporate\_tax_i + \beta_4 STEM\_graduates_i + \beta_5 Patents\_granted_i + \beta_6 Pop\_Median\_age_i + \beta_7 GERD_i + \varepsilon$$

where i indicates a country

Figure 11 presents the results returned by the analysis of the "CVC-backed firms density ratio" dependent variable.

Goodness of Fit	
Number of Observations	29
F (7, 21)	16.1117
Prob > F	0.0000
R-squared	0.8430
Adjusted R-squared	0.7907
Standard Errors	0.2320

Variables	β	Standard Errors	P-value
Independent Variables	1.2328	0.5785	0.0451
Scaleups_patents	0.2025	0.0722	0.0106
Founders_univ	0.7273	0.1577	0.0002
Corporate_tax	-4.7035	0.9032	0.0000
STEM_graduates	0.4555	0.6545	0.4941
Patents_granted	-0.0014	0.0009	0.1434
Control Variables			
Pop_Median_age	-0.0072	0.0123	0.5641
GERD	10.9529	8.3799	0.2053
α	1.2328	0.5785	2.1308

$p < 0.05$

Figure 11: Parameters of Estimation – Model 1

The regression output highlights that the number of firms in which CVC players invested is strongly related to most of the factors considered in this study. In particular, the corporate tax rate appears to be very important for investors in planning investments in various countries. This independent variable not only shows to be highly significant for the dependent variable but also meets the expectation of a negative correlation with it. This result could be explained by the logic of geographic diversification of the corporate investor. As mentioned earlier, most CVC vehicles are founded by large companies with large amounts of cash disposal. Very often these companies are multinationals and take investment decisions also according to where the most interesting ventures are based and where taxation is more favourable to make profits. In addition, the most tax-friendly countries are able to attract more foreign startups. This is reasonable when you consider that their cash-burning is very fast and saving cash flows by paying fewer taxes could be decisive for the startup's survival. The history of CVC teaches that, in the U.S., governments that imposed an easier fiscal policy stimulated the CVC activity in the late 1970s and early 1980s. Therefore, a clear negative relationship between CVC-backed firms and taxation looks coherent.

As regards the impact of scaleups' quality on the number of companies supported by corporate venturing, both founders' education and the number of patents granted to scaleups are significant and positively related. Scaleups with founders who attended university can boast a more prepared team, and therefore more attractive for investors on paper. Despite graduate founders do not necessarily imply they are more capable or expert, in the eyes of an investor who has relatively recent knowledge of the team, having attended university could be

both a sign of greater seriousness and competence. Then, in countries where firms develop more product or process innovations and to whom authorities grant more patents, scaleups have a greater appeal, especially for corporate investors. Indeed, in Chapter 1, Paragraph 1.1.3, I highlighted that one of the primary motivations for companies to make venture investments is to access technology in a cost and time-efficient manner, which would have hardly been possible in their larger and more bureaucratic structure. This remark clarifies and elaborates on why the "Scaleups' patents density ratio" is, as expected, positively correlated with the number of CVC-backed firms. CVC divisions (or funds) seek disruptive technologies beyond their borders and definitely tend to invest more where these technologies come from the most.

Different considerations should be done for the negative relationship between our dependent variable and the total number of patents granted in each country. This result indicates that countries producing a larger number of patents not necessarily have a more animated CVC activity. To explain it, we could notice that most patents issued in one country are granted by larger companies than startups. From the dataset used for this study, we know that, in 2019, only 4,3% of the total patents granted on average in the observed countries are issued by scaleups (Crunchbase, 2021). Typically, larger companies can afford to spend more on R&D, use very expensive and modern equipment, have more heterogeneous human resources and can employ highly qualified teams. Moreover, the training data used for the analysis show that the countries that are considered as the global innovation leaders in terms of the number of CVC-backed firms, such as the U.S., China or U.K., are not the same in terms of patents issued per capita, whose global leading countries are Switzerland, Japan and South Korea (WIPO, 2019). Therefore, a technological inequality exists across countries, and this could be one of the most relevant drivers for the negative relationship between the total number of patents granted and the number of CVC-backed firms.

Finally, as it can be noticed from Figure 11, the last independent variable of interest, the "percentage of STEM graduates", showed not be significant for this study. Actually, this output could be anticipated by a low correlation coefficient with the "CVC-backed firms density ratio". A rationale of this result may be that the number of graduates in technical or scientific subjects could affect more the capital raised by each startup rather than the number of firms that attract a CVC investment. The logic is that, as the literature underlines, generally, investors tend to invest more in human capital-intensive businesses (Yiming, 2003), and human capital-intensive businesses are typically those with a more technology-based solution. If this is true, the percentage of a qualified technical workforce in a country should influence more the size of investments in each investor-backed firm (and so the total amount in the country) rather than the number of investor-backed firms. Therefore, we may explain such poor correlation assuming that this variable is more significant for the "CVC-backed funding ratio" dependent variable in Model 2.

2.2.2 Model 2

For Model 2, I estimated the following econometric model:

$$CVC\_funding_i = \alpha + \beta_1\ Scaleups\_patents_i + \beta_2\ Founders\_univ_i + \beta_3\ Corporate\_tax_i + \beta_4\ STEM\_graduates_i + \beta_5\ Patents\_granted_i + \beta_6\ Pop\_Median\_age_i + \beta_7\ GERD_i + \beta_8\ Scaleups\_startups_i + \varepsilon$$

where i indicates a country

Figure 12 presents the results returned by the analysis for the "CVC-backed funding ratio" dependent variable.

Goodness of Fit	
Number of Observations	29
F (8, 20)	10,8979
Prob > F	0,0000
R-squared	0,8134
Adjusted R-squared	0,7388
Standard Errors	0,0005

Variables	β	Standard Errors	P-value
Independent Variables			
Scaleups_patents	0,0003	0,0001	0,0337
Founders_univ	0,0007	0,0003	0,0503
Corporate_tax	-0,0012	0,0019	0,5280
STEM_graduates	0,0044	0,0015	0,0074
Patents_granted	0,0000	0,0000	0,0112
Control Variables			
Pop_Median_age	-0,0001	0,0000	0,0035
GERD	0,0571	0,0179	0,0046
Scaleups_startups	-0,0018	0,0013	0,1759
α	0,0025	0,0012	0,0541

$p < 0.05$

Figure 12: Parameters of Estimation – Model 2

The regression output shows that the capital raised by firms backed by a CVC vehicle has a significant relationship with most of our independent variables of interest. First, Figure 12 shows that the quality of scaleups is a relevant factor for corporate investors to believe in external innovative solutions. In confirmation of what was said before for their relationship with the "CVC-backed firms density ratio" variable, founders' education (at university) and the number of patents granted to scaleups are two important aspects that may induce CVC investors to finance a scaleup. As discussed above, the motivations are simple. Founders with a longer educational path appear to be more prepared and reliable in the eyes of the investor. Attending university not only enriches founders' academic background but also brings other benefits, such as a wider

network of connections, a well-structured way of working, the habit of working/studying hard to achieve goals and deeper knowledge in a specific field (which is very useful especially if consistent with the startup's business). These aspects make teams with graduate founders potentially more interesting than those with non-graduate ones.

On the other hand, as regards the impact of the number of patents granted to scaleups on the funds raised, I cited that often large companies invest through their CVC division (or fund) intending to access technology. Thus, being the number of patents a scale to measure firms' technological level, a positive relationship with CVC-backed funding results to be consistent with the expectations, namely that new technologies attract more investments.

Unlike the first regression model, in Model 2, the variable "Patents granting ratio" has a positive relationship with the "CVC-backed funding ratio". Actually, such a result is in line with some previous researches that studied the relationship between corporations' R&D and the existence of a CVC program (Chesbrough et al., 2002). Elaborating on the results of Model 1, I underlined that most of the patents issued within a country are granted to medium-large companies, while those granted to startups are just over 4% on average. This supposes that large companies have greater know-how and financial capabilities than startups to develop and invest in new technologies, both internally and externally. Research published by the École Polytechnique Fédérale de Lausanne highlights a strong positive correlation between companies' R&D expenditure and the presence or absence of a CVC division (Chesbrough et al., 2002). This study also points out that higher internal R&D expenditure, and so a greater patent issuance potential, is reflected in higher external R&D expenditure. Therefore, companies that invest more in technology tend to invest more in CVC as well, and this assumption could also influence the differences across countries at a macroeconomic level. This peculiar link is also confirmed by both the positive and significant relationship between CVC-backed funding and our control variable "GERD", and the high correlation coefficient between "GERD" and "Patent granting ratio" (Figure 10). To sum up, while the total number of patents granted in one country does not necessarily indicate more firms backed by CVC vehicles (see Model 1), it may imply more attitude to invest in technology, and so more funding raised by these CVC-backed firms. In fact, where more patents are granted, corporations seem to invest more in external innovation.

Instead, as concerns the relationship between the dependent variable and the "Percentage of STEM graduates" in Model 2, it looks to be positive and significant. This outcome has already been hypothesized in paragraph 1.2.1, noting that, as previous literature professed, investors tend to invest more in human capital-intensive businesses (Yiming, 2003), and, since they usually need a high scientifically qualified workforce, national ecosystems offering more STEM graduates are also more appealing for corporate investors. For example, South Korea is one of the countries with the highest percentage of STEM graduates (29%) among those observed (UNESCO, 2019), and ranks in the top-5 for CVC-backed funding raised as a percentage of GDP. This is a peculiar case in which technical-scientific education might represent an important driving force for CVC activity in the country.

In conclusion, surprisingly, in Model 2, the independent variable “Corporate tax rate” is not significant to explain the level of CVC-backed funding across countries. Such a result is in contrast with both Model 1 outcomes and expectations. Some reasonable motivations could be, in part, related to the statistical limitations of a linear regression model, whose accuracy is far from perfection, especially for models involving a large number of variables, and, in part, to one of the main CVC divisions’ objectives, that is to find innovative solutions that should both introduce to new technologies and fit with core products and processes. It means that often generating profits from the acquired firm (or from the startup in which the corporate invested) is not the primary goal of a CVC vehicle because other vital strategic goals are preferred. Therefore, since corporate tax mainly affects profits, a shift of its rate in a country does not necessarily affect CVC funding because a strategic purpose may lay behind the investment. However, history, literature and Model 1, illustrated that a sort of link between corporate fiscal policies and CVC activity exists, and certainly future researches in this direction would help to clarify this point.

2.3 Discussion and limitations

2.3.1 Final considerations about results

Corporate Venture Capital is a complex phenomenon and, in the last thirty years, it has become one of the most popular investment practices used by organizations to find innovative solutions externally. However, countries show substantial differences in their CVC activity, and this is not only due to cultural diversities in terms of entrepreneurship and investing attitudes, but also to other elements that make some environments more dynamic than others.

This research attempted to return a quantitative insight of what factors let some national ecosystems have a privileged role in the global innovation market and on which they have leveraged to mature their CVC industry. Specifically, the purpose was to identify the aspects a country must act on in order not to lag behind the global innovation leaders.

The above analysis reveals that these explanatory factors are, in part, political and economic, such as education and taxation, and in part, technological, referring to what innovative assets startups could offer to investors. In particular, it confirms that technology and education are two decisive drivers for the progress of an innovative ecosystem: countries with a high number of patents granted, a high number of graduates in STEM subjects and high-qualified (startup) teams enjoy both a large number of companies backed by CVC investors and large CVC investments. Consequently, a key driver to encourage corporate venturing is fuelling the development of startups with high-qualified teams, which can periodically be renewed by a young workforce of technically trained students. In fact, according to the data collected on the 29 observed countries, among those with the lowest "CVC-backed funding ratio" there are the countries with the lowest percentage of STEM

graduates, like Spain and Ireland. In this area, Italy is an exception. It has a percentage of STEM graduates in line with the average of the considered countries, but it performs the third-lowest amount of CVC investments. In its case, such a result seems to be linked especially to the very low number of founders who attended university and to the few patents granted to scaleups. In essence, in Italy, most of the startups financed by investors have both low-qualified teams and products or services with a low technological profile. This partially discourages corporate investors from investing in the country's startup ecosystem and does not allow the CVC to develop on a par with countries like the U.S. or Israel (positioned in the top 3 for the number of CVC-backed firms and CVC-backed funding as a percentage of GDP). On the other hand, the analysis showed that fiscal policy significantly influences the number of companies in which the CVC industry invests. For example, in Ireland and Hungary, despite CVC investments are not large, an average corporate tax rate of 12.5% and 9% respectively (compared to an average of 23.5%) (OECD, 2019) favour companies to invest in over 1 scaleup per 100,000 inhabitants (which is well above the average 0.56 scaleups per 100,000 inhabitants) (Crunchbase, 2019).

Therefore, the empirical analysis demonstrated the two hypothesises H1 and H2 (mentioned in Chapter 1). However, it must be noted that, in two circumstances, independent variables proved not to have a significant relationship with the dependent variables. They are the case of corporate tax rate with CVC-backed funding and the percentage of STEM graduates with the number of CVC-backed firms. Then, in another case, the outcome of the analysis refuted the hypothesis H2. Indeed, the patent granting ratio evidenced a negative proportionality with the number of CVC-backed firms, while a positive association was expected.

2.3.2 Limitations

It is also worth pointing out the limitations of this analysis and the aspects that future research can investigate. First, the data was collected from the biggest and most authoritative databases on innovation and startups, such as Crunchbase, GEM and CB Insights, and other global statistics platforms, such as those of OECD and UNESCO. However, it is hard to believe that this sample is complete and takes any firm, founder or student into considerations. Thus, our findings cannot be easily generalized, but they could be a good approximation of reality. In fact, the data used for this research are some of the most accurate among the second-hand ones available on online platforms. Moreover, the analysis does not consider any size difference among the companies that received an investment by a CVC vehicle, either in terms of total assets value and total revenues, or in terms of the number of employees. Such disparities have not even been contemplated also for the average size of CVC investors across countries, which may affect the financial spending capacity that corporates have for CVC and Open Innovation programs. In future researches, the correlation between these variables and the CVC activity could be further explored. Secondly, all the data refer to 2019, so before the pandemic crisis caused by Covid-19 which heavily influenced global economies, especially some sectors, and the resources destinated to invest in innovation. Indeed, concerning this last point, a brief focus on how the

pandemic could have influenced the outcome of this analysis will be addressed in Chapter 3, where I will analyse the available post-Covid data about CVC and our variables of interest, investigating possible aspects that could have had an impact on the pre-pandemic scenario.

In conclusion, I underline that this research by its construction cannot determine whether there is any causality between the reported associations and it does not claim to prove them. This apparent complementarity could have some other explanations behind these observed relationships. Through this study, I only found a connection between the startups' quality, political and socioeconomic factors and the CVC activity in countries, without demanding to discover a universal answer to countries' different CVC development status.

Chapter 3: Impact of the Covid-19 pandemic on CVC and startup funding

This chapter discusses how the latest data reported in 2020 and the economic crisis caused by the Covid-19 pandemic affected the CVC industry and, more generally, the implications for the previous quantitative analysis. This section is organized into two parts. In the first part, I report the main trends, statistics and insights on the CVC activity across countries, showing how the coronavirus epidemic influenced investments in the international startup ecosystem. Then, I highlight both the countries' political and economic reaction to the crisis, focusing in particular on policies and manoeuvres that fostered innovation and startups, and on private companies' investment strategies driven by recent changes in the global scenario. In contrast, the second part deals with the impact that the Covid-19 pandemic could have had on the development of CVC in light of the main conclusions we drove in the quantitative analysis, discussing how this crisis could have influenced it.

3.1 Impact of the Covid-19 pandemic on CVC

3.1.1 Main trends in the CVC industry

Covid-19 was initially reported to the World Health Organization (WHO) on December 31, 2019. It was declared a global health emergency on the following January 30, 2020, and finally a global pandemic on March 11, 2020. In a very short time, the virus spread to the entire world population, over 3 million people died and countries' health systems were overwhelmed, changing the way we live in cities and communities. The need to rapidly modify many attitudes and common behaviours and the imposition of mobility restrictions all around the world led to dramatic transformations in the economic and social fabric of many countries. Some of these changes will be temporary, others permanent, and some national, state or provincial lockdowns are partially still underway. The Global Entrepreneurship Monitor states that, along with the Spanish flu in 1918, the Great Depression in the 1930s, the two World Wars and the financial crisis of 2008-2009, this pandemic could be considered a sort of epic "black swan"[12], that has radically altered the approach businesses and organizations work. Although recent vaccinations opened a window to the end of this crisis, uncertainty persists on the global market and experts predict the establishment of a future "new normal", especially about the management of social relations and firms' working methodologies. Therefore, these events both mutated the global competitive scenario and affected corporate strategies and investments in terms of geography, industry, and also business models. The radical increase of companies employing remote working, the expansion of online platforms for working and communication, and the higher workers' sensibility for a more flexible and life-

[12] *Black swan*: an unpredictable event that is beyond what is normally expected of a situation and has potentially severe consequences. Such events are characterized by their extreme rarity and grave impact.

balanced job are only a few evidences of how new market needs rose to the surface and many innovative firms strove to adapt their products and services to these growing trends. A paradigmatic example is an incredible increase in the use of digital platforms for many aspects of our life. Despite it has already been a growing trend in the last years, the need to carry out many activities from remote locations due to the pandemic pushed even less digitally educated users to learn how to use and practice with these tools. According to a survey made by McKinsey, the Covid-19 crisis accelerated the digitalization of customer interactions by several years. Considering a sample of customers from all backgrounds and any market, the consulting firm estimates that, in 2020, 58% of customer interactions globally were digital, compared to 36% in 2019 (McKinsey, 2020). This statistic underscores the huge shift in customer needs that firms had to face. Such a radical change, on the one hand, benefited the companies that were already running their business online or whose business was related to the health crisis; on the other hand, had a disastrous impact on companies whose services and products involve social contact or indirectly have to do with sociability. While industries, like the Internet, healthcare and e-commerce experienced unprecedented growth, other sectors such as tourism, sport and fashion had to face severe restrictions and a much lower turnover than in the past. Consequently, this affected also large corporates' strategies and capital allocation, and so, even those addressed to R&D projects and corporate venturing investments.

Regarding the impact of these new conditions on CVC investments, we could argue that, despite the number of CVC-backed deals overall declined year-on-year, CVC-backed funding soared to an all-time high of $73.1 billion in 2020, increasing of about 24% from the previous year (Figure 13). This means that the deals' average size increased from $17.3 million to $21.8 million (CB Insights, 2021). Even the number of CVC-backed firms increased. Excluding the U.S., in 2020, in each of the countries observed in the analysis in Chapter 2, on average about 38 new companies received an investment from a CVC investor compared to 2019, with a rise of 26% (Crunchbase, 2021). Thus, on average 26% more companies are involved in the CVC ecosystem of each country. These metrics are very supportive considering that we are experiencing one of the worst economic crises ever and reinforce the idea that CVC allows us to fuel the growth of a business environment and its ability to innovate through cooperation between companies (Mercan B., Göktas D., 2011).

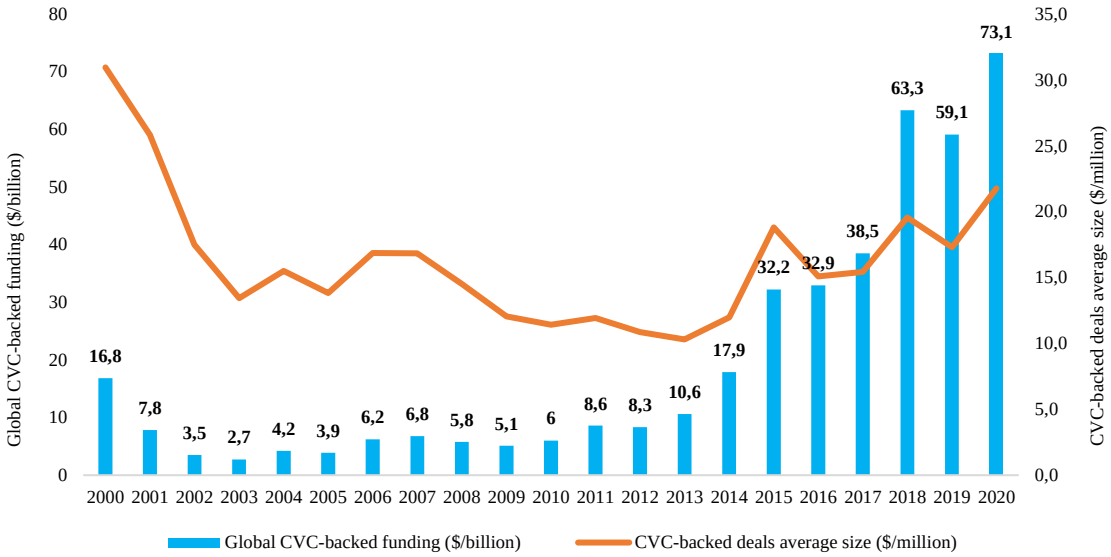

Figure 13: Annual CVC global funding and average deal size trend, 2000-2020, CB Insights

As far as it concerns the geographic distribution of the CVC activity, Israel, U.S.A. and Singapore remain among the countries with the highest level of CVC-backed funding as a percentage of GDP. In particular, in 2020, investments by CVC investors were worth 0,58% of Israelian GDP and 0,21% of the U.S. GDP, compared to an average of 0.08%. However, some countries experienced extraordinary growth in their CVC industry in terms of investments. For example, in 2020, Sweden and India are both ranked in the top-5 countries for CVC-backed funding (as a percentage of GDP) for the first time, with a year-on-year increase of nearly 60%. In addition, also Italy surprisingly performed great progress in this area. Its CVC-backed funding rose nearly threefold last year, especially driven by some "local champions"[13] in the insurance industry. Nevertheless, regarding the case of Italy, it is important to notice that the country's CVC activity underperformed the size of its economy in the past ten years. It was mainly related to the few players engaged in this type of corporate investments compared to other countries, as well as further motivations linked to education and technology (mentioned in Chapter 2). Anyway, the Italian ecosystem is evolving and "its rapid development of recent years is slightly bridging the gap with the other leading CVC countries in Europe", such as the U.K., Germany and France (Mind the Bridge, 2021).

Moreover, if we should indicate a continent whose CVC industry overperformed the expectations during the Covid-19 crisis, this would be Asia. Although its CVC-backed funding declined (compared to 2019) in the first two quarters of 2020, it recovered from July onwards and achieved $22.1 billion, with a 33% annual increase. China contributed substantially to such a rebound, with its CVC-backed funding to companies increasing 68% compared to the previous year. Those metrics could be explained by both the earlier Chinese recovery from the pandemic in comparison to the rest of the world and by the substantial growth of its startup ecosystem that has been in existence for several years. Nowadays, China hosts some of the most active CVC

[13] *Local champion*: a particularly innovative and successful company that stood out from the average in a specific location.

funds in the world, such as Tencent Holdings, Lenovo Capital and Alibaba Capital Partners, and this gives a great boost to all the related industries.

At last, we observe that, in 2020, the industries in which CVC vehicles invested the most are digital healthcare, fintech and cybersecurity; instead, the most invested technology is Artificial Intelligence. CB Insights estimated that the global CVC-backed funding to digital health companies hit a record of $8.8 billion, growing by almost 70 % compared to the previous year. In particular, one-tenth of this funding was raised by firms producing software for healthcare and approximately one fifth by companies offering Telehealth solutions (CB Insights, 2021). These data witness the outstanding development of the healthcare industry during 2020. However, this could have been quite predictable given that the health emergency caused by the spread of Covid-19 required huge investments not only aimed at the discovery of vaccines (mainly by large pharmaceutical companies) but specifically in those assistance services that are complementary to mobility restrictions. In fact, the use of mobile applications or health support devices, the greater openness to share personal data and the adoption of platforms for remote diagnostics have been included by Deloitte among the most important trends of healthcare consumers in 2020[14]. Additionally, this reveals a connection between the simultaneous increase of CVC investments in server and data management companies and the growth of the cybersecurity industry. The privacy management and the security of personal data have become crucial issues in recent years, and corporate investments reflect it. In 2020, global CVC-backed funding to the cybersecurity industry was $3.8 billion, about 31% more than in 2019. Then, fintech also reported significant numbers. In 2020, CVC vehicles invested $10.8 billion and closed 416 deals globally in this industry. Even though such a performance is down from its all-time high of $12.6 billion in 2019, fintech remains the most important sector in terms of startup funding. In particular, last year, a larger share of these funds came from Asia and Europe, 32% and 20% respectively (CB Insights, 2021).

3.1.2 Political and economic reaction to the crisis

When a fierce shock like the Covid-19 pandemic occurs, the government's role in managing the crisis is extremely important for society and the economy. It has to face a disastrous crisis with both hard social and health impacts on the community, and irreversible economic effects on companies of any size. Although the initial main focus is (and remains) on limiting the number of infections, regimes must also consider the implications for businesses and their employees due to repeated lockdowns and social restrictions. Many governments responded with relief packages, but not all have the same pocket. In some cases, firms were still able to pay wages, whereas, in others, they had to adapt and find alternative solutions. Many entrepreneurs were forced to miss them during the second and third waves of lockdowns, and many temporary workers risk entering a state of poverty. However, businesses and entrepreneurs are the glue that underlies society, so the

[14] Betts D., Korenda L., Giuliani S., (2020), Deloitte 2020 Survey of US Health Care Consumers, *Deloitte Insights*

political and economic manoeuvres that governments approved for the next few years will help us to understand the direction in which entrepreneurship and, consequently, corporate investments are headed.

In this regard, the European Union opted for an unprecedented macroeconomic policy in response to the crisis. It allocated a huge monetary stimulus package to increase the money supply and encourage consumption and investments. This long-term economic plan is addressed to the period 2021-2027 and has a budget of over €2 trillion (in current prices). In particular, its main instrument is known as "Next Generation EU", with a budget for the recovery of about €806.9 billion (in current prices) (Publication Office of European Commission, 2021). The EU sets the limits of its spending in the Multiannual Financial Framework (MFF), a budget allocation plan for the next years. It states the financial resources that will be allocated to each member state and their destination. In particular, the Commission limited the use of these funds to only the business areas considered as political priorities by the EU, such as digitization and sustainability. Nevertheless, it should be noted that, although this budget aims more at supporting the recovery rather than investing in private companies, the plan includes a large amount of loans and public grants earmarked for the development of some industries. Next Generation EU is expected to distribute approximately €338 billion in grants and over €385 billion in loans. Among the most prioritized industries will be: Energy and Utilities, with a focus on renewable energy and energy efficiency; Smart Mobility, with a focus on sustainable means of transport; Education, IT and Telecommunications, with particular attention to the digitalization of public administration, SMEs and schools. These funds represent an incredible opportunity to invest in these industries both for companies and financial institutions, including banks and investment funds, such as VC and CVC ones. According to CB Insights, in Europe, 66% of CVC investors are backed by corporations that operate in the aforementioned industries (CB Insights, 2021). These data are quite significant and highlight how the CVC business can also benefit from these measures. Thanks to the Next Generation EU plan, in the next future, many startups are expected to scale up in these sectors, so as to attract many large companies to enter these markets with massive corporate investments.

Other countries also did not stand by, but rapidly reacted to the pandemic through great economic manoeuvres and stimuli from their governments. For example, in the U.S., the Covid-19 health crisis pushed the stock market to drastically drop in March 2020. The S&P 500 fell 34% (not recovering to pre-pandemic highs until June 2020) and the unemployment rate rose to 14.8% between March and April (Investopedia, 2020). The federal government responded by enacting several policies to provide both a fiscal stimulus to the economy and relief to companies and individuals affected by the disaster. Firstly, the Federal Reserve took a series of expansive measures to increase the money supply. In March 2020, it cut the main U.S. benchmark interest rates, namely the federal funds rate and the discount rate[15], it restarted its Quantitative Easing program and it set up new lending programs to increase the liquidity of American banks. Secondly, similarly to the European

[15] The *federal funds rate* and the *federal discount rate* are two of the most important benchmark interest rates of the American banking system. The *federal funds rate* is the target interest rate set by the Federal Open Market Committee at which commercial banks borrow and lend their excess reserves to each other overnight. Instead, the *federal discount rate* is the interest rate set by the Federal Reserve on loans extended by the central bank to commercial banks.

response, the U.S. government implemented some monetary relief packages to compensate businesses and individuals who have been severely damaged by the pandemic. The most important is the so-called "American Rescue Plan Act" accomplished by president Biden in March 2021. It is worth $1.9 trillion and, beyond family-oriented welfare measures, such as cash payments of $1,400 for each individual with an annual income of less than $75,000, it allocated funds to support the higher education, public transit and emergency rental assistance (Investopedia, 2021). The education and healthcare industries have evidently been the most favoured by state subsidies and, in part, this has already been reflected in the CVC investments in 2020. Indeed, healthcare companies drove funding gains in the U.S. last year and, as mentioned in the previous paragraph, healthcare startups literally boomed. In 2020, CVC funding in American healthcare firms was around $12 billion, namely 30% of the total CVC funding in the country and almost twice that of 2019 (CB Insights, 2021). In addition, the government also moved towards investing in green transports and mobility. The "American Jobs Plan" allocated $174 billion in investments in these sectors, placing great stress on the production of domestic electric vehicles, from cars to greener school buses, and their relative accessories, like electric smart chargers (China Dialogue, 2021).

On the other side of the ocean, Asian countries, particularly China and South Korea, experienced faster economic recovery from the pandemic than the U.S. but put in place similar political commitment. For example, China managed to get out from the worst effects of the pandemic earlier and this allowed it to be one of the few countries to expand its economy last year. Even if the Chinese pace of growth is probably independent of the public intervention to recover from the crisis, the government also implemented a mix of monetary stimulus and expansionary fiscal policies. In particular, the latter was focused on boosting consumptions and make the economy restart. In March 2020, many local governments issued prepaid shopping vouchers to promote consumer spending, the Chinese government asked banks to extend the terms of business loans and landlords to reduce rents. Then, regional governments increased the limit on the maximum number of cars that can be owned in a certain location and introduced new subsidies for their purchase. To these measures of over $730 billion, it must be added another $506 billion package for tax cuts and funding to locally cope with the health emergency (Investopedia, 2021). These resources accelerated Beijing's transition to a greener policy and were mainly allocated to fund transports and infrastructures. In February 2020, China implemented a huge infrastructural plan of $600 billion for the construction of 60,000 kilometres of railway and 162 new airports by 2035. Despite the negative impact of denser air and rail traffic on the climate in the next future, the government is trying to compensate through stimulating private investments in renewable energy. Only last year, the purchase of components used to build solar panels showed an annual increase of more than 20% (China Dialogue, 2021). Instead, from a CVC funding perspective, similarly to other countries, investments in Internet and healthcare startups took the lead in 2020. Together, these two industries attracted half of the total CVC funding in China, since corporate investors employed $2.1 billion in Internet ventures and $3.7 billion in healthcare ones (CB Insights, 2020). As already mentioned, it could be primarily due to the severe effects of the health crisis and mobility restrictions all around the world that prompted consumers to take better care of their health and become more digital-friendly.

To conclude, 2020 represented a hard time for all nations and the role of governments was and will be crucial for a rapid recovery from the economic crisis. The countries most affected by the pandemic employed expansionary economic and fiscal policies, with which, on the one hand, they invested in their health system due to the emergency, and on the other hand, stimulated some key sectors for further sustainable economic development. Recent events also influenced the CVC industry, in which the most progressive companies even increased investments compared to the past, especially in the business areas most encouraged by public incentives, such as smart mobility, sustainability, green infrastructures and digitalization. The latter seems to be the industries of the future, towards which global innovation is headed and CVC will probably be oriented in the next years.

3.2 Implications for the quantitative analysis

This past year has been a time of radical changes and great difficulty for humanity. A random and unexpected event challenged our status quo and influenced many aspects of our social life. Governments found themselves facing an unprecedented emergency with a devastating impact on the global economy. In this unconventional scenario, the world of innovation and its national ecosystems have also been concerned. Similarly, in the CVC industry, investments, startup funding and companies have irremediably been affected by the pandemic and what it has entailed. This research aimed at elaborating on how some determinants of a startup ecosystem and socio-economic environment mark the CVC activity in a country. In particular, I focused on some specific factors, such as taxation, education and technology, investigating their impact on the number of companies that received an investment from a CVC vehicle and the total funding these firms benefited from in each country. The main purpose was to unveil the most relevant insights from the relationships between these variables and try to understand which elements some countries can work on to bridge the gap with global innovation leaders. However, the empirical analysis was carried out with data collected before the Covid-19 outbreak. Therefore, to make this study complete and meaningful at present, it is necessary to review previous results in light of post-pandemic data, if available, and discuss how these may influence the development of CVC across countries in the next years.

Before exploring the key statistics available for 2020 and examining their possible implications for the national CVC industries, it is useful to summarize the main outcomes of the previous analysis in Figure 14.

Proportionality between the variables			
		Model 1	***Model 2***
		CVC_firms	CVC_funding
Startup Quality	Scaleups_patents	+	+
	Founders_univ	+	+
Ecosystem factors	Corporate_tax	-	Not significant
	STEM_graduates	Not significant	+
	Patents_granted	-	+

Figure 14: Summary of the analysis results

As represented in Figure 14, both the number of patents granted to scaleups and the estimated number of founders that attended university showed a positive and significant relationship with the independent variables related to CVC. This implies that, being the startup quality positively associated with the CVC activity in a country, an improvement of the former could involve the development of the latter and vice versa. According to Crunchbase, in 2020, the number of patents granted to scaleups decreased compared to the previous year. While in 2019 around 1.3 patents were granted to each scaleup on average (in the 29 countries observed in the analysis), in 2020 this value fell by over 6% (Crunchbase, 2021). This indicates that the pandemic somehow slowed the technological growth of the national startup ecosystems. Since the Covid-19 outbreak severely restricted individuals' mobility, many workers, scholars and researchers were not allowed to be physically at their workplace, and so to frequently access to laboratories and technical equipment. This probably limited the studies and testing of new products and processes, as well as the application for patents. In addition, young companies may have been understandably reluctant to invest in new technologies in a scenario of high uncertainty. Among the countries with the best performance in terms of scaleups' patents density ratio in 2020 are Poland, Finland and Iceland. In this regard, it must be noted that these countries were less affected than others by the health crisis in Europe, with a number of infected people below the European average[16] (European Centre for Disease Prevention and Control, 2021). In contrast, the countries with the worst performance are Hungary and Greece. Before the crisis, their scaleups were already among the latest in terms of innovation, but it appears that the pandemic partially amplified the gap these countries have with the leading ones. In confirmation of it, other underperforming ecosystems, such as Estonia and Portugal, also recorded a decline in patents granted to scaleups of 41% and 24% respectively (Crunchbase, 2021).

In this sense, the annual marginal number of scaleups[17] also dropped during the crisis. Between 2018 and 2019, each observed country "produced" an average of 235 new scaleups, with a rise of 46% year-on-year;

[16] Total Covid-19 cases as a percentage of the population in Poland, Iceland and Finland are 7.5%, 1.8% and 1.6% respectively. The average of European countries is 7.6%.
[17] *Annual marginal number of scaleups*: annual increase of the total number of scaleups within a country.

instead, between 2019 and 2020, new scaleups have been 250 on average, with a rise of only 38% (Crunchbase, 2021). It means that the growth rate of the number of scaleups decreased in 2020, highlighting that the pandemic partially suppressed the birth of some entrepreneurial initiatives due to an unfavourable external outlook. Such an assumption is also supported by the level of Total early-stage Entrepreneurial Activity[18] (TEA) reported last year. According to the Global Entrepreneurship Monitor (GEM), in 43% of the economies participating in the research, TEA fell significantly in 2020 compared to the previous year, and in 26% of the economies, it fell by more than a quarter. Remarkably, the lowest levels of TEA are recorded in Europe and North America, whose 75% of the economies have less than one in 10 adults starting or running a new business (GEM, 2021). Therefore, in the short term, statistics display that the pandemic negatively influenced entrepreneurship and the rise of new companies.

Conversely, education exhibited significant growth during 2020. From the perspective of this analysis, the estimated number of founders attending university increased by 36% between 2019 and 2020 in the observed countries. In particular, it is interesting that the median growth rate year-on-year is 27%, meaning that half of the observed countries grew with a rate higher than it (Crunchbase, 2020). Such an increase underlines that, despite the crisis, founders care more and more about their academic preparation and, as Figure 14 shows, this has a positive impact on the CVC activity across countries. Among the best performing ecosystems, we can mention Sweden, as well as Poland and Finland, for which, similarly to the previous logic, a lower incidence of the pandemic may have benefited them compared to others. Nevertheless, it should be specified that all 29 observed countries reported progress in the founders' level of education and that, therefore, the health emergency did not much affect this aspect. Indeed, the extraordinary development of several digital e-learning platforms and online tools due to remote work and study opened up a digital revolution of this industry in which also schools and universities are rapidly taking part. To perceive the magnitude of this phenomenon, EdTech[19] companies raised approximately $1.87 billion globally in 2019, while they raised $3.84 billion in 2020, more than twice the previous year (Crunchbase, 2021). Digitalization would enable much more students to access better quality learning materials and workers to be more qualified at a lower cost. This trend is extremely positive for the development of CVC across countries and may allow backward countries to close the gap to the most innovative ones.

As concerns taxation, the corporate tax rate in almost all the observed countries remained unchanged. Only Belgium and Greece adjusted their fiscal policy under this aspect in 2020 (OECD, 2020). However, in both cases, the corporate tax rate was slightly reduced compared to the previous year and it looks incautious to envisage substantial improvements in their related CVC industries. As history highlighted in Chapter 1, CVC has been fostered by radical expansionary fiscal policies enacted by the government to favour investments. In the current situation, these manoeuvres were mainly aimed at reducing the tax burden on the numerous

[18] *TEA*: percentage of adults aged 18–64 actively engaged in starting or running a new business.
[19] *EdTech*: Education Technology

companies in difficulty during the economic crisis, even if it does not cancel the potential positive impact on corporate investments.

To sum up, the socioeconomic crisis caused by the pandemic had different effects on the CVC industry. On the one hand, CVC-backed funding increased, soaring to a new all-time high of $73.1 billion on a global level. It could have been promoted, in part, by the higher demand of investments to face the health emergency, the need to work and study from remote locations and the higher sensibility towards sustainability; in part, by the better startup quality due to more qualified workers and the several opportunities offered by the need to digitalize some traditional industries, like the education one. On the other hand, the coronavirus outbreak implied a slowdown of R&D activities (except for the pharmaceutical industry) and limited startups in generating innovations of products and processes. Furthermore, the pandemic hindered entrepreneurship and broke down businesses' trust to invest due to a situation of great uncertainty. These are the main implications that such unpredictable events had on CVC consistently with the variables considered in the empirical analysis. Unfortunately, the still scarce availability of data about 2020 made it impossible to use the regression model to predict the future and compare the estimated values with the real ones. Updated information about some independent variables still misses and it did not enable to re-apply the model in the post-pandemic scenario. However, this last Chapter tried to return an overview of how recent happenings affected CVC across countries and critically reported the most relevant statistics, highlighting their possible logic and intriguing connections.

Conclusion

Corporate Venture Capital is an investment practice used by large corporations to partner strategically with rising innovative companies in exchange for monetary resources, management expertise and their commercial network. While, in the past, large companies dealt with innovation primarily through expensive R&D divisions, in recent decades, they are more likely to access technology by investing, directly or indirectly, in disruptive startups that are about to rapidly grow and scale their market. However, the state of development of the CVC industry differs from country to country. In particular, the U.S., China, Israel and the U.K. hold a leadership position within the global innovation landscape. Their companies invest a lot of resources in CVC every year, spurring their startup ecosystem to grow and thrive. In contrast, other countries, such as Italy, have only recently embarked on the path towards Open Innovation and are striving to bridge the gap with the leading ones. This research attempted to quantitatively examine those factors that let some national ecosystems have a privileged role in the global innovation market and to draw relevant insights on which aspects backword countries should leverage to mature their CVC industry. In particular, regardless of cultural peculiarities, it focused on the impact that startup quality and some socioeconomic factors (taxation, education and technology) had on national CVC activity.

Empirical analysis showed that especially startup quality and technology have a significant relationship with both the number of firms that received an investment from a CVC vehicle and the CVC-backed funding in a country. The former proved a positive association with the two independent variables, clarifying that founders' education and the number of patents granted to scaleups are very important to induce CVC investors to finance a startup. Teams composed of members with a long academic path may appear more prepared and reliable in the eyes of the investor, as well as projects that have already developed an innovative product or process. Nevertheless, unexpectedly, the number of patents granted in a country resulted to be negatively correlated with the number of CVC-backed firms, but positively with CVC-backed funding. An explanation could be that a great portion of patents is issued by large companies, particularly those that frequently invest in both internal and external innovation. Therefore, countries with high CVC-backed funding level tend to report also high patent granting, but this is not necessarily related to a rich ecosystem in terms of the number of CVC-backed firms (as a percentage of the population). Finally, even taxation and (STEM) education exhibited to be significant variables for the state of development of CVC across countries. Historically, taxation is negatively associated with CVC investments and my analysis confirmed it. Countries that enjoy a below-average corporate tax rate also tend to have more businesses (per capita) supported by CVC funds. Instead, countries with a higher percentage of graduates in scientific subjects attract more CVC investments. Literature also underlines that investors tend to believe more in human capital-intensive businesses, and so, in ecosystems with a more scientifically qualified workforce.

In the last chapter, I reported the available updated information about the global CVC industry. I outlined how the Covid-19 pandemic affected corporate investments in startups and how the political manoeuvres to cope

with the crisis let countries boost innovation and invest in education and technology. Despite the hard time signed by the epidemic, global CVC funding recorded an all-time high of $73.1 billion and the average deal size increased to about $22 million per deal. Israel, U.S.A. and Singapore are still among the countries with the highest level of CVC-backed funding as a percentage of GDP, but China and South Korea led the exorbitant Asian CVC growth in 2020. Indeed, the latter benefited from a faster recovery from the health crisis and succeeded in investing in strategic industries, such as healthcare and Artificial Intelligence. Furthermore, comparing the last available statistics with the previous empirical analysis (made with a dataset related to 2019), I highlighted the most relevant implications for the analysis' results in light of the 2020 crisis. In particular, the reduction of the scaleups' patents density ratio may indicate the young companies' distrust in investing in technology because of the unfavourable external outlook, involving a technological slowdown in many countries. On the other side, improving founders' educational level could positively affect the CVC activity. This may be a once-in-a-lifetime opportunity for some national ecosystems to partially close the gap with global innovation leaders, especially for those, such as Italy, whose startup teams have shown lower academic preparation than the average of the countries observed.

In conclusion, I would like to underline that, as mentioned in Chapter 1, each country has its specificities in terms of innovation and it is often related to mere cultural aspects. National socio-economic culture, as well as national history, sometimes could have favoured the creation of an entrepreneurial ecosystem or a more or less disposed approach to investments in technology and innovation. These variables have not been included in the previous analysis, thus limiting the applicability of our outcomes, but opening the discussion to broader scenarios for further research. Moreover, it must be noted that CVC has a deeper tradition in some countries rather than in others, such as in the Anglo-Saxons and Japan, whose large companies began investing in Silicon Valley as early as the late 1980s. Although it undoubtedly facilitated them to gain a leadership position in the global CVC industry, European and Asian countries are slightly, but significantly, reducing the gap. According to CB Insights, between 2016 and 2020, European and Asian companies stole approximately 9% of global CVC-backed deals from American companies, so that 40% of such deals are now closed in Asia (CB Insights, 2021). This data points out how the CVC industry is changing and highlights the new entry into this market of numerous companies seeking to seize its countless opportunities. Established firms are increasingly adapting their corporate strategy to the flourishing and dynamic startup ecosystem, where innovation occurs daily and new businesses continue to grow in every sector, driven by technological advances and fuelled by the availability of funds.

At last, I reiterate the main objective of this study. It was certainly not to find the universal formula for a country to excel in generating CVC investments, but to (re)affirm that some of the factors on which national governments can partially intervene (in this case, taxation, education and technology) are closely related with the creation of a network economy. I strongly believe in this concept, namely the possibility to frame interactive business clusters (or ecosystems) on a national level in which cooperation between companies allows to compensate for the lack of resources, stimulating knowledge exchange, and so innovation.

Appendix

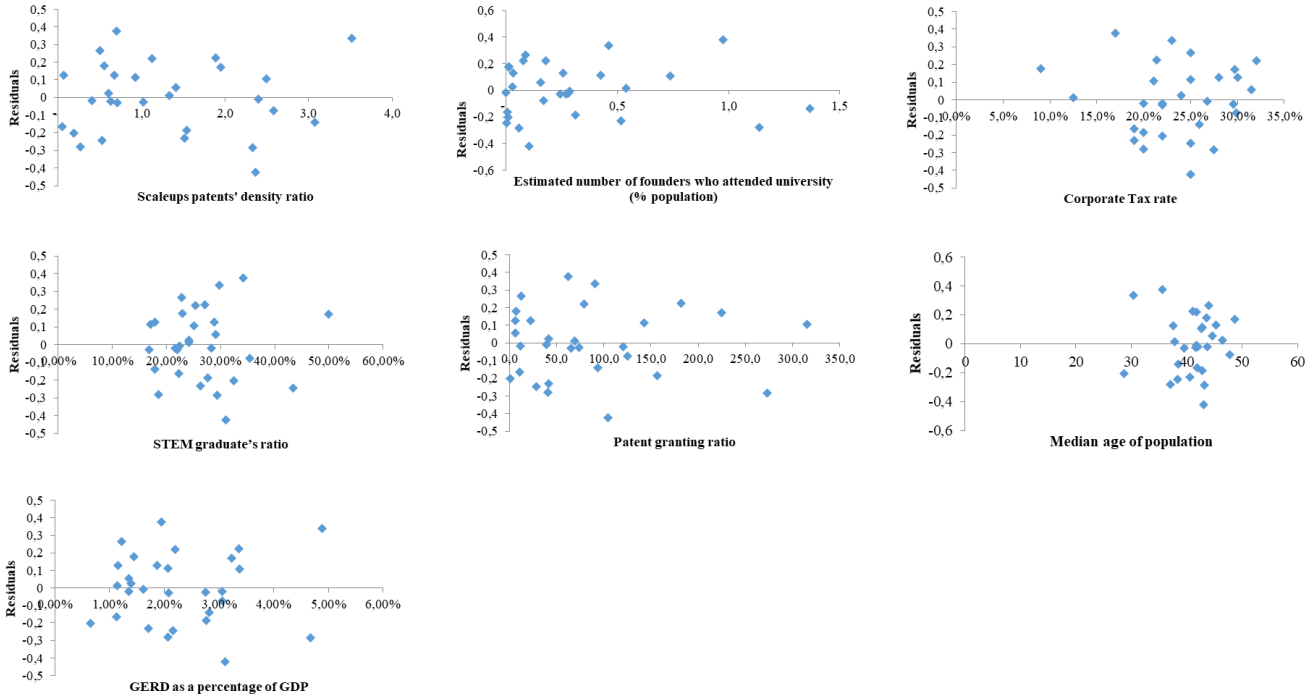

Figure A.1: Residual plot – Model 1

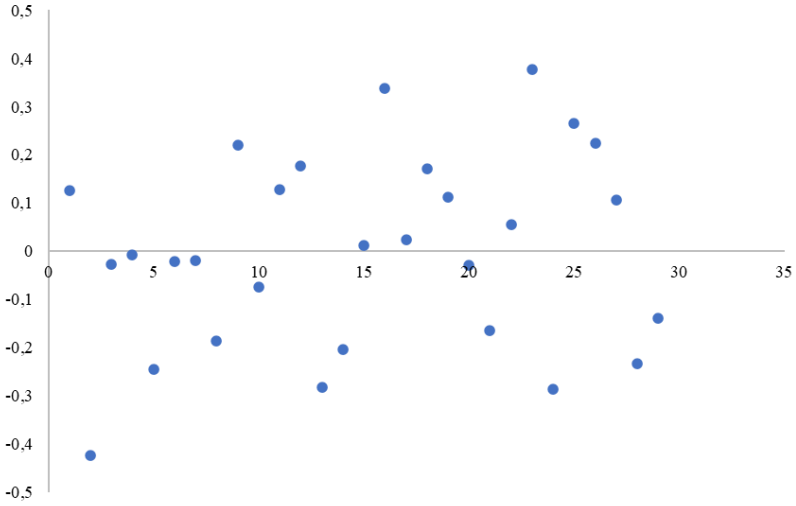

Figure A.2: Time Residual plot – Model 1

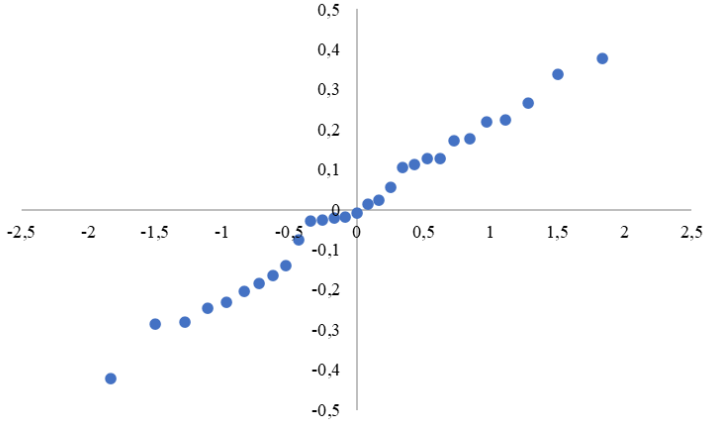

Figure A.3: Normality Q-Q plot – Model 1

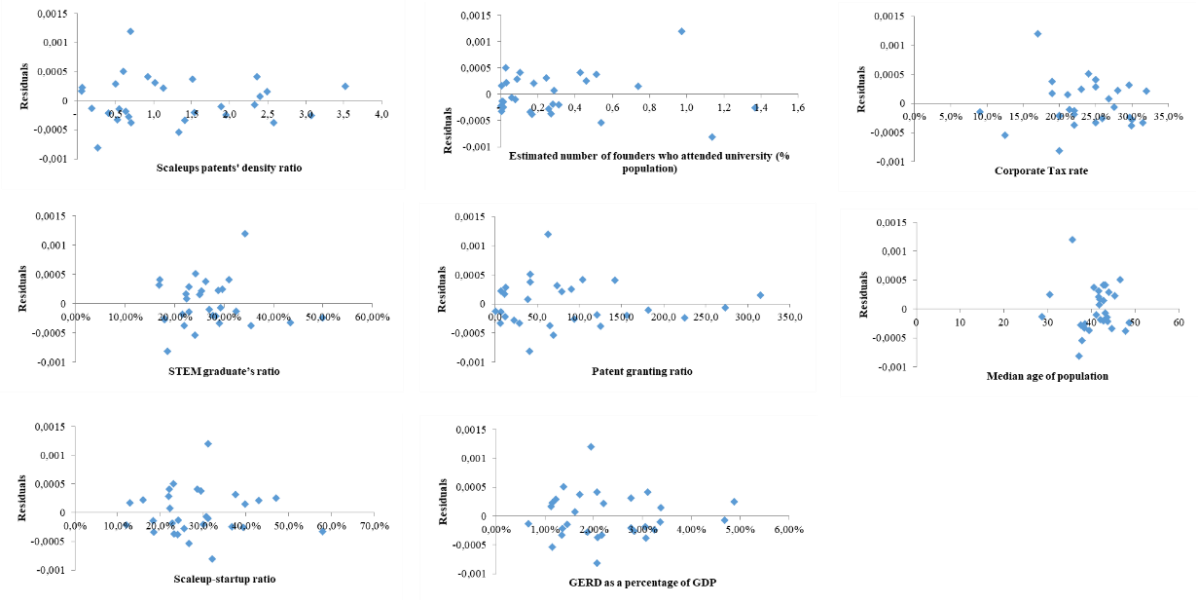

Figure A.4: Residual plot – Model 2

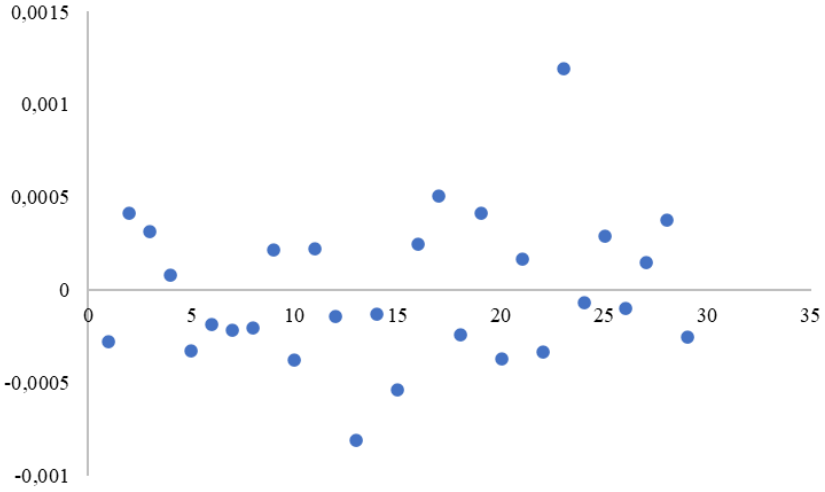

Figure A.5: Time Residual plot – Model 2

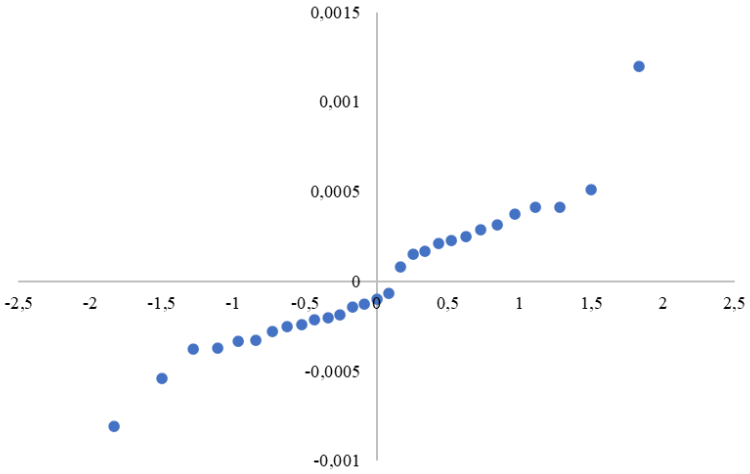

Figure A.6: Normality Q-Q plot – Model 2

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Summary

Literature review

Innovation is the common practice that an organization uses to reshape, update, or reconvert its products, systems or processes creating value or redistributing it. Such an approach enables companies to keep up with the times by employing their resources to increase the technological rate of their products or services and enhance the intrinsic value delivered to customers. Each country has its specificities in terms of innovation. Businesses tend to specialize, and such specificities are often translated into consistent "industry clusters" formed by companies in a defined area. Clusters are a geographical concentration of specialized suppliers, service providers, organizations, commercial unions and interconnected enterprises. Its actors both compete against each other and collaborate in their industry. In clusters, companies also interact with education institutions, such as universities, that contribute to enhancing new knowledge and technology. However, as some famous entrepreneurial stories have shown, innovation does not only depend on the cluster's elements but mainly on relations between them. An innovation ecosystem has a dynamic nature and an ever-changing structure. For example, in the hospitality sector, Airbnb established a business model that engages travellers to be the primary house renters, involving them in its business ecosystem. In this way, the company created a virtual network in which customers are renters and renters are customers, exploiting the interaction between its stakeholders. This mentality, open to the interconnection of the company with external subjects and organizations, lays the foundations of the so-called "Open Innovation", namely the ability of corporations to look over the fence and seeking for innovation from the outside.

Open Innovation indicates a new R&D and investment mindset towards innovation that goes beyond traditional research within the boundaries of the company but encourages the discovery of new products, technologies and business models in the external environment. American professor Henry Chesbrough is deemed as "the father of Open Innovation". He stated the concept that "firms should use external ideas to advance their technology", involving external subjects in their value creation process (Chesbrough, 2003). Particularly, since the 1980s, large corporations have started competing with new fast-growing startups that were ready to find new ways to use knowledge and technology, threatening incumbents' market-leading position and making their products and services obsolete. This new dynamic and evolving habitat pushed scholars, but also managers, to understand that innovation can actually be generated also by open approaches. They agreed to tear down the walls of their company and stimulate the entry of external flows. Other scholars also studied the interaction between companies and their surrounding ecosystem. For example, D. West et all. examined Open Innovation ecosystems in the software and the food industries, showing how small firms flighted and succeeded thanks to the creation of an ecosystem that shares knowledge, encourages individuals' growth, and embeds trust among participants. In fact, value creation increases with each additional actor in the ecosystem, nurturing its potential. A common practice that companies, especially medium-large sized ones,

use to meet these needs is Corporate Venture Capital, through which they participate in the capital of disruptive startups to boost their capacity to innovate and obtain competitive advantages on the market.

Corporate venture capital (CVC) is the investment of corporate funds, directly in small but innovative or specialist firms. A large corporation typically provides monetary resources (usually in exchange for an equity stake) along with management and marketing expertise, letting the small company scale up rapidly. Differently from traditional Venture Capital (VC), CVC is not an investment into startups made by an independent external fund, managed by a third party, even if the investment vehicle is funded by a single company. In CVC, the invested funds are provided by a non-specialized investment company, whose core business is usually different from finance. The investing corporate is frequently a well-established company with structured operations and processes, and rigid bureaucratic rules placed to manage both internal and external relationships. Its decision-making process is slow and involves several middle managers. On the other hand, startups are characterized by the complete absence of any structure or consolidated procedures. They have very few employees, a lean and simple business model, few products or services, and neither a reputation to defend nor a binding relationship with institutions. An external venture could provide the investing company with the occasion to build new and different competencies, which can even make current capabilities obsolete. The only concern is that the potential startup's contribution in terms of knowledge can be crushed by the braking impulse of a consolidated mindset and modus operandi within the company. This is the reason why housing such capabilities in a separate legal entity, like a CVC fund or division, can isolate them from internal undermining efforts.

Corporates may have several motivations to partner with or invest in external ventures. First of all, dealing with startups allows them to explore and study the technological progress of products and services in a very cost and time-efficient manner. Moreover, partnerships enable corporates to become aware of new potentially disruptive technologies and strengthen their market position thanks to startups that either improve the corporates' existing products (or services) or bring substitute solutions for the same market need. Furthermore, startups can update the corporate's managerial processes giving insights to managers about new ways of working. As well, startups hope a corporate partner is willing to help accelerate their growth and upgrade their reputation, so as to send a positive signal to both investors and customers. According to McKinsey Digital, receiving financing is one of the key motives for startups to engage in partnerships. Besides, they often want to become a future customer of the corporate or to receive useful customer insights from it.

History of Corporate Venture Capital

The origin of CVC can be traced back to the first decades of the 20th century in the U.S.A. when the first corporate giants started up their business. In 1914, Pierre S. du Pont, president of chemical and plastics manufacturer DuPont, invested in a young private automobile venture known as General Motors. The shares he bought just before World War I increased their value seven-fold during the conflict since wartime needs led the demand for automobiles to grow exponentially. DuPont's board of directors invested $25 million in the car manufacturer, hoping that the cash injection would have speeded its development, and consequently

would have also expanded the demand for the parent company's products (like artificial leather, plastics, and paints). DuPont's blended approach of combining both commercial and financial strategies behind the acquisition definitely worked and became an example for businesses willing to create more formal CVC units.

This mid-century period was characterised by American big firms' race for diversification. It was driven by the strict anti-trust enforcement by the government, to avoid large companies exercising too much control in their established market and force them to look to new profitable opportunities in other markets. Thus, for companies willing to invest, corporate venturing became a viable solution to extend the firm's reach into a variety of different sectors and industries. The two prevailing CVC models of investment were the internal and the external model. The former implied that companies invested in their employee ventures or tried to spin out their technologies in new companies. A classic case of this CVC type is 3M, whose CVC internal program produced the well-known Post-it notes. Instead, as regards the external model, corporates simply invested in external startups that were aligned to their needs or strategic objectives. An emblematic case of the first wave was that of Exxon Enterprises, a CVC vehicle founded in 1964 to exploit underutilized technologies from Exxon's corporate labs, as DuPont did with General Motors.

Actually, the first wave of CVC definitively declined in the mid-1970s. The oil shocks and the stagflation crisis caused the economic recession, comporting also the IPO market to drop and the American industries' availability of cash to evaporate. Anti-trust regulation eased and the frantic push to diversification gradually stopped.

In the late 1970s, the crucial event that changed the history of CVC was the release of the first personal computers. In the second wave technology became closer to consumers, so access to it was a top priority for every company. The 1980s were the period in which subsequent innovations in the Information Technology (IT) industry created the myth of "Silicon Valley". In this period, CVC was reinvigorated by some favourable business conditions. In 1978, and then again in 1980, the U.S. government significantly reduced the capital gain tax and incentivized private investments. CB Insights estimates that resources dedicated to VC grew from $2.5 billion in 1977 to $6.7 billion in 1982, of which 34% on average came from corporate investors (CB Insights, 2017). Companies employed different models in pursuing CVC programs during this period, sometimes mixing more than one strategy. Some corporations preferred to have an indirect approach, addressing their resources to independent VC funds. Others provided capital to create a specific VC fund run by an external fund manager. This type of vehicle was known as a "client-based fund". Sometimes, companies even pooled their strengths to build together client-based funds, as AT&T, Viacom and 3M did with Edelson Technology Partners in 1984. Corporates could also either establish traditional internally-managed CVC funds or made direct investments in external startups or finance the ideas generated by their employees.

The second wave was also the first time in which foreign companies, especially from Japan and Europe, instituted CVC programs. In 1989, Japanese corporations invested in 60 U.S.-based firms and provided 12% of total funds raised in CVC programs by U.S.-based companies. In addition, in 1990, more than 130 European companies invested directly in European VC funds, while internally-managed CVC vehicles were still rare.

However, the extreme rapidity with which many companies attempted to enter the high-tech industry or tried to improve their core products was the cause of failure for their CVC programs. Often large corporations excessively rushed the invested ventures to find innovative solutions for their needs, but this just as often led many startups not to have enough time to mature and their respective corporates to abandon them too early.

While the personal computer was the leading technology of the second wave of CVC, the Internet was definitely the driving force behind the third wave, whose scope and size far exceeded the previous times. According to CB Insights, over 20 new CVC units made their first investment in 2000, and about 100 CVCs did it between 1995 and 2001. This significant growth in CVC activity was in part built up on hype and enthusiasm for what was seen as "the market of the decade", namely the Internet and all products and services related to it. Nevertheless, along with rising tech companies, also pharmaceutical companies, media and advertising firms, like Reuters or Reed Elsevier, arose as the major investors, starting millionaire CVC programs. In addition, the third wave was characterized by a tight relationship between corporations and independent VCs. The main reason for it was that the VC market was overcrowded, especially in the U.S., therefore, partnerships with corporations were deemed as a great competitive advantage for VC funds (Gompers and Lerner, 2001). This kind of cooperation often went beyond mere financial logic, and sometimes had the goal to stimulate the demand in specific markets or to defend the demand for existing products by nurturing the ecosystem around them. A paradigmatic example is the Intel Capital CVC program in the 1990s, remembered as one of the most successful in history. Its purpose was not only to fill the gap in Intel's technologies but also to power the ecosystem of products that orbited the company. The strategy was to invest in multiple startups competing in the same market in order to stimulate emerging technologies and market sectors rather than single companies' success. The result was that, in 2000, Intel Capital reported profits of $3.7 billion, about one-third of the company's total profits (CB Insights, 2017). Unfortunately, the golden wave of CVC ended in the early 2000s when the dot-com bubble produced a massive drop in the stock market, enormous losses in venture-related units and many companies closed their CVC units (CB Insights, 2017).

In the years following the dot-com bubble, CVC investments halved year after year until 2003, and then slightly resumed growth until the 2008 crisis (Figure 2).

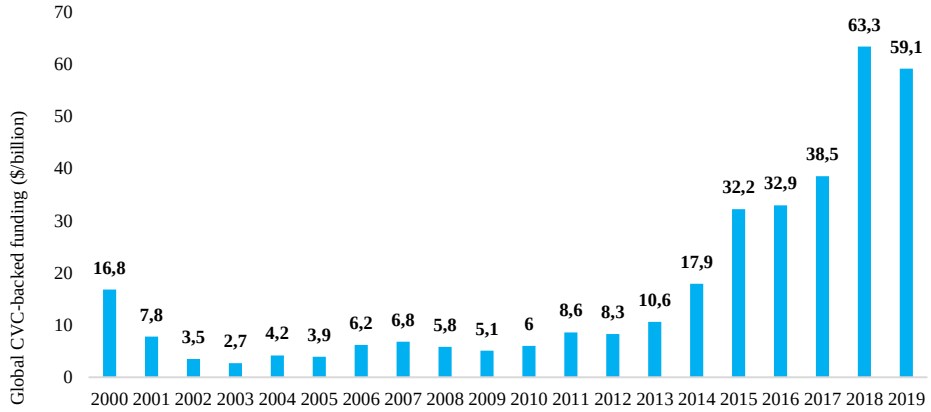

Figure 2: Annual CVC global funding trend, 2000-2019, CB Insights

For CVC investments to recover to the level of 2000, it was necessary to wait until 2014. Indeed, between 2013 and 2019, we witnessed an exorbitant 36% annual growth in CVC funding to reach the record level of $63.3 billion in 2018. CVC's incredible resurgence around this time was due to the combined rise of social media and smartphones. Microsoft's investment in Facebook in 2007 and the launch of Google Ventures in 2008 also played an important role.

Apart from the size of investments and the innovations that drove the two waves, there are some structural differences between the dot-com era and the tech boom of the 2010s. In recent years, many of the largest CVC investors are not emerging units of companies that are facing the CVC market for the first time, but rather the CVC arms of great high-tech companies that survived the last recession and are continuing to invest, such as Intel Capital and Cisco Investments. This makes them very reactive to external stimuli and ready to capitalize on the current opportunities. Contrariwise, in the dot-com era, CVC was establishing as "the modern way" to invest outside the corporate's borders, and many of the companies that overlooked it did it for the first time.

In conclusion, recent CVC trends communicate how it is, in a sense, getting back to its origins, receiving a strong boost from the technology industry that has become predominant in the current decades. Some high-tech giants have just taken the lead. A few years ago, they were growing startups like many others, while now they are known as "unicorns". The importance of the high-tech sector in CVC's initiatives in the 2010s has also allowed many Asian companies to establish themselves as protagonists on the global scene. The CVC market in Asia produced nearly $20 billion in CVC investments and 351 deals in 2018, of which just over half came from China (CB Insights, 2020).

Global context and research question

As discussed in the first paragraph, clusters can be assimilated into business ecosystems to some extent. The cluster is a small version of a business ecosystem, within which there are very similar economic, social and cultural conditions, which undoubtedly influence its organizations' activities. By the way, countries have these characteristics too and can also be considered like business ecosystems, but on a larger scale.

In Figure 5 and Figure 6, I represented the interesting link between scaleups[20] and the CVC activity in 29 countries in 2019.

[20] *Scaleups*: startups with more than $1 million funding raised (before December 31, 2019)

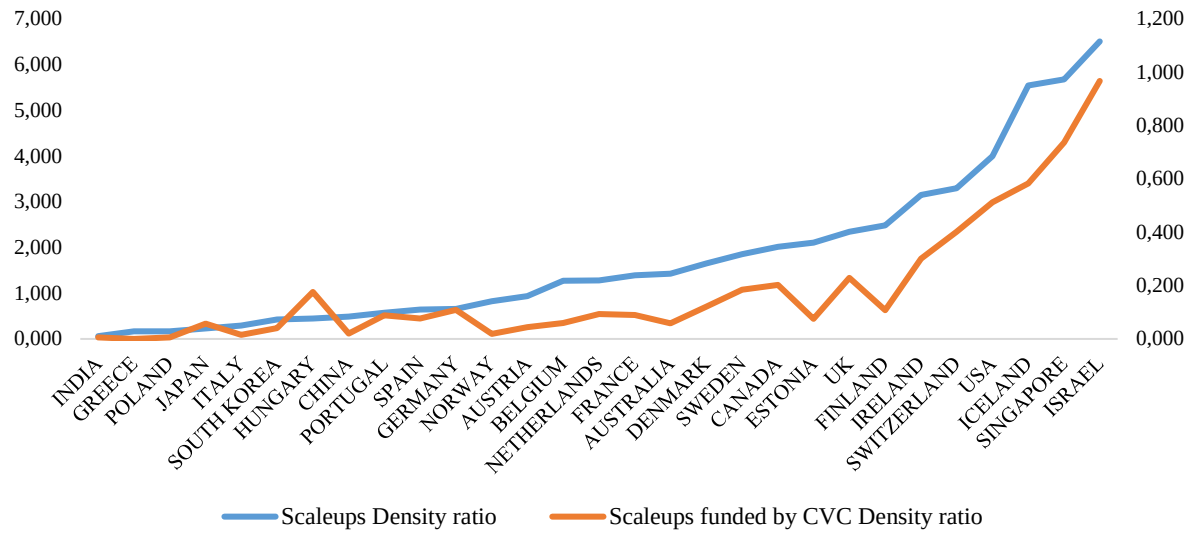

Figure 5: Scaleups density ratio[21] vs. Scaleups funded by CVC density ratio, 2019, Crunchbase

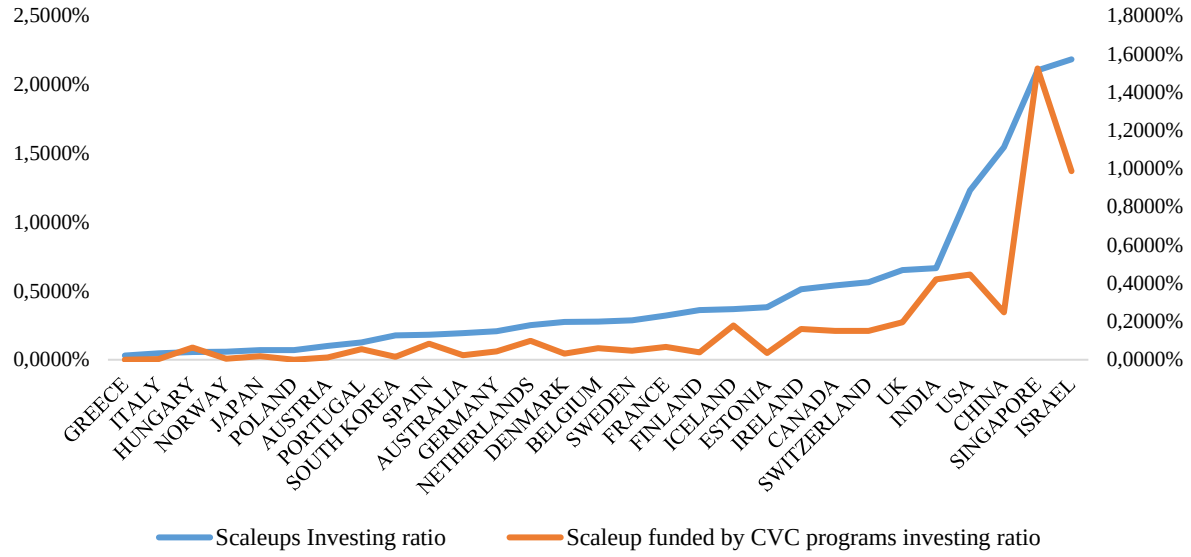

Figure 6: Scaleups investing ratio[22] vs. Scaleups funded by CVC investing ratio, 2019, Crunchbase

As it can be noticed, in both cases the performance of a country's startup ecosystem is overall in line with the performance of its CVC activity. The trends of the scaleups density ratio and the scaleups investing ratio remain almost the same compared to the corresponding ones of the scaleups funded by a CVC investor. Thus, analysing a country's state of progress in the context of CVC reveals some information about the ability of the country to cultivate new enterprises, products and business models, that are elements of innovation and technology.

This research attempts to find a connection between countries' CVC industry and their state of innovation. By "state of innovation", I mean the level of development of national innovation ecosystems concerning the

[21] *Scaleups density ratio*: number of scaleups per 100,000 inhabitants within a country
[22] *Scaleups investing ratio*: capital raised by scaleups as a percentage of thousands of dollars of GDP

relationships between companies, startups, and those factors that favour their technological development, such as taxation, education or access to technology. Therefore, the goal is to fill this analytical gap in the economic literature that associates the state of development of countries' CVC activity with the state of development of their startup and socioeconomic ecosystems. The work aims to answer the following questions: "Apart from cultural issues, are differences across countries in terms of CVC activity due to the quality of their startups and some ecosystem factors, such as taxation, education technology? What is the relationship between these variables? How could a country leverage these factors to develop its CVC industry and bridge the gap with the global innovation leaders?".

To find out the answer, I decided to analyse a set of variables that could significantly affect a country's path towards innovation and specifically determine the trust of large companies in investing in that national innovative ecosystem. In particular, I identified some dependent variables affecting the number of firms backed by CVC programs and the total funding from CVC investors within the country. On the other hand, independent variables refer mainly to:

- Quality of startups operating in the country
- Social and economic ecosystem factors

Here are the hypotheses I want to investigate:

H1. CVC activity is positively related to the quality of startups.

H2. CVC activity is positively related to some socioeconomic factors, such as education and technology, and negatively related to the level of taxation.

Data, variables and methodology

To examine the impact of the quality of startups and other ecosystem factors on the CVC activity across countries, I created a dataset where I included a wide range of variables on different themes. The most of data have been collected from authoritative databases that are available online on the official websites of national and international institutions, such as the United Nations Educational, Scientific and Cultural Organization (UNESCO), the Organization for Economic Co-operation and Development (OECD), the World Bank and the World Intellectual Property Organization (WIPO). Other data come from some specific sectoral organizations, such as the Global Entrepreneurship Monitor (GEM) and the Global Innovation Index (GII) platform. Then, a portion of data was also taken from private well-known databases, like Crunchbase, Statista and CB Insights. All data refer to the year 2019, except for the variables "STEMs graduates' ratio" and "GERD as a percentage of GDP", whose values are an average between those of 2017, 2018 and 2019. The decision to use data relating to or before 2019 originates from two different reasons. The first pertains to the availability of data since those after 2019 are not available for all the observed variables yet. The second reason concerns the accountability of the possible results of the analysis. 2020 and 2021 have been marked by the tragic economic crisis due to the Covid-19 outbreak and governments' social restrictions to avoid the virus spread. Therefore, to prevent

my analysis from driving to conclusions that are decisively influenced by these recent events, I preferred to carry out a study based on a "standard" situation (such as the one before the pandemic), from which more truthful results and more significant implications may emerge. Then, I performed my analysis on 29 countries (observations), of which 20 are European and 9 are non-European.

In Figure 8, there is a summary of all variables employed in the analysis, while, in Figure 9, variables' descriptive statistics can be found.

Type	Abbreviation	Noun	Year	Description	Source Database
Dependent	CVC_firms	CVC-backed firms density ratio	2019	Number of firms in which CVC programs have invested (per 100,000 inhabitants)	*Crunchbase - World Bank*
Dependent	CVC_funding	CVC-backed funding ratio	2019	Annual funding to firms by CVC investors (as a percentage of GDP)	*CB Insights - World Bank*
Independent	Scaleups_patents	Scaleups' patents density ratio	2019	Number of patents granted per scaleup	*Crunchbase*
Independent	Founders_univ	Estimated number of founders who attended university (% population)	2019	Total number of scaleups' founders who attended university (per 100,000 inhabitants)	*Crunchbase - World Bank*
Independent	Corporate_tax	Corporate Tax rate	2019	Corporate tax rate on profits	*OECD*
Independent	STEM_graduates	Percentage of STEM graduates	average 2017-2019	Percentage of total graduates in a country that studied STEM subjects	*UNESCO*
Independent	Patents_granted	Patent granting ratio	2019	Number of patents granted in a country (per 100,000 inhabitants)	*WIPO - World Bank*
Control	Pop_Median_age	Median age of population	2019	Age that divides a population into two numerically equally sized groups	*Wikipedia*
Control	GERD	GERD as a percentage of GDP	average 2017-2019	Gross domestic expenditure on R&D (GERD) (as a percentage of GDP)	*UNESCO*
Control	Scaleups_startups	Scaleups-startups ratio	2019	Percentage of scaleups on the total number of startups within a country	*Crunchbase*

Figure 8: Summary of variables

Variables	Observations	Min	Max	Mean	Median	S.D.
CVC-backed firms density ratio	29	0,00	1,86	0,56	0,39	0,51
CVC-backed funding ratio	29	0,0%	0,4%	0,1%	0,0%	0,1%
Scaleups' patents density ratio	29	0,05	3,52	1,29	1,02	0,96
Estimated number of founders who attended university (% pop.)	29	0,00	1,37	0,30	0,18	0,36
Corporate Tax rate	29	9,0%	32,0%	23,5%	24,0%	5,4%
Percentage of STEM graduates	29	16,8%	50,0%	26,7%	25,4%	7,5%
Patent granting ratio	29	0,79	314,87	84,40	64,98	81,74
Median age of population	29	28,70	48,60	41,13	41,90	4,45
GERD as a percentage of GDP	29	0,7%	4,9%	2,3%	2,1%	1,0%
Scaleups-startups ratio	29	12,0%	57,9%	28,6%	26,8%	10,3%

Figure 9: Descriptive statistics

For my analysis, I used the multiple linear regression model to apply panel data and analyse the relationship between CVC activity across countries, startup quality and socioeconomic ecosystem factors. I chose this type of quantitative methodology mainly because all variables (both dependent and independent) are continuous. Furthermore, the main objective of this study is not a precise forecast, but it is to understand if the independent variables can somehow explain the dependent variables, and so to understand on which factors countries, such as the U.S., Israel, or China, should leverage to be positioned as the global innovation leaders.

Multiple linear regression requires some conditions to be met. First, we need to check the multicollinearity among the variables. Even though I constructed two different linear regression models for the two dependent variables, we can test for multicollinearity of both through the correlation matrix in Figure 10.

	CVC firms	CVC funding	Scaleups patents	Founders univ	Corporate tax	STEM graduates	Patents granted	Pop Median age	GERD	Scaleups startups
CVC_firms	1									
CVC_funding	0,65103	1								
Scaleups_patents	0,45350	0,57796	1							
Founders_univ	0,72262	0,39671	0,28601	1						
Corporate_tax	-0,49895	-0,05995	0,23405	-0,19770	1					
STEM_graduates	-0,13349	0,21872	0,15162	-0,33944	0,14873	1				
Patents_granted	0,16381	0,14037	0,58016	0,13463	0,13051	0,19994	1			
Pop_Median_age	-0,43742	-0,55384	0,01096	-0,36958	0,27830	0,12135	0,25332	1		
GERD	0,30366	0,52712	0,73812	0,15025	0,23704	0,18919	0,75874	0,00224	1	
Scaleups_startups	0,30130	0,45746	0,43017	0,30386	0,20230	0,31906	0,35984	-0,32781	0,55249	1

Figure 10: Correlation matrix

From the matrix, there is no sign of multicollinearity. The only independent variable with higher correlation coefficients than others is "GERD as a percentage of GDP". In particular, it appears to be slightly correlated with "Scaleups' patents density ratio" and "Patent granting ratio". However, "GERD" is only a control variable and has the sole purpose of isolating the effect that differences in R&D expenditure across countries could have on the final results. In addition, keeping this variable as moderator, the regression model exhibits a higher R-squared, a lower standard error and independent variables show higher significance. Thus, I have decided to use it in the model anyway.

Multiple linear regression must also meet other four conditions: homoscedasticity, independence, normality and linearity. In both models, the random errors comply with the former three conditions. This assumption is supported by the Residual plots, the Time Residual plots and the Q-Q plots available in the Appendix, from Figure A.1 to A.6.

In conclusion, I processed the collected data with STATA software version 16 (StataCorp LP, USA).

Empirical results

For Model 1, I estimated the following econometric model:

$$CVC\_firms_i = \alpha + \beta_1 Scaleups\_patents_i + \beta_2 Founders\_univ_i + \beta_3 Corporate\_tax_i + \beta_4 STEM\_graduates_i + \beta_5 Patents\_granted_i + \beta_6 Pop\_Median\_age_i + \beta_7 GERD_i + \varepsilon$$

where i indicates a country

Figure 11 presents the results returned by the analysis of the "CVC-backed firms density ratio" dependent variable.

Goodness of Fit	
Number of Observations	29
F (7, 21)	16.1117
Prob > F	0.0000
R-squared	0.8430
Adjusted R-squared	0.7907
Standard Errors	0.2320

Variables	β	Standard Errors	P-value
Independent Variables	1.2328	0.5785	0.0451
Scaleups_patents	0.2025	0.0722	0.0106
Founders_univ	0.7273	0.1577	0.0002
Corporate_tax	-4.7035	0.9032	0.0000
STEM_graduates	0.4555	0.6545	0.4941
Patents_granted	-0.0014	0.0009	0.1434
Control Variables			
Pop_Median_age	-0.0072	0.0123	0.5641
GERD	10.9529	8.3799	0.2053
α	1.2328	0.5785	2.1308

$p < 0.05$

Figure 11: Parameters of Estimation – Model 1

The regression output highlights that the number of firms in which CVC players invested is strongly related to most of the factors considered in this study. In particular, the corporate tax rate appears to be very important for investors in planning investments in various countries. This independent variable not only shows to be highly significant for the dependent variable but also meets the expectation of a negative correlation with it. This result could be explained by the logic of geographic diversification of the corporate investor. Most CVC vehicles are founded by large multinationals and take investment decisions also according to where the most interesting ventures are based and where taxation is more favourable to make profits. Moreover, the CVC history teaches that, in the U.S., governments that imposed an easier fiscal policy stimulated the CVC activity in the late 1970s and early 1980s. Therefore, a clear negative relationship between CVC-backed firms and taxation looks coherent. As regards the impact of scaleups' quality on the number of companies supported by corporate venturing, both founders' education and the number of patents granted to scaleups are significant and positively related. Scaleups with founders who attended university can boast a more prepared team and, therefore, more attractive for investors on paper. Then, in countries where firms develop more product or process innovations and to whom authorities grant more patents, scaleups have a greater appeal, especially for corporate investors. Indeed, being cost and time-efficient access to technology one of the primary motivations for companies to make venture investments, CVC divisions (or funds) definitely tend to invest more where these technologies come from the most. On the other hand, the negative relationship between the number of CVC-backed firms and the total number of patents granted in each country (unexpectedly) indicates that countries producing a larger number of patents not necessarily have a more animated CVC activity. To explain it, we could notice that most patents issued in one country are granted by larger companies than startups. Typically, larger companies can afford to spend more on R&D, use very expensive and modern equipment, have more heterogeneous human resources and can employ highly qualified teams. Moreover, the training

data showed that the countries that are considered as the global innovation leaders in terms of the number of CVC-backed firms are not the same in terms of patents issued per capita. Therefore, technological inequality across countries could be one of the most relevant drivers for this negative relationship. Finally, the "percentage of STEM graduates", showed not be significant for this study. The logic is that, as the literature underlines, generally, investors tend to invest more in human capital-intensive businesses (Yiming, 2003), and human capital-intensive businesses are typically those with a more technology-based solution. If this is true, the percentage of a qualified technical workforce in a country should influence more the size of investments in each firm rather than the number of investor-backed firms. Consequently, we may explain such poor correlation assuming that this variable is more significant for the "CVC-backed funding ratio" dependent variable in Model 2.

For Model 2, I estimated the following econometric model:

$$CVC\_funding_i = \alpha + \beta_1\ Scaleups\_patents_i + \beta_2\ Founders\_univ_i + \beta_3\ Corporate\_tax_i + \beta_4\ STEM\_graduates_i + \beta_5\ Patents\_granted_i + \beta_6\ Pop\_Median\_age_i + \beta_7\ GERD_i + \beta_8\ Scaleups\_startups_i + \varepsilon$$

where i indicates a country

Figure 12 presents the results returned by the analysis for the "CVC-backed funding ratio" dependent variable.

Goodness of Fit	
Number of Observations	29
F (8, 20)	10,8979
Prob > F	0,0000
R-squared	0,8134
Adjusted R-squared	0,7388
Standard Errors	0,0005

Variables	β	Standard Errors	P-value
Independent Variables			
Scaleups_patents	0,0003	0,0001	0,0337
Founders_univ	0,0007	0,0003	0,0503
Corporate_tax	-0,0012	0,0019	0,5280
STEM_graduates	0,0044	0,0015	0,0074
Patents_granted	0,0000	0,0000	0,0112
Control Variables			
Pop_Median_age	-0,0001	0,0000	0,0035
GERD	0,0571	0,0179	0,0046
Scaleups_startups	-0,0018	0,0013	0,1759
α	0,0025	0,0012	0,0541

$p < 0.05$

Figure 12: Parameters of Estimation – Model 2

The regression output shows that the quality of scaleups is a relevant factor for corporate investors to believe in external innovative solutions. In confirmation of what was said before for their relationship with the "CVC-backed firms density ratio" variable, founders' education (at university) and the number of patents granted to scaleups are two important aspects that may induce CVC investors to finance a scaleup. Attending university

enriches founders' academic background but also brings other benefits, such as a wider network of connections, a well-structured way of working, the habit of working/studying hard to achieve goals and deeper knowledge in a specific field (which is very useful especially if consistent with the startup's business). On the other hand, being the number of patents a scale to measure firms' technological level, a positive relationship with CVC-backed funding results to be consistent with the expectations, namely that new technologies attract more investments. As regards the variable "Patents granting ratio", unlike the first regression model, in Model 2, it has a positive relationship with the "CVC-backed funding ratio". Such a result is in line with some previous researches that evidenced the relationship between corporations' investments in R&D and the existence of a CVC program (Chesbrough et al., 2002). As underlined before, most of the patents issued within a country are granted to medium-large companies because they typically have greater know-how and financial capabilities than startups to develop and invest in new technologies. Hence, companies that invest more in technology are likely to invest more in CVC as well, and this assumption could also influence the differences across countries at a macroeconomic level. Instead, as concerns the relationship between the dependent variable and the "Percentage of STEM graduates" in Model 2, it looks to be positive and significant. This outcome has already been hypothesized noting that, as previous literature professed, investors tend to invest more in human capital-intensive businesses (Yiming, 2003), and, since they usually need a high scientifically qualified workforce, national ecosystems offering more STEM graduates are also more appealing for corporate investors. In conclusion, surprisingly, in Model 2, the "Corporate tax rate" is not significant to explain the level of CVC-backed funding across countries. Such a result is in contrast with both Model 1 outcomes and expectations. A reasonable motivation could be that one of the primary CVC divisions' objectives is to find innovative solutions that should both introduce new technologies and fit with core products and processes. It means that often generating profits is not the first goal of a CVC vehicle and, since corporate tax mainly affects profits, a shift of its rate in a country does not necessarily affect CVC funding because a strategic purpose may lay behind the investment.

Discussion and limitations

The analysis reveals that the explanatory factors of CVC activity are, in part, political and economic, such as education and taxation, and in part, technological, referring to what innovative assets startups could offer to investors. In particular, it confirms that technology and education are two decisive drivers for the progress of an innovative ecosystem: countries with a high number of patents granted, a high number of graduates in STEM subjects and high-qualified (startup) teams enjoy both a large number of companies backed by CVC investors and large CVC investments. A key driver to encourage corporate venturing is fuelling the development of startups with high-qualified teams, which can periodically be renewed by a young workforce of technically trained students. On the other hand, the analysis showed that fiscal policy significantly influences the number of companies in which the CVC industry invests. Therefore, the empirical analysis demonstrated the two hypothesises H1 and H2. However, it must be noted that, in two cases, independent variables proved not to have a significant relationship with the dependent variables, namely corporate tax rate

with CVC-backed funding and the percentage of STEM graduates with the number of CVC-backed firms. Then, the patent granting ratio presented a negative proportionality with the number of CVC-backed firms, refuting hypothesis H2.

As for the limitations of the analysis, the data was collected from the biggest and most authoritative databases on innovation and startups, but it is hard to believe that this sample is complete and takes any firm, founder or student into considerations. Thus, our findings cannot be easily generalized, but they could be a good approximation of reality. Moreover, the analysis considers neither size difference among the companies that received an investment by a CVC vehicle, nor disparities for the average size of CVC investors across countries. In future researches, the correlation between these variables and the CVC activity could be further explored. Lastly, all the data refer to 2019, so before the pandemic crisis caused by Covid-19. This last point has been addressed in Chapter 3.

Impact of the Covid-19 pandemic on CVC

The radical increase of companies employing remote working, the expansion of online platforms for working and communication, and the higher workers' sensibility for a more flexible and life-balanced job are only a few evidences of how new market needs rose to the surface and many innovative firms strove to adapt their products and services to these growing trends. According to a survey made by McKinsey, the Covid-19 crisis accelerated the digitalization of customer interactions by several years. Such a radical change, on the one hand, benefited the companies that were already running their business online or whose business was related to the health crisis; on the other hand, had a disastrous impact on companies whose services and products involve social contact or indirectly have to do with sociability. While industries, like the Internet, healthcare and e-commerce experienced unprecedented growth, other sectors such as tourism, sport and fashion had to face severe restrictions and a much lower turnover than in the past.

Regarding the impact of these new conditions on CVC investments, despite the number of CVC-backed deals overall declined year-on-year, CVC-backed funding soared to an all-time high of $73.1 billion in 2020, increasing of about 24% from the previous year (CB Insights, 2021). Even the number of CVC-backed firms increased. Excluding the U.S., in 2020, in each of the countries observed in the analysis in Chapter 2, on average about 38 new companies received an investment from a CVC investor compared to 2019, with a rise of 26% (Crunchbase, 2021). As far as it concerns the geographic distribution of the CVC activity, Israel, U.S.A. and Singapore remain among the countries with the highest level of CVC-backed funding as a percentage of GDP. However, among the countries that experienced the highest growth in their CVC investments, Sweden and India are both ranked in the top-5 countries for CVC-backed funding (as a percentage of GDP) and Italy has increased it nearly threefold last year. Instead, the continent with the best performing CVC industry compared to expectations is Asia. Although its CVC-backed funding declined (compared to 2019) in the first two quarters of 2020, it recovered from July onwards and achieved $22.1 billion, with a 33% annual increase. China contributed substantially, with its CVC-backed funding to companies increasing 68% compared to the previous year. At last, in 2020, the industries in which CVC vehicles invested the most are

digital healthcare, fintech and cybersecurity; while, the most invested technology is Artificial Intelligence (CB Insights, 2021).

Implications for the quantitative analysis

Before exploring the key statistics available for 2020 and examining their possible implications for the national CVC industries, it is useful to summarize the main outcomes of the previous analysis in Figure 14.

Proportionality between the variables			
		Model 1	***Model 2***
		CVC_firms	CVC_funding
Startup Quality	Scaleups_patents	+	+
	Founders_univ	+	+
Ecosystem factors	Corporate_tax	-	Not significant
	STEM_graduates	Not significant	+
	Patents_granted	-	+

Figure 14: Summary of the analysis results

As represented in the Figure, both the number of patents granted to scaleups and the estimated number of founders that attended university showed a positive and significant relationship with the independent variables related to CVC. According to Crunchbase, in 2020, the number of patents granted to scaleups decreased by 6% compared to the previous year (Crunchbase, 2021). This indicates that the pandemic somehow slowed the technological growth of the national startup ecosystems, probably due to, in part, the impossibility for workers, scholars and researchers to be physically at their workplace, in part, to companies' distrust in investing in an unfavourable external outlook. Among the countries with the best performance in terms of scaleups' patents density ratio in 2020 are Poland, Finland and Iceland. In this regard, it must be noted that these countries were less affected than others by the health crisis in Europe, with the number of infected people below the European average[23] (European Centre for Disease Prevention and Control, 2021).

Conversely, education exhibited significant growth during 2020. From the perspective of this analysis, the estimated number of founders attending university increased by 36% between 2019 and 2020 in the observed countries. Such an increase underlines that, despite the crisis, founders care more and more about their academic preparation and this has a positive impact on the CVC activity across countries. Although the most performing countries in this aspect are Sweden, Poland and Finland (for which a lower incidence of the pandemic may have played a role again), all 29 observed countries reported progress in the founders' level of education. Indeed, the extraordinary development of several digital e-learning platforms and online tools opened up a digital revolution of this industry in which also schools and universities are rapidly taking part.

[23] Total Covid-19 cases as a percentage of the population in Poland, Iceland and Finland are 7.5%, 1.8% and 1.6% respectively. The average of European countries is 7.6%.

To perceive the magnitude of this phenomenon, EdTech companies raised approximately $1.87 billion globally in 2019, while they raised $3.84 billion in 2020 (Crunchbase, 2021).

As concerns taxation, the corporate tax rate in almost all the observed countries remained unchanged. Only Belgium and Greece adjusted their fiscal policy under this aspect in 2020 (OECD, 2020). However, in both cases, the corporate tax rate was slightly reduced compared to the previous year and it looks incautious to envisage substantial improvements in their related CVC industries.

Unfortunately, the still scarce availability of data about 2020 made it impossible to use the regression model to predict the future and compare the estimated values with the real ones. Updated information about some independent variables still misses and it did not enable to re-apply the model in the post-pandemic scenario.

Conclusion

In conclusion, I would like to underline that, as mentioned in Chapter 1, each country has its specificities in terms of innovation and it is often related to mere cultural aspects. National socio-economic culture, as well as national history, sometimes could have favoured the creation of an entrepreneurial ecosystem or a more or less disposed approach to investments in technology and innovation. These variables have not been included in the previous analysis, thus limiting the applicability of our outcomes, but opening the discussion to broader scenarios for further research. Moreover, CVC has a deeper tradition in some countries rather than in others, such as in the Anglo-Saxons and Japan, whose large companies began investing in Silicon Valley as early as the late 1980s. Although it undoubtedly facilitated them to gain a leadership position in the global CVC industry, European and Asian countries are slightly, but significantly, reducing the gap. According to CB Insights, between 2016 and 2020, European and Asian companies stole approximately 9% of global CVC-backed deals from American companies. At last, I reiterate that the main objective of this study was certainly not to find the universal formula for a country to excel in generating CVC investments, but to (re)affirm that some of the factors on which national governments can partially intervene (in this case, taxation, education and technology) are closely related with the creation of a network economy. I strongly believe in the possibility to frame interactive business clusters (or ecosystems) on a national level in which cooperation between companies allows to compensate for the lack of resources, stimulating knowledge exchange, and so innovation.

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