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Venture Capital for the development of smart cities: the Italian case

Anna Gervasoni*, Cristina De Silva**, Michele Lertora***, Andrea Odille Bosio****

Abstract
Urban transformation represents an increasingly urgent goal in accelerating the transition towards innovative, sustainable and digital cities to make them more efficient and smarter. An extraordinary availability of public funding is currently mobilized to this effect; however, it is not sufficient to pursue sustainability goals. Since the acceleration of smart city growth requires a huge amount of investment, venture capital could play a key role in launching the smart city of the future. In our research we analyse the role of venture capital as a promoter and accelerator of industrial sectors through the financing of innovative start-ups and funding disruptive technologies, which impact the smart city.
Descriptive analysis was conducted based on data collected through venture capital deals carried out in Italy during the period 2015 to 2021, as monitored by $\boldsymbol{VeM^{TM}}$, selecting specific industries which impact the smart city: digitalization, ecological transition, financial services, healthcare and mobility. The results suggest that there is an overall growth of interest from venture capitalists in investing in the smart city, which makes the market more dynamic and ready to accelerate urban transformation. This represents an impressive trend that may be good groundwork for further growth in the years ahead.

Keywords: venture capital, smart cities, innovation, digitalization, ecological transition

JEL Codes: G24, G32, Q01

1 Introduction

Over the last few decades, scientific evidence has pointed to the increasing challenges brought by climate change. This has been driving economic activity towards a paradigm of sustainable growth, focused on a thorough analysis of the environmental and ecological impacts of economic activities from an intergenerational perspective with long-term goals (Gro Harlem Brundtland, 1987).

In this scenario, urban areas play a pivotal role: today urbanization already accounts for about 55% of the world's population, and it is expected to reach nearly 70% by 2050[1]. In fact, more than half of the world's population currently lives in cities (United Nations, 2018), and these urban areas are growing at high rates as more and more people migrate from rural areas attracted by the benefits of urbanization (Ismagilova et al., 2019; Nam & Pardo, 2011).

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[1] United Nations, (2020). UN 75 – I grandi temi: Una demografia che cambia. https://unric.org/it/un-75-i-grandi-temi-una-demografia-che-cambia/

Cities already consume over 65% of the world's energy and account for more than 70% of global CO2 emissions[2].

Considering also other trends such as increasing global population and scarce energy resources, the need to accelerate a transition towards innovative, sustainable and digital urban areas is widely debated among academics, practitioners and policymakers, leading to the implementation of several measures over the last few years.

In 2015 seventeen interconnected goals, called "Sustainable Development Goals"[3], were established by the United Nations Organization to implement a strategic plan for a better and sustainable future. In the same year, the so-called "Paris Accords"[4] were launched to contain temperature rise and monitor climate change towards a sustainable ecological transition.

The European Union has also developed a strong commitment to supporting inclusive and sustainable growth, implementing concrete strategies and actions. In December 2019, the European Commission presented the EU Green Deal[5], which was introduced to define the strategic plan for a sustainable Europe. Following the COVID-19 outbreak, in 2020 the European Union approved the National Recovery and Resilience Plan[6], which is currently being implemented by member countries, to repair the economic and social damage caused by the pandemic crisis. The aim is to achieve urban regeneration by focusing also on digitalization and ecological transition. For instance, Italy's National Recovery and Resilience Plan includes urban regeneration (identified as the fifth mission and a key priority[7]).

Urban regeneration through digitalization has been identified as one of the main pillars of the European Union strategy, as confirmed by a specific mission of Horizon Europe, which supports urban transformation in order to deliver 100 climate-neutral and smart cities by 2030[8].

[2] European Commission. Emission monitoring & reporting. https://ec.europa.eu/clima/eu-action/climate-strategies-targets/progress-made-cutting-emissions/emissions-monitoring-reporting_en
[3] United Nations. Do you know all 17 SDGs?. https://sdgs.un.org/goals
[4] The Economist (2021). What's in Paris agreement on climate change. https://www.economist.com/interactive/paris-climate-agreement-annotated/?gclid=CjwKCAjws8yUBhA1EiwAi_tpEXioL-sEDBZAtWvhbqy_t1NkyBi-6DC5MED3NzFX4Uf4Ih_AiR8ijBoCZBgQAvD_BwE&gclsrc=aw.ds
[5] European Commission. Un green deal europeo. A European Green Deal | European Commission (europa.eu)
[6] European Commission. Italy's recovery and resilience plan. https://ec.europa.eu/info/business-economy-euro/recovery-coronavirus/recovery-and-resilience-facility/italys-recovery-and-resilience-plan_en#italys-recovery-and-resilience-plan
[7] European Commission. Piano Nazionale di ripresa e resilienza. https://www.governo.it/sites/governo.it/files/PNRR.pdf
[8] European Commission. https://ec.europa.eu/info/research-and-innovation/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/eu-missions-horizon-europe/climate-neutral-and-smart-cities_en

Thanks to these policy resolutions, an extraordinary availability of public funding is currently being mobilized. Governments are taking advantage of every possible opportunity to capture value[9], also including cooperation with the private sector, to realize their smart city goals[10]. This means that the public sector should promote an effective involvement of private players, such as venture capitalists to speed up the growth of smart cities. Several researchers prove the significant impact of private investment on city smartization projects (e.g. Blanck & Ribeiro, 2021).

In general, innovation and new technologies are typically considered as enabling and accelerating factors for smart cities, but require huge amounts of investment in digitalization, transport efficiency, track water facilities, as well as other factors that would be considered.

In this, venture capital appears to be a crucial actor for the process of urban transformation, as venture capital is defined as an alternative form of investing in innovation, besides direct public investment in research and development (Cooke et al, 2002). It funds and accelerates the growth of companies active in industries with a strong impact on smart cities.

Based on the scenario defined above, the aim of this work is then to study empirically the role of *venture capital* in the Italian market in financing innovation and disruptive technologies and enabling the growth of innovative startups operating in industries that impact *smart cities.* This is done through a comparative analysis of the deals performed by both national and international investors on Italian startups in the period.

The article is divided into four sections. In the first paragraph, the theoretical context is briefly summarized, defining the smart city and the role of venture capital as an alternative finance tool to support its development. The second section describes data collection and the construction of the sample, as well as descriptive statistics and definition of the variables used in the empirical analysis. The third reports the main findings of an analysis carried out on a sample of deals extracted from ***VeM^{TM}***[11].

[9] Deloitte (2021). Connect for Future | Next Generation EU https://www2.deloitte.com/it/it/pages/about-deloitte/articles/connect-for-future---next-generation-eu---deloitte-italy---about.html?utm_source=google&utm_source=google&utm_medium=cpc&utm_medium=cpc&utm_campaign=generica&utm_campaign=generica&gclid=CjwKCAjwlgOXBhBgEiwA-hhitM7pL1yD5cKEzJp8uLKIt3XlMYfdlZoCYNG23hHCr8L09e1cwiOv9xoCdzsQAvD_BwE

[10] The Economist (2018). Smart cities: Investing in the future. https://impact.economist.com/sustainability/resilience-and-adaptation/smart-cities-investing-in-the-future

[11] ***VeM^{TM}*** Venture Capital Monitor - is an Observatory born in 2008 from the collaboration between AIFI and LIUC - Cattaneo University, active at the Business School of the University and realized thanks to the contribution of Intesa Sanpaolo Innovation Center and E. Morace & Co. Law Firm and the institutional support of CDP Venture Capital SGR and IBAN, with the objective of developing permanent monitoring of the early stage institutional activities carried out in our country, in order to offer operators, analysts, scholars and institutional referents useful information for the performance of the related activities and to establish itself as a primary source of information in the sector. It

Finally, the fourth section summarizes the main conclusions, identifying further topics to be discussed by newcomers.

2 Theoretical framework

Starting from different literary definitions, the *smart city* has been defined in a proper way by Toli & Murtagh, (2020) as "*a concept of urban transformation that should aim to achieve a more environmentally sustainable city with a higher quality of life, that offers opportunities for economic growth for all of its citizens, but concerning the particularities of each locality and its existing inhabitants. This transformation is currently enabled by various types of technologies, typically provided by global industrial partners, that are embedded into the city's infrastructure system, transforming the existing provision of services by adding layers of interconnectedness".* Similarly, the OECD took up this definition in its report as *"initiatives or approaches that effectively leverage digitalization to boost citizen well-being and deliver more efficient, sustainable and inclusive urban services and environments as part of a collaborative, multi-stakeholder process*" (Smart Cities and Inclusive Growth, OECD, 2020). Based on these definitions, the role of smart cities is centered on a concept of sustainability and new digital services, which are integrated into the city's environment to help it to evolve and simplify.

Considering an institutional point of view, UNECE (United Nations Economic Commission for Europe) and ITU (International Telecommunication Union) have jointly defined smart sustainable cities as "*innovative cities that use information and communication technologies to improve quality of life, service efficiency and competitiveness while ensuring that the needs of present and future generations are met with reference to economic, social, environmental and cultural aspects*". The UNECE, together with other United Nations agencies, has established a global initiative (United for Smart Sustainable Cities - U4SSC)[12] and several activities to support the growth of smart cities, identifying, monitoring and evaluating sustainability goals at urban level.

Thanks to the U4SSC initiative, key performance indicators have been developed for Smart Sustainable Cities to provide cities with a consistent and standardized method to collect data and measure performance and progress for:

represents the main source of data that has been identified in a proprietary database and published yearly at LIUC - Carlo Cattaneo University.

[12] The United for Smart Sustainable Cities (2022).https://u4ssc.itu.int/

1. Achieving sustainable development goals
2. Becoming a smarter city
3. Becoming a more sustainable city (Bambagioni, 2022)[13].

The *smart city* concept advocates the private sector taking a leading role in the generation of new economic opportunities, improving service delivery and facilitating citizen engagement (OECD, 2019). Yet, this conception of smart cities needs broadening. In this endeavor, two decades' worth of research and experimentation on smart cities by the private sector provides a wealth of experience and data which can be drawn on.

One of the key private players that are crucial to supporting this development is *venture capital*. It was born in the United States, in the so-called "alternative finance" field, which is defined by European and American literature as *investments aimed at stimulating new entrepreneurial activities (start-up financing, early-stage financing) as well as further developing existing businesses (development financing, expansion financing), in the broader context of private equity investments, which represent the multitude of investments made by institutional venture capital investors, which are internationally referred to as private equity and venture capital operators* (Gompers & Lerner, 2004; Gervasoni & Sattin, 2015). Venture capital seeks to promote the diffusion of innovation through digitalization and environmental change in the evolution of smart cities.

As already highlighted, despite several initiatives implemented by the Government, this transition cannot be managed using only public resources, but requires a more significant intervention of venture capital, defined by Cooke, Davis and Wilson (2002) as an alternative form of public investment in research and development to invest in innovation.

According to the literature, both innovation and economic growth can influence the level of venture capital in the stages of economic development. This ensures that there is a prospect of joint interdependence between innovation, venture capital and economic growth, determining a positive impact on the real economy. A part of the literature investigates the economic impact of venture capital on the target start-ups, in

[13] Bambagioni (2022). Città del futuro: infrastrutture e finanza sostenibili Progettare e finanziare lo sviluppo e la resilienza delle città UNECE | LIUC Università Cattaneo Center of Excellence on Sustainable Finance for Infrastructure and Smart Cities (ExSUF).

order to verify the effect generated at the economic level (Gervasoni et al., 2016; Gervasoni and Bollazzi, 2011).

Moreover, it can be possible to consider *venture capital* not only as a structural partner for the realization of the digital and environmental innovation system but also by pushing for a greater go- to market optic. In fact, Hellmann and Puri (2002), also find evidence that venture-backed companies, especially innovative ones, are faster in bringing their product to market. There is evidence that venture capital has a positive impact on economic performance and innovation and helps to create a new value creation process.

According to data reported by the Bank of European Investments, the venture capital market now offers significant investment opportunities, creating more specialized thematic funds for digital, ecological and energy transition. As a result, there are over 20 venture capital funds active in the pipeline, amounting to over € 500 million in invested capital (BEI, 2022).

The ability to create new value and opportunities through digital and environmental transformation is one of the main pillars of venture capital that takes into consideration the improvement of urban sustainability, resilience, quality of life, performance and new development paradigms that must be evaluated based on international super partes methodologies (Bambagioni, 2022)[14].

Therefore, to finance the development of smart cities in a resilient and sustainable way, it is necessary to cooperate with private actors, especially with venture capital funds, fostering innovation in green projects and incentivizing the digital transformation process.

3 Data collection, variables and methodology

This section reports data collection and the construction of the sample, as well as descriptive statistics and the definition of the variables used in the empirical analysis.

3.1 Data collection

Data include all venture capital deals carried out in Italy from 2015 to 2021, as monitored by $\boldsymbol{VeM^{TM}}$.

[14] Bambagioni, (2022). Città del futuro: infrastrutture e finanza sostenibili Progettare e finanziare lo sviluppo e la resilienza delle città. UNECE | LIUC Università Cattaneo Center of Excellence on Sustainable Finance for Infrastructure and Smart Cities (ExSUF).

The $\boldsymbol{VeM^{TM}}$ database includes 1,064 deals over the chosen time span (2015-2021). Among these, we selected specific industries that directly impact smart cities; these were identified taking into consideration literature definitions included in academic papers and specialized reports[15]. The sectors include digitalization, financial services, healthcare, mobility and ecological transition.

As a result, the final sample is composed of 317 deals involving the relevant industries mentioned above.

All the deals have been further cross-checked with external sources including Orbis[16]/AIDA[17]. Additionally, we retrieved from these sources financial and non-financial data (patents and average turnover)

Finally, additional information on investors was retrieved from the special section of the Business Register DL 178/2012, (e.g.: data regarding patents and incumbents).

3.2 Descriptive statistics

Table 1 provides the number of deals by year for each industry of the smart cities sample with a total of 317 deals, divided as follows:

Table 1: VC deals by year

	Digitalization	Ecological transition	Mobility	Financial services	Healthcare	Total
2015	16	3	1	2	1	23
2016	23	3	4	0	1	31
2017	16	6	2	5	0	29
2018	22	1	1	2	1	27
2019	23	8	5	6	1	43
2020	43	11	4	7	2	67
2021	53	22	6	11	5	97
Total	196	54	23	33	11	317

Source: Personal elaboration

[15] See the series of reports, papers related to the topic of smart cities and involving the reference areas used in the analysis: OICE report, Talia *et al* (2020), Riva Sanseverino E., Riva Sanseverino R., Vaccaro V,(2015), Atlante delle smart city. Comunità intelligenti europee ed asiatiche, 3 ed., Milano, Franco Angeli.

[16] Orbis is a database with data on global companies, containing information on more than 400 million companies and entities worldwide, including 40 million with detailed financial information.

[17] AIDA is the database realized and distributed by the multinational Bureau van Dijk, containing the balance sheets of the last 10 years, personal and product data of about 980.000 active and bankrupt Italian corporations.

The total number of 317 deals, referring to the above considerations, represents a significant sample to answer the chosen research question.

A set of variables, listed in the table below, was identified for each monitored deal:

Table 2: Variables definition

Deal characteristics	Characteristics of target company
Total amount of equity and quasi-equity	Geographic location
Investment stage	Specification of smart city sector
Investment year of deal	Average turnover
Deal origination	Presence of patent
Nationality of active investors	Year of the company's foundation

Source: Personal elaboration

Table 3 shows how the smart cities sample is geographically distributed. The general pattern that emerges is that the absolute catalyst in Italy is Lombardy, which has 44% of the deals, immediately followed by Lazio with 19%. This distribution is in line with what has been monitored by the $\boldsymbol{VeM^{TM}}$ regarding the overall distribution of venture capital investment in Italy.

Table 3: Geographic distribution

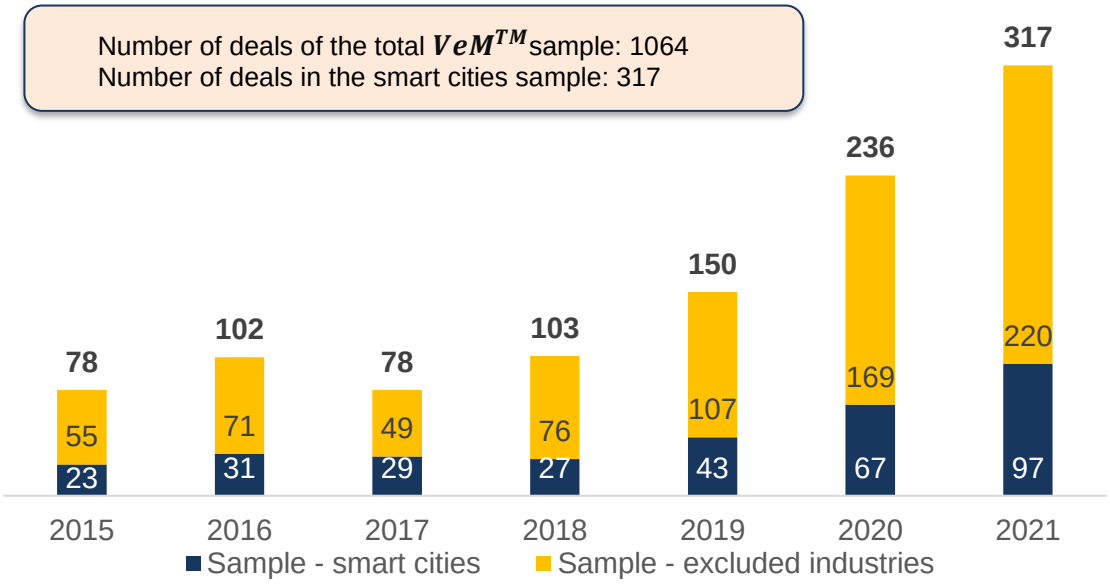
Region area	Number of target companies	%
Lombardy	139	44%
Lazio	60	19%
Piedmont	29	9%
Tuscany	20	6%
Emilia-Romagna	19	6%
Veneto	10	3%
Campania	8	2%
Puglia	6	2%
Liguria	5	2%
Calabria	4	1%
Sicily	3	1%
Trentino-Alto Adige	3	1%
Umbria	3	1%
Abruzzo	2	1%
Marche	2	1%
Sardinia	2	1%
Basilicata	1	0%
Friuli-Venezia Giulia	1	0%

Source: Personal elaboration

4 Findings

Looking at the overall sample, the article analyses in detail the current picture of the Italian venture capital market in the selected industries. Considering the distribution of the number of deals related to the smart cities sample out of the total $\boldsymbol{VeM^{TM}}$sample, (see **Graph 1)**, it is possible to notice a significant increase in absolute values over the years, standing at 97 deals in 2021, compared to 2020 with approximately 67 closed deals. Moreover, it can be highlighted that the number of deals in this sample is 4 times higher than in 2015. This sets a good basis for venture capital growth in these areas.

Graph 1: Number of deals of the smart cities sample out of total $\boldsymbol{VeM^{TM}}$ sample



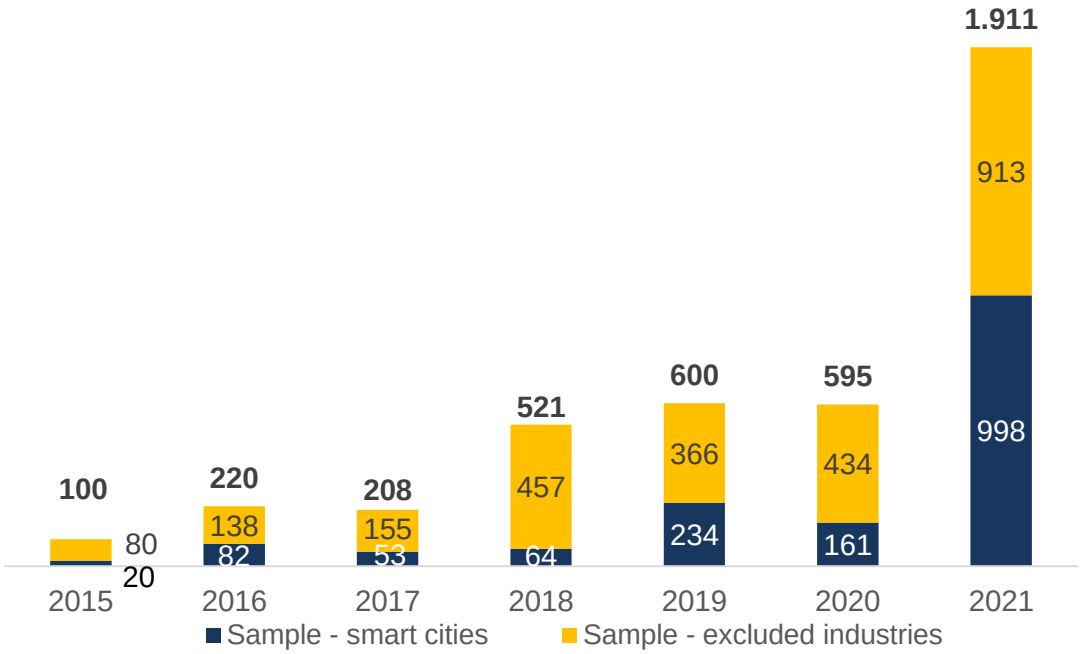
Source: Personal elaboration

In relative terms, considering the smart cities sample out of the total $\boldsymbol{VeM^{TM}}$ sample, it remains constant over time, reaching a percentage of about 30%. This indicates a stable overall growth of venture capital investment. 2021 was also a record year in terms of absolute values and invested amounts, as can be seen in graphs 1 & 2.

Graph 2 displays the invested amount per year. In 2021 the invested amount in smart cities industries is nearly equal to € 998 million, compared to the invested amount of € 20 million in 2015. This proves that in 2021, therefore, the invested amount is increased 50 times compared to 2015, which confirms venture capital's willingness to invest.

This confirms an increase in the invested amount by venture capital funds in the smart cities sample, not only in absolute terms but also in relative terms, rising from 20% in 2015 to 52% in 2021.

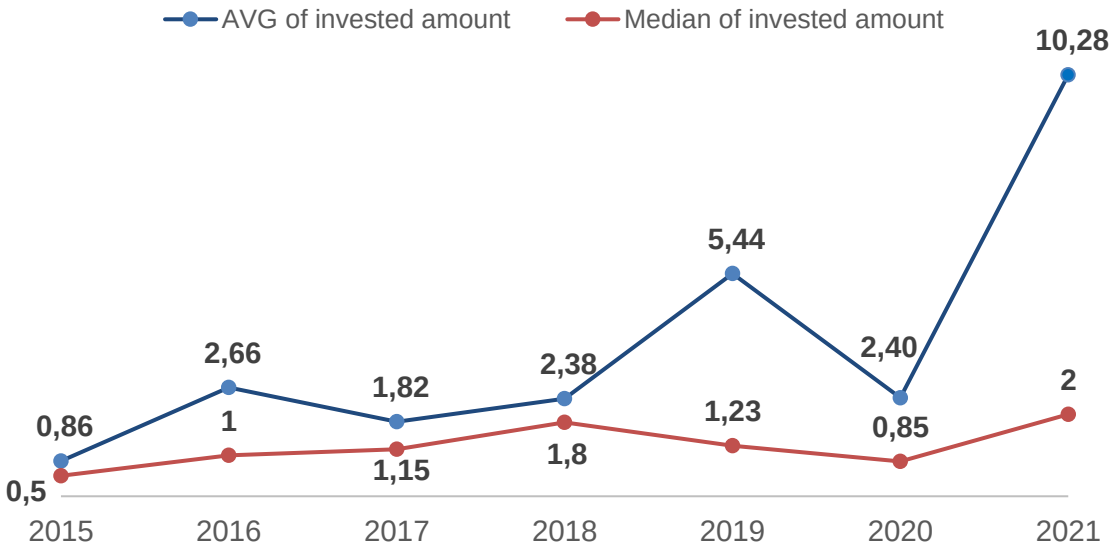
Graph 2: Invested amount of the smart cities sample out of total $\boldsymbol{VeM^{TM}}$ sample (€ m)



Source: Personal elaboration

Graph 3 shows that the average invested amount in the smart cities sector increases significantly. The ratio between the total invested amount and total number of deals per year, rises from € 860 thousand to € 10 million. In addition, the red line indicates the median amount invested for each year, to understand how values are equally distributed. An increase of invested amount can be noted from €500 thousand in 2015 to €1.8 million in 2018. This means that the level of invested amount increased from one year to the next. The numbers realized immediately after the COVID-19 pandemic outbreak are significant, showing the 2020 degrowth. However, the increase in 2021 demonstrates how the venture capital market reacted positively to the recovery of the Italian economy.

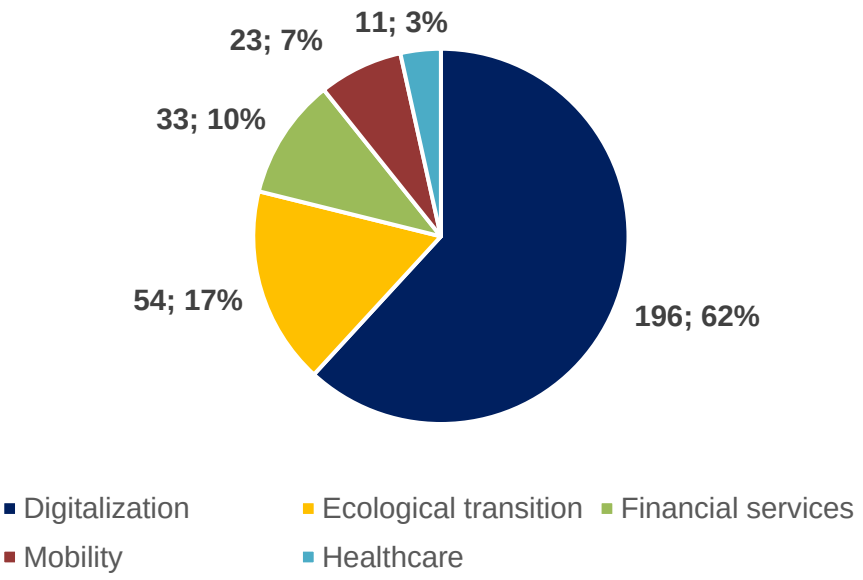
Graph 3: Average and median of invested amount per deal of the smart cities sample (€ m)



Source: Personal elaboration

Furthermore, graph 4 points out industrial sector classification of the smart cities sample.

Graph 4: Sector composition of the smart cities sample

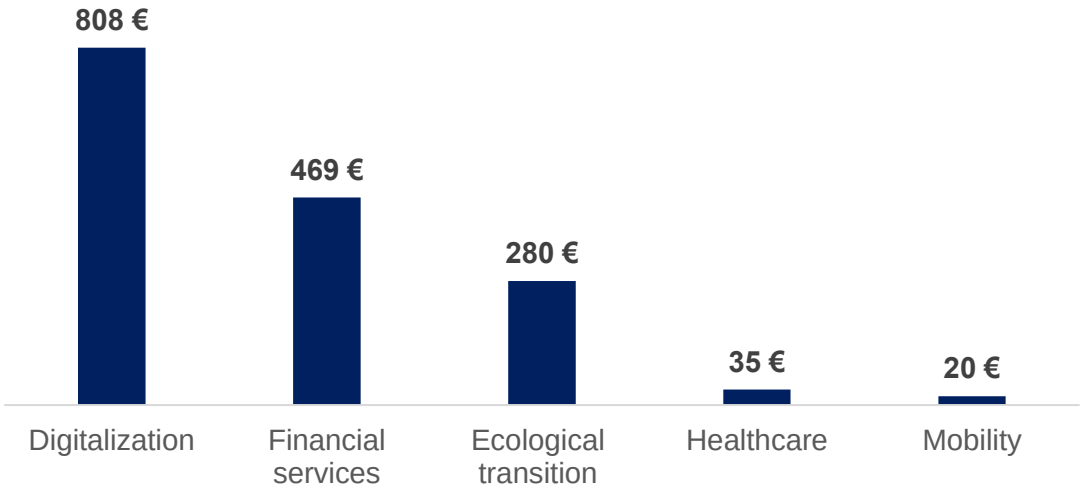


Source: Personal elaboration

As shown in **graph 4**, two particularly important aspects emerge, namely the strong interest of operators in the digitalization industry, which represents the main component of the investors' portfolio with 196 deals out of the total of 317 deals (62%) and ecological transition with 54 deals (17%).

Graph 5 shows the relevance of invested amounts on the digitalization and financial services sector, where the latter has fewer deals in absolute terms but a higher average investment size over the whole period of analysis.

Graph 5: Invested amount in the selected industries of smart cities sample (€m)

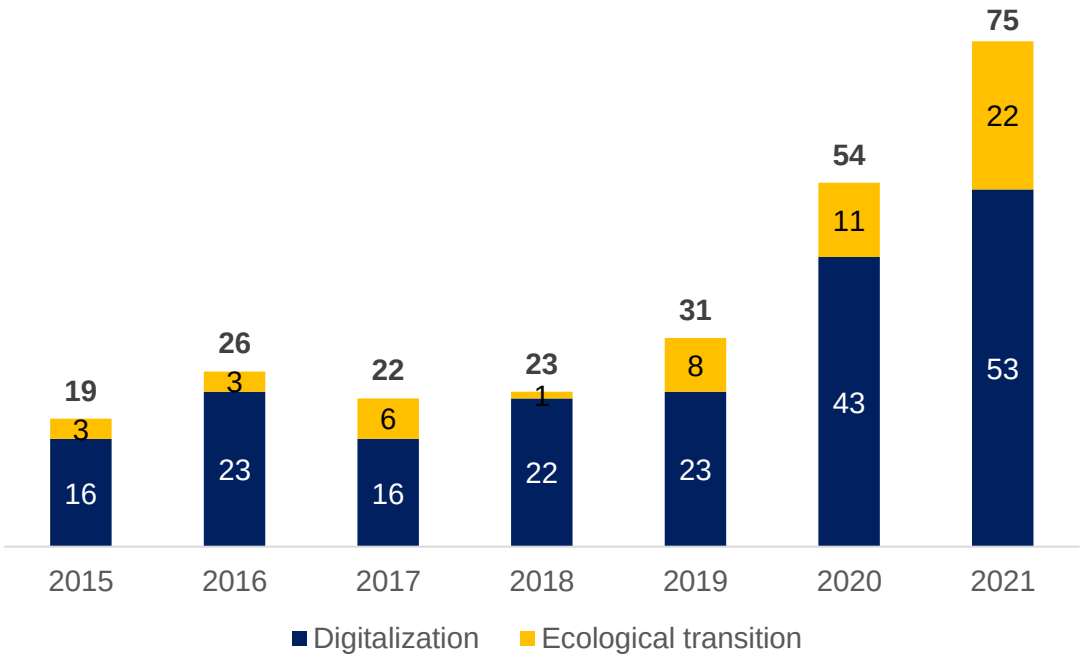


Source: Personal elaboration

Focusing on the two industries with the highest number of deals (see **graph 4**), the analysis also provides a yearly overview of their trend, as shown in **graph 6**.

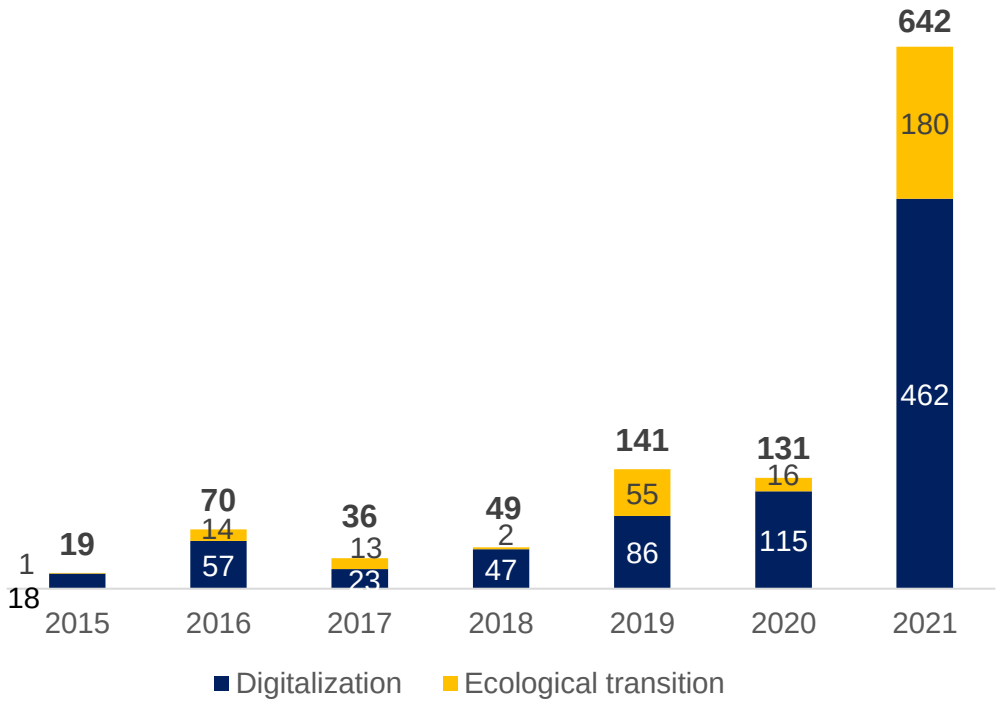
In 2021, there was a huge rise: 75 deals were closed in the sector of digitalization and ecological transition, compared to 54 deals in 2020. As widely studied, the pandemic accelerated the need for digitalization services, also due to transformations in the labour market as a consequence of a massive use of remote-working.

Graph 6: Distribution of deals of the digitalization and ecological transition industries



Source: Personal elaboration

Graph 7: Invested amount in digitalization and ecological transition industries (€ m)

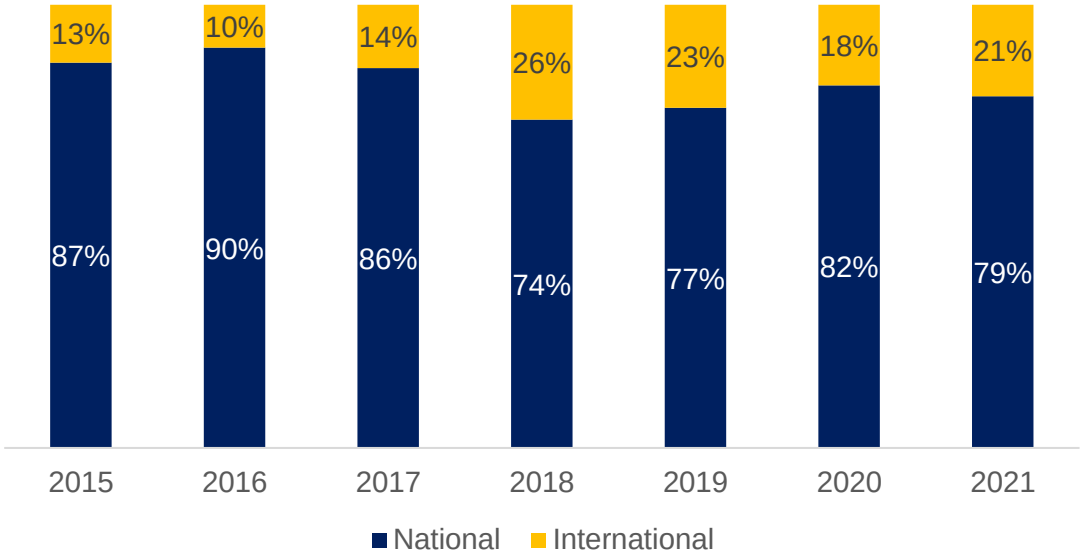


Source: Personal elaboration

In terms of counter values, as **graph 7** points out, there is an evident sharp increase from €131 million invested in 2020 to € 642 million euros in 2021, of which €180 million were invested in ecological transition and €462 million in digitalization. These impressive numbers represent good groundwork for further growth in the years ahead.

Graph 8 shows the percentage of deals carried out by national and international investors over the whole period of analysis. In relative terms, there has been an increase in investment made by international players.

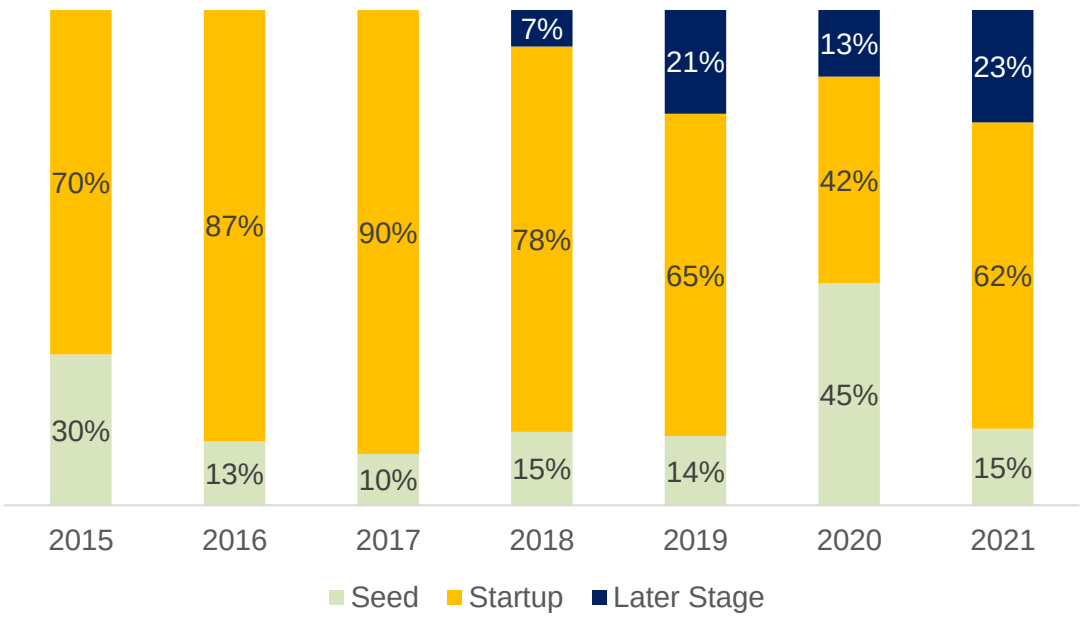
Graph 8: Distribution of active investors in the smart cities sample (%)



Source: Personal elaboration

Graph 9 shows the distribution by investment stage of the target companies in the smart cities sample. Based on what has been said above, the trend is further confirmed by the increase in investments in more mature companies with a particular focus on start-up and later stage, which in 2021 stands at 62% and 23% respectively, as opposed to the first three years (2015 - 2017) where investments are concentrated on start-up and seed, with an absence of later stage investments. This means that an increasingly significant number of target companies can develop and mature over time, reducing the so-called “living dead” investments.

Graph 9: Distribution by investment stage in the smart cities sample (%)

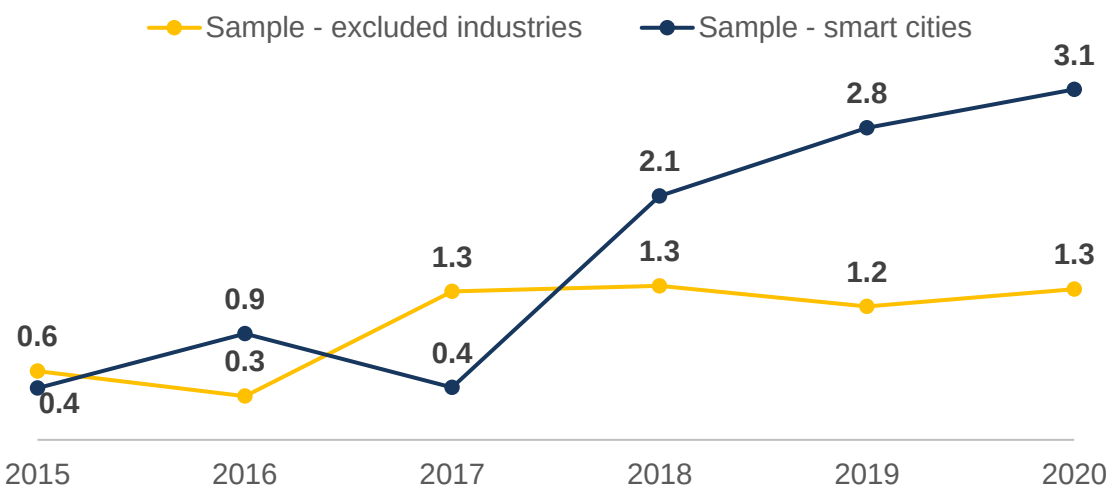


Source: Personal elaboration

In conclusion, the analysis is focused on the variable “average turnover” to study the size of the target companies in which venture capital invests and the variable “patent” with high innovative content, to investigate the trend of venture capital investments toward technologically advanced companies that have their own patent.

According to what has been said above regarding the growth of the average investment deal size over the analysed period, **graph 10** shows that, in 2020, the average turnover of invested companies is roughly 8 times higher than in 2015. This indicates a more dynamic market that can sustain rounds in dimensionally large companies, particularly evident in the smart cities sample.

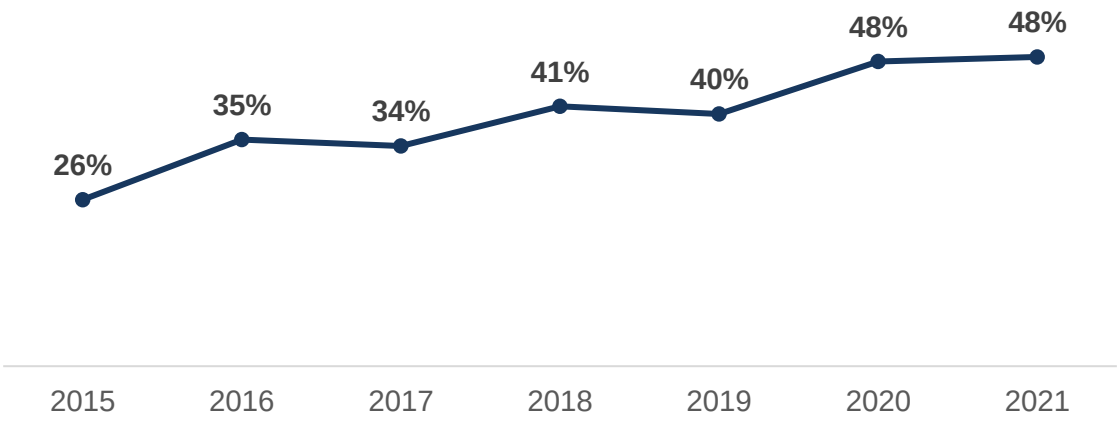
Graph 10: Average turnover in the year of investment (€ thousand)



Source: Personal elaboration

Focusing on patents, **graph 11** shows the percentage of smart city companies that have proprietary patents at the time of investment. There is a noticeable growth in investments toward technologically advanced companies that have their own patents (with high innovative content stabilizing at 48% for the years 2020-2021). Considering the trend from 2015 to 2021,1 in 2 companies already have the patent at the time of investment, instead of 1 in 4 back in 2015.

Graph 11: Percentage of companies with proprietary patents in the year of investment (%)



Source: Personal elaboration

5 Conclusions and remarks for future research

This study provides evidence of how *venture capital* in Italy promotes and accelerates the growth of *smart cities by investing in companies active in strictly correlated industries*, thus investing in the future and innovation, which represent the pillars for the development of new services in the smart cities. In the area of urban generation, an extraordinary availability of public funding is currently mobilized; however, it is not sufficient to pursue sustainability goals. Since the acceleration of smart city growth requires a huge amount of investment in innovation, such as new technologies, transport efficiency, track water facilities, etc., venture capital could play a key role in launching the smart city of the future. Moreover, taking this path, it becomes an unparalleled accelerator for this transformation growing into an important lever for development.

The smart urban system is one of the few solutions that can effectively and efficiently respond to the demands emerging in recent times. There is a demand for better quality of life, more social inclusion, greater digital literacy, active participation in administrative life, more space for entrepreneurship, with full respect for the environment so as not to harm the living conditions of future generations. Our cities need to develop and fortify themselves, to compete globally to make the innovative financing ecosystem in Italy stronger and stronger.

Summarizing some key aspects that emerge from the descriptive analysis carried out on the smart city sample in Italy monitored by $\boldsymbol{VeM^{TM}}$, there is a strong growth in venture capital investments in the selected industries both in absolute values and invested amounts. Moreover, a sharp growth in investment by active international players has emerged, ensuring greater financial support in the Italian market. In addition, the analysis revealed a very dynamic venture capital market capable of supporting rounds in larger companies, valued in terms of average turnover. The analysis showed that there are more later stage investments, making target companies more long-lived over time. Finally, it turned out that venture capital investments in target companies that already have a patent at the year of the investment have grown significantly.

This study has limitations that could provide opportunities for future research. Since this analysis is based on a small sample of the Italian market, the results are nation-specific.

The next possibility for future research could be a comparative analysis across European markets to better understand the role of venture capital in smart city development in terms of different investment practices, boundaries and outcomes. The link between innovation, venture capital and smart city development needs to be explored within various contexts. Comparative studies would be useful to build a contrastive understanding for both scholars and practitioners.

In addition, the real ESG impact of smart city investment growth by venture capital should be analysed at the firm level, also investigating how practitioners influence this path and what strategies are adopted by investee companies, taking into account ESG metrics; further research should also be focused on patent analysis to study the different strategy of venture capitalists when they decide to invest in a target company that already has a patent compared to companies which do not, in order to see whether VC are able to accelerate innovation. Further analysis could also focus on the evolution and survival of invested companies over time, taking into consideration the “living dead” investment rate. Finally, as many of the industries impacting smart cities might be particularly affected by incentives and laws made by national and local governments, the impact of policy making on investment trends should be closely analysed.

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