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PropTech: new technologies applied to the real estate industry

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Introduction

According to the Federal Reserve, the world real estate industry is worth $ 273 trillion, a huge figure that represents about one third of household wealth, making its proper functioning fundamental for the stability purpose of society.

However, the real estate sector has always been characterized by numerous limits and challenges, which partially hinder its growth and make it highly vulnerable to potential threats, including periods of market downturn.

The economic crisis occurred in America in 2008 and expanded in the major world economies had a significant impact on the real estate market, causing both a strong devaluation of prices and a drastic reduction in sales. If we focus on house values in Europe, the Eurostat report confirms an average drop in prices of 11.5% from 2011 to 2018. However, the numbers are even more negative in the Italian market, which has seen an average drop of 17.6%, recording one of the worst results of the continent.

After the great recession, the real estate sector was at the center of a strong renewal driven by a wider change in the technological ecosystem, giving rise to the proptech neologism, used to underline the growth of a close relationship between property and technology, which promises to eliminate some of the main limits that characterize the real estate industry.

The following work aims to analyze in detail the change currently underway in the sector, starting from an analysis of the key aspects and then reaching an illustration of the main models and actors present in the context.

Chapter 1 aims to introduce the reader to the real estate market, indicating its characteristics, obstacles and the various market segments, as well as analyzing its functioning through the use of theoretical models, necessary to understand the changes that the industry is currently experiencing.

Chapter 2 introduces the concept of proptech, a phenomenon that has arisen in the past but only recently in the spotlight of world economies. The chapter will analyze the development of proptech, from its inception to possible future evolutions, describing the main technologies involved. The industry will also be segmented through two different classification models and according to an analysis of the main geographic markets.

The following three chapters will divide and analyze the main areas of proptech activity, as well as the business models currently growing; in particular, chapter 3 will focus on Smart Real Estate, represented by technology-based platforms that support the monitoring, use and management of real estate assets.

Chapter 4 will analyze the concept of Sharing Economy and its application on the real estate market; as we will see, this area of activity is represented by technological platforms that simplify the use of real estate assets, making the distribution of resources efficient and avoiding the presence of underutilized assets.

Chapter 5 will focus on the area of greatest development of the proptech industry, namely Real Estate Fintech, which describes the technological platforms that support real estate transactions, making them more reliable and cheaper. The chapter will analyze the development of automatic valuation models, a revolution in the real estate sector that has always been characterized by a strong heterogeneity and by the great subjectivity of the valuation process. The chapter will also refer to a case study on Casavo, the main ibuyer operator in Italy and Europe, analyzing its business model and its expansion

CHAPTER 1

THE REAL ESTATE MARKET

1.1 Definition and characteristics

Real estate is a large market, different but also related to other sectors. Its definition is: "*a physical or virtual place where real estate values, services or securities that are part of a real estate business are developed and exchanged and where, when market demand and supply meet, a market value of an asset is defined* "

The real estate is a unique asset class with singular characteristics, difficult to find in other sectors, including that of being at the same time a consumer and an investment asset. Indeed, in addition to being used as a workplace or home, a property also represents an investment, being able to be purchased, renovated and subsequently sold, receiving from the transaction a capital gain given by the difference between the purchase and sale price or it can also be rented receiving a periodic income.

The characteristics of real estate asset, such as its durability and high unit value, imply that generally it represents an important part of the value of the total investments made by an individual, as well as making up a large portion of his wealth; generally the ownership of the main residence often constitutes the most important asset in the family heritage. The home thus represents about 28% of the wealth of families in the United States, 30% of families in France and even 53.3% of the wealth of Italian families. The patrimonial characteristic of real estate properties is the basis of their possible use as collateral[1], as well as their autonomous exploitation as an investment asset, to the point of composing a very significant market with own operators rules, conventions and specific trends[2].

The characteristics of the real estate properties derive either from the nature of the assets or from the choices of the investors, or even from the legal system[3].

[1] The term **collateral** refers to an asset placed as a guarantee for the contracting a loan with a financial intermediary. The collateral acts as a form of protection for the lender, in the event that the debtor defaults on the loan payments, the lender can take possession of the collateral and sell it to recover some or all of the loan losses.

[2] This economically significant value of real estate is what distinguishes it from other real assets, for which an independent market is not established outside their industrial production.

[3] Especially the fiscal one.

The main characteristics of the real estate properties that make this asset class singular and very different from the other sectors are analyzed below:

-***immobility:*** as is immediately evident from the meaning of the term, properties cannot be moved. The consequence of the immobility of real estate assets is that the local economy strongly influences their value; for example, a growth in the local economy could potentially lead to an increase in the value of a property or land, or even to a change in its intended use. Some areas previously destined to deposits, following an economic development, may be converted into residential, office and commercial complexes.

-***high unit value***: real estate activities are characterized by a high unit value, with direct investments which require large amounts of capital.

-***indestructibility***: the land is indestructible, but could become unsuitable for construction or use. Potential events that can lead to the impossibility of building are the collapse of a land or e pollution of the soil. The properties are destructible, but have a long life and a low rate of decay, being able to survive countless technological periods and economic cycles.

-***heterogeneity***: each property is exclusive and a non-standardized asset. As for its technical characteristics, its temporal value and its position, each property is subject to its own evaluation and as such is not susceptible to any seriality or substitutability.

-***location***: this characteristic derives from the immobility of the land and buildings. Location for a property is essential, and its quality is often linked to accessibility: when buying a home, a family will consider accessibility to schools, shops, leisure and work; for commercial buildings, the crucial factors are accessibility for customers, employees and suppliers as well as proximity to the transport arteries.

- ***long-term investment:*** real estate investments are oriented in the long term for three main reasons: the indestructibility of the land and the long life of the buildings, the strategy of the investors and the legal system; the first element requires no further explanation, while the same cannot be said for the other two. As for the investor strategy, we can cite the use of real estate as a consumer good; an individual who buys a house or a company who buys a building to carry out his business, in both cases the real estate property is purchased for the purpose of being used and therefore the time horizon of these investors is mainly oriented towards the long term. Other investors buy

real estate solely for investment purposes, but continue to think in a long-term perspective, such as pension funds or insurance companies that follow a long-term oriented policy characterized by a "buy and hold" strategy**.** Regarding the influence of the legal model on the long-term nature of real estate investments, we can cite the case of some national systems where there is a tax on real estate capital gains, often regressive according on the duration of ownership[4].

-illiquidity: one of the main characteristics of real estate activities is their low liquidity; it often takes a long time to sell a property at the market price. However, the time interval between the listing of a property and its actual sale varies according to the phase of the real estate cycle. Furthermore, it is possible to speed up the sale of a property if you are ready to make a concession in relation to the sale price: there is therefore an inverse relationship between the time necessary to carry out the transactions and the amount of the transaction itself. The illiquidity of the properties derives from their high unit value and their heterogeneity, which do not give real estate investments a fungibility characteristic. Illiquidity is also linked to long-term investment characteristics; as we have seen, the motivation of numerous investors and the legal system often lead to the purchase and holding policies, which do not create liquidity on the real estate markets. However, with the recent development of proptech new business models have emerged capable of making the industry more liquid, which will be analyzed in detail in the following chapters

-***opacity***: generally the transactions on the real estate market take place through private negotiation between two counterparties who, for various reasons and in some cases, are reluctant to communicate the value of the transactions transparently. Indeed, the information obtainable regarding real estate resources is not always reliable, since in some cases the prices provided deviate from the actual sum exchanged, leading to the construction of inaccurate indices and market benchmarks. In addition, a real estate transaction are characterized by an information asymmetry between the counterparties,

[4] In general the longer the asset is maintained, the lower the tax rate on any capital gain from the transaction; thus having a dissuasive effect on the rapid sale of a property.

in which the seller is often better informed of the relevant aspects of the property than the buyer. However this problem could be minimized through a due diligence process[5].
-***rigidity***: the development times of a property are generally high and this generates a constant delay in the process of updating prices based on the meeting between market demand and supply, creating a short-term imbalances in the market which is reflected in its efficiency;
-***high level of leverage:*** this characteristic derives from the high unit value of real estate activities, which allows this class of activity to represent a worthy collateral. In general, investors do not have enough liquidity to buy a property using only their capital and therefore finance the purchase using partially debt. The buyer may also prefer the use of debt while having the necessary capital; in the case of a private investor, for example, this will happen if he believes he can use the capital not invested in the purchase of the property to make investments whose profitability is higher than the cost of interest on the debt contracted. In general, the lender can finance much of the value of a property, since he has a guarantee consisting of the real estate itself. If the entrepreneur is unable to repay the loan, the creditor will then be able to sell the asset pledged as collateral and recover the loan amount granted.

1.2 Key factors that drive the real estate market

The proper functioning of the real estate market is a prerequisite for a healthy economy also because this assets class represent a significant portion of an individual's wealth. The growth of the real estate market is driven by several elements, the main ones are analyzed below:
-***Demography***: these are the data that describe the composition of a population, such as gender, age, income. While these statistics are often overlooked, they represented a significant factor affecting the demand and prices of real estate assets. Major changes

[5] The ***real estate due diligence*** indicates the investigation and investigation of data and information relating to the subject of a negotiation. The purpose of this activity is to evaluate the convenience of a deal and to identify the risks and related problems, both to negotiate the terms and conditions of the contract, and to prepare adequate guarantee instruments.

in a nation's demographics can have a big impact on real estate trends for several decades; a generational change tends to shift the trend of consumer demand towards different types of real estate activity; for example in recent years, following the adulthood of millennials, there has been a shift in the demand for housing to rent rather than purchase, with the demand for small properties more functional to the fast and light lifestyle of this generation.

-***Interest rates***: changes in interest rates can significantly impact the performance of the real estate market mainly through an increase or decrease in the cost of debt. For example when interest rates fall, the cost of obtaining a mortgage decreases, thus creating higher real estate demand which in turn pushes prices up[6].

-***The state of economy***: the condition of the economy plays a fundamental role for the correct functioning of the real estate market. Generally measured by indicators such as GDP, manufacturing activity and the employment rate, it has a direct relationship with the real estate market: when one goes up, the other goes up and when one goes down, the other goes down. Specifically, it must be clarified that the various types of real estate have a different correlation with the state of the economy: commercial properties are usually less correlated with the economic cycle, being often characterized by long-term lease contracts, instead the receptive segment is closely related to the economic cycle, due to the type of leasing structure of the activity; for example, renting a hotel room can be considered a form of short-term rent easily avoided by customers if the economy enters a period of crisis.

-***Government policies***: legislation generally plays an important role in determining the demand and prices of real estate, with deductions, subsidies and tax credits representing some of the tools used by the government to temporarily increase the demand in real estate market.

[6] However, when we look at the impact of the exchange rate on interest rates on an equity investment, such as in mutual funds (REITs), rather than a direct investment in property, the relationship changes, becoming similar to a bond relationship with the interest rate. In this case, when the rate of interest in the market decreases, the high REIT yields become more attractive and their value increases. When interest rates rise, the yield of a REIT becomes less attractive and reduces the value of its value shares.

1.3 The four quadrants model

An interesting economic model to deepen the functioning of the real estate market is the four quadrants model of Di Pasquale and Wheaton[7], which starts from the dual character of real estate, both a consumer and investment asset. From here the model makes a first distinction of the real estate in two different markets:

- ***the property market:*** where buildings are considered in their ability to produce utility generated by the availability of space;
- ***asset market***: in which buildings are considered in their ability to produce cash flows deriving from rental income[8];

two other aspects of the real estate market are isolated from the model and treated as markets in which different factors, defined by a function that represents its logical tendency, intersect to define a specific value; these are:

- ***real estate development (primary market):*** represented by the construction sector, in which the offer of new real estate units is established;
- ***the properties trading market (secondary market):*** in which exchanges are made and the quantity of real estate existing assets at a given moment is determined.

Each aspect is analyzed in a quadrant in which the variables, parameters and functions are defined; subsequently, the analysis of these four quadrants converges into a joint model in which the values determined in each individual market mutually condition each other, to explain the relationships and processes that govern the performance of the real estate market. Below we will analyze the individual quadrants.

[7] "The Markets for Real Estate Assets and Spaces: A conceptual framework" published by Journal of American Real Estate and Urban Economics Association in 1992

[8] The model does not explicitly take into account the real estate investment and the subsequent sale in order to obtain a potential capital gain; however this does not affect the model. The sale can also be considered as an option for which the investor intends to liquidate in a certain period "t" all the future discounted instalments of the annuity that can be generated from the rental of the property.

1.3.1 First quadrant: Property Market

The first quadrant of the model analyzes the property market, relating to the possession of the asset, precondition for its use. A property can be used by individuals for personal use, as a home, or it can be adapted as a production factor, such a factory or an office. The players present in this first market are:

-the owners: which constitute the offer side in the property market. These are represented by individuals, real estate companies and funds who sell the right to use a property against the payment of a periodic rent.

-the tenants: who make up market demand and who are represented by individuals and companies who pay the rent to owners to acquire the right to use the property.

The meeting of supply and demand determines the price of the space, that's the rent (R) paid by the tenants and received by the owners. In the following graph, the demand curve represents the average propensity of the population to acquire space according to the price.

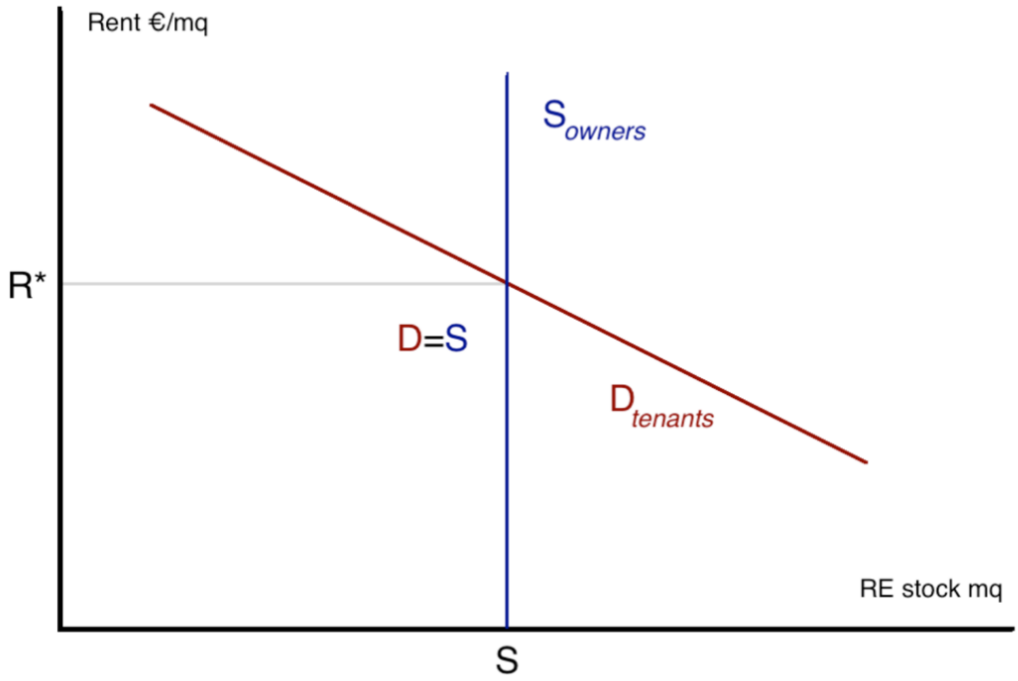

Figure 1: Representation of the property market

Its elasticity, the reactivity of demand to price changes, depends on various elements such as: demographic level, macroeconomic and institutional conditions as well as individual preferences such as the propensity to save, mobility and the relative value attributed to the real estate sector both for personal use and for productive use.
The position of the demand curve, its height in the graph, is indicative of the propensity to buy. In the case above, with a fixed short-term offer, which can be explained by the rigidity of the real estate market, a translation of the demand curve upwards, and therefore a relative increase in the propensity to consume by individuals, translates into the desire to buy a certain stock of space at a higher price.

1.3.2 Second quadrant: Asset Market

In the asset market, the value of real estate activity is determined. The players in this market are private and institutional investors who seek to determine how much of their financial portfolio invest in the real estate market. Therefore, in a period prior to the purchase decision, they undertake a series of assessments both on the properties and on other activities such as those belonging to the securities market.
The development of valuation theory has led to the definition of different methodologies used to evaluate a real estate investments, including the main ones:
-*Market Approach*
-*Cost Approach*
-*Financial methods*
-*Income Approach*
The asset market quadrant is connected to the use of the income approach, which is based on the principle that the value of an asset derives from its ability to produce income. Specifically, according to the income method, the value of an asset is given by the present value of its future income discounted at a certain capitalization rate, which represents the risk of realization of the prospective income. The present value of future income flows can be calculated through various financial formulas, including the one shown below, useful for calculating the present value of a perpetual annuity whose

installments are constant and follow each another over time based on their maturity but without have a deadline.

$$\boldsymbol{Value = \frac{Income}{Cap.Rate}}$$

Regarding the capitalization rate, a definition is given by the property valuation dictionary published by the Appraisal Institute, which suggests that: *"the capitalization rate is a rate of return for a property that reflects the relationship between expectations of a single year's net operating income and the price or total value of the property and is used to convert operating income into an indication of total property value"*. [9]
From this definition it is possible to understand that the capitalization rate identifies a rate of return of a real estate unit which expresses the relationship between the expected net operating income and the value of the property. By elaborating the previous formula, the capitalization rate can be calculated as the ratio between the income generated by the property and its market value.

$$Cap.Rate = \frac{Income}{Market\ Value}$$

Returning to the asset market, it can be framed in a graph whose function, dependent on income (R) and cap rate (i), defines the total value of the asset (P).

[9] For further information on the topic: http://www.appraisalinstitute.org/assets/1/7/IncomeCap.pdf

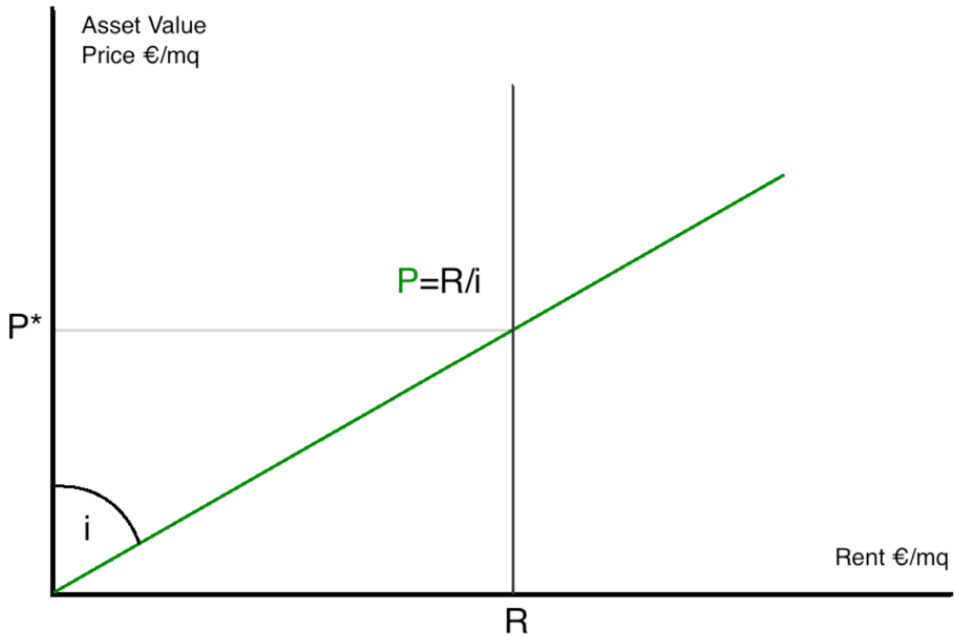

Figure 2: Representation of the Asset Market

The income (R) is established in the real estate market according to the logic illustrated above. The capitalization rate (i) is the angular coefficient of the value function and depends on various factors, exogenous and endogenous to the model; moreover, in its economic meaning, it can also be understood as an indicator of risk, which actualizes the value of the investment in a direct relationship.

Among the *exogenous factors*, that is external to the model, we can find:

- ***the expected growth of the economy***: the positive outlook in economic growth pushes an increase in demand and prices, lowering the investment risks and with it the capitalization rate.

-***interest rate trends***: mainly government bond rates, which generally represent risk free securities and the minimum reference threshold for assessing the risk of alternative investments; but also other rates such as interbank rates from which the level of credit rates derives, fundamental for the efficient functioning of the real estate market. An increase in interest rates leads to an increase in the capitalization rate;

-***the riskiness of an investment:*** which can be incorporated into the risk premium, an indicator of the expected return in excess of the risk free; an asset's risk premium is a

form of compensation for investors who tolerate the extra risk, compared to that of a risk free asset[10]. An increase in the risk premium indicates that investors consider a particular investment riskier and consequently request a higher return; furthermore, this situation, if characterized by a general instability of the markets, would induce investors to shift their capital towards less risky activities such as real estate.

-***inflation:*** an increase in inflation indicates an increase in the costs of goods and services, including real estate assets, which are generally less affected than other activities such as financial ones. Furthermore, an increase in inflation, by reducing the real value of the debt, could favor borrowers and thereby encouraging real estate investments, which generally use debt extensively.

With regard *to endogenous factors*, internal to the model, they define the real estate risk premium, that is the minimum return required by investors in the sector; among the main ones we have:

-***rental growth expectations***: an upward forecast of rental income encourages the investors and reduces the expected risk premium;

-***the risk of cash flows:*** the flows generated by the properties depend on market conditions and the liquidity of the tenants, which influences the timing and methods of realizing the rent;

-***the conditions of the individual property:*** the technical and functional characteristics of the properties, their current and expected rate of obsolescence, the forecasts on the preferences of the tenants in the context of the trends in the general housing and rental conditions, has a decisive impact on the risk of a specific investment.

An increase in the capitalization rate reduces the slope of the value curve and, for the same income generated by the property, will lead to a decrease in the present value of the cash flows and a decrease in the market value of the asset.

[10] **Risk free asset:** is a term to indicate an asset that has a certain future returns and theoretically no possibility of loss. Debt obligations issued by the U.S. Department of the Treasury (bonds, notes, and especially Treasury bills) are considered to be risk-free because the "full faith and credit" of the U.S. government backs them.

1.3.3 Third quadrant: Development

The third quadrant analyzed is the development, which sees as protagonists the operators engaged in the production of new real estate units and in the refurbishment of existing ones. In order to frame the real estate development sector, the model analyzes the logical base on which new buildings are built or existing ones refurbished and summarizes them in a rule that can be described using a mathematical formula. Its worthy to note that developers undertake new real estate projects only when the overall cost of realization is lower than the current value of the assets with similar characteristics already present on the market. In the graph below this third quadrant is depicted.

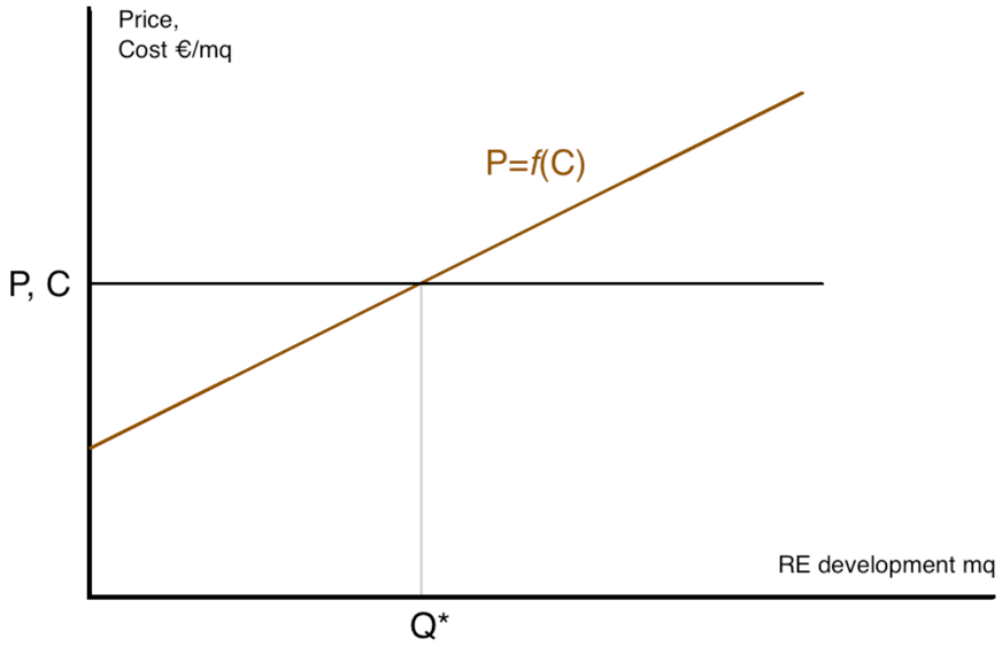

Figure 3: Representation of the Development quadrant

The y-axis represents both the cost and the price for a property unit, while the x-axis represents the real estate development units. The function of the model will set the number of development units in square meters based on the estimated price of the property; this price coincides with the full unit cost plus a risk premium required by the developer for the risk undertaken with the real estate investment. The points of the curve are all states of equilibrium in which the unit cost and the risk premium are in proportion with the price, thus incentivizing the developer to invest in new real estate

projects. The degree of positive slope of the curve reflects the propensity to make new development investments given a certain estimate of the value and therefore given the unit cost of production plus a remuneration margin for the investment risk taken.

1.3.4 Fourth quadrant: Stock Adjustment

The last quadrant of the model analyzes the secondary market for the negotiation of existing properties. In this market, the stock of properties present at a given moment is determined, that is the current offer of the real estate market.

The dependent variable in the last quadrant becomes the independent variable of the first; indeed, in the property market, the new market demand meet the offer to establish the price for the use of the space, or the rental fees, and thus start a new balance of all the fundamental values in the entire market. The new stock of real estate S at a time *t +1* can be defined through this relationship:

$$S_{t+1} = S_t - H + Q$$

where: ***Q*** represents the new real estate stock developed between t and t + 1;

H represents the real estate units that have become obsolete and therefore excluded from trading and the market; specifically the model considers the real estate units that have become obsolete as a percentage of the stock ***S,*** in this way we can define the obsolescence rate through the link that unites the existing properties and the quantity of properties that are no longer available:

$$H = dS_t$$

where ***d*** represents the obsolescence rate.

From this we can rewrite the main equation as:

$$S_{t+1} = S_t - dS_t + Q$$

Assuming also a state of equilibrium in the offer:

$$\Delta S_{t+1} = S_{t+1} - S_t = 0$$

we can conclude that:

$$S = \frac{Q}{d}$$

Therefore, the model shows that the offer S is determined on the basis of the level of real estate developments and the obsolescence rate. The value d represents the complementary angular coefficient of the supply curve S. Graphically the last model is represented below.

Figure 4: Representation of the stock adjustment quadrant

1.3.5 The complete model

The usefulness of the four quadrants model in understanding the mechanisms on which the real estate market is based can be assessed through the construction of a graph composed of each of the previously analyzed quadrants, where it is possible to perform both a static analysis to represent the existing relationships between the variables of the model and through a dynamic analysis to determine the variation of one or more variables following the change of the others. The graph representing the model of the four quadrants can be read in two directions.

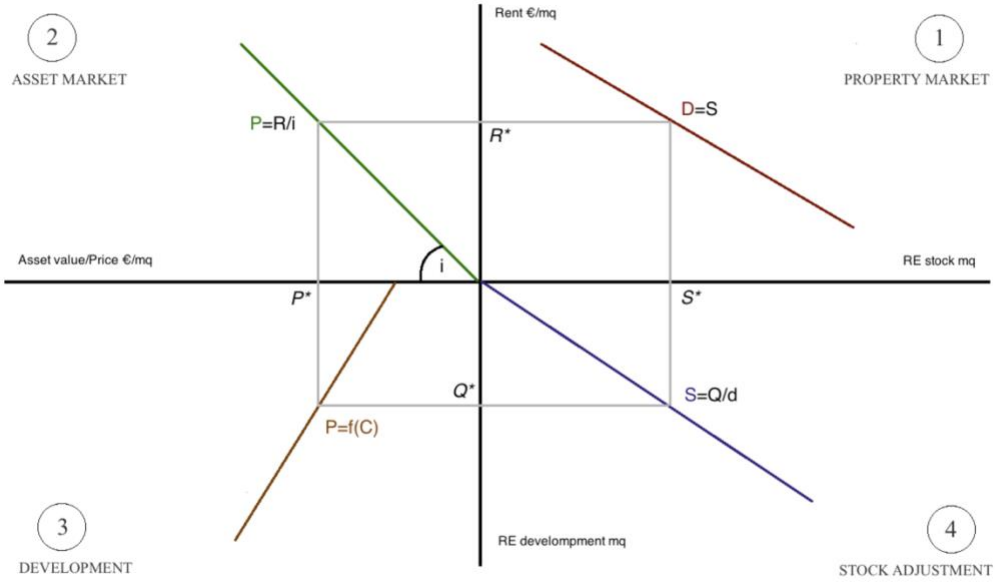

Figure 5: The Complete Model

With a vertical reading, the right quadrants (1 and 4) represent the space market and the left quadrants (2 and 3) represent the investment market. A horizontal reading of the model allows instead to isolate the primary and secondary market. The two upper quadrants (1 and 2) represent the secondary market for real estate trade, in which the exchange of real estate assets takes place; the two lower quadrants (3 and 4) describe the real estate development market in which the production of new real estate units takes place and the determination of the overall volume currently offered on the market.

In the first quadrant, market demand and supply determine the rent, that is the price for the use of the space which, together with the capitalization rate, defines the current value of the real estate asset, shown in the second quadrant. This value, compared with the construction costs C, is at the basis of the investment evaluations in new real estate development projects; in addition, the new real estate stocks developed, discounted by the obsolescence rate *d*, determine the new real estate offer, which in turn starts a new market cycle by repositioning curve C in the quadrant of the property market.

Starting from this representation, it is possible to dynamically analyze the changes of the model following possible variations in the exogenous variables, some of which described below.

An ***expansionary phase of the economy***, with an increase in available income, has a significant effect on aggregate demand for real estate. Individuals will ask for greater and better availability of space, businesses will invest more resources in production plants and offices, and the public administration will expand its range of structures with the aim of offering a greater number of services to citizens, translating all that into a transaction towards the top of the demand curve in the property market, which will lead to an increase in rental rates, in the value of the properties and in a growth in the development sector.

In a subsequent period, the developed properties will be aggregated with the existing ones, expanding the offer on the market which, in the medium / long term, will bring the rents back to equilibrium values.

A stock market crisis generates an increase in the risk premium on equity investments and a relocation of investors' portfolios in favor of *"safe havens goods"*, including real estate assets. The effect is a decrease in the risk premium for real estate investments and therefore in the capitalization rate. The price curve in the asset market increase the slope due to an increase in the value of the real estate assets, also stimulating the constructions and the expansion of the offer.

A restrictive monetary policy, with a consequent increase in short-term interest rates, makes access to debt for real estate developers more expensive, leading to a decrease in investments. All this on the model translates to a shift of the curve in the third quadrant to the left; a constant or increasing obsolescence rate, in the event of a

reduction in redevelopment operations, the stock of properties available on the market will reduce.

Another relevant case is a ***technological evolution***, which pushes towards an increase in the obsolescence rate of existing properties by reducing the offer and leading to a negative inclination of the curve of the fourth quadrant.

1.4 The Real Estate Market Segmentation

After analyzing the characteristics of the real estate market and representing its mechanisms through the four quadrants model, it is right to proceed with its segmentation. The real estate market can be segmented according to various aspects: by location (central, semi-central or peripheral), by current status and quality of the building (new, used, renovated) or by the intended use of the properties; the latter represents the most used classification within the sector. The different intended uses of the properties in turn constitute a multiplicity of sub-markets or segments, with their own actors and valuation metrics. The main ones are:

I) land

II) residential segment

III) office segment

IV) retail segment

V) industrial segment

VI) receptive segment

Below we will analyze the different segments of the real estate market and its own characteristics:

I) Land: represents the main category of the real estate market, distinguished in various sub-categories from the regulatory plans drawn up by the administrative authorities; in general, the main categories of land are divided into buildings and non-buildings. The development of the lands, as well as their value, is driven by a complex combination of elements such as the proximity to infrastructure and transport systems that encourage real estate development projects in the area.

II)Residential segment: this category includes all buildings built for residential purposes. The growth of this segment is characterized by a high dependence on family income, ease of access to credit and population growth in the area, all factors capable of influencing the level of demand, and therefore property prices and the vacancy rates. Another factor that plays a key role in the segment is fiscal and cultural policy; as we can see from the following table, the Italian residential segment is characterized by a high rate of ownership compared to the European average, mainly due to the heavy internal bureaucracy and a tax regime that is not favorable to rent; however, the high percentage of ownership of the Italian population also derives from cultural aspects, including the historical saving philosophy of the population which sees real estate as a safe investment.

country	residential	receptive	offices	industrial	retail
France	50,4%	14,2%	19,6%	1,9%	13,9%
Germany	58,6%	4,0%	16,0%	4,0%	17,4%
UK	40,6%	3,1%	23,4%	7,7%	25,2%
Spain	49,4%	12,7%	17,1%	3,8%	17,1%
Italy	81,4%	1,6%	6,6%	3,4%	7,0%
total	56,4%	6,8%	16,6%	4,1%	16,1%

Figure 6: Share of ownership by segments in Europe

III) Office segment: this category includes the buildings used by companies, freelancers, associations and public administrations, which are highly influenced by the state of the economy thus pushing the demand in this segment to be strongly correlated to the national and international economic cycle and therefore indirectly related to the unemployment rate. The office segment can be distinguished by location, with properties located in the central business district (CBD) and properties located in peripheral areas. Furthermore, this segment is considered the most suitable for rent, given the characteristics of the contracts, generally long and stable.

IV) Commercial segment: in this segment there are several types of properties: retail stores, shopping centers, hypermarkets, retail parks and factory outlet centers. In

general, most retail properties, especially the large ones, indirectly belong to groups of institutional investors. The retail segment can be further divided into three subclasses:

-***shopping center***: they are independent stores that share a specific area like a shopping gallery usually located on the main streets of the city. The idea behind the shopping centers is that the sum of the parts taken individually has a lower value than the complex of the grouped parts[11]. This advantage is known as positive externalities and derives from a multiplicity of factors, such as the possibility for customers to find a wide range of products in a limited area.

-***aggregation of shops***: a series of independent activities located in the city or in the nearby areas.

-***regional shopping center***: this is the largest retail category, characterized by a combination of multi-brand wholesale stores and small single-brand stores, offering customers a wide range of products.

V) Industrial segment: includes all buildings in which a production activity is carried out: warehouses, logistics platforms and all production plants. Generally these structures are characterized both by a simple architectural structure but with precise technical specifications, such as a certain ceiling height and a surface free of pillars, as well as the position near the main communication arteries, such as airports, highways and stations**.** The industrial segment is strongly connected to the trend and needs of the production system and as such is influenced by the economic state of the country.

Over the years, due to the process of transferring manufacturing production to low-cost countries, such as China, India and Eastern Europe, and the explosion of online markets, there has been a gradual shift in interest. of the sector in the properties used in industrial logistics, for example warehouses. This interest has been translated into a series of important investments in the development of buildings for the storage of goods and in the search for new technologies to reduce construction costs and increase the quality of buildings in terms of structural and plant engineering, such as the recent modular construction, which allows to adapt the supply of structures to different levels and types of demand. As for the Italian market, the data reveal that the national segment has recently undergone a strong growth thanks to a process of reorganization of the

[11] Among the main advantages for the shops there is the possibility of exploiting a greater flow of customers attracted by the numerous products offered in shopping center.

national distribution system with a widespread geographical expansion, as well as an increase in operations in the countries of large foreign players such as FedEx and GLS.

VI)Receptive segment: companies operating in the receptive sector are involved in the production and exchange of hospitality services. These services may consist of the simple provision of accommodation or include other auxiliary services such as sports facilities and wellness centers. Based on the spaces necessary to carry out these activities, it is possible to divide the segment into two categories of property: accommodation use, divided by type of service offered, and hotel and complementary structures, such as tourist villages and camping sites. In the more developed countries, generally the receptive sector is characterized by a division between ownership and management, entrusted to large international operators capable of achieving important synergies in the business. The main types of contractual agreements between hospitality operators are:

-*Franchising*: with the payment of a royalty, the hotel chain allows an operator to use its own brand and commercial and management systems, provided that during the course of the activity it respects certain standards such as location, the quality of the structure , the furniture and services provided. Through this contractual form, the operator benefits from the popularity of the brand, but still assumes all the risks related to the activity.

-*Management contract:* the owner of the structure entrusts the management of the business in a chain that will use its own brand and internal systems. In this type of agreement, however, the owner of the property maintains the entire risk of the business, indeed, the manager is paid through management fees and incentive fees to the achievement of certain objectives.

-*Leasing*: the manager of the hotel business license and pay an annual fee to the owner of the property.

1.5 The real estate cycle

Real estate, exactly like all the other industry that compose the economic system, moves within a continuous cycle, which in turn can be divided into smaller cycles that differ from each other in terms of type of real estate asset and geographical area; the cycle is characterized by four reiterative phases:

I) Growth

II) Maturity

III) Decline

IV) Crisis

These phases are also influenced by a series of endogenous and exogenous forces. The endogenous forces are function of the dynamics of the actions put in place by the actors that make up the market demand and supply, while the exogenous forces are functions of events not directly controllable by the operators of the real estate market.

Among the endogenous forces we can find: the high construction costs, the opacity of the real estate market, the location of the property and the limited reactivity in the adaptation between supply and demand.

The exogenous forces are represented by: the general macroeconomic trend, the regional or national regulatory frameworks, the role of the public administration and the state of financial markets.

Within the exogenous forces an important role is played by technological progress introduced on the market, represented by a series of innovative and intelligent tools capable of controlling the levels of supply and demand in real time, potentially reducing the impact of the various phases of the model, in particular those relating to the market downturn.

Below we will analyze the individual phases of the real estate cycle:

I) Growth: represents the initial phase of the real estate cycle; in this phase, there is an excess market demand over the supply, which leads to a decrease in the vacancy rate and an increase in real estate prices and rents. The imbalance between supply and demand continues until the developers begin to plan the construction of new real estate units.

II) Maturity: represents the second phase of the cycle, where there is a constant growth in real estate development activity, stimulated by an increase in rents and prices. This

phase is characterized by a progressive increase in the market supply until reaching a point of equilibrium with demand or a partial imbalance, where the amount of available spaces offered slightly exceeds the quantity requested. In this case, there is an increase in the vacancy rate and a slowdown in the increase of prices and rents. When the newly built units are placed on the market, there is a strong interruption in prices and rents as well as a considerable increase in the vacancy rate.

III) Decline: this phase is characterized by a greater increase in market supply than in demand. As a result there is a rapid drop in prices and rents, as well as an increase in the vacancy rate which subsequently causes a further drop in property prices.

IV) Crisis: represents the last phase of the real estate cycle, characterized by low market values for buildings and the absence of new real estate development projects. The offer remains stable given the excess of space available on the market. At some point the market reaches its bottom and then goes up again, with the slow increase in market demand that begins to absorb the excess supply, leading to a reduction in the vacancy rate and a slow increase in real estate prices. Subsequently, the real estate market returns to an initial phase of growth.

Figure 7: Representation of the Real Estate Cycle

CHAPTER 2

PROPTECH

2.1 The years of great recession

After the outbreak of the subprime mortgage crisis that originated in 2007 in America and spread to the main world economies, the real estate market suffered a sharp contraction especially in the American and European continent, characterized by a previous decade of strong growth. This crisis, which started in the real estate market, also affected other sectors, primarily the financial and industrial sectors, causing a drop in GDP in many developed countries, as well as a drop in income and in the employment rate. The result was the beginning of a strong global recession, causing the failure of major financial institutions and the subsequent mistrust of savers towards the banking system, which entered in a phase of credit crunch[12]. This situation in the mortgage market caused a further decrease in the already weak real estate demand which led to a generalized collapse of market prices. Also in Italy the real estate market has suffered a strong contraction; according to estimates, real estate national sales made in 2012 fell by 25% compared to the previous year, with a 10.2% drop in prices; the following year the number of real estate transactions decreased again reaching 403.124 and marking the lowest level ever recorded within the nation since 1980. The Italian real estate sector in that period was strongly affected by the contraction in the provision of mortgages, passing from 34.3 billion euros in 2011 to 19.6 billion euros in 2012, with a drop of over 40%. Stopping this great recession was not easy, drastic and pioneering tools were adopted by the major world institutions: in 2014 the ECB began an accommodative policy that resulted in Quantitative Easing[13], a constant injection of liquidity on the markets aimed at promoting the recovery of the economy and access to credit, other instruments were of a fiscal nature as subsidies for companies and a decrease in the level of taxation.

[12] ***Credit Crunch***: refers to a decline in the lending activity by financial institutions caused by a sudden shortage of funds. Often an extension of a recession, a credit crunch makes it almost impossible for companies to borrow because lenders are afraid of bankruptcies or defaults, resulting in higher rates.
[13] ***Quantitative Easing***: is a form of unconventional monetary policy in which a central bank buys long-term securities from the open market in order to increase the money supply and encourage loans and investments. In Europe, this tool has been implemented since 2009 by the European Central Bank, arriving at full capacity with an injection of 80 billion euros per month.

2.2 The evolution of technology in the real estate field

The recession of 2008 has encouraged the adoption of new technologies in many sectors. Although this statement may seem contradictory, numerous studies have highlighted a strong renewal within industries during and after the great recession. A study by Hershbein and Kahn, which analyzed the job offers published between 2007 and 2015, highlighting a change in the background of the positions required, more focused on the technological skills of the workers. The report found that companies were not only more demanding in terms of employee skills, but were also becoming more digital, increasing their investments in technology[14]. Then a possible question might be: *"why do companies invest in technology during the recession when the money available to them is limited?";* economists have responded to this question by showing that during periods of economic downturn the opportunity cost of money is lower than in periods of wealth; indeed when the economy is growing, a company has all the incentives to expand its business, with industries expanding their production chains or real estate development companies investing in the acquisition of further plots of land, reducing the amount of investment in technology. But during an economic downturn, when people are less willing to buy products and services, there is a greater freedom for companies in allocating their budget, leading to an increase in investments in research and development. Other practical reasons may concern the management phase, with technologies that could help the company to be more flexible, transparent and efficient, automating activities and streamlining the process; the introduction of technology within a company allows to analyze internal and external data, support managers' analysis in understanding how the recession is affecting the business and which actions should be pursued in order to obtain a competitive advantage over the main competitors in the industry.

The technological developments that occurred during and after the great recession have shaken and innovated almost all sectors, from the financial sector with fintech, to the

[14] B. Hershbein and L.B. Kahn, "Do Recessions Accelerate Routine-Biased Technological Change? Evidence from Vacancy Positing", American Economic Review Vol. 108, 2018.

insurance sector with insurtech[15] and the real estate sector with proptech. The real estate, characterized by a traditionalist philosophy and technologically lagging behind other sectors, was among the main industry affected by the crisis which, according to scholars, triggered a strong innovation process, with the adoption of innovative tools aimed at safeguard the efficiency and correct functioning, avoiding possible collapse scenarios such as those that occurred after 2008.

The real estate sector is highly regulated and cannot be summarized as the construction or renovation of real estate units and the subsequent transaction process. Take an example of a real estate transaction, in a highly regulated market, it typically involves multiple parties other than the buyer and the seller and can become very complicated when the value of the transaction involves millions of euros.

Furthermore, the real estate industry can be defined as the most traditional and slowest in adopting the changes and innovations that modern technology offers, this for a number of reasons: firstly, the practices of the sector are influenced by a series of inefficient transaction costs, defended by professional consultants who dominate the process, such as real estate agents and lawyers, who have an interest in protecting their sources of income and resisting to technological innovation that could simplify the real estate process and digitize some phases of the transaction, cutting their work. Another reason is due to the nature of the traded asset classes, which as we have previously defined, are huge heterogeneous assets traded on a large private market, which may be too important as part of a private portfolio to take any risk with the process by which it is negotiated, held or evaluated.

However, the real estate sector has also undergone profound period of modernization over the years, due to a radical change in market demand and supply and a series of technological periods that have changed consumer habits. "*These innovations in the sector gave birth to proptech neologism, to identify all the possible applications of*

[15] The term **Insurtech**, from the union of the terms insurance ("insurance") and technology ("technology"), is the neologism used to describe the technological and digital transformation underway in the insurance sector. The Insurtech contraction therefore indicates, in a broad sense, innovation in the insurance sector enabled by technologies.

technologies and new business models in the real estate sector for the profiles of negotiation, management and financing of real estate investments". (Baum, 2017).

This broad definition includes software, hardware, material or manufacturing produced by start-ups and that create innovation using the technologies available on the market to solve the limitations present in the real estate industry. Specifically, digital technologies set the foundation of proptech development; proptech wouldn't be possible without the technological evolution.

Although the concept was recently introduced, proptech is not such a new phenomenon, there have already been technological introductions in the real estate market in the last century. In particular, we can indicate three periods of progress in the real estate sector, which in turn reflect a wider transformation of the technological ecosystem. The beginning of the first forms of technology related to the real estate sector dates back to 1980 with the introduction of personal computer and database management systems, whose daily use, led by the ability to digitize a variety of information, has revolutionized the way of analyzing and store real estate data and information. Excel and other IT systems for the management of real estate portfolios became, in that period, essential tools for the real estate professionals, who started to adopt a more quantitative approach to investments and portfolio management. We can therefore speak of a first form of Proptech 1.0 as early as 1980 with the advent of companies focused on the development and sale of software for analyzing the real estate market and related services, such as Argus and Yardi, two companies based in America, today world leaders in the supply of software and solutions for the analysis and management of real estate investments. However, it is good to underline that the innovations belonging to this historical phase have been characterized by a *"closed form"*, connected to internal improvements of the company but with limited integration and communication skills with the outside. The subsequent evolution of proptech began after the 2008 financial crisis, a period characterized by a continuous waves of innovations, investments and entrepreneurial activities.

We have witnessed a strong evolution of the market passing from very simple applications of technologies to the real estate sector (Proptech 1.0) to more advanced scenarios in which the main added value derives from the technology applied to the

property, made possible from a wider technological revolution taking place in the world, with the introduction of:

-*Websites and Smartphone Apps;*

-*Application Programme Interfaces;*

-*Data Analysis and Visualization;*

-*Internet of Things (IoT);*

-*Artificial Intelligence and Machine Learning;*

-*Sensors;*

-*Virtual and Augmented Reality;*

-*Geospatial technology;*

-*Cloud computing;*

The biggest shift in the real estate market, which marked the beginning of the second wave of real estate technology, called Proptech 2.0, was the transition from the digitised to the digitalised real estate system.

Specifically, the term digitisation refers to the conversion of paper hard copies into unintelligent digital soft copies; the data contained in the digitised documents cannot be extracted through computer programs and require human interpretation. In practice, digitisation can be considered as scanning a page, uploading a photo or creating a pdf, in order to have a digital copy of an original document.[16]

On the contrary, "digitalisation" is the act of converting anything into a digitally readable format. The digitalised data allow the software to automatically perform activities without the need for human intervention, being able to collect, analyze and respond independently to the available data.

This shift was the starting point for the development of proptech 2.0, which produced an unprecedented growth of startups operating in the sector, supported by huge investments by venture capital funds and accelerators such as Venture Scanner, CrunchBase and PiLabs. In particular, the proliferation of startups operating in the real estate sector has represented an important accelerator for innovations, capable of introducing disruptive and not only incremental solutions..

[16] We can link the use of digitization technology to Proptech 1.0.

In addition, the birth of Proptech 2.0 has led to the development of new business models, characterized by a different approach to real estate transactions, such as the instant buyer (IBuyer), who through algorithms evaluate the price of a house and subsequently release a purchase proposal in short time and real estate crowdfunding platforms, the introduction of which has made possible investments also for a part of the population previously excluded from the sector, thus expanding the public of investors and promoting a boost to investments in the sector.

Although the third wave of proptech has not yet happened, according to the experts in the next decade we will see this new technological chapter in the real estate sector, driven by technologies that have been recently available, such as Blockchain technology and 3D printers in the real estate development phase, that could solve the problem of rapid urbanization, offering the possibility to potentially reduce the amount of labor required by 70%, overall project costs by 90%, and the duration of construction by 80%[17].

In particular, the Blockchain is a decentralized resource database that can be shared on a network of sites, geographical areas or institutions and that does not require any third party involvement. The Blockchain is essentially a digital ledger, in which transaction information is recorded, analyzed and archived, but with a fundamental difference compared to traditional databases, inherent in the use of algorithms that allow the collaborative creation and storage of information. These "distributed registries" have properties and capabilities that goes far beyond traditional ones; first of all participants within a network have their own identical copy of the ledger, which automatically and instantly records subsequent changes on all copies, creating maximum transparency on transaction information. This information is inserted into "blocks" which are in turn placed on a "blockchain", making them public and permanent.

Basically, the introduction of blockchain within the real estate sector could allow transactions to move from the analog to the digital age in a secure and transparent way. Among the main advantages obtainable from the introduction of blockchain technology in the real estate market are:

[17] Among the main countries interested in the use of this technology are the United Arab Emirates, that have mandate that 25% of all new buildings will be constructed using 3D printing technology by 2030.

-***Simplification of transactions***: the use of the blockchain will lead to a simplified administrative process and a reduction in the processing times of real estate transactions for all the institutions involved. Through this technology it will not be necessary to check and verify the information on a specific transaction, which instead will be confirmed automatically, drastically reducing the heavy bureaucratic process currently belonging to the real estate sector.

-***Faster transactions and fraud mitigation:*** blockchain technology would allow to authenticate and control contracts in real time, without the need for an intermediary intervention. With a blockchain, all real estate offers could be executed through smart contracts, that is a digitally signed agreements. All this could lead to the elimination of intermediaries, with large savings in transaction costs.

-***Increase market transparency***: blockchain technology could lead the real estate market to be more transparent, through the public nature of the transactions included in the ledger. Below is a table summarizing the main advantages and challenges in adopting blockchain technology:

Advantages	Challenges
• A self-regulated and secure system, more so than current analogue and digital ledgers, as it is decentralised and not dependent on any single server or person • It can save costs and increase efficiency, as it can allow for a quick and easy transfer of assets by cutting out intermediaries who currently hold information that is not shared • Increased transparency and fraud prevention. Blockchain enables a clear log of the data that is inserted, and is often checked by multiple sources, reducing opportunities for forgery.	• Security: while seen as less susceptible to fraud than paper and digital documents, checks and balances need to be in place to limit the risk of fraud. As a popular saying goes, 'anything digital can be hacked' • The potential lack of willingness of involved parties to share data in the first place, as sharing data may go against their interests.

Figure 8: Main advantages and challenges in the implementation of blockchain technology.

2.3 Disruptive innovation theory (DIT)

The advent of proptech and more precisely of the technological wave in the real estate of the last decade, has led traditional sector players to reassess their organizational structure, with the aim of aligning with the new business models that have arisen.

Indeed, innovation is an element that changes almost every aspect of an industry, changing the structure and models implemented. The real estate sector is no stranger to this process, with a series of changes that are currently breaking the old traditionalist patterns, which have seen it as a slow, illiquid and opaque sector, in favor of rapid development in the use of innovative technologies. This series of innovations made in the sector together with the start of new activities has generated a prominent theme regarding the potential of the new proptech models to interrupt and disintermediate the traditional real estate sector, characterized by great inefficiencies and remained unchanged for decades. Indeed, scholars view proptech as a challenge within the real estate industry, with the potential to disrupt the activity of traditional actors. To this theme we can connect the *disruptive innovations theory*, which offers a linear framework for evaluating the degree of mutation in the real estate sector following the introduction of new technologies already used in numerous other industries that have encountered disruptive innovations. Basically, DIT aims to clarify why successful and established companies are in difficulty when new businesses, offering lower but more modern and scalable products and services, enter in the market. Before proceeding, it's right to define a disruptive innovation as: *"a new product or service that is generally launched by a smaller, new entrant company with lower or dissimilar performance characteristics than what is currently offered on the market, initially targeting the low-end part of the market and then gradually improving its performance, until it impacts or disrupt incumbent companies in the mainstream market"* (Christensen and Raynor, 2003).

The disruptive innovation theory offers numerous core tenets and principles of disruptive innovations, categorized into some aspects which describe the behavior of the market following the introduction of these technological-enabling models; we will therefore focus on two main elements of the theory, namely characteristics of disruptive innovations and process of disruption.

2.3.1 Characteristics of disruptive innovations

Generally a disruptive innovation introduces a new business model which is driven or enabled by technology and which is very different from those currently used by historical operators; often presents features not previously available, introducing new and different value proposals on the market and offering simpler, less expensive and faster products and services than those currently offered, giving the possibility to a part of the population to access products and services previously considered too complex and expensive. Although disruptive innovations may initially show lower performance on certain attributes and criteria valued by established companies, they often offer higher performance on alternative measurements that are deemed useful by low-end customers or in new markets. The analysis conducted on a sample of models considered innovative has shown that they often present activities and key success factors very different from those that characterize companies already on the market, introducing new customers who previously lacked the resources and skills necessary to participate in a given industry and thus generating growth and expansion. The following table summarizes the main characteristics of disruptive innovations.

Figure 9: Core characteristics of disruptive innovations

2.3.3 The process of disruption

Disruptive innovations is a process that generally follow three specific phases namely: *initial market entry*, *main market entry* and *market disruption*. In the first phase, disruptive innovation is launched in a market, in the lower-end of the existing market or in a new and emerging market. The new entrant firm with disruptive technology, at this stage of the process, tends to engage in a "lower attack", targeting customers in the low-end market or new customers who have less demand, and can accept the product or service as it currently is. Indeed, starting in a smaller segment of the market can help the new entrant, especially if the competitors are consolidated companies with large resources available, to develop their performance, size and momentum before expand and competing with incumbents.

Often, when disruptive innovation is launched, larger companies and major customers initially reject or dismiss the disruptive innovation, as it doesn't meet their performance requirements.

In the second phase of the disruptive process, called the main market entry, the companies that have adopted the innovative business model continue to improve and enrich their offer, eliminating possible factors that could hinder the correct competition with the products and services offered by the consolidated companies. The objective pursued by the disruptive companies in this phase is to achieves an acceptable level of performance and reach the main customers, belonging to the high end-of the market.

The third phase, called market disruption, is characterized by the disruptive innovation that has reached a good level of performance and standardization, managing to enter the main market and subtract customers belonging to established companies; at this stage, a lower price level is often practiced in order to facilitate the switch of customers towards the disruptive innovation.

Typically following this phase, the traditional model used in the sector is replaced in favor of the disruptive business model, even if between the two phases there will be response strategies from the incumbent companies, such as the purchase of the startup that promote the disruptive innovation.

2.4 Classification of the proptech industry

Proptech is made up of various business models, with the aim to offer different technological solutions and tools for the innovation of processes, services and products offered in the real estate sector. Proptech is a young industry, continuously evolving and characterized by wide boundaries that make difficult to precisely classify its individual subsectors. Over the years, numerous proptech classifications have been made, which differ from each other based on the criteria used; specifically we can find three types of classifications:

-***one level classification***: which presents a clustering by types of business with the aim of precisely describing the different areas of proptech innovation;

-***two-level classification***: proposes a differentiation of proptech into asset classes: residential, commercial, receptive, office, industrial;[18]

-***matrix classification:*** which proposes a matrix between vertical and horizontal features.

Below we will initially analyze a one-level classification of the proptech sector deriving from a study carried out by the real estate consulting firm Venture Scanner, and then move on to a matrix classification created by professor A. Baum whose representation, through a multiplicity of reading criteria, will be supportive to understanding the effective influence of tech innovations on the real estate field.

The classification carried out by Venture Scanner divides the proptech industry into 12 categories listed below:

I)Property Management: are companies that operate through digital platforms that support the management of property on behalf of an owner. For example, in the case of a rental property, these companies deals with the brokerage and subsequent management, such as the collection of rents and the ordinary and extraordinary maintenance of the property.

II) Construction management: the companies operating in this category are part of the ConTech segment, an area of activity of proptech, which uses technology to innovate the way in which structures are designed, developed and built, as well as production and installation of their components.

[18] Examples of two-tier classification of proptech are used by CBInsights, James Dearsley and JLL

III)Facility Management: following the wave of proptech 2.0, the facility management area has undergone a profound change, with the introduction of innovative technologies that support the collection, communication and storage of building's data aimed at achieving a long term self-sustainability of the structures from an environmental and energy point of view. Examples include tools to quantify building's data (energy usage, water usage, etc.), tools to make building more efficient and building inspections platforms.

IV)Portfolio Management: a wide range of platforms that offer, through the use of algorithms and databases, consultancy services regarding efficient portfolio allocation, such as investment choices and diversification of real estate activities. Within the portfolio management category there are also real estate crowdfunding models, a recent phenomenon which will be analyzed in the fifth chapter.

V)Home services: this category is represented by technologies that support consumers in managing their homes; examples include cleaning services and renovation management.

VI)Commercial Real Estate Search: digital platforms that operate as real estate brokers, promoting the match between supply and demand of commercial properties, also offering additional services such as automated valuation models. This category includes companies that rent co-working spaces.

VII)Long-Term Rentals / Sale Search: real estate platforms that help customers in finding the property closest to their needs. This category is seen by many scholars as an evolution of traditional real estate agents. The largest platform in Italy is "immobiliare.it"[19].

VIII)Short-Term Rental/Vacation Search: online search engines containing advertisements for short-term rentals and vacation rentals. Example include platforms for individuals to list their personal properties as well as traditional vacation lodging search engines.

IX)Life, Home, Property & Casualty Insurance: the category is represented by digital operators offering a large set of insurance, such as life and property insurance.

[19] **Immobiliare.it**: is the main Italian real estate portal for searching and posting advertisements

X)Real Estate Agents Tools: represented by technologies that support the activities of the real estate agent as well as innovative business models that actually automate the process.

XI)Indoor Mapping: a series of software that can be used for the creation of real estate renderings, 3D models of the structure and virtual property tours.

X)IoT Home: Internet of Things is radically changing the way in which structures and cities are managed and developed; through smart devices that can connect to each other, it is now possible to collect a lot of data in real time, leading to efficiency in the management of structures or areas. IoT technology is rapidly spreading in various sectors, including the urban one with Smart Cities and the residential one with Smart Homes. The classification made by Venture Scanner is certainly exhaustive, including numerous operational areas of proptech.

Figure 10: Representation of the one-tier classification of the proptech industry (Venture Scanner, 2018).

Andrew Baum, professor of the University of Oxford, in his work entitled *"Proptech 3.0: the future of the real estate sector"*, classifies the segments of the industry by

enclosing its operating fields in a matrix made up of three criteria, defined as *"vertical"*, which identify different functionalities or phases of the real estate life cycle, and three business segments, defined as *"horizontal"*, which instead identify the different proptech business areas.

In particular, the vertical components are:

I) Information: technologies that support a more efficient exchange of data between the players in the real estate market, making this process faster and safer.

II) Transactions: technological solutions that aim to make the intermediation process simpler and more transparent.

III) Management: digital technologies that regulate a more accurate monitoring of properties, including their management.

With regard to the three horizontal components, or areas of activity, they are:

-***Smart Real Estate***: describe a set of technology-based platforms that automate, simplify and make the *operation and management* of real estate activities more efficient. The smart real estate consists of several components, the union of which creates an integrated system based on technology, which offers consumers a series of integrated systems to improve their quality of life.

Among the main applications we can find smart building, consisting of a series of technological tools with the aim of improving the building management, as digital solutions for energy optimization and home automation.

-***Sharing Economy***: it's the second area of proptech activity identified by Baum, which is focused on simplifying the *use* of real estate assets and is represented by a new economic model based on alternative processes of resources distribution and income generation, such as short-term housing rental, a new model of space sharing supported by technology. Co-working is a rapidly growing business model in this area, which implies the sharing of a workplaces among multiple companies and professionals; the positive aspects of co-working spaces are, in addition to the reduction of rental and utilities costs, the synergies created through the sharing of knowledge between multiple professionals.

-***Real Estate Fintech***: it is represented by a series of digital platforms capable of simplifying the transaction on the real estate market. Within Real Estate Fintech there are also companies engaged in the secondary market which, through the use of

technology, guarantee greater transparency, divisibility, liquidity and market negotiability. One of the main innovative business models within this subsector is the real estate instant buyer, an innovative business model that offers alternative solutions to the traditional agency's mandate; in particular, the owner of the property sells directly to the ibuyer company, which in turn assumes the economic risk of the future resale of the property against a discount on the market value of the property during the purchase phase.

The Real Estate Finctech can be considered as an extension of the largest Fintech area, defined as "*the use of technology and innovative business models in financial services*". Several business models fall within the Fintech industry, such as online payment systems, crowdfunding equity and debt platforms and online exchange, which in turn have also been adapted to the real estate sector. From all this it follows that the development of the Fintech industry has provided the basis for the growth of Proptech 2.0, which however must be understood as a distinct area of activity. We can therefore define Proptech and Fintech as two separate groups that share one overlap area of activity that is the Real Estate Fintech.

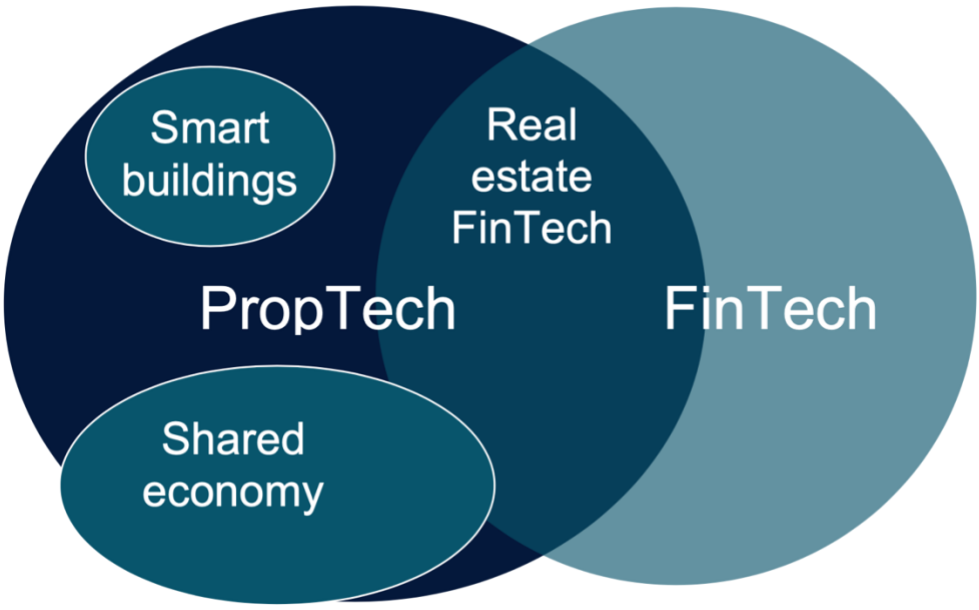

Figure 11: Proptech roots (Baum, 2017).

The matrix classification shown, however, omits to indicate among the areas of proptech activity that relating to the technology applied to the real estate development phase; in particular, ConTech can be defined as the technology for innovating the design and construction of buildings, as well as the production and installation of their components. Among the main innovations introduced in this area are those belonging to Building Information Modeling (BIM), a smart process based on 3D models that offers architects, engineers and builders various information and tools to plan, design, build and manage buildings and infrastructure in the most efficient way. ConTech is certainly among the areas of greatest potential growth within the proptech universe, with investments aimed at startups that went from 730 million in 2017 to over 3 billion in 2018, this for a number of reasons: mainly the construction industry is huge, estimates indicate that today it is worth over 24 trillion dollars globally; moreover, it is not yet technological, especially as regards construction methods, characterized by traditional and inefficient procedures. However, to date, its potential still remains partially hidden, due to the complexity of the segment, characterized by numerous actors such as: owners, designers, engineers, contractors, subcontractors, regulators and investors, who are not always willing to accept radical innovations that require large capital and long periods of development and adoption. Analyzing a sample of over 600 operators in the proptech sector, Baum segmented them according to the different functionalities (vertical components) and according to the different areas of activity (horizontal components); the result of his work is summarized in the following matrix.

	Real Estate Fintech	Sharing Economy	Smart Buildings	Contech	Total
Information	12.9%	0.6%	0.9%	3.1%	17.5%
Transactions	38.3%	16.6%	3.4%	3.4%	61.7%
Control/management	0.0%	2.5%	15.0%	2.1%	19.7%
Total	51.2%	19.6%	19.3%	8.6%	98.8%

Figure 12: Percentage of operators in the different phases and in the different areas of proptech activity according to the matrix classification

As can be seen, the majority of proptech operators, around 62%, focus on the horizontal phase of transactions, with the aim of facilitating the sale or leasing of real estate assets.

As far as the most populated subsector is concerned, Real Estate Fintech currently includes most of the proptech operators, thus suggesting that the main innovations include those relating to the financialization[20] of the sector.

2.5 Market size and types of investors

Just as the word proptech is very young, the development of this technological subsector is still in its infancy and only in recent years we have observed a strong growth in the interest of markets and governments, also driven by the work of numerous networks and hubs; they, that operate in the form of private companies or non-profit associations, have contributed to creating an environment of market education and inspiration, where proptech startups can build relationships between them and obtaining important synergies.

Thousands of startups are currently operating in the real estate value chain, redefining the products and services offered in the sector, optimizing the ways in which real estate professionals works and changing how consumers interacts with the market. New job positions are being created within the real estate sector, closer to the technology world, such as “Chief Transformation Officer”, “Chief Digital Officer” and “Chief Innovation Officer”. There are currently 22 unicorns[21] proptech startups, ten of which are located in the US and twelve in China, with a market valuation of over $ 70 billion. To date, proptech unicorn startups are not yet present in Europe, this for two main reasons:

1) the European area is characterized by a strong fragmentation of the market, made up of 28 countries with different languages, culture, skills, industry standards and legal frameworks, which make it difficult for operators to expand their activities in multiple geographic markets.

2) In Europe there is a lack of venture capital funds, especially those specializing in later stages investments.

[20] The term "***financialization***" of the real estate market refers to the progressive approach, in the methods and techniques of economic evaluation and in the market structure, of real estate activities to those relating to the securities market

[21] **Unicorn company**: is a privately held start-up company valued at over 1 billions of dollars. The term was coined by venture capitalist Aileen Lee. To date, there are 465 unicorn companies worldwide.

Analyzing the frequency of searches of the term "Proptech" on the Google Trends website, it is possible to notice a sharp increase in its popularity in recent years, especially in countries such as Norway, Hong Kong, United States United Kindom and Germany, where a large part of the population is attracted to industry news and articles. Italy ranks among the last positions on the European proptech scene, confirming the slowness of the country towards innovations already underway in other countries of the world.

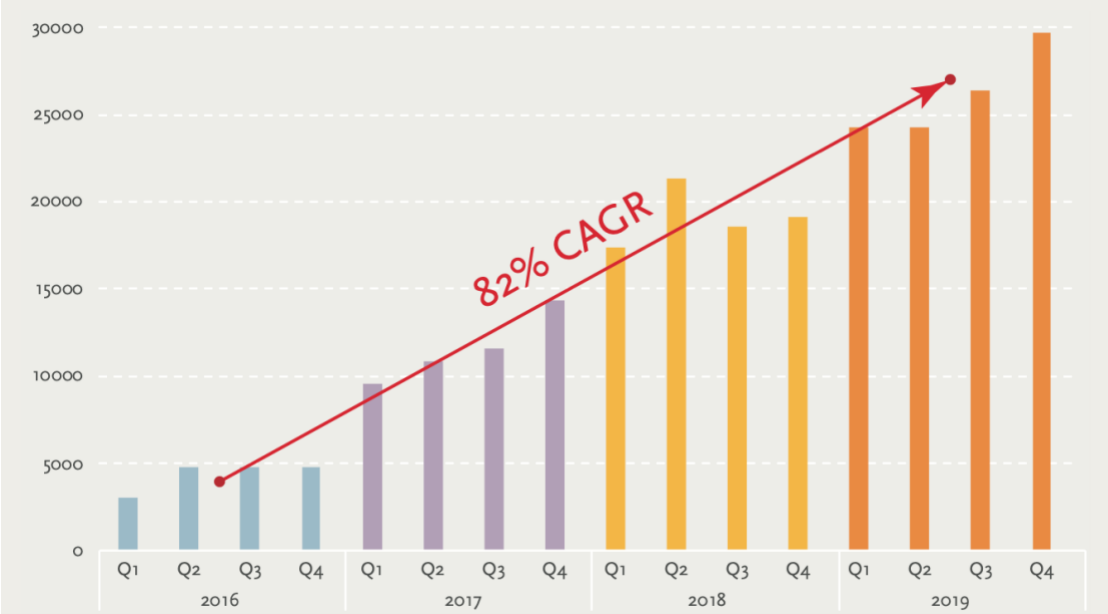

Figure 13*: Number of searches for the term proptech on Google Trends*

Although interesting, the analysis of the frequency of web search cannot certainly be considered a reliable tool for evaluating the growth of an industry. One of the metrics that can be used to understand proptech's real growth is related to the volume of investments; indeed: *"how much money gets poured into an industry is often seen as a sign of health"* (Faraudo, 2019).[22] Consequently, most attempts to size the proptech market look at the growth of funds achieved year after year.

In recent years the industry has attracted numerous capitals, driven by a huge size of the real estate market equal to a share of world GDP between 17% and 20%. According to research conducted by Venture Scanner, while in 2014 the global investments

[22] F. Faraudo: "The Truth About PropTech Funding", 2019. https://www.propmodo.com/the-truth-about-proptech-funding/

dedicated to the digitization of the sector amounted to about $ 8 billion dollars, these in 2019 reached the share of $ 28 billion, with an average annual growth of 30%.

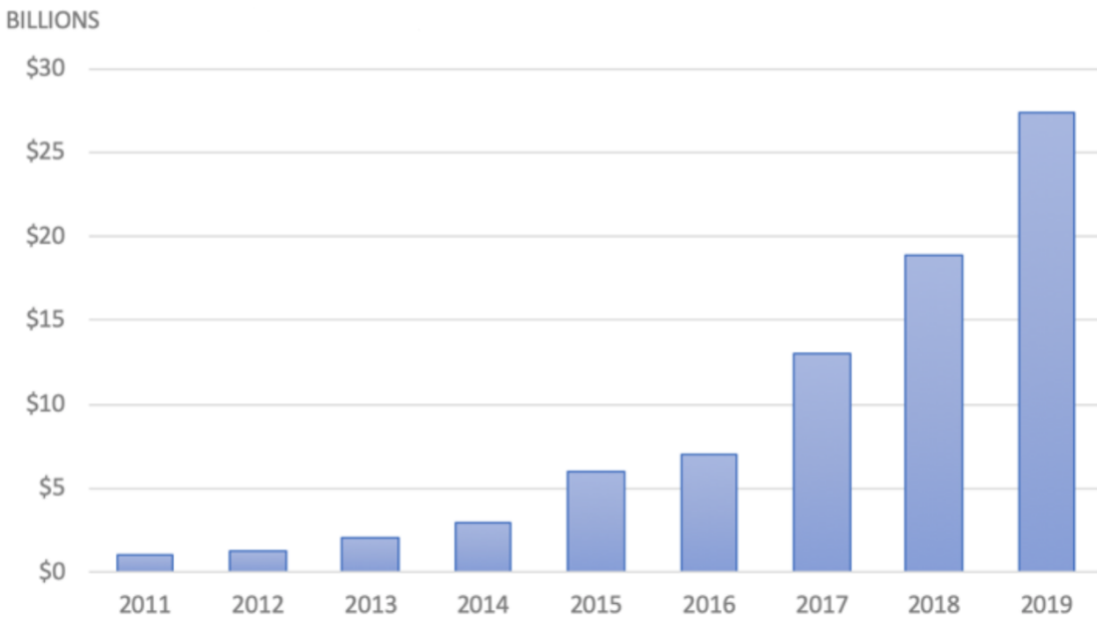

Figure 14: Overall value of proptech investments worldwide

The growth of investments in proptech is attributable to the transition of the industry from a take-off phase to a first phase of consolidation, which emerges from an analysis of the type of investments made, that in the 2018-2019 period decreased in the overall number of rounds completed (-25%) but increased in the size of each individual investment. In particular, by distinguishing the investments on startups in the initial phase (focused on the development of the product and service offered and for production and first sales) and in the subsequent phase (capital necessary for working capital and business growth) we can observe a reduction in overall investments in the initial stages and an increase in the subsequent stages, demonstrating that the proptech industry has entered in a consolidation phase with investors willing to put a greater amount of capital but in specific areas deemed potentially profitable. According to experts, in the next five years the proptech market will undergo in a maturity phase with an increasing number of IPOs and M&A deals, pushing the birth of large global proptech players.

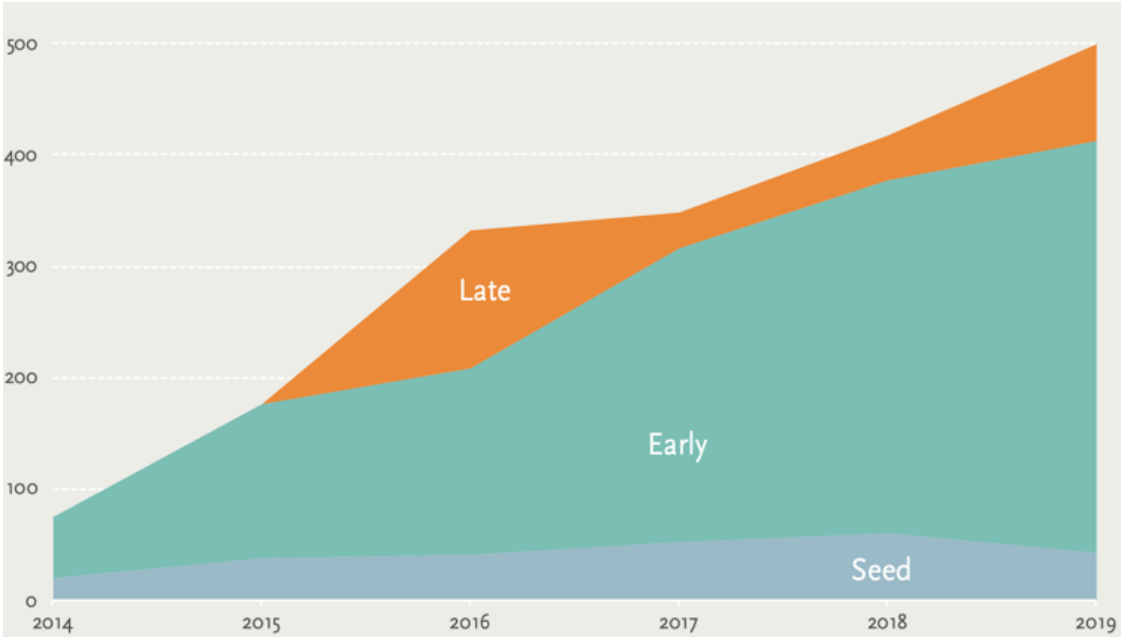

Figure 15: Financing volume of proptech start-ups according to stage. (Proptech1, 2019)

Analyzing the investment activities, we can see that the capital landed in the proptech industry comes from different sources, the main ones are:

1) Cross-industry VCs: they represent the category of investors who have placed the largest amount of capital in the proptech industry. This class of investors are active in at least four different sectors without a specific focus on real estate. Several research organizations have tried to quantify the amount of capital placed in the industry by this class of investors, with results that differ from each other due to the lack of clarity in defining the proptech universe. According to Venture Scanner, cross-industry VCs invested approximately $ 30 billion in industry between the 2014-2018 period. The table below shows the percentage increase in proptech investments compared to the total investments made by this class of investors. As you can see, although the percentage of total investments in the proptech industry has dropped from 15.2% to 8.5% between 2017 and 2018, the total amount of investments in the industry has increased by about six times between 2015 and 2018, from $ 1.8 billion to $ 11.15 billion.

	2015	2016	2017	2018
VC in Proptech	1.80	4.20	12.60	11.15
Total VC	83.00	77.20	83.00	130.90
Proptech/VC	2.2%	5.4%	15.2%	8.5%

Figure 16: Venture Capitalist investments in the proptech industry

2) Accelerators: also known as seed accelerators and often coordinated by important universities, they are programs focused on supporting startups in the initial phase of activity, offering not only capital, but also mentoring, business guidance and expertise. Among the main European accelerators supporting the proptech industry are: Seedcamp (United Kingdom), Impact Accelerator (Spain), The Faculty PropTech Accelerator (United Kingdom).

***3) Corporate Venture Capitalism (CVC)*:** represents one of the main tools used by companies to invest indirectly in new technologies and business models such as those belonging to the proptech industry. CVC is a type of investment made by consortia of medium and large traditional companies on one or more startups through a dedicated fund. CVC funds acquire a share of capital, generally in the minority, of new innovative startups in the same sector or in a related one, with the aim of gaining privileged access to innovations and developed technologies. According to Altus Group, approximately 53% of the main real estate companies are directly investing at least in one proptech startup.

Among the main companies, not only involved in the real estate but also belonging to other sectors such as telecommunications and the energy industry, active in investments through CVC funds we find: Saint-Gobain (France), Duval (France), Kärcher New Ventures (Germany) and Countrywide PLC (United Kingdom).

4) PropTech VC: these are venture capital funds focused on the proptech industry, most of which located in Silicon Valley. Eight proptech VCs are active in Europe, mainly based in the United Kingdom, Germany and France.

The following table shows a detailed list of the main Proptech VCs and accelerators currently active in the sector; while the pie chart shows the percentage distribution of investments in industry from the four sources of capital.

VC Fund	Investments	Target
500 Startups	28	US
Thrive Capital	20	US
Founders Fund	16	US
Y Combinator	15	US
MetaProp NYC	15	US
General Catalyst	14	US
Greylock Partners	14	US
Khosla Ventures	14	US
Felicis Ventures	13	US
Andreessen Horowitz	12	US
SV Angel	12	US
Global Founders Capital	12	Eu
Navitas Capital	11	US
Resolute Ventures	11	US
Right Side Capital Management	11	US
Pi Labs	11	Eu
Seedcamp	11	Eu
Seaya Ventures	7	Eu
Bpifrance	6	Eu
HOWZAT Partners	6	Eu
Passion Capital	6	Eu
LocalGlobe	5	Eu
Picus Capital	5	Eu
Piton Capital	5	Eu

Figure 17: List of the most active Proptech VCs and accelerators in US and Europe

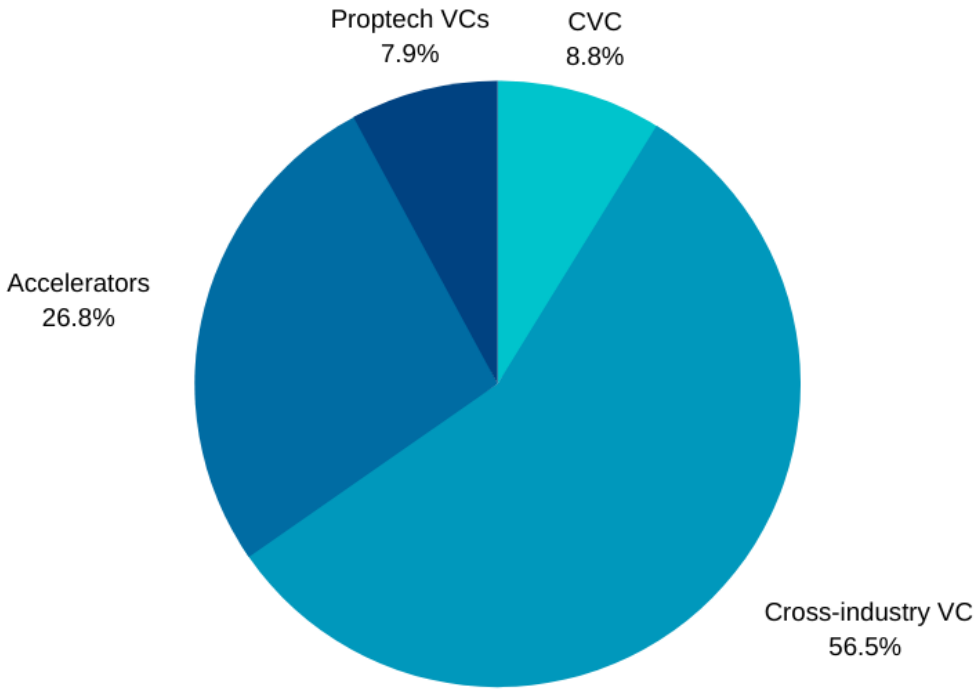

Figure 18: Distribution of the different sources of investment in the proptech industry (2018)

2.6 Geographic distribution

The proptech industry is characterized by the presence of numerous operators located in different geographical areas, with a strong relevance in the American (38.9%) and European (45.1%) markets. Specifically, the main areas of the proptech industry are California, the US coast, Western Europe (especially the UK) and some regions of the Asian continent. Below we will analyze in detail the main countries characterized by a strong and growing proptech industry.

2.6.1 United States

The United States, with over 2.000 operators, is one of the most important proptech market in the world. The strong economy and the enormous technological heritage have

made it possible to develop many radically innovative projects in the real estate industry. New York and San Francisco are home of several accelerators and venture capital funds involved in innovative projects and represent the country's main technology hubs, as well as being among the main global technology cities; about 53% of the national proptech operators focus on the residential market, which requires huge investments in technology with the aim of reducing national problems such as housing inaccessibility for a large part of the population and the limited sustainability of urban areas. A business model recently developed in the residential segment is the *"Build to Rent"*, that is the development of large residential complexes with the aim of renting units to individuals and families who cannot or do not want to own a house; the major players in this business model include large pension funds, long term oriented and focused in investments with a low degree of risk. According to many experts, this new business model could drive the growth of management technologies such as those related to property monitoring and digital rental platforms. Another share of the country's proptech operators, in particular 38%, are active in the commercial segment which, following the development of a strong online market, suffered a strong contraction in demand. The development of proptech in this segment is focused on a series of services relating to the life cycle management phases and the segmentation of properties, of which the main operator is Wired Score, which offers a real estate valuation system that allows owners and potential customers to understand, improve and promote the digital connectivity of their buildings.

As for the Contech subsector, less than 10% of the country's proptech operators are currently active in this sector; however, taking into account the expected housing shortages in the country due to the current strong urbanization, many scholars predict a rapid growth in the number of operators and investments in this sector in the coming years.

2.6.2 Europe

There are currently more than 3.200 proptech startups and scaleup companies in Europe (including Great Britain and Switzerland), located mainly in United Kingdom,

Germany and France. Below we will analyze in detail the proptech industry in the main European countries.

United Kingdom

With around 800 operators, the United Kingdom is one of the most influential proptech hubs in the world. Unlike other European countries, almost all proptech operators are not distributed homogeneously in the country, but are concentrated in London, making the capital one of the main proptech cities in the world. Thanks to the favorable internal conditions and a series of government-funded incubators, the United Kingdom is now one of the models to follow in terms of technological innovations; further favorable point is the awareness of many real estate companies of the central role of technology, many of which are ready to finance or acquire startups operating in the sector to have agility and adapt in a rapidly changing environment. In the last decade, the British residential segment has been hit by a deep housing crisis, characterized by limited supply, a high level of prices and long sales times; these factors represented a trigger for the growth of numerous real estate startups with a specific focus on the residential market, which today represents the operating area for around 60% of proptech operators. The residential rental market is experiencing strong growth, with over 20% of operators focused on renting and managing properties. Another really interesting trend in residential proptech in the United Kingdom is modular construction, belonging to the ConTech area, which allows developers to build faster and more economically, making houses accessible to a larger portion of the population, companies such as Ike Homes they are market leaders in this area.

As for the offices, the data show that 38% of the proptech companies operate in this segment. Due to rapid evolution face of the workplace and rising costs for offices in central business districts, the number of long-term rental contracts is decreasing dramatically, with modern companies requiring flexible and short-term spaces, distinctive features of the coworking which is estimated to have increased by around 5.320 in the UK in the past year, with growth close to 10%. Among the peculiarities of

the offer of English co-working spaces, there is that of being characterized by a great fragmentation, with the three largest operators in the country representing only 17% of the total market share. Currently the biggest limit of proptech in the United Kingdom is the lack of large operators, with a reduced number of companies that have expanded their offer beyond national borders expanding internationally and with an increasing number of foreign companies operating in the United Kingdom.

France

Characterized by a healthy economy and an estimated GDP growth of 2% in recent years, also led by a series of development plans in many sectors, France is among the main European countries for investments in technology.

Among the main supporters of the proptech is President Macron, who understood the need for a digital transformation in the real estate sector, guaranteeing large capital in the sector and drawing up various development plans, including "Vision 2030", with the aim of make Paris a Smart City by 2030. Today there are 500 proptech operators active in France, of which about 220 are only in Paris.

Although the number of houses in some French cities, including Paris and Lyon, is already at a level close to saturation, over 71% of proptech operators provide products and services in the residential segment and in particular in the area of urban sustainability.

Rapidly growing business models include short-term rental, with platforms such as Bnb Sitter and HostnFly offering real estate and rental management services.

In recent years, the commercial segment has also been at the center of important developments, with large sums of public and private capital destined to finance the development and regeneration of urban areas, such as the Confluence District in the city of Lyon, the largest city urban redevelopment project in Europe, which has attracted numerous foreign investments. Another strong growth trend in the office sector is flexible work, with an increase in interest and in the use of co-working spaces by companies. In particular, the co-working sector is growing in the country and

particularly in Paris, with international (WeWork) and national (Start-Way and Kwerk) operators committed to expanding its offer throughout the territory.
The development of the French proptech industry will certainly continue in the future, also thanks to the strong support of the government and the presence of startups characterized by a high rate of innovation, capable of attracting large foreign capitals and expanding internationally.

Germany

Characterized by a large population and a strong economy, Germany is a world leader in many industrial and technological sectors. Over the years the country has experienced a strong growth in the proptech technology, driven by three main factors:
- a large property market, characterized by growing demand, which has led to a recent rise in property prices of 8.5% per year in the country's urban areas and 9.5% in the main cities including Berlin, Cologne, Hamburg and Stuttgart;
- a lively business community, supported by universities and professional associations which, through events and accelerators of regional startups, have coordinated and encouraged the development of several innovative projects. An example is the German Proptech Initiative a private association made up of numerous companies and entrepreneurs operating in the real estate, construction and consultancy sectors, which supports sectoral cooperation by promoting the exchange of knowledge and supporting all projects related to proptech[23].
- an increase in the level of technological investments in the country, thanks to the strong presence of venture capital funds, many of which are interested in the proptech area. With around 300 operators, the German technology industry has recently made its presence known both at home and abroad. About 66% of operators are active in the residential segment which, following the entry into the labor market of millennials characterized by greater attention towards the digitalization and sustainability of

[23] For further information on the Proptech Initiative, see the website: https://gpti.de/#infos

buildings, has led to a change in the offer in favor of smart real estate area. The office segment is also following this technological trend, with 29% of the country's proptech operators active in this segment. Among the main rising trends within the segment are co-working spaces, in which Germany represents the first nation to open an official co-working space in Europe, the "Batahaus" in 2009. To date, this business model continues to grow, driven by a continuous increase in office rental prices in the main German cities and by numerous operators present, including Leverton, a German company founded in 2012 and which today operates in several countries including the United Kingdom . According to leading experts, German proptech will continue to grow in the future, driven by strong domestic and foreign demand.

Italy

Italy is a country characterized by a great cultural wealth and a huge real estate heritage, with over 70% of the population owning at least one property. Although the proper functioning of the real estate sector is considered fundamental for the growth of the national economy, today it is strongly traditionalist and characterized by a large gap compared to other European countries. One of the main obstacles to the development and digitalization of the sector is an inadequate financial system, with a limited presence of large investors and venture capital funds. Analyzing the financing deals concluded in the proptech industry, we can see a large gap between the capital invested in the Italian territory, which is around a few tens of millions of euros, and those invested in the United Kingdom, which exceed hundreds of millions of euros . The low capital that has flowed into the industry over the years represents the main limit to the digitalization of the Italian real estate sector.

Even if these obstacles slow down the path of technological growth, in the last three years in Italy the proptech technology industry is growing exponentially, strongly affecting a sector that is currently very flat and stagnant; according to an analysis conducted by the Milan Polytechnic, from 2017 to 2019 the number of operators in the Italian market has almost tripled, from 50 to 150 proptech companies. About 70% of

companies originate in Northern Italy, in particular in Milan (50%), while in the center and south there are respectively 15% and 5% of companies operating in the sector.

2.6.3 Asia

Asia today represents the continent of greatest development in many sectors, with numerous Asian countries world leaders in the introduction of new technologies on the market. Although the continent had a slower start than America and Europe in the area of proptech technology, today it represents the place where the highest development potential is found.

To date, there are approximately 548 proptech operators in Asia, with China, India and Singapore representing the main hubs with 144, 170 and 84 operators respectively. However, this figure that places India above China is highly misleading when one considers the total amount of funding obtained by each of the nations. Indeed, although the number of operators is similar in the two regions, the amount of capital raised varies considerably between the two countries: with about 50 financing agreements concluded, India has purchased just under 1.5 billion dollars, while China 53 deals it raised over $ 10 billion, thus demonstrating its strong leadership in the Asian proptech sector, as well as the great investors' confidence in this country.

According to scholars in the next 10 years, Asia will reach the same level as the United States and Europe, ranking among the world leaders in the PropTech sector. The Indian real estate sector is also expected to have a market value of $ 1 trillion by 2030, while the industry is expected to contribute around 13% of the country's total GDP by 2025.

The opportunity for proptech in such a lively market is evident. Technological advancements in China have made it a world leader in 5G technology; in addition, the government is planning a strong urbanization of the country in the coming years, with over 250 million people who will move from the countryside to the cities to improve the nation's production capacity, influencing the growth of proptech as a support to urbanization and the potential crisis housing. China is destined to play a crucial role in the development of the PropTech sector with the development of smart cities and

technologies related to the real estate sector, being able to become a proptech world leader in the near future.

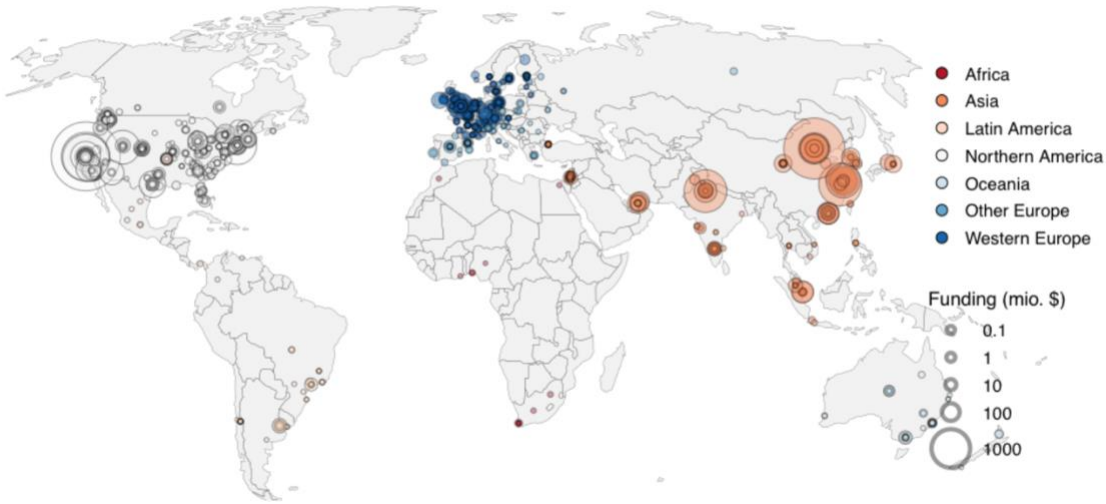

Figure 19: Global distribution of proptech companies.

CHAPTER 3

SMART REAL ESTATE

3.1 Introduction

This chapter will focus on the smart real estate which, as mentioned above, includes all those technological platforms and applications responsible for collecting and supplying data to customers, agents and real estate managers, with the aim of promoting an efficient management of assets and resources. The characteristics of this model are focused on the user, on sustainability and on the use of innovative and disruptive technologies in order to obtain benefits that would otherwise not be achievable. In particular, four disruptive technologies used in the smart real estate area can be identified, which are:

I) Cloud computing: is the innovative practice of using a network of remote servers hosted on the Internet to store, manage and process data, rather than using a local server. This means that files previously stored in a single location can now be used by anyone with authorization, anywhere in the world and on a multitude of compatible devices. The virtual data rooms replaced the physical documents for the due diligence process, improving transparency and security; collaborative software applications have become industry standards and digital workflows aid transparent and time-optimized execution of standard processes. Professionals are now free to work from anywhere, changing the nature of work. Cloud computing is therefore one of the main disruptive technology of the real estate industry, allowing to manage properties in the best and efficient way.

II) Big Data and data analysis: refers to a large set of structured and unstructured data. Since the volume of data is huge, its processing becomes difficult to implement using conventional data management techniques.

The characteristics of big data reveal a great potential in terms of progress and possibilities of use, linked to the tools and technologies available. The use of big data in recent years has had a strong development in many sectors, including proptech, where the main uses come from the smart real estate.

III)Artificial intelligence (AI): involves coding a device to perform a certain number of tasks in a smart way. Among the major uses of this technology there's the

predictive analysis, capable of producing several insights from the analysis of big data.

IV) Internet of Things (IoT): includes technologies and applications that equip and connect devices, systems and buildings in order to generate a large amount of information and make their management more efficient, sustainable and intuitive.

Conceptually, the integration of IoT technology within the real estate industry is aimed at promoting a smarter management of the structures as well as increasing the well-being of the occupants and the environment.

The development of sustainability and smartness within society is a recent topic, driven by changing demand, increasingly oriented on a sustainable and efficient economy. The smart real estate sector operates in a close relationship with the green economy: the change in climatic conditions due pollution and intense global urbanization has been one of the main triggers of the recent real estate revolution. According to studies conducted by the European commission, buildings are responsible for around 40% of the total energy consumed worldwide and 36% of CO2 emissions, representing the sector with the highest waste of resources. This is because about 35% of existing buildings are over 50 years old and about 75% are considered inefficient from the point of view of current energy standards[24]. For these reasons, in recent years there has been a common awareness of the society towards a new frontier of the sector called smart real estate, focused on smart devices and systems capable of bringing numerous benefits, including an efficient management of energy consumption with the aim of generating a positive environment impact. The integration of these technologies in the real estate sector will lead to the creation of building management systems (BMS) capable of performing numerous autonomous tasks in a more efficient and economical way, including:

- ***Operating systems based on actual use***: which through the use of sensors and artificial intelligence software will allow optimal use of the energy resources of the buildings. For example, balancing the heating and lighting system based on the number of people present in a specific room.

[24] https://ec.europa.eu/info/news/new-rules-greener-and-smarter-buildings-will-increase-quality-life-all-europeans-2019-apr-15_en

***- Operating systems based on predictive use*:** through continuous data collection, the BMS will be able to learn which areas of a building will generally be used at certain times of the day, managing the heating of the area in advance and avoiding unnecessary system stress and spikes in energy demand.

-Operating systems based on environmental factors: the connection between multiple devices and sensors allows the system to regulate the lighting and heating level autonomously according to the climatic conditions.

-Preventive maintenance: an intelligent BMS is able to learn the energy consumption requirements of the individual units of a system. For example, if a unit shows an anomaly, the system will notify the manager, allowing appropriate corrective actions to be taken before the problem occurs.

According to the major experts in the sector, although twenty years ago the characteristics of connectivity and efficiency were considered an added value, today they are among the main drivers in the price of a property, with the rise of standardized certification systems to classify the level of smartness of a building, such as the "Intelligent Building Index"[25], developed in collaboration with Microsoft, Investa Property Group, Willow, University of Technology Sydney and EG. From how it is possible to understand in the proptech sector, smart real estate is certainly one of the main models in terms of number of operators and volume of investments; it can also be divided into three specific business areas: smart home, smart building and smart city. Below we will analyze these three areas individually.

[25] As buildings move towards digitization and modernization, there is a growing need on the market for a framework suitable for assessing and classifying the degree of smartness related to buildings around the world. The first in chronological order created and accepted by numerous institutions is the ***Intelligent Building Index***, which uses both quantitative and qualitative measurements to evaluate the relative intelligence of a building.
https://www.willowinc.com/2019/06/11/introducing-the-worlds-first-intelligent-buildings-index/

3.2 Smart Home

Smart Home is defined as *"an intelligent environment that is able to acquire and apply knowledge about its inhabitants and their surroundings in order to adapt and meet the goals of comfort and efficiency"* (Perumal, 2013).

Smart Home includes a series of technologies applicable to the residential segment capable of monitoring and automating a wide range of digitally connected devices such as lighting, heating, ventilation, air conditioning (HVAC) and safety systems, as well as appliances such as washing machines, ovens and refrigerators. These products are connected and controlled remotely, anywhere in the world from a mobile device or from any other internet-enabled network. In the last decade, a large number of technological developments have taken place in the IoT domain, with the aim of promoting a better lifestyle and making some working areas more efficient, including automation, transport and healthcare; also in the real estate sector this technology has had a strong impact, with the introduction and subsequent growth of smart devices aimed at creating a large IoT ecosystem connected to smart homes.

The Internet of Things can be defined as an extension of the Internet and other networks connected to different sensors and devices, whose implementation in the real estate sector allows to obtain numerous advantages, including a greater efficiency in consumption and an improvement in the user experience of residents. As mentioned above, buildings and in particular heating, ventilation and air conditioning (HVAC) systems are responsible for a large part of world energy consumption and air pollution, more than other sectors such as transport and heavy industry; today, where environmental sustainability has become a hot topic, intelligent control of consumption in buildings is necessary.

This condition has led to a growing interest in the use of IoT devices installed inside homes; in a smart home various electrical devices and applications are interconnected and communicate with each other, pushing towards the efficiency of the houses, through the use of sensors capable of monitoring HVAC systems, occupancy monitoring and other connected systems, in order to make them smarter and more adaptive to the needs of the occupants.

In this technological ecosystem, where a large number of smart devices communicate with each other, a huge amount of data is generated, the so-called Big Data. This

phenomenon has led to the rise of new technologies capable of collecting, filtering and analyzing such data with the aim of revealing certain trends and promoting further development in the process of building efficiency, as well as fueling a wider implementation of the process and relatively wide range of smart technologies, through the introduction of smart cities.

The Smart Home market today is still in its infancy and only in recent years has it experienced strong growth, dominated by a series of innovations introduced on the market. According to a study, the IoT device market between 2015 and 2020 grew at an average rate of 78.8% per year, reaching a value of around $ 1.3 billion today.

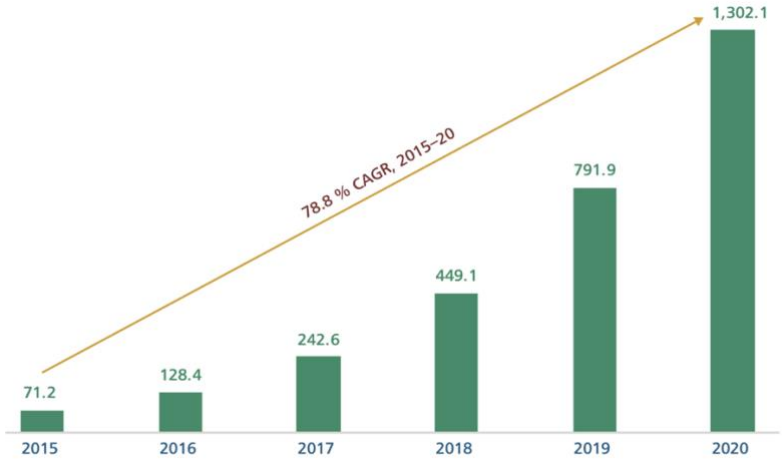

Figure 20: Growth of the global smart home market

3.3 Smart Building

The origin of the term smart building is not recent, but dates back to the nineteenth century when the first sensors for the control and automated management of assembly lines were introduced in large production plants, with the aim of achieving greater operational efficiency through savings on labor costs and increased production. However, only in the new millennium, following the development of data analysis technologies and storage systems, the concept of Smart Building and Building Management System had a strong development in the real estate sector.

The concept of smart building, unlike the smart home which includes systems and sensors connected with the aim of improving efficiency and user experience in the residential segment, refers to a complex technological system capable of achieving management efficient of the building, optimizing the various operations and automating the management of mechanical and electrical equipment, such as assembly lines, ventilation and lighting systems, prevention and safety tools, obtaining significant increases in productivity and significant cost savings. Smart building is composed of three main components:

- ***Construction devices and solutions***: systems and sensors capable of achieving energy efficiency, those relating to the theme of building safety and those with the aim of increasing the well-being of the occupants.

-***Automation technologies***: a series of technologies related to connectivity between sensors and data collection, including the Internet of Things area.

-***Control and management platforms***: a set of software systems with the task of filtering, analyzing and processing data.

Only with the presence of these components a building can be considered smart and obtain some benefits including a reduction in waste, thanks to the active use of the data collected by the sensors, lower energy consumption, less repairs and maintenance costs, savings in administrative costs, as well as continuous data monitoring capable of preventing potential mechanical problems. The implementation of a technological ecosystem inside buildings is already a driver in their value, with a strong demand on the rental market, thanks to significant benefits for occupants, such as a reduction of energy bills which, particularly in large sites such as industrial plants, offices, shopping centers, airports, can reduce energy and maintenance costs by up to 30% and achieving greater safety of the structure, through real-time monitoring systems capable of strengthening security and specialized weather sensors that provide advance warnings for potentially adverse weather events.

Today with the development of even smaller, cheaper and more intelligent sensors, potentially located in an increasing number of devices, the area of smart buildings is continuously growing. In general, we can identify three different implementations of building management systems, each progressively more connected and integrated:

Individual BMS: the owner of the property install a series of technological components with the aim of automating individual tasks, such as an elevator or lighting controls. This category is characterized by limited system connectivity which brings minimal benefits for the user of the property.

Partially integrated BMS: this category represents an evolution of the previous one, with the integration of multiple activities with a specific focus, such as the optimal management of energy consumption or the implementation of a valid safety system. In this category, the activities are more automated and connected, requiring few manual interventions and characterized by a faster decision-making process thanks to a partial set of information available.

Fully integrated BMS: this category represents the most advanced in technological terms, characterized by a strong IoT ecosystem that allows greater cost savings, greater productivity of the structure and benefits in terms of revenues with a deep attention to the customers and data. Fully integrated BMS requires minimal or zero manual intervention, transmitting a constant flow of information and simplifying the decision-making process. Below there is a representation of the different degrees of implementation of a BMS inside a building.

Figure 21: Representation of the three degrees of implementation of building management system

The use of a building management system is synonymous of efficiency and value generation. In addition to improving the performance of buildings, there are many other fields of application of these technologies, including an improvement in the management of real estate portfolios.

Indeed, the improved tracking and monitoring at a building and portfolio level may result in a lower capital risk, a more granular valuation and enhanced portfolio management capabilities. For example, monitoring the flow of people in a building can allow the owners to analyze occupants behavior and space usage patterns, helping them to identify excess capacity and implement management plans and strategies with the aim of reaching a higher level of revenues and an efficient property portfolio management.

In the same way, a BMS can also support the phases preceding the purchase of a property; many proptech startups have implemented activities related to purchase and

lease brokerage, sharing detailed information on properties with customers, reducing the potential barriers inherent in the buying and selling process and leading to greater transparency and liquidity in the real estate market. Potential buyers through these technologies can make a more informed and rational choice, consulting not only statistics data on prices and evaluations, but also real-time data of the traffic in the area, crime or other real-world factors that could influence the property values.

Among the main fields of application of IoT systems is the commercial segment, with the correct implementation of a BMS that can increase business performance. Analyzing data on employees movements during working hours can help the company manager to improve productivity by better designing individual activities, as well as promoting collaboration and even socialization in the workplace. Moreover, through the various sensors applied inside a building, the manager can guarantee an optimal level of ventilation and temperature, providing a healthier environment for the occupants and increasing the well-being of the employees who, certified by numerous studies, have a positive correlation with their productivity. A study has shown that the smart building is a driving factor in the value of real estate, with an average increase of between 8% and 35% in the market value of a building and a decrease between 9% and 18% in the vacancy rate of the segment[26].

Many companies in the sector continuously reduce their space needs, adapting to the change in the sector characterized by the growth of the size of online marketplaces, which constantly erodes the demand for physical sales spaces. Analysts predict that around 50% of American shopping malls will close by 2030. The strategic importance of commercial real estate space in a company's business plan and the consequent contraction in demand are pushing property owners to invest in building management systems that can predict demand levels and attract and retain tenants.

Indeed, the implementation of an IoT ecosystem can be seen as a reaction to the growth of online markets, the main competitors of physical stores, which use numerous digital technologies to profile and attract consumers on their digital sales platforms. The connectivity and efficiency of retail stores today have become a determining factor for the value of real estate, while the importance of location takes a second place; the

[26] http://www.institutebe.com/Green- Building / Multiple-Studies-Document-Green-Buildings-add.aspx

growth of the proptech sector has led to the rise of several operators offering support technologies, such as internal mapping combined with occupancy monitoring sensors, to provide information on the customer's journey both within individual stores and in large shopping centers. The collection of data on the routes and average times spent by customers in the shops allows managers to coordinate spaces and position their products more effectively, improving the customer shopping experience through personalized offers. London's Westfield Stratford, one of the largest shopping centers in Europe, recently launched within its "Trend" pop-up shop structure, which through the analysis of big data and artificial intelligence (AI) is able to communicate in real time with its tenants the information relating to the number of customers in the structure and inform them of potential future trends that can be extracted from social networks and customer profiling. A recent trend linked to the implementation of IoT systems and the analysis of big data is their use as a source of value; specifically companies can collect, combine and analyze insights from a large set of data and sell these to interested third parties. For example, information about people moving inside a building can potentially be sold to advertisers or urban planners to assist them in the decision-making process.

Contrary to Smart Home devices, such as home automation systems, focused on the B2C market, the Smart Building market is typically oriented towards a B2B approach. Geographically, North America is the main country by number of operators focused on the sphere of smart real estate, with around 40% of the total share. In Italy, the turnover associated with smart building in 2018 was approximately 3.6 billion dollars,

41% divided into building devices and solutions, 31% in automation technology and 28% in management and control platforms. It should be stressed that investments in building management and control infrastructures, adding hardware and software components, are greater than investments in the engineering part of the plants, testifying to the growing importance of the digital component in smart buildings.

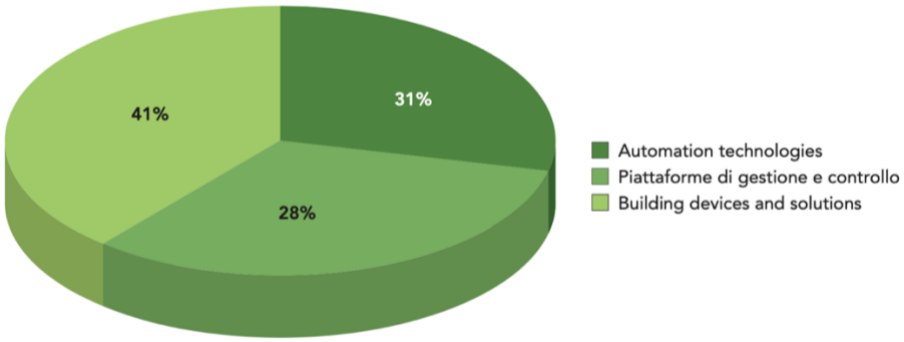

Figure 22: Investments in smart building domain

3.4 The Information Value Loop

A possible framework suitable for theoretically describing the process by which an organization creates value from information is the Information Value Loop, composed of a series of sequences and activities supported by different technologies but linked together with the aim of collecting information and turn them into a source of value. To allow information to create value, they go through various stages, each characterized by specific technologies.

Everything stems from an act monitored by different types of sensors capable of tracking certain characteristics, such as movement, pressure, light, temperature and flow, thus creating a large amount of data. Subsequently these data pass through a network in such a way that various parts of the BMS communicate with each other, generating a vast series of aggregated information in real time, which can then be analyzed through the use of different tools aimed at developing descriptive, prescriptive and predictive insights. The cycle is completed when the BMS demonstrates increased behavior by allowing a series of automated actions and promoting a more efficient and informed decision-making process. Furthermore, the amount of value created by the information is a function of the value drivers identified in the middle of the cycle, represented by the magnitude, risk and time.

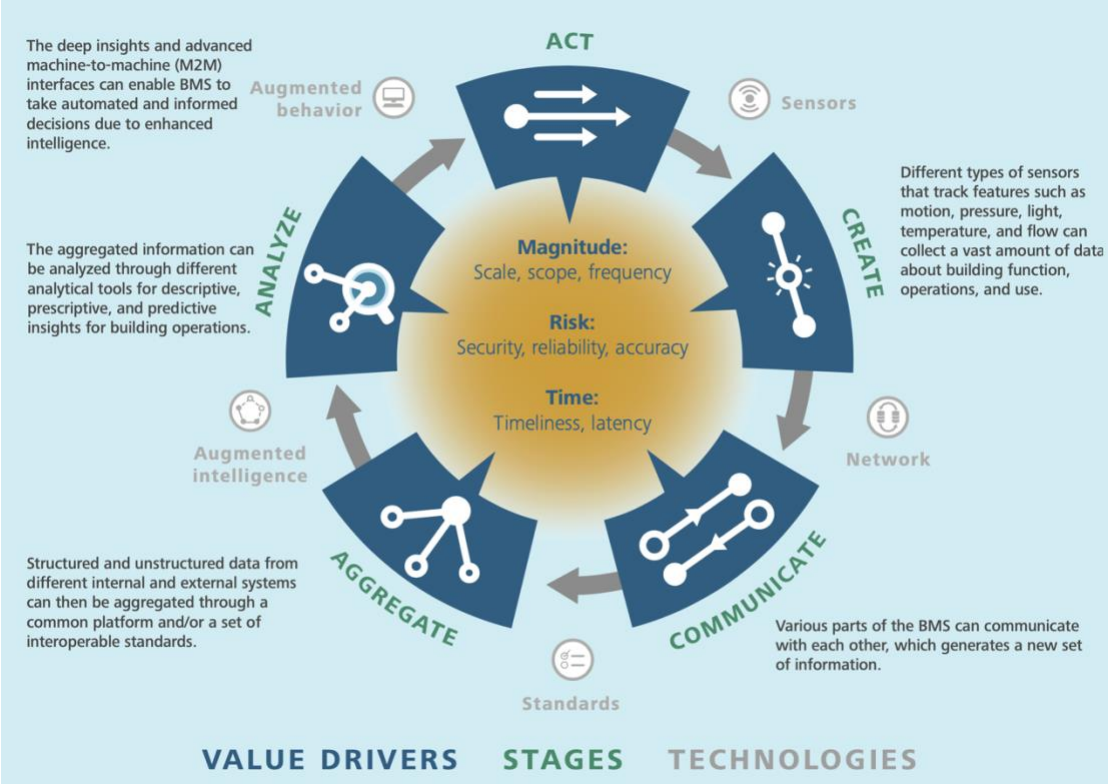

Figure 23: The Information Value Loop (Deloitte).

3.5 Smart City

Historically, technology has played a fundamental role in the progress of cities. An example is the industrial revolution of 1870 that took place in the main countries, with the introduction of urban electricity and transport systems as well as a redefinition of cities through a series of real estate projects considered innovative at that time. As in the past, today a new era of urban innovation is emerging, supported by the introduction of two related technological frameworks: Internet of Things and Big Data, which allow the creation of "intelligent" systems capable of collecting a wide range of data in real time on the functioning of the city, analyzing and consequently adapting the entire urban system in response, in order to optimize its performance. Smart city is a term used to indicate a series of innovations implemented in the main cities of the world, based on the installation of a wide range of devices capable of connecting to each other and with online platforms, creating a system capable of analyzing and influencing the

functioning of the city. A definition of smart city is "*a place where traditional networks and services are made more flexible, efficient and sustainable with the use of new technologies and innovations to promote productivity and efficiency, reducing waste and costs, and enhances diversity and inclusion* ".[27]

According to scholars, this revolution will have different effects in the real estate industry compared to the previous ones, not requiring the configuration of new urban spaces, but rather focusing on the redevelopment of existing buildings and infrastructures; among the areas of greatest impact are public utilities, such as energy and water systems, transport systems, but also governance, healthcare, education and safety.

Global cumulative investments in smart city technologies are expected to reach a total of $ 174.4 billion between 2014 and 2023[28]

Cities play a key role in the social and economic aspects of the world; according to the United Nations, 55% of the world population currently lives in urban areas and this number should rise to 68% by 2050[29]. This will have a significant impact, especially in those countries currently characterized by strong population growth, such as in the Asian continent, where the Indian population is expected to increase to 416 million inhabitants and in China with an expected growth of 255 million inhabitants during this period, leading to an increase in the number of buildings, industries and transport systems, which today are already heavily responsible for a large part of global pollution. All this has sensitized society to the topics of sustainability and efficient use of infrastructures, pushing towards the use of technology adapted to urban areas. Smart cities can indeed lead to numerous advantages such as:

more efficient use of infrastructure: the smart city systems will allow a more efficient management of infrastructure and physical resources, allowing to satisfy a greater volume of demand without the need for a reconfiguration of the current infrastructure environment.

[27] Mohanti, Choppali & Kougianos, "Everything you wanted to know about smart cities" IEEE Consumer Electronics Magazine, Volume 6, Issue 3, July 2016, pages 60--70.
[28] The Urban Developer, September 2015.
[29] https://www.un.org/development/desa/en/news/ population / 2018- revision-of-world-urbanization-prospects.html.

a more informed decision-making process: through the use of a wide range of data and new methods of analysis and forecasting, government authorities will be able to undertake a more informed decision-making process pertinent to the real needs of the city and citizens, avoiding waste of time and resources;

a more involved population: smart cities will allow users to interact directly with the urban system and with the decision-making process. The increase in connectivity made possible by mobile devices, computers and other digital platforms will allow users to quickly access urban data, request personalized services and release feedback;

more resilient cities: a key benefit of smart cities technology is the adaptability of systems, capable of measuring data in real time and adapting their operations accordingly. This will lead to more resilient cities that are better able to respond to potential adverse events such as natural disasters, economic and political shocks.

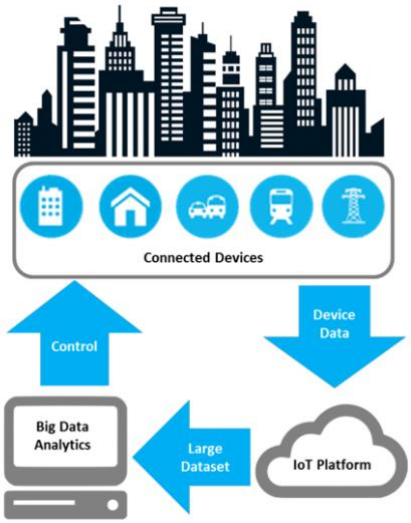

Figure 24: Smart City (Emerge Capital Partners, 2016).

Governments, corporations and citizens are realizing that smart cities could help to solve some of the problems that currently affect society, such as overcrowding, an aging population and environmental degradation. In recent years, the number of governments that have declared their intention to make their cities smart is huge. More than 1.000 cities worldwide have started to develop initiatives related to the implementation of

smart cities, half of which are only in China[30]. The Indian government followed suit by launching its Smart Cities mission, a five-year plan for its central and state governments to provide $ 14 billion in funding between 2017 and 2022, kick-starting the development of 100 smart cities[31]. It is not just the number of smart city initiatives that is growing at a spectacular rate; according to market intelligence firm IDC, cities spent $ 81 billion on smart city initiatives in 2018, and this figure will nearly double to $ 158 billion by 2022. Frost & Sullivan, another leading market intelligence firm, have estimated that by 2025 the smart cities market opportunities will be worth more than $ 2 trillion dollars.[32]

The real estate sector is the heart of cities, the correct development of a strong urban ecosystem has the potential to stimulate technological developments, bridge the gap between technology and people and allow smart cities to become a successful reality. Proptech innovations therefore have a significant impact on cities, promoting efficiency, sustainability and improving the decision-making process, attracting entrepreneurs and companies and thus creating job opportunities.

However, although what has been described brings benefits to the whole population, there are several elements that hinder the development of smart cities. Indeed, of those 1.000 previously defined smart city initiatives, a 2019 report compiled by global consultancy Roland Berger found that only 153 cities have an official smart city strategy. In particular, of the approximately 500 initiatives for cities with a population of over 1 million, only 49 had a real strategy and only 10% had what the report described as a global strategy that included detailed objectives and activities. There are a number of reasons that explain why the spread of smart cities is still low and struggling to take off. To deliver real value, the smart cities ecosystem faces several key challenges, including:

-***complexities in implementing a strategy***: the size and scale of cities create many organizational challenges. Cities are made up of many areas of activity and numerous authorities, which make it difficult to implement a single strategy. However a solution

[30] Chia Je Lin, "Five Chinese smart cities leading the way", GovInsider, 10 July 2018 .

[31] Smart City Mission, Ministry of Housing and Urban Affairs, Government of India.

[32] "Frost & Sullivan Experts Announce Global Smart Cities to Raise a Market of More Than $2 Trillion by 2025", Aftermarket News, 6 April 2018. https://www.aftermarketnews.com/frost-sullivan-experts-announce-global-smart-cities-to-raise-a-market-of-more-than-2-trillion-by-2025/

already adopted by some cities such as Singapore, is the creation of a national body responsible for the implementation and implementation of technologies within the city, called "*Smart Nation and Digital Government Office"*.

-a conservative philosophy not prone to change: among the main obstacles to the development of smart cities there is often a conservative bureaucratic mentality that does not support drastic changes. Many government agencies have not adapted their models for years, making them resistant to innovation; changing this bureaucratic mentality is really complicated, and it is vital that these cultural changes take place at the top, by individuals willing to fight and eliminate these attitudes.

-***the fragmentation of the technological market:*** a possible explanation for the slow development of smart cities is the difficulty in creating software platforms capable of integrating data from a wide range of devices.

CHAPTER 4

THE SHARING ECONOMY

4.1 Introduction

This chapter will focus on the sharing economy, a particular economic model born in the early 90s but officially established on the markets after the 2008 financial crisis and characterized by a different execution compared to traditional business models represented by the production and sale of goods and services. In the sharing economy, the distributed ownership of a resource allows to divide its use among several subjects, as well as the purchase cost, shared between a larger group of users or recovered by a single owner through the rental of a part of the asset.

The last decade has therefore been characterized by a wide adoption of sharing economy, primarily within transport and hospitality. "*In a few years, the main platforms that host this model went from being small experimental startups to multinational billionaire-size companies*" (Konrad and Mac 2014); so far, their growth has been exponential, and they are expected, at least in the near future, to keep expanding at the same rate. As further evidence of this, PwC, which in 2014 quantified the overall revenues of the whole sharing economy industry as $ 15 billion, also forecast that it will probably reach the value of $ 335 billion by 2025 (PwC 2014).

Since 2014, the first year of its significant growth, the emergence of this phenomenon has generated a great deal of interest in the mass media which has described it as a real shift in paradigms that signifies an evolution of the culture of possession to the culture of sharing. (Martin 2016, pag.149-159)

Proptech is among the main fields of application of this new economic concept, whose recent technological development has made data on real estate assets available and transparent for individuals and companies and has reduced transaction costs in the sector, opening up the way to this new model based on the use of underutilized assets.

The proliferation of the internet in the daily use of the population via smartphones and the introduction of digital technologies has simplified the relationship of consumers with products and services offered digitally through online platforms and markets, allowing property owners to transform unused or underutilized assets in revenue generators.

Through digital platforms, property owner can find potential users who rent an additional bedroom, an unused space in a commercial store or an unused desk in their office; today through proptech and more precisely the real estate sharing economy, individuals can optimize the use of their real estate assets by finding users for any excess capacity.

Although the development of the sharing economy in the real estate sector was made possible by the proliferation of innovations, its spread is due to a number of factors; among which the main ones are:

social elements: in the first place it is good to clarify that this economic model can be seen as a mindset, led mainly by the millennials, subjects born between 1990 and 2000, who currently represent the growing economic strength[33], prone to a lighter and more flexible lifestyle, characterized by loan, rent and sharing; indeed, these subjects, having first grown up in an era characterized by strong consumerism and an abundance of goods, then living in a strong economic recession characterized by high unemployment and witnessing the negative footprint of excessive consumerism, today prefer live in a flexible way, owning as little as possible, but borrowing and subscribing, having everything accessible thanks to technologies.

State of economy: austerity, crisis, high house prices in major global cities and an increase in the unemployment rate have redirected consumers behavior towards more cost-efficient models, such as the sharing of goods and services.

Political: the increase in political instability, the promotion of entrepreneurship and the constant replacement of institutions by global companies has created a shared channel for idealism and social enterprise.

Technology: the proliferation of the internet in the daily life of the population has made easier for companies to aggregate supply and demand and has transformed consumer relationships with products and services. Smartphones have revolutionized market access for both consumers and producers. Satellite positioning functions help to find nearby markets and social media networks and recommendation systems have helped to establish a bilateral trust system. Finally, electronic payment systems have made market transactions easier and safer.

[33] According to the U.S. Bureau of Labor Statistics, the generation of millennials will account for approximately 75% of the American workforce by 2030

A recent study analyzed the potential link between the sharing economy and the real estate sector, trying to understand the impact of this economic model on the American residential market. This study found that the percentage of the American population renting a house has gone up from 31% to 35% since the 2008 financial crisis, while the percentage of home ownership has decreased from 69% to 65%, the lowest level since 1990[34]. Rental in general has many advantages over home ownership: monthly costs can be lower than ownership costs, cash flow and additional capital can be invested in other asset classes and offer tenants flexibility to move to another place or city especially if looking for new career opportunities; according to Deutsche Bank, the monthly cost of renting was lower than buying in 20 large metropolitan areas at the end of 2013[35]. From how you can understand there is a strong relationship between the growth of the sharing economy and the real estate market, characterized by a constant decrease in ownership in favor of the lease, even partial, of the property.

Today, almost every real estate segment is part of the sharing economy: the sharing of housing, often single rooms, in the residential sector (co-living) and the sharing of properties within residential complexes (co-housing), shared workplaces in the office segment (co-working) and the rental of short-term spaces in the commercial segment (pop-up stores). Below we will analyze the evolution of this proptech model in its individual business segments:

4.2 Residential Segment

4.2.1 Co-living

The short-term rental plays a central role in the universe of the real estate sharing economy, representing in its business model the maximum expression of this new mentality: the sharing of flexible spaces. This model has created a new rental market, parallel to the traditional one, characterized by short and very short term contracts and

[34] http://ternercenter.berkeley.edu/uploads/Single-Family_Renters_Brief.pdf

[35] A.E. Espinosa, "Impact on the sharing economy on housing", pag.11 (2014).

by the immediate and direct meeting between market demand and supply, supported by digital platforms.

In the residential landscape, co-living is becoming increasingly popular, driven mainly by the lack of affordable housing, urbanization and technological innovation. This model is represented by the coexistence of more people inside a building with private rooms and by the sharing of common areas such as kitchens, living rooms and working area, promoting the creation of a community that, in addition to sharing physical spaces, shares values, philosophies and interests.

Although recently developed, the concept of buildings aimed at the coexistence of multiple subjects is not new, but already in the last century housing shared by different people with common ideals or needs were available, examples are the public housing created after the Second World War to offer accommodation for immigrants transferred to the city in search of job opportunities; from the reconfiguration of this past phenomenon, today the modern co-living is born, whose main features are:

-***a shared philosophy***: one of the main distinctive aspects of co-housing structures is that related to sharing, in addition to physical spaces, the interests of the occupants. One of the aspects found mainly in co-living spaces is the sharing of similar values, interests and life goals among residents. These structures offer a series of services aimed at spreading these values within the community, in order to build strong ties and affinities that resolve the social isolation typical of large cities.

-***use of technology with the aim of improving the well-being of occupants:*** co-living operators offer a wide range of services in their structures, such as online platforms with the aim of facilitating communication between residents and managers, including the possibility to request remote services such as room cleaning or laundry services. Modern technology can allow new forms of sustainable life and encourage social interaction between residents of the same operator but who live in different places or communities.

In addition to management platforms, operators in the segment are improving their offer through auxiliary services such as surveillance, facial recognition software or biometric or keyless access for absolute occupant safety.

-***a universal and flexible offer***: the offer of living spaces is designed for young workers looking for flexible and economic environments. All this has led the segment to offer

plug-and-play models, with the operators who manage the structure and the payment of domestic users. Monthly rents of co-living spaces usually include all auxiliary services such as TV, cleaning, Wi-Fi and facilities maintenance. Today there are more than 400 co-living operators worldwide, which can be divided according to the business model implemented. The first type consists of operators who offer co-living services without being owners of the property, but by renting a building and dividing it into small units, and therefore managing the structure; which includes marketing campaigns, rent collection, property maintenance and management, and event management within the community. In this type of model, the contracts concluded between the operator and the owner of the property often take the form of a revenue sharing agreements, thus providing for a participation of the latter in the business, with percentages that vary depending on the state of the property and investments in renovation.

The second model takes place when the operator buys the property that best suits his needs by converting it into shared living spaces. In this model, no third party is involved in the operations and the owners take all the profits from the rental of the units.

Although co-living is an industry still at an early stage of development and with a reduced customer audience represented by millennials, it is expected to mature in the coming years, with a change in the perception of the public around the benefits of shared life, which they end up attracting a more diverse audience. Indeed, many scholars predict that, as continued population growth will lead to a reduction in the availability of space and an increase in prices in the main urban centers, there will be a further development of the co-living model, which will offer more inclusive and targeted for a wider range of customers, including families.

4.2.2 A focus on the European market: the JLL co-living index

This paragraph will examine the growth of the co-living model in Europe, the key factors driving its demand and how its development is reshaping the traditional residential market. As indicated above, the growth of the co-living market is driven by consumer demand, mainly millennials, in an era of free movement, market

globalization, technological progress and greater social mobility, with the flexibility that has become an essential component of today's life.

According to research conducted by JLL, there are 23.150 co-living beds built or under development across Europe, of which about 60% built after 2017, indicating a rapid growth of this model in the past three years[36].

In general, co-living model is based on elements from the student housing, multifamily and hospitality sectors, but is beginning to form its own distinctive character.

In fact, compared to traditional models in the residential segment, co-living structures have a greater offer of services and shared spaces, with operators who place more emphasis on the integration of additional services with the aim of positively influencing the experience and well-being of the occupants and that are becoming increasingly synonymous with co-living. According to a recent study, the size and design of the structures are changing with the evolution of the model; of the current stocks offered, 50% of the assets were designed and built specifically as co-living structures, but this increases to 85% of those in the pipeline. In addition, 53% of the currently operational activities exceed 100 beds, the large size of which can improve operational efficiency by offering a wider range of services to residents.

Regarding a geographical analysis, we can note a large concentration of European co-living spaces in London and Amsterdam, which represent more than 40% of the stocks offered, which is not surprising given their status as a global city as well as internal characteristics like young populations and dynamic property markets. In general, about three quarters of the European housing structures are located in only eight cities, demonstrating that model is in an infancy phase characterized by limited expansion and large margins for growth.

A suitable tool to measure the expansion and the development potential of the model within the European continent is the co-living index, developed by Jones Lang LaSalle (JLL) which responds to the demand and suitability for co-living in European cities. The JLL Co-living index comprises 15 metrics, all integrated by some common elements such as robustness, significance and cross-market comparability which cover

[36] JLL, "European Co-living Index" pag.2 (2018).
https://www.jll.co.uk/en/trends-and-insights/research/jll-european-coliving-index-2019

a series of factors that influence the demand for co-living. The index aims to weight and combine the various parameters to create an overall score in order to identify the best locations for co-living across Europe.

The result of this work is a table showing the top 40 European countries characterized by an environment favorable to the growth and proliferation of the co-living model.

Strongest coliving fundamentals supported by scale of market activity

Market type

No/limited market at present but conditions are in place to support the growth of the sector in the longer term

Key	Growth	Opportunity	Longer-term Opportunity
1. Amsterdam	11. Zurich	21. Lyon	31. Rome
2. London	12. Brussels	22. Liverpool	32. Warsaw
3. Copenhagen	13. Manchester	23. Barcelona	33. Lille
4. Paris	14. Dublin	24. Utrecht	34. Antwerp
5. Berlin	15. Glasgow	25. Milan	35. Marseille
6. Munich	16. Cologne	26. The Hague	36. Budapest
7. Stockholm	17. Gothenburg	27. Lisbon	37. Krakow
8. Frankfurt	18. Birmingham	28. Rotterdam	38. Seville
9. Vienna	19. Oslo	29. Madrid	39. Porto
10. Hamburg	20. Helsinki	30. Prague	40. Valencia

Figure 25: Representation of the JLL co-living index (2019)

Among the main European co-living markets shown in the table are:

Amsterdam: The Dutch capital has a high proportion of single person households (47.8%), while the young population has grown by 18.5% over the last decade. Nearly 4.000 co-living beds are planned.

Berlin: The second lowest home ownership rate (14%) across the index and strong net migration ensure favorable conditions for co-living in the German capital. However, household formation is slower compared to other key markets.

Barcelona: The Iberian capital for higher education has 5 ranked university and 12% of its inhabitants are students. The lack of rental living space provides a unique opportunity for co-living operators. However, the planning environment does create uncertainty in the market.

Warsaw: The Polish capital offers longer-term potential by virtue of its university presence and student population (16.9%). However, to date its potential has still not been expressed due to the high percentage of home ownership (85%).

4.2.3 Co-housing

The co-housing model is represented by residential complexes consisting of private units but with large common areas shared by residents, with the aim of promoting social interaction; each real estate unit is independent, while the common spaces generally include large kitchens, dining rooms, green areas, gyms, study stations and other recreational spaces. Co-housing developments vary between 20 and 40 units; residents generally have an independent income and private life, but plan and manage collaboratively certain community-related activities, such as parties, films, games and other events, with the aim of facilitating interaction between neighbors and offering a series of benefits, including:

- ***a more accessible cost of living***: through the sharing of goods and services between residents; co-housing structures often report a more accessible cost of living;
- ***greater social and physical resilience of residents:*** through the provision of shared structures that lead to the creation of a strong community.

Co-housing differs from co-living for a number of reasons, mainly the type of offer, which in the co-living model is represented by spaces for rent within a real estate unit, while in co-housing it is represented by independent units inserted in a large residential complex. Another important difference is the quantities and types of services offered in the two models: co-housing has private properties located around a shared entertainment space, such as a garden or a playground, however the co-living integrates many other elements such as dining areas, work areas, gyms, playgrounds.

Another difference concerns the length of the stay which, in the case of the co-living model, given the greater flexibility required, varies from a few days to a year, while in the co-housing models the residents generally purchase the property, planning to live there for a longer period of time.

In general, in co-living spaces, in addition to flexibility, the position plays a fundamental role, with the occupants who are often young professionals and students, who need to live near a central urban area; with regard to co-housing areas, one of the central themes of this model concerns the redevelopment of sparsely inhabited areas often located in the suburbs.

The last difference concerns the community, in which in co-living areas can become extremely specific, for example they can include groups of musicians or students, while

in co-housing it is more often dedicated to people than relationships with neighbors without necessarily having the same lifestyle or similar job.

4.3 The Sharing Economy in the receptive segment

Another form of expression of the sharing economy in the real estate sector concerns the sharing of spaces in the receptive segment.

The main operator in this area is Airbnb, an online platform that connects hosts who have a short-term rental space with guests, tourists who need accommodation.

"Airbnb is considered a disruptive innovator in the hospitality segment, which provides access to social and cultural experiences to tourists on a budget by unlocking latent market demand and offering growth potential in an otherwise competitive and saturated market" (Stephany, 2015).

Founded in 2007 in the United States and with a market value of over $ 13 billion, Airbnb is the largest tourist accommodation player in the world, offering a wide range of structures, without being the owner of any of them. It manages over three million properties worldwide, distributed in approximately 65.000 cities and 192 countries.

The main advantage of this new form of rental in the accommodation segment is the possibility offered by online platforms to owners to rent their apartments for a short period of time without being involved in long and complex administrative procedures. Closely related to this is the flexibility inherent in the operating model, which offers homeowners the opportunity to freely choose when and to whom to rent their accommodation. *"In addition, the accommodations offered for rental on the Airbnb platform offer guests authenticity, uniqueness and familiarity, helping them connect with the local culture and benefit from a different experience than the specific one of the hotel. Therefore, the Airbnb concept consists of "belonging" and "uniqueness" provided to the guests' experience* "(Liu and Mattila, 2016). Airbnb holds a position of value for both counterparts, both guests and hosts. In terms of hosts, Airbnb offers five value propositions:

1) Airbnb allows hosts to publish their spaces on its online platform, characterized by great visibility and capable of attracting a very large number of guests from all over the world.

2) Generally allowing outsiders to use their own space is risky as it is not known in advance how they will behave. However Airbnb takes measures to reduce this risk; guests will have to verify their identity before they can operate on the platform. In addition, Airbnb has a large database containing a peer-to-peer curriculum vitae (P2P-CV) for each user.

3) Airbnb manages monetary transactions: exchanges on Airbnb are cashless. The guest provides the credit card details on the platform at the time of booking and subsequently the host receives the money in his bank account 24 hours after the stay.

4) Airbnb manages the short-term rental: the Airbnb platform takes care of the marketing aspect of the short-term rental business, payments, deduction of taxes, and helps with management by imposing structure on the rental process and offering a calendar for the host to manage bookings.

5) Airbnb offers the opportunity to connect with similar hosts: some Airbnb hosts enjoy interacting, learn and share with other hosts.

Airbnb offers the following value propositions to guests:

1) Airbnb allows guests to find accommodation: Airbnb platforms offer an interface that allows guests to appear efficiently and book a considerable number of accommodation options around the world 24 hours a day.

2) Airbnb provides access to spaces: Airbnb processes offer guests access to properties after completing a series of required steps.

3) Airbnb mitigates the guest risks: to reduce the perceived risk, Airbnb implements a series of measures, including encouraging reviews, managing monetary transactions and offering a guarantee and assistance to guests in case of difficulties at check-in.

4) Airbnb enhances the guest experience by offering more than just access to a bed. Many hosts provide guests with useful destination advice, making their experience memorable.

4.4 Office segment: Co-working

Optimization workplace is another operating field of the real estate sharing economy. In particular, co-working spaces are emerging as a distinctive phenomenon in this context, not only promoting the transfer of knowledge and facilitating innovation, but also influencing the urban and socio-economic structure of the main countries. Co-working concept was born in Europe in 1990 with the idea of promoting the sharing of spaces for writers and programmers as an alternative to remote working from coffee shops. However, following the introduction of innovative technologies and the redefinition of the working culture, the concept has been reshaped, today based on three fundamental principles: effectively use of spare capacity[37], minimize the cost of the transaction[38] and add interesting benefits beyond space.

The development of this model within the office segment is generally analyzed with the sharing economy, as it involves both access to shared physical assets and the sharing of intangible assets such as information and knowledge. In general, many studies have associated co-working spread with a reduction in the vacancy rate and a smart allocation of spaces. A recent study of Stanton analyzed the potential economic benefits of efficient use of office facilities in London through co-working spaces, finding that the average cost of a workplace in the CBD costs 17.500 per year and the desk usage rate is only 45%. In an office containing 500 workstations, a system that allows 100% use of the desk could generate nearly £ 5 million a year (Stanton, 2019).

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[37] **Spare Capacity** is an economic term used to describe the potential use of an asset, service or space that is not currently used. This measure estimates the potential not currently used of a resource through its efficient use. It therefore represents a negative economic measure as it creates the so-called "output gap", the difference between what is currently produced in an activity and what could be produced through the efficient use of the resource, leading to a lower output and a lower income .

[38] **Cost of a transaction**: represent the costs that must be incurred to carry out an exchange, a contract or an economic transaction. The relationships that economic agents establish on the market would be at no cost only if there was perfect information, distributed symmetrically and the parts were perfectly rational; however, markets are generally characterized by great uncertainties, with agents having to bear costs during transactions. These costs can be divided into three separate categories:

-*Search and information costs*: related to the phase preceding the transaction and represented by the expenses associated with the collection of information on the asset and the search for the counterparty.

- *Bargaining costs:* represented by the brokerage costs necessary to reach an adequate agreement between the parties and for the definition and drafting of a transparent contract.

-*Monitoring costs*: represented by the costs relating to the next phase of control and compliance with the agreements.

The spread of this sharing practice was enabled by digitalization, which allowed both the creation of sharing platforms and the possibility of working from different locations. According to the data, the demand for co-working is driven both by independent workers who have found in these shared spaces an ideal place for their business and by employees of large companies which, following the globalization that has led to greater market competitiveness, have paid more attention to flexibility and lower costs. Other benefits linked to this model are the creation of a community represented by different individuals with different backgrounds, whose collaboration and interaction allows the sharing of skills, experiences and innovations. Today many companies believe that "*thinking, speaking and brainstorming creates the maximum value for an organization. In response, companies are turning to alternative work solutions such as teamwork to encourage collaboration between individuals*" (JLL, 2016).

Numerous reports have confirmed a strong relationship between co-working spaces and an increase in member incomes, driven by an intensification of working relationships, an increase in productivity and an improvement in health and private factors thanks to a reduction of social isolation. Today the number of co-working spaces has almost doubled every year and current estimates indicate that over a million workers around the globe use these spaces, characterized by flexibility in contracts, sharing of knowledge and cost-effectiveness. There are currently many types of co-working structures, which can accommodate an individual or company with over 1.000 employees, offering the flexibility of short-term contracts, which can range from one day to a month or a longer period.

In general we can identify two co-working models. In the first, the proptech operator only covers an intermediary or broker role; among the main companies we can find LiquidSpace, PivotDesk and Spacious.

The second co-working model is characterized by the operator who directly or indirectly controls the capital assets, thus acting as renters of spaces and facilities managers. WeWork represents the main operator of this model. Founded in 2010, and today a proptech unicorn, it manages over 4 million square meters of offices in 86 cities and 32 countries and with a market valuation of over 20 billion dollars. Among the main strengths of this startup, in addition to offering a wide range of office spaces located in various areas of the main cities of the world, there are a series of related

auxiliary services, such as customer satisfaction classification services, useful for comparing the various office spaces and, ultimately, the degree of satisfaction of tenants, as well as technological platforms used to analyze and manage data relating to the use of the various spaces, in order to allow a dynamic price offer based on the real time occupation levels of the offices, effectively managing all available spaces and maximizing the value of the structures.

A study conducted by the real estate consulting firm JLL predicted that by 2030 approximately 30% of offices in the United States will be managed by proptech operators.

Although the co-working area appears to be a segment destined to a continuous growth in volumes, some uncertainties lie in its long-term sustainability following a potential economic downturn, such as that of 2008. Indeed, flexible leasing contracts offered by operators in the segment often do not provide for cancellation penalties, which induce occupants to early terminate the lease in the event of economic problems. Furthermore, among the main occupants of the coworking spaces there are start-ups and small companies, which statistically are the first companies to fail during a financial crisis and, representing a fundamental share of income for proptech operators, could seriously compromise the sustainability of the co-working business model.

4.5 Commercial Segment: "Pop-up Stores"

The growth of technology is radically changing the mechanism on which the economy is based, today increasingly oriented towards the digitalization of different sectors and with consumers experiencing a profound change in the commercial sector due to the amount of information they can now access.

In the last fifteen years, with the rise of a large online market capable of reaching many more customers than in any physical store, the traditional retail operating model has profoundly changed, both with the disappearance of large traditional players and with the reconfiguration of the operational model of others.

Although the development of technology in the commercial sector suggests the end of physical stores, it is not so; indeed, these still play a fundamental role, but their role is

changing radically. Today the advent of online channels has introduced a new buyer to the retail market: the omnichannel consumer, defined as a buyer who combines multiple channels for a single purchase. Physical stores therefore remain a central element in creating an innovative and lasting shopping experience, but they are no longer the only point of contact for a retail brand. Instead they are positioned as part of the broader customer engagement model, which combines physical inventories, online platforms and a personalized physical environment to enhance the customer experience.

Although the influence of physical stores on the sales of these online operators is difficult to quantify, studies have shown that offline channels can generally encourage online sales. Several major retailers report that their online sales have increased following the opening of offline channels and vice versa. These trends offer further evidence that consumers prefer to combine multiple channels to make a final transaction and that having access to multiple channels to research, test and buy a good or service increases sales.

Recently the need has emerged for a large number of digital companies, born and operating on the web, to expand their offer through physical spaces, with the aim of offering customers a shopping experience that cannot be achieved through digital platforms. However, owning physical spaces requires high costs, often excessive for digital startups, especially if still in an initial phase of activity, leading most of them to be reluctant to expand their business through offline channels.

The use of the internet and the development of the sharing economy also in the commercial segment offered digital operators the opportunity to expand their activities with physical stores and more precisely through "pop-up shops". Today spaces available for a day, a week or a month can be booked using different digital platforms. The proptech operators in the sharing pop-up shop offer customers, mainly digital startups, to share sales spaces, staff and operating costs among multiple users.

The growth of pop-up shops is driven by a change in the needs of tenants; instead of an asset value, the use value is now the center of attention, with an ever increasing demand for flexibility in short-term rental. The classic point of sale (POS) of the retail segment has become a point of experience (POE), with commercial spaces that become more phases of marketing campaigns and less functional for the sale of products. The acquisition of new customers takes place, for example, in pop-up stores, with products

that can be experienced physically and emotionally and subsequently acquired through online sales channels.

Many companies have started to implement their business through pop-up stores, often using them more as a marketing tool than as a sales channel, for example to support a new product line or even to customize products on customer request. In summary, the implementation of pop-up stores maximizes the customer experience by creating physical spaces that interact with online channels, with the aim of better understanding customer requests and in order to increase customer engagement and loyalty.

Among the main reasons that push towards this new form of sharing commercial spaces are:

-***reduced costs***: the sharing of rents, staff, transport and storage spaces between multiple brands significantly reduces operating costs.

-***generation of traffic and visibility***: sharing space between multiple brands allows to attract more customers.

-***risk reduction***: by sharing pop-up stores, companies can test a range of spaces before making a long-term commitment.

The growing demand for shared spaces in the commercial segment has led to the emergence of numerous operators, including Appear Hear, an online platform created in 2013 that acts as an intermediary between owners of commercial buildings and companies that need a physical location for their activities. To date, the company has managed over 200.000 transactions in America, England, Holland and France, with the aim of creating a global network of short-term shared spaces in the commercial segment. Among the main customers of this startup we can find brands such as Google, LVMH and Apple, Netflix and Spotify, as well as world-renowned artists and creatives.

CHAPTER 5

Real Estate Fintech

5.1 Introduction

The traditional real estate market has a number of limits that hinder its proper functioning, including the lack of transparency and liquidity, which leads to a general inefficiency of transactions in the sector. In particular *"the concept of liquidity is multidimensional, not only including the time taken to sell an asset, but also the probability of a sale and, critically, the costs associated with the transaction"* (IPF, 2004). Indeed, the efficient transfer of a property requires transparency, so that the parties can access all the information necessary to make a rational decision, minimizing the time and costs associated with the transaction.

A strong contribution to overcoming these limits can be found in the introduction of proptech and more precisely in the use of a series of technologies that have proposed to increase the transparency of the real estate market and overcome potential information asymmetries between the buyer and the seller, with the aim to allow a faster and more convenient exchange of real estate activities and helping to reduce the illiquidity typical of this asset class. Real Estate FinTech is the third vertical sub-sector of PropTech, which supports the sale and leasing of real estate, as well as shares or funds, debt and capital, property and activities of third parties[39]. Within this area there are numerous operators focused on offering different services, such as brokerage platforms, which provide useful information to potential buyers and sellers, or investment and financing platforms, which support real estate transactions. Real Estate Fintech represents the largest of the three vertical models of the Baum matrix, and its development is driven by the wider revolution of the financial technology ecosystem, which refers to the software and innovative technologies used by companies that provide automated and improved financial services. Operators active in the area of Real Estate Fintech not only guarantee that multiple factors are considered within an investment decision, but also provide data in a digitalised format, enabling machine learning programs to execute investment decisions with greater accuracy. The main models analyzed in this chapter include research and information platforms, which

[39] Baum, "Proptech 3.0: The Future of Real Estate" (2017).

aggregate a large amount of real estate data by converting them into exploitable information for potential buyers; real estate crowdfunding platforms which, in addition to making investments less expensive and complex, open up real estate investment opportunities to a wider audience of investors and finally the ibuyer, a recent business model that promises to revolutionize the sector by creating a secondary market for real estate transactions.

5.2 *How technologies are changing the evaluation process?*

Valuations are likely to be more important for investment in real estate than any other asset class, particularly for unlisted real estate vehicles, playing a crucial role in reporting to investors, in monitoring portfolio strategy and in operations and as a basis for the secondary market. Each good can be compared and valuated, sometimes in a simple way as in the case of commodities, which do not require a professional to determine their market value, while other times determining the value of an asset requires more skills and experience. Trying to valuate a real estate asset certainly requires a more complex and lengthy process: rarely two buildings will be exactly the same and the benefits of ownership or interest on the property are generally realized over longer periods of time.

Valuation of a real estate property is a fundamental process, which plays a key role in many reporting and business decisions, including financial reporting, tax reporting, litigation and transaction support, as well as secured lending decisions[40]. However, it is a long and complex process, which includes numerous stages, the main ones being:

-***Terms of engagement***: an valuator and a client are required to discuss and agree certain details before work start, such as the assumptions to be made in the valuation.

-***Investigation***: is a research conducted on a property, through the use of four resource sources: inspections, property analysis, market research and public databases.

-***Treatment and interpretation of data***: represents the process of identification, quantification and interpretation of data relevant to the process. These steps are strongly

[40] International Valuation Standards (IVS), 2017.

influenced by the level of maturity of the reference market in terms of transparency and availability of data on transactions and on the characteristics of the building. Generally the process is difficult due to the opacity of the real estate market, with the lack of a systematic and centralized collection and management database on information on past transactions and energy performance data.

-***Valuation***: represents the final communication tool between the value and the customer, which provides an independent and least subjective evaluation of a property.

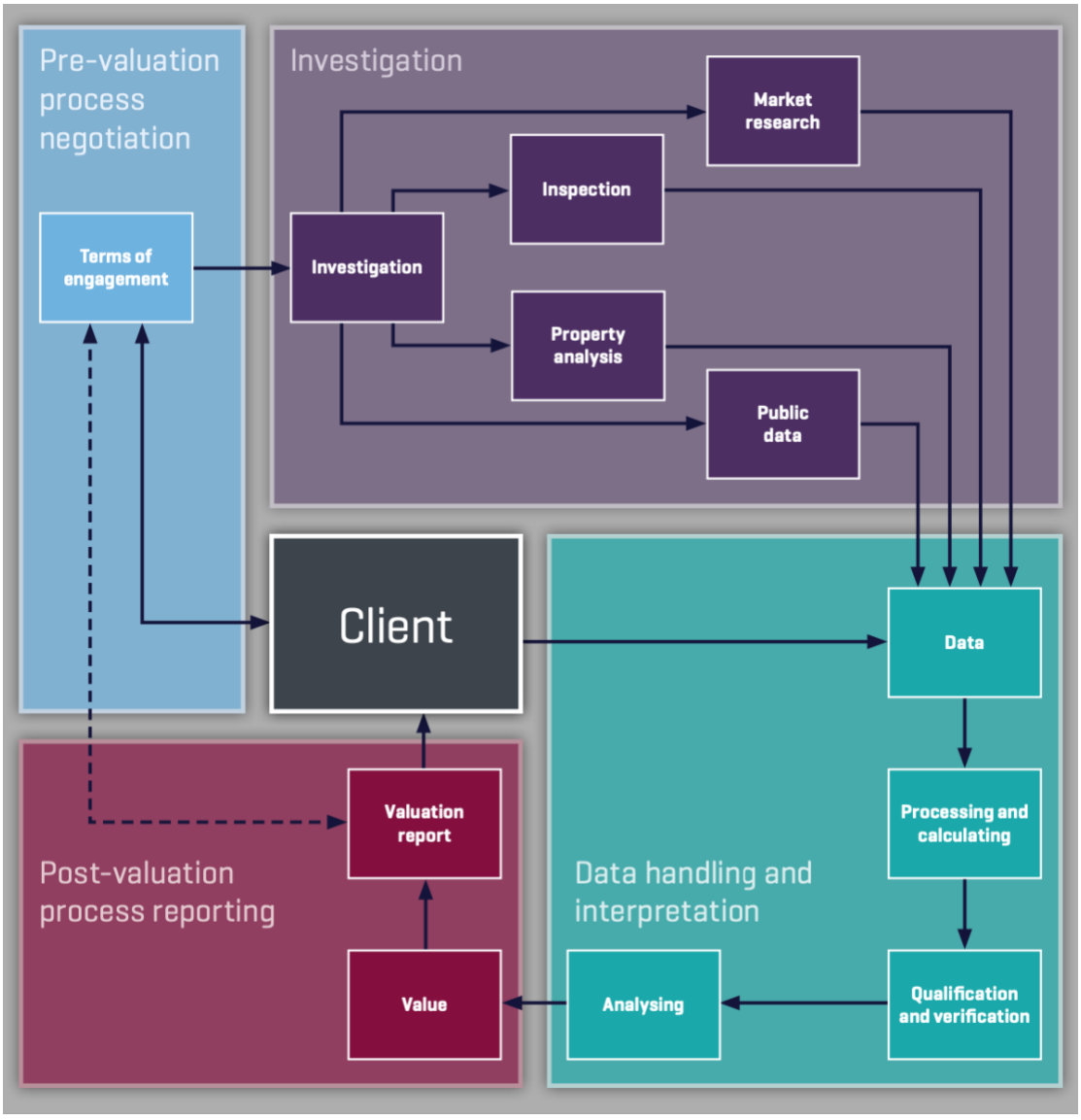

Figure 26: An overview of the valuation process

With the introduction of innovative technologies, many sectors have changed their modus operandi, offering numerous value-added services to their customers and, also in the real estate sector, investors are starting to benefit from the potential of these innovative tools.

Although the introduction of technologies in the past has mainly caused changes in manual and routine works, their introduction today is having a strong impact on highly skilled, non-routine and cognitive works, including the field of valuation, making the process faster, more objective and increasingly sensitive to a wide range of variables.

Indeed in recent years there has been an automated valuation approach in the real estate sector, widely used by real estate professionals, governments and the general public, driven by the introduction of disruptive technologies, including two in particular. The first concerns the use of big data, the analysis of which can be used in the valuation in order to draw a clearer picture of the current value of a property and provide assistance in predicting its future value; examples of data affecting property values include crime and school data, flood map data, house prices, insolvency rates, equity, housing inventory, local industries and much more.

The second technology is artificial intelligence (AI), which collects inputs from a large set of sources[41] and through an evolutionary process, generates algorithms suitable for creating automatic valuation models..

A definition of AVM is a "*statistic-based software, which use a series of artificial intelligence algorithms capable of performing rapid and precise assessment of a real estate property through the analysis of a large data set, with minimal error margin*"[42].

Today many important operators, including the main financial institutions, use automatic valuation models within their business; the ability to accurately determine the value of a property can simplify the process of issuing mortgages and loans, reducing the costs and time needed to valuate a property.

We can identify a number of benefits in using automated valuation models, including:

-a saving in time, costs and resources used during the valuation process

[41] The source can be traditional ones such as age of the asset, state of repair and location, but also non-traditional ones through Big Data, such as demography, crime rates, etc.

[42] RICS, "The Future of Valuations", 2017.

-the removal of the human factor, which reduces the subjective element inherent in the traditional valuation process, also eliminating potential fraud risks.

However, the development of automatic valuation models is still at an early stage, which has some challenges to overcome, including:

-automatic valuation systems can be subject to fraudulent activity through the insertion of distorted inputs.

-generally the use of the AVM is related to a previous inspection phase of the property, which may reveal some conditions which cannot be extrapolated from the data.

5.3 Digital real estate broker

The advent of the Internet in the daily use of the population and the development of proptech have changed the business model of many companies, also because the offers of traditional services were no longer able to fully satisfy the market demand focused on flexibility and transparency. Indeed, the innovations introduced in the real estate market have transformed the traditional role of brokers, changing the nature of their interaction with customers, including contact channels, information made available, the possibility to processing large quantities of data in a short time and offering different types of additional services that previously could not be offered at economically reasonable costs for potential users. The areas of greatest development include property negotiation services; indeed, according to studies, while in the past the majority of potential customers contacted a traditional real estate agent to manage the entire transaction process, today thanks to the use of digital platforms it is possible to disintermediate some phases of the process. *"The choice of properties by individuals and companies often involves an analysis of investment opportunities through search engines to identify characteristics of available assets and get an idea of the market prices for a specific types of properties in a particular area "*(Beracha and Wintoki, 2013).

These research services collect information from a large number of real estate agents, publishing it on their sites reclassified according to the type of property, location and

current status. The main added value offered to the customer is the availability of a wide range of information, which allows to evaluate the various market offers with transparent and updated data. Recently within the real estate brokerage area, some operators have expanded their offer by introducing auxiliary services including systems capable of supporting real estate negotiation and leasing processes, in order to make it more transparent, eliminating possible asymmetries of information between the parties and ensuring their correct functioning. Real estate marketing in the brokerage sector has also undergone a strong development, through the introduction of numerous promotional tools based on digital channels. "*The forms of promotion are not limited to simple advertisements for properties for sale or for rent, but additional information is also provided on the services and quality of life in the area to valuate any purchase or rental"* (Bond, Seiler, Seiler and Blake, 2000). Among the most innovative tools there is augmented reality software, which through virtual home tours allow to reduce the time needed by potential buyers on site visits, selecting only the properties deemed most interesting for a subsequent physical visit.

Proptech operators are growing and developing, introducing new services always capable of managing the entire cycle of transactions through online platforms, subtracting important market shares from traditional real estate intermediaries.

The presence of online brokers increases the level of competition in the sector, reducing real estate transaction costs thanks to the lower commissions applied. According to a recent study conducted by the British government agency in the United Kingdom by 2020, online brokers are expected to represent around 50% of the total transaction market. Comparing the average commissions required by physical and online intermediaries, we can see that for the first correspond to about 6% of the total value of the transaction between the buyer and the seller; if for example a property is sold to 200.000 the parties pay about 12.000€ for the real estate agency, compared to a fixed commission between 500€ and 1.000€ in the case of an online sales platform, it follows that for a possible buyer the use of digital platforms is economically convenient compared to the use of a real agent physical real estate.

In addition, some digital brokers, in order to maximize the number of potential customers, have started to segment customers by offering them the opportunity to choose between various levels of commissions based on the degree of services needed.

Then less sophisticated customers will be interested in purchasing the full service, agreeing to pay higher commissions than more experienced customers. In parallel with the growth of these online real estate brokers, the market has recently seen the evolution of a new business model represented by operators who instantly buy real estate, promising to create a large and efficient secondary market for transactions.

5.4 IBuyer

Among the most interesting sub-sectors of Real Estate Fintech in terms of percentage growth of investments and in the number of transactions there is the instant buyer, an innovative business model based on the "industrialized" purchase of property that overturns the traditional sales process. IBuyer companies, mainly active in the residential segment, through the use of technologies such as automated valuation models (AVM), manage to industrialize the real estate buying process by releasing a price offer and completing the transaction in a short time; after a renovation of the property they plan to sell it, through online and offline marketing campaigns, autonomous customer visits and the use of innovative technologies such as virtual home tours, obtaining a small profit margin.

Although this industry is still in its infancy and represents a small part of the real estate market, it cannot be ignored, especially if the transactions made by the ibuyer operators present a grow rate of 25% per year. The recent success of ibuyers goes well beyond the release of an instant offer for a property, but includes a massive use of technology with the aim of offering an excellent customers experience. Through the use of Internet of Things operators allow potential customers to enjoy unaccompanied, any time of the day, property visits. Once registered through their app, geolocation technology will guide individuals to the property before remote access is granted via an electronic door lock. A system of remote security monitoring is enabled by the installation of motion sensors coupled with the client's mobile phone location data. Transparent demand statistics regarding the number of viewings, and thus the level of interest, are able to be published in real time.

Big Data algorithms are also used to identify potential sellers through targeted marketing strategies on the main property brokerage platforms. In addition, the use of automated technology systems helps to identify the optimal capital market structure available at the time of ibuyer purchase, facilitating the subsequent number of properties into portfolios that will optimize their financing options.

The ibuyer model was born in the United States from Opendoor, founded in 2014 and currently the market leader in terms of annual transactions. United States is now the main market by number of transactions, with approximately 60.000 purchases made in 2019 against the total real estate transaction of 5.57 million, thus representing around 1% of the national market share.

Among the main players in the US market are:

Opendoor: founded in 2014 in Phoenix, today with over 1.300 employees, it is the largest ibuyer on the market. It operates in twenty American cities and raised $ 1.3 billion in equity, $ 3 billion in debt and has a market valuation of approximately $ 3.8 billion. Its radically innovative business model has forced big real estate brokerage firms such as Zillow and Redfin to react and redefine their business model. Together with Zillow represents approximately 86% of the total transactions carried out by US ibuyer operators in 2019.

Zillow: leader in real estate brokerage services in the United States, in 2018 it expanded its business model by entering in the ibuyer market. This operator is currently growing exponentially, rapidly becoming the second ibuyer in terms of number of transactions, thanks to a deep experience in the real estate sector, which has allowed to have a large database of potential clients and a solid network of relationships. In addition, the company has adopted a hybrid model, characterized by digital platforms and a vast network of physical real estate agents that support the property valuation phases and provide further contacts.

Redfin: born as a real estate brokerage platform, it has recently added ibuying services to its offer. Its success in this new business model is mainly due to its AVM, which has proven to be the most accurate on the market, capable of selecting the least risky properties and issuing the most competitive offers. In addition, the company uses innovative technologies such as the advanced home virtual tour which offers to potential customers an excellent buying experience.

Offerpad: founded in 2015, it is one of the major operators in the subsector. It operates in nine American states, including Florida and Texas, and has recently received $ 350 million in funding.

Analyzing the business model of the ibuyer operators, we can identify two main sources of income: service fees and the spread on the properties they buy and sell (price appreciation).

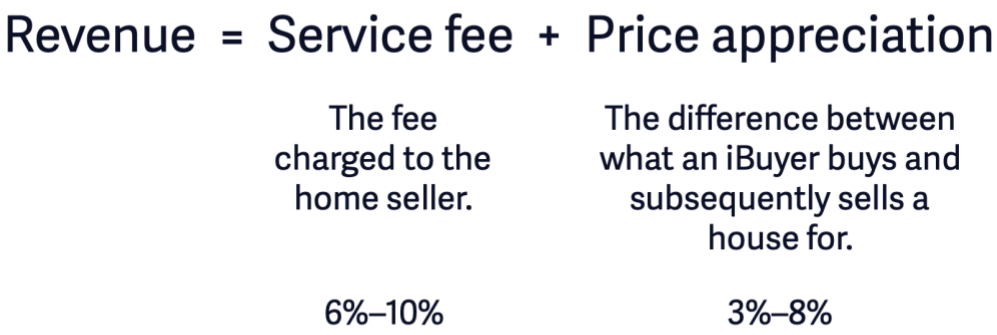

Figure 27: IBuyer sources of revenues

Service fees are included in the offers issued by the operators, which are generally between 6% and 10% lower than the market value of the property; from an instant buyer's point of view, higher commissions cover the investment risk associated with holding the property for a potentially long period, while for a seller, commissions are paid in exchange for a much faster property sale process compared to a traditional real estate model and to avoid the need to make improvements of the property before the sale. As for the second component of profit, the *price appreciation*, concerns the difference between the purchase and sale price obtained through renovations and marketing campaigns aimed at increasing the value of the property, which on average

is around 3% and 8%; taking into account the operating costs and the cost of capital, the profit margins of ibuyer operators are rather low, varying between 7% and 10%.
The low profit margins mean that operators need to achieve economies of scale in their activities which can be obtained mainly through geographical expansion.
Specifically the benefits reachable for ibuyer operators through expansion on a multitude of markets are numerous, including the main ones:
-***a risk diversification***: the expansion on more markets led to a greater diversification of the risk, protecting the operator's income in the event of a real estate crisis in a limited area.
- ***greater bargaining power:*** the ibuyer business model is capital-intensive and requires large sums of money to be able to conclude an optimal number of transactions. Debt capital therefore covers a fundamental role in the operator's activities, which by expanding its business has the possibility of achieving greater contractual power with the lenders and thus obtaining more flexible terms on the debt.
-***brand visibility***: thanks to the expansion of its activities, the ibuyer operator will obtain greater visibility of its brand both in local and national and international markets.
The following table summarizes in detail the differences between operating in a single market and diversifying its activities on a multitude of markets.

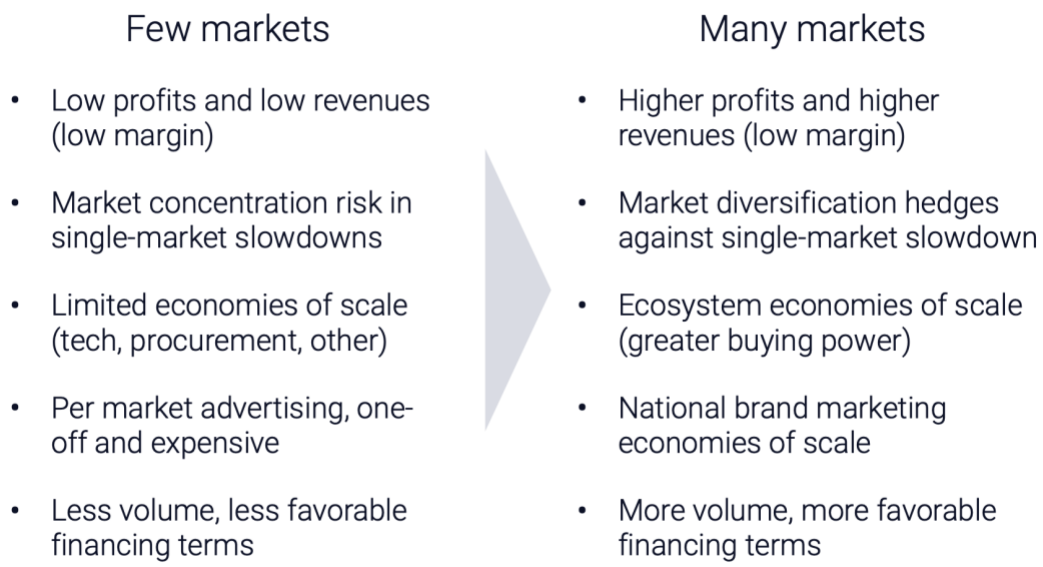

Figure 28: Advantages achievable in the IBuyer model through geographic expansion

5.4.2 Threats in the IBuyer model

The IBuyer industry, as previously illustrated, is still in a phase of infancy, characterized by numerous critical issues. Below we will try to summarize the main ones. The first threats encountered in the ibuyer model concern the management of geographical areas of activity, which must be adequately analyzed and selected, as well as properties. In particular, many operators have identified limits in the automated valuation models in heterogeneous markets, characterized by a wide range of different types of properties. Indeed, studies have shown that the ibuyer model works very well in homogeneous markets where real estate assets are similar in size and age. Another significant problem for ibuyers is inherent the phenomenon of adverse selection: sellers know better than anyone else the weakness of their properties, in particular those that are not recognizable in a due diligence process, such as the annoying neighbors that could disturb potential buyers. The evaluation models used by the ibuyers have a range of accuracy just like all evaluations and when this estimate is higher than the market value, the sellers are likely to recognize it and are more willing to accept the offer; the opposite will happen if the offer is too low, the sellers will turn to other ibuyers or other traditional sales options. Hence there is the risk that well-informed sellers may take advantage of potentially high offers by damaging the operator.

Among the threats faced by ibuyer operators there is that related to the sales process. In particular, among the various services offered there is an autonomous visit of the properties through smartphone application, which, especially in the peripheral areas of the cities and in periods of serious crisis, could be targeted by false buyers. According to the data, real estate intrusions became more common when borrowers were evicted from their homes during the 2008-2010 crisis. Such subjects could therefore enter the empty apartments and occupy the property or take possession of any object inside, such as domestic appliances. A possible repellent for this problem could be a two-factor authentication process in order to minimize this risk.

Last but not least is the possible criticality of the model in a bearish economy. It should be noted that the ibuyer industry was born in 2014, following the economic crisis of 2008, and to date its resilience has not yet been tested in a bearish market period. As we all know, following the spread of the COVID-19 pandemic, which broke out in January in China and arrived almost all over the world, the market suffered a sharp

slowdown, with the forecasts of the main experts towards the beginning of a global recession which would also affect the real estate sector with a decrease in the volume and prices of real estate. As for the volumes of transactions, today with all the global countries in lockdown, there has been a freezing of the economy, with reports published in recent weeks that have recorded a drop between 50% and 75% of real estate transactions. The IBuyer industry also had to arrest its business, temporarily closing its buying and selling services.

A tool to understand the effects of a real estate crisis on ibuyer operators is a scenario analysis that considers the changes in their portfolio values. Specifically the following table shows the number and the total market value of the properties currently held by the three major U.S. operators, Opendoor, Zillow and Offerpad, as well as their possible losses in the event of a 10% and 20% reduction in the real estate market value.

Company	Homes owned	Current value	Potential Loss If Homes Prices Drop 10%	Potential Loss If Homes Prices Drop 20%
OpenDoor	4,727	$1,223,031,000	$122,303,100	$244,606,200
Zillow	2,268	$751,087,000	$75,108,700	$150,217,400
OfferPad	974	$240,734,000	$24,073,400	$48,146,800

Figure 29: Scenario Analysis of the change in portfolio values following a drop in property market prices.

As indicated in the table, a 10% to 20% reduction in the value of the properties owned by the ibuyer operators would result in serious losses identified at around 226 million and 452 million respectively.

Indeed, in the normal course of buying and selling process, ibuyers, by maintaining large quantities of assets in the portfolio, are constantly exposed to changes in the market and property valuations.

The predicted global recession that started as a health crisis and also revealed a financial crisis will therefore put a strain on the consistency of the ibuyer model, which in my opinion is currently in a situation of great uncertainty, with many of the operators characterized by high costs. fixed and unprepared to face an unexpected recession. Opendoor recently announced a 35% reduction in staff, equal to 600 employees, aimed at increasing its chances of survival in a market that is currently frozen. Future changes

in the sector are uncertain, but it is clear that huge capital will be needed to resist and start again.

5.4.3 The European ibuyer industry

With the growth of the ibuyer in the United States, the model also began to spread in Europe with different degrees of development and nuances of business in each country. We can find three different models of ibuyer currently operating in the European market. The first is similar to the classic ibuyer created in the United States by Opendoor, summarized as "*purchase, renewal and resale*"; properties are purchased and sellers paid immediately, which requires a huge amount of capital to finance the process; the appreciation of the property through refurbishment and marketing campaigns represents a large portion of the profit margin.

The largest European operator by number of transactions made during the year is Casavo, an Italian start-up on which we will focus in the next paragraph.

The second model is characterized by a hybrid form between ibuyer and property management, with operators that doesn't needs large amount of capital but act on behalf of institutional investors with a buy-to-let strategy, such as sovereign wealth funds and pension funds. Among the main companies present in this model is IMMO, founded in 2017 in London, its core business is represented by the "instantaneous purchase" of residential properties, the refurbishment and subsequent rent on the long-term rental market.

The activity of this category of ibuyer is based on the consumer-to-business (C2B) model which, unlike the traditional ibuyer based on a consumer-to-consumer (C2C) model, is less exposed to temporary market crisis events, thanks to the stability of long-term rents characterized by a predictable return.

The latest model mentioned is also a hybrid, but this time between the ibuyer and the money lender. The operators in this model aim to allow chain-free transactions, with an advance amount guaranteed to the seller, that offers him the opportunity to buy the next property before his own is sold. This model of ibuyer manages the sale of the property but acts more as a broker than as a real buyer. With this model, capital is

rapidly made available to the client and is only required in the event that the client needs access to the funds before the property is sold. Unlike any other IBuyer model, customers enjoy full advantage when their property is sold at a premium greater than the advance.

Nested is a company founded in London in 2015 operating in this business model, indeed, in addition to managing the evaluation, marketing and sale of the property, it also offers an advance to customers, guaranteed by the property offered for sale, aimed at buying of the next house.

Although the growth of these models is useful to indicate that ibuyer's expansion trend in Europe is much slower than in America, this is due to a number of reasons. First of all in some European countries, especially the southern ones, real estate data are not transparent, making the various published market analyzes difficult and often contradictory to each other. This lack of transparency and accessibility in data inevitably makes automatic valuation models less reliable as they have a reduced pool of market data.

Another important factor is the lack of harmonization of real estate transaction costs in the European area, with various types and amounts of taxation in individual countries which make it difficult to implement a standardized model on a large geographical scale; an example is Germany, where to date there is no successful ibuyer operator in the area due to too high taxation on the transfer of ownership.

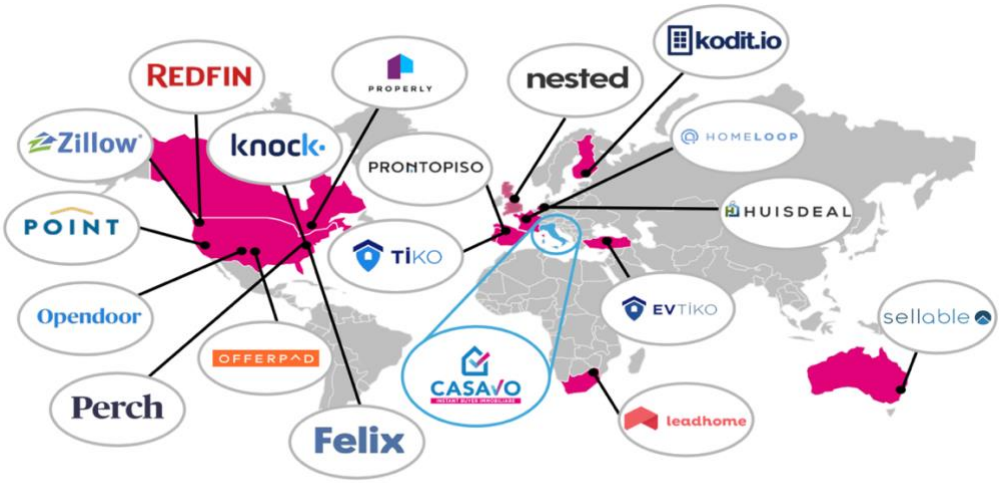

Figure 30: Real Estate players adopting the Instant Buyer model, CrunchBase.

5.4.4 Casavo's case study

This paragraph will focus on a case study from Casavo, an Italian startup active in the field of ibuyer. Today Casavo represents the main residential ibuyer present in Italy and among the largest for the number of transactions in Europe. Its success is mainly due to the extraordinary added value offered on the national real estate market, historically characterized by substantial inefficiencies. In particular, the residential segment has long been dominated by traditional brokerage firms, which have the main purpose of creating a correspondence between market demand and supply without offering real added value to the transaction.

However, following the introduction of a series of innovative technologies in the sector which led to the development of proptech, new business models were born that are able to respond efficiently to the changing needs of the actors present in this operating sector.

Analyzing the traditional buying and selling schemes within the Italian segment, we can highlight three main problems:

-***illiquidity of the sector:*** statistical data show that generally in the main metropolitan cities the time required to sell a house through traditional channels varies on average between six and seven months, increasing in secondary urban centers.

-***complexity of the process***: due to the high bureaucratization and the numerous actors present in the sector, the buying and selling process is characterized by being long and complex; for example, a potential seller must manage the required documentation, the relationship with banks and brokerage firms, as well as negotiation with potential buyers;

-***high degree of uncertainty***: the transactions, in particular for the sellers, are characterized by a high level of tension due to the long time and significant resources involved, as well as the wide uncertainty of the process and the sale price of the property.

The introduction of the instant buyer model in the real estate sector aims to simplify the whole process, allowing sellers to avoid the uncertainties related to the different phases of the sale, acting as a technological market marker that guarantees fast, efficient and safe transactions. In particular, the introduction of the instant buyer in the real estate market aims to offer three main values added to the transactions:

-The instant buyer is characterized by the industrialization of the purchase process, in particular through the use of automated evaluation models and a specific team of evaluators who can issue a purchase offer to a potential seller within a few days, in addition to paying the full amount within 30 days.
-The instant buyer operators, thanks to an efficient and diversified internal team, are able to professionally manage the entire transaction, eliminating the potential complexities inherent in the selling process.
-The great transparency on which the transaction is managed by the operator, with the counterpart who immediately knows the price and timing of the sale, allows to drastically reduce potential uncertainties.
Casavo represents the first market maker of the residential real estate market in Italy, guaranteeing the immediate purchase of a house and subsequently handling the resale. This operator can count on two pillars on which his business model is based: an automated evaluation model and a management platform, which allows the evaluation of the ownership and in general of the risk profile of the operation and a clear internal process with a strong human component, which allows carrying out a thorough due diligence investigation on real estate activities.

5.4.5 The operating process and commission schemes:

Even if at first sight the business model of the ibuyer could mistakenly resemble the classic large-scale real estate trading of private investors, who buy properties at discount and, after a partial restructuring, sell them on the market, gaining a capital gain given by the difference between the purchase and sale price is not like that. The instant buyer's business model through technology support aims to create a liquid secondary real estate market, where potential sellers can sell their properties quickly and at a reasonable price.
We can summarize Casavo's operating process in two phases and in four main points. The stages are the acquisition process and the sales process; the first phase is represented by two points:

1) Evaluation request: in this phase the seller, through the Casavo digital platform, completes an online form in which he provides the main information on the property, such as: dimensions, year of construction, energy class, geographical exposure, etc.

2) Online evaluation and offer: the use of automated evaluation models (AVM) that take into consideration more than 70 variables and a team of expert evaluators, who through a physical inspection of the property detect possible structural problems such as potential damage to the water systems, allows Casavo to determine the right market value of the property and to make a discount offer in a short time that does not exceed a couple of days.

The other two points are part of the sales process and are:

3) Purchase and renovation: within 30 days of the purchase offer, the sale is made through a notarial deed, Casavo pays the full price and the renovation works begin. In general we can divide the transactions carried out by Casavo into two types: the so-called *"negotiations"*, in which the operator carries out marketing interventions on the property, in order to increase its visibility and subsequently resell it obtaining an average revenue of 8% of the purchase price and the *"value added offers"*, in which there is also a structural intervention on the property, which in 90% of cases coincides with a division into two or more units and the subsequent resale, which allows to obtain an higher profit margin.

4) Marketing and sale: the property is commercialized through a partner agency and sold to the final buyer. Indeed the business model implemented by Casavo is strongly based on the business to business (B2B) channel, used both in the procurement and sales phases.

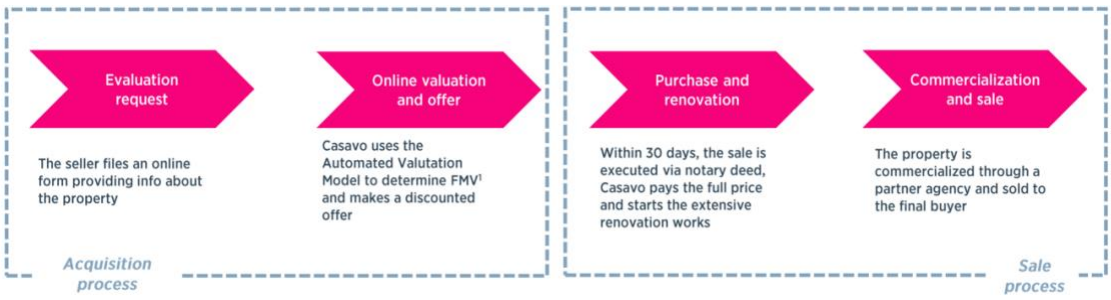

Figure 31: Representation of the Casavo operating process

Indeed Casavo's interactions with traditional real estate brokers are characterized by close collaboration, based on a personalized commission scheme.
Analyzing the Italian market, a broker, through traditional channels, sells on average a real estate unit in six months, obtaining a commission of 3% on the sale price from the seller and 3% from the buyer.

Figure 32: Traditional fees schema

However, through Casavo the process is different, in that the broker has the possibility of receiving a greater profit through a double agency mandate; in practice, the broker who uses the Casavo sales channel has the possibility to sell the property in 30 days, in a short time receiving a commission of 3% from the seller and 1% from Casavo; subsequently, the resale mandate from Casavo will be proposed to the same broker, obtaining 3% from the prospective buyer and 1-2% from Casavo from the sale. This fees scheme therefore has the characteristic of projecting both parties into a win-win situation, in which the broker can easily receive 2-3% more fees than traditional brokerage, of which more than half received within 30 days through the use of the Casavo purchase channel.

Figure 33: New fees schema with Casavo

5.4.5 Market Size and main competitors

Founded in 2017 in Milan, today Casavo has achieved important milestones, representing the largest ibuyer operator in Europe with over 300 transactions carried out for a total market value of over 85 million euros.

Casavo's activities have grown rapidly over the years, first on the national market, through expansion in the main Italian urban centers such as Rome, Florence, Turin, Bologna and Verona and then in southern Europe, with the opening of a branch in Madrid. The huge collection of shares and debts is proof of investor confidence in this innovative business model; Casavo has in fact raised over 100 million in two years, thus becoming the Italian startup to have raised more capital, through large venture capital funds that support its growth and the enhancement of the offer, including Greenoaks, Project A Venture, 360 Capital and Picus Capital.

The IBuyer industry has numerous barriers to entry, including:

-***operational efficiency***: ibuyer operators must implement efficient internal processes in their activities and acquire the skills necessary to manage the large amount of transactions in the best way.

-***large capital***: as previously described, the ibuyer model is capital-intensive, with the need for large quantities of capital to achieve economies of scale and profits.

-***brand awareness***: acquiring customer trust is fundamental for the success of the company; the house represents an important asset and consequently a relationship of mutual trust between the operator and the customer must be established. In general, ibuyer operators, especially in the early stages of the activity, invest enormous resources in educating the public and intermediaries in this new business model, trying to create strong relationships.

Despite these limitations, the number of ibuyer operators on the European market is growing; Casavo's main competitors include Kodit, a Finnish startup operating in Scandinavia and recently also expanded its business in Madrid and plans to open a branch in Paris later this year.

In Spain we can find ProntoPiso, an ibuyer hybrid operator that offers the capital in advance before the actual sale of the house, and Tiko, which provides an evaluation of the house within 24 hours and concludes the sale of the house within a week; the latter startup proptech raised around € 35 million from venture capital funds. Homeloop is a

French ibuyer who raised 20 million capital to carry out his activities; recently launched an annual plan that foresees a volume of transactions close to 100 million euros by the end of 2020. From how capital is possible, although this business model is characterized by high barriers to entry, it represents a potentially revolutionary model in the sector; in the near future, Casavo will therefore have to continue a strategy of strong expansion in foreign markets to remain competitive.

5.5 Real Estate Crowdfunding

The real estate market is characterized by various attributes that distinguish it from the financial market. Some of them reduce its proper functioning, such as the high unit value of direct investments in the development and renovation of properties, which require enormous capital and considerable transaction times. The development of proptech, as we have seen so far, has the aim of eliminating some limits that hinder the proper functioning of the real estate sector. Raising capital in the private market remains a vital function for the correct development of the sector, but at the same time it often proves to be a difficult activity, especially if based on raising equity rather than debt.

To reduce the limits linked to the capital raising in the real estate sector, intensified also by the global financial crisis of 2008 which drastically reduced access to credit, creating a strong distrust in the banking system, the collective financing technique of crowdfunding was born, aimed to encourage capital flows to the real estate sector, allowing entrepreneurs and small businesses to obtain funds through digital platforms to start their own projects. Among the main characteristics of crowdfunding there is that of being aimed primarily at small investors who, even with minimal capital, can participate in sizable projects without having large capital and skills.

Crowdfunding can be defined as: *"the practice of financing a project, which collects monetary contributions from a large number of people, obtained through the use of digital platforms. In other words, crowdfunding is the way to raise funds directly from the crowd "*(De Buysere).

Real estate crowdfunding is a rapid-growing technology-enabled innovation model, which allows real estate developers to raise and aggregate small amounts of capital

from a wide group of investors through the use of technology and specifically internet based platforms. The projects promoted by these platforms can be numerous; they generally concern the purchase of a property, its renovation and the subsequent sale or lease, but can also concern the development of a greenfield project. Large infrastructure projects are also becoming popular, such as the construction of hospitals and schools, where investors are more focused on positive externalities towards society than on potential return on investment.

The real estate crowdfunding model is based on the action of four main actors:

- ***the sponsor***: who promotes and subsequently manages the real estate project to be financed;
- ***the platform***: which has the task of evaluating the investment proposal and the sponsor on the basis of numerous elements including years of experience, past average returns and investment market risk. In addition, these platforms offer investors a number of useful tools such as investment analysis, monitoring and forecasting tools that will allow even novice investors to quickly understand the opportunities and risks associated with a specific project.
- ***investors***: also called "crowd", which selects the projects to be financed with equity or debt.
- ***secondary market***: following the development of real estate crowdfunding platforms, a secondary market has been created with the aim of creating greater liquidity of this instrument, where investors can resell their shares of the project.

Figure 34: Real Estate Crowdfunding process

Although the concept of real estate investment undertaken by various investors is not new, in the past it depended strictly on the knowledge network and was characterized by the need for large entry capital, conditions that created strong barriers to entry in the sector and made this form of investment direct inaccessible to most investors. However, following the changes in the regulations in the main developed countries, the crowdfunding model has undergone considerable development and today represents a new and alternative financial instrument.

Specifically, the fundamental passage to the development of crowdfunding occurred in 2012, following the issue in the United States of the "Jumpstart Our Business Startups Act" (JOBS Act)[43], a law that eliminated some general restrictions on investments, such as the inability to make general solicitations to the public of investors, making real estate crowdfunding platforms a viable options for financing the construction,

[43] Specifically, title III of the JOBS act, also called Crowdfunding act.
For further information: https://econsultancy.com/blog/9548-the-crowdfund-act-everything-you-need-to-know/

renovation and ownerships of real estate projects. However, only after the SEC approved the third title of the Jobs Act in 2015, which also allowed non-accredited investors[44] to fully participate in this type of investment, real estate crowdfunding has undergone a significant growth. According to recent research, the real estate crowdfunding market in America in 2019 was estimated at around $ 8 billion, with forecasts to reach $ 250 billion worldwide by 2024.

The development of a real estate crowdfunding market is mainly due to the oppression of some typical limits of traditional real estate investments, such as the need for substantial capital resources and for active investment management. Furthermore, a real estate investment is characterized by low liquidity and a limited possibility of diversification.

RECF platforms therefore allow to solve the problems described above, leading to numerous advantages such as:

i) the possibility of participating in a limited capital project; crowdfunding platforms often require minimal capital to participate in a project such as € 500.

ii) the opportunity for diversification, since by reducing the capital necessary to make an investment, an investor has the opportunity to distribute his capital on a greater number of projects diversified by geographical area, size and type.

iii) delegate the management of the property to the sponsor, who will be carefully selected by the platform at an earlier stage on the basis of past experience, qualifications and economic feasibility of the project.

iv) greater liquidity of the investment if the platforms have implemented a secondary market in which it is possible to negotiate the shares of a project.

[44] Prior to the issuance of the third title of the JOBS Act in 2015, only accredited investors were authorized to use crowdfunding. According to the Security Exchange Commission (SEC), an investor is qualified as *accredited* only if he has one of the following characteristics:
- an individual income greater than $ 200,000 a year, or a conjugal income greater than $ 300,000 a year, in each of the past two years and expected to reasonably maintain the same level of income.
- equity worth more than $ 1 million, individually or jointly
-be a bank, an insurance company, a registered investment company or a business development company.
-be a partner, manager, or director of the company offering the bonds
-be a company in which all members are accredited investors
-be a charitable organization or a company with an asset value greater than $ 5 million

v) constant monitoring of the project through the crowdfunding platform with the possibility of interacting with the sponsor.

vi) the possibility for the investor to select the specific project in which to invest accompanied by the potential returns; while, on the other hand, classic REITs offer few opportunities for investor involvement in asset allocation choices

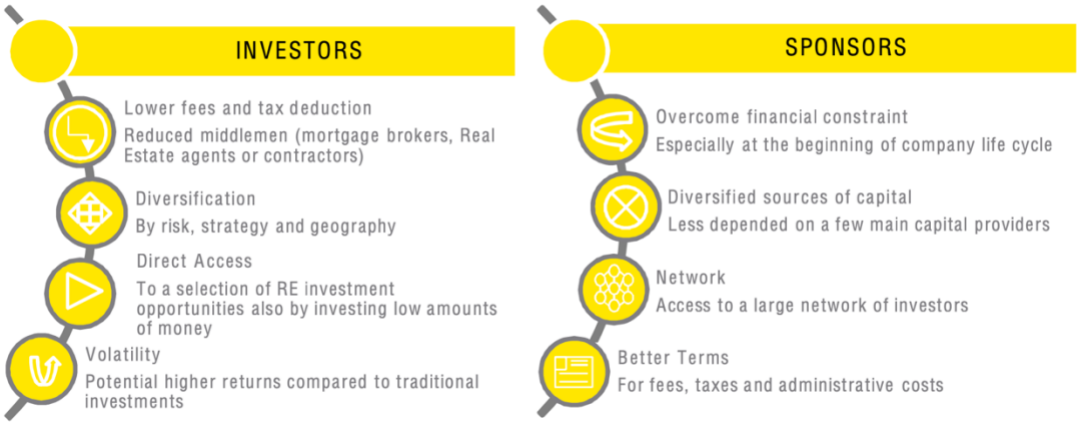

Figure 35: Investors' and sponsors' benefits

5.5.2 Real estate crowdfunding models:

As previously described, real estate crowdfunding is a process in which the project owner collects and aggregates small amounts of capital from a large group of investors through the use of technology, in particular Internet-based platforms.

Usually in real estate crowdfunding, the collection campaigns are of the "*all or nothing*" type; this means that a minimum collection volume (called the "goal" of the project) is set, for example one million euro, which must be reached in a pre-established period of time and in the event that the minimum funding target is reached, the platform, which in the previous period had raised and held the capital, will unlock it to the sponsors and in subsequent periods it will constantly monitor and inform investors on the progress of the project.

Crowdfunding is an interesting tool for real estate developers, who have the ability to eliminate intermediaries (banks) and directly reach the source of capital, the private

investors. From this it follows that real estate crowdfunding represents a process of disintermediation between real estate developers, private investors and the traditional financial system.

This innovative capital raising process can be divided into three different types based on the business model implemented by the platform:

1) ***equity-based crowdfunding***: the sponsor generally creates an "ad hoc" vehicle to promote the project and the investors receive a share of participation in the project proportional to the paid-up capital. In this case, the investors become shareholders of the company, receiving in the subsequent periods the profits deriving from the rental income of the property or the capital gain following the sale.

The main risks of equity-based crowdfunding are:

Capital loss: The success of the operation depends on the variable price of shares. So if the project fails, the difference between the exit value and the invested capital will be negative, therefore investors lose money.

Liquidity risks: shares in smaller or early state companies are illiquid and subject to volatility. In this case investors might find it difficult to access their money after the investment.

Among the most relevant equity-based crowdfunding platforms there are "1031 Crowfunding", based in the United States and with a total financing of 1.3 billion dollars, Crowd House, based in Switzerland and with 203 million euros raised and Property Partners , based in the United Kingdom and with 151 million euros raised.

2) ***lending-based crowdfunding***: in this case the group of investors covers the figure of financiers of a specific project, lending capital to the real estate company. The investors becomes the holders of a company credits which will be repaid over a specified period at a fixed or indexed rate.

The main risks of lending-based crowdfunding are:

Late payments: there is no certainty that borrowers will be able to repay investors on time.

Mortgage: the crowdfunding platforms are not allowed to register a mortgage on the asset. The real estate company which borrows the money requires the property of the assets and gives it as a mortgage guarantee to a third party (SPV) that holds it as a guarantee for all lenders.

Some of the most important platforms in the world we can find Sharestates, based in the United States and with 1.56 billion dollars raised, Exporo, based in Germany and with 201 million euros raised and EstateGuru, based in Estonia and with 94 millions of euros collected.

3) ***hybrid crowdfunding***; they are operators who offer both equity and debt services on their platform. In the last year there has been a sharp reduction in the latter category of platforms, given the trend of operators towards specialization in a specific collection model. Examples of hybrid crowdfunding platforms are: "Reality Shares", based in the United States with $ 870 million raised and "Tessin", based in Sweden and with 124 million euros raised.

Also note that, as with any investment, the main difference between the equity and debt platforms lies in the higher potential returns of the former due to the higher risk faced by the investor, rather than in a return limited to a fixed interest rate. o indexed not linked to the economic result of the project and therefore characterized by a lower degree of risk. According to the data collected, the lending platforms now represent about 48% of the world market, the equity ones 31% and the hybrid ones 21%.

5.5.3 The growth of real estate crowdfunding

Although crowdfunding is a recent concept, it has already reached a large portion of the market previously owned by the traditional financial system, creating new opportunities for real estate operators and allowing millions of private investors to participate in the financing of projects simply through the use of a computer or smartphone. Real estate crowdfunding was born in America when "Fundrise" was launched in 2012, which triggered a process of expansion and knowledge of this innovative investment tool by the population.

“Fundrise is a RECF platform, which offers investors the opportunity to choose offers based on investment preferences: position, type of business, risk profile and return; transactions take place online, including legal digital documentation and the transfer of funds; investment management and monitoring are easily accomplished through an online portfolio ”. A recent report published by the Milan Polytechnic Observatory

mapped 123 real estate crowdfunding platforms operating all over the world, including 38 in the United States and 58 in Europe and 27 in other continents.

The United States, although with fewer operators than the European market, are currently the leaders in the real estate crowdfunding sector, with approximately $ 6 billion in total funding, while in Europe this number drops to 1.3 billion. Within the European continent, Germany and the United Kingdom are the leaders of this area with a slightly lower collection of 400 million each.

Even in Italy the crowdfunding industry, although starting late compared to the main European competitors, is growing; since 2015, this capital raising instrument in Italy has recorded an amount of approximately 250 million euros, of which 112 million euros collected only in 2018. The year 2017 was crucial for the industry, as the value of crowdfunding increased 45%, with equity crowdfunding which has raised around 60 million euros in Italy since its inception. On the other hand, lending crowdfunding recorded a total raised amount of around 130 million, of which around 52 million in 2018. The remaining 55 million were collected from donations and other types of personalized campaigns. The clearest sign of growth is the fact that both crowdfunding equity and lending, during the first half of 2018, exceed the entire 2017 in terms of capital raising. This is the result of the opening of the market to all SMEs, previously limited only to start-ups and innovative companies, thanks to the 2017 Budget Act.[45] In Italy the two main real estate crowdfunding platforms, Concrete and Walliance, have raised € 8.8 million in 2019.

[45] The approval of the Budget Act in 2018 officially established the entry of the crowdfunding tool in the real estate market with all small and medium size enterprise (SMEs) that could finally have access to online capital collections, with the limits of innovativeness decayed.

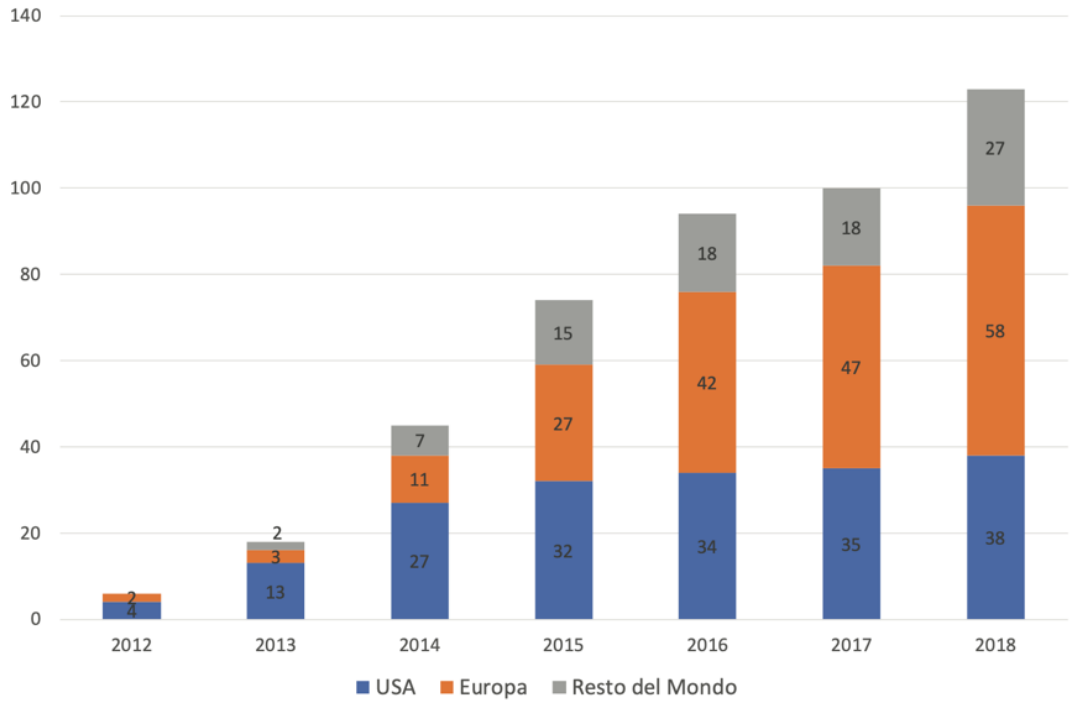

Figure 36: Growth in the number of real estate crowdfunding platforms

5.5.4 The benefits and threats in real estate crowdfunding platforms

The development of crowdfunding platforms as a means of financing real estate projects offers numerous advantages compared to the traditional financing methods present for decades in the sector, among which the main ones are:

-a lower cost of capital: the introduction of crowdfunding platforms have led to disintermediation in the real estate market, cutting financial institutions, brokers and advisors, which traditionally connected borrowers and lenders. This led to a lower cost of capital for real estate developers and higher risk-adjusted returns for lenders. Numerous reports have highlighted a drastic reduction in fees and commissions required by these technological platforms compared to traditional financing channels. *"For investors, low-threshold entry levels and low capital commitments, attractive returns, low fees structures and the opportunity to invest direct into real estate draw*

more investors to RECF platforms, thereby directing capital into real estate finance industry" (IPF Research, 2016).

-***a more efficient capital allocation process***: the introduction of real estate crowdfunding platforms have simplified the entire process of raising capital and investing in the real estate sector. Through these platforms the whole process has moved online, from reviewing and finding properties, to signing legal documents and transferring funds, to monitoring the investment, significantly saving time and costs for investors and developers.

Digital analytics tools provide investors with targeted and tailored information to help them to make informed decisions. Investors are able to investigate numerous potential investments at one time and determine quickly whether the opportunity fits their portfolio strategy, risk appetite, or other criteria.

-***greater transparency:*** through the massive use of technology, crowdfunding platforms allow a faster and easier transfer of information making the whole investment process more transparent.

-***broader investor base***: the use of digital platforms allows the developers of a project to expand the number of potential investors geographically; in addition, the minimum investment capital, a fundamental characteristic of the RECF, allows to eliminate the inherent entry barriers of a sector traditionally considered to be highly capital intensive, making direct investment available also to a portion of investors previously excluded.

-***enhance user experience***: the technologies used by the platforms offers investors an excellent user experience, characterized by numerous digitally available tools.

-***self-directional tools:*** the crowdfunding platforms perform in-depth analyzes on the investments proposed by the sponsors, in order to detect possible anomalies. Investors have the possibility to consult a series of documents made available by the operator, such as due diligence reports and metrics on the profitability and risk of the project, having the possibility to select only the investments related to the degree of risk, giving them control and autonomy over the capital allocation.

Real estate crowdfunding is therefore an alternative way to traditional financing, bringing significant advantages both to developers, through a large investor base and to individual investors, with the elimination of obstacles to entry and lower commissions. The intensive use of technology is a milestone of this new business

model, which grows rapidly, representing a competitor for traditional intermediaries. However, according to many scholars, real estate crowdfunding platforms present numerous risks, which so far have not been completely removed due to the infancy of the industry. The online aspect and nature of crowdfunding create a sense of anonymity, increasing the risk of fraud; *"Anonymity means that there is always an opportunity for fraud, both for the debtor and the issuing parties, and for the lenders or investors"* (Kirby and Worner, 2014).

Indeed, while for traditional investors who damage their reputation following a fraud they could act as a brake, the anonymous character of online platforms could instead increase the risk of fraud in crowdfunding, representing the main threat inherent in this model; furthermore, given the initial phase of the model, with a limited level of experience and resources, many platforms to date do not have a consolidated control and due diligence process.

"Disclosure asymmetry prevents potential investors from getting adequate disclosure and disclosure regulations and requirements for online platforms are weaker than those for listed companies or brick and mortar businesses" (UC, 2017).

In particular, to date there is no harmonization of the main crowdfunding countries, with few of them possessing clear regulation on the matter.

Another feature is the limited liquidity of this model, with a partial number of platforms having a secondary market, in which investors can liquidate their shares of a project, thus foreseeing a risk inherent in this model.

The last drawback concerns the insolvency of risks and corporate bankruptcies for the projects financed online since historical data are generally lacking to evaluate the performance of the crowdfunding assets. Platform failure is also a high risk; there are hundreds of crowdfunding platforms globally, with many already closed.

Conclusions

Innovation has always played a fundamental role in the development and improvement of our lives. The wide Internet access, the use of smartphones and the spread of digital platforms are the proofs of some of the phenomena that have had a profound impact on society and on our way of life. The recent global shift towards the digitalization of many sectors has placed these at the center of a significant change with the development of innovative business models capable of bringing significant added values; even the real estate sector, which has always been represented as a sleeping giant from the point of view of technological progress, has been "awakened", triggering an unprecedented revolution in the sector, called Proptech.

The innovations introduced are numerous and, taking the Baum matrix as a reference, they can be summarized in three main areas of operational development: information, consisting of technologies that support a more efficient exchange of data between market players, making the process more faster and safer; *transactions,* represented by technologies with the aim of making the intermediation process simpler, cheaper and more transparent; and *management,* technologies that aim to make property monitoring and management more efficient.

However, even if everything seems simple, it is not so, since history has taught us that innovations have two sides, the first bright, the other less. It is essential to know how to manage wisely the innovations that technology offers us, both to take full advantage of its features and to avoid possible threats deriving from the often unexplored territories that make it up.

To date, there are numerous obstacles and threats to the adoption of proptech in the real estate sector, including operational, regulatory and social obstacles.

Operational barriers represent the process changes required in the current system of the real estate sector and include:

- integration of software processes: each new system must be correctly integrated with the practices and software currently used in the sector;
- critical mass: in general, the benefits deriving from the introduction of a new system are fully realized only when this is widely used.

-transaction costs: the transition towards the adoption of new technologies in the real estate sector is linked to significant financial charges, which could slow down the adoption process.

-data security: with the introduction of digital technologies it is essential to ensure that they are safe and that they have no weak points that can be exploited by third parties.

Regulatory barriers represent the legal issues that new technologies have overlooked; these include:

- legal framework: although it is essential to ensure that current legislation encourages innovation, it is equally important to have an updated regulatory framework that regulates all aspects of the new business models that have arisen.

Social barriers are related to behavior and emotional resistance to the adoption of any new system. These include:

- damaged revenues: the new technologies introduced that attempt to bring process efficiencies must do so for the financial benefit of their target users. The long-term financial benefits that a technology can bring must be clearly understood by everyone involved.

- threat from the actors of the traditional sector: with the growth of proptech there will be a great redistribution of wealth in the real estate sector, far from the old, traditional and slow systems towards young and agile actors who see change as an opportunity. This could lead the traditional actors of the sector to act in contrast with the innovations introduced in the sector.

From how it was possible to understand Proptech represent a unique opportunity for the development of the real estate indsutry, bringing numerous advantages both to market operators and to the community in general, but to truly exploit its benefits it is essential that all actors understand the innovation and adapt accordingly.

Bibliography

A. Baum, "Proptech 3.0: the future of Real Estate", University of Oxford, 2017.

A. Baum, A. Saull and F. Braesemann, "PropTech 2020: the future of Real Estate", University of Oxford, 2020.

A. E. Espinosa, "Impact of Sharing Economy on Housing", Babson College, 2014.

A. Kumar, C. Hatti, "Global Co-living Report", The Housemonk, 2019.

A. Nandan, V. Rathi, D. Grover, A. Lalchandani, "CoLiving: Rent a Lifestile", Knight Franck, 2019.

A. Phipps, M. Heavey, "Innovation in the Sharing Economy: what are the real implications?", CBRE, 2017.

A. T. Totonchi, "Smart Buildings Based on Internet of Things: A Systematic Review", University of Malesia, 2019.

Bellintani, S., Ciaramella, A., Celani, A., Leoncini, S., & Tagliaro, C. "PropTech Monitor: Tecnologie, strumenti e servizi innovativi per il Real Estate", Politecnico di Milano, 2019.

Bellintani, S., Ciaramella, A., Celani, A., Magnani, M., & Tagliaro, C. "PropTech Monitor: Tecnologie, strumenti e servizi innovativi per il Real Estate", Politecnico di Milano, 2018.

CH Alliance, "Proptech: Innovation in Real Estate Finance", 2019.

Digital Transformation Monitor, "Smart Building: Energy efficiency applications, European Commission, 2017.

E. Allameh, De Vries, M. Heidari, "The Role of Smart Home in Smart Real Estate", Journal of European Real Estate Research, 2012.

E. S. Hershfield, "The Sharing Economy Has Landed", Thompson Reuters, 2018.

Emerge Capital, "Smart Cities: Implications for the Real Estate Sector", 2016.

Ernst & Young, "Real Estate disruption: challenges and opportunities in a rapidly changing world", 2016.

Ernst & Young, "Real Estate crowdfunding: introduction to an alternative way of investing", 2019.

F. Ullah, C. C. Wang, "A Systematic Review of Smart Real Estate Technology: Drivers of, and Barriers to, the Use of Digital Disruptive Technologies and Online Platforms", Sustainability, 2018.

G. Mattarocci and S. Roberti, "Proptech, le nuove strade del mercato immobiliare", 2019.

G. Morri, M. Ravetta, "Real Estate Crowdfunding", Politecnico di Milano, 2016.

G. Squires, "Disruptive potential of real estate crowdfunding in the real estate project finance industry: A literature review", Property Management, 2018.

George Matysiak, "Automated Valuation Models (AVMs): a brave new model?", Cracow University of Economics. 2017

H. Jarvis, K.Scanlon, M.F. Arrigoitia, "Cohousing Shared Futures", Economic and Social Research Council, 2016.

I. Goossens, "Demystifying Proptech: a complete overview of the European PropTech ecosystem", Proptech house, 2019.

J. Hills, T. Duncan, "The Role of Real Estate in Smart City Development", CBRE, 2018.

J. Madden, "Exploring the New Sharing Economy", NAIOP Research Foundation, 2015.

J. Shin, Y. Park, D. Lee, "Who will be smart home users? An analysis of adoption and diffusion of smart homes, Elsevier, 2018.

JLL, "European Coliving Index", 2019.

JLL, "Smart City Success: Connecting people, proptech and real estate", 2019.

KPMG, "The road to opportunity", KPMG Global PropTech Survey, 2018.

L. Sdino and S. Magoni, "The Sharing Economy and Real Estate Market: The Phenomenon of Shared Houses", Springer International Publishing, 2018.

M. Barlassina, "Vendo Casa a pronta cassa", Forbes, 2018.

M. Chan, D. Estève, C. Escriba, E. Campo, " A review of smart homes: Present state and future challenges, Elsevier, 2008.

M. DelPrete, "The IBuyer Report", 2019.

M. Hoesli, G. Morri, "Investimento Immobiliare: Mercato, valutazione, rischio e portafoglio", Hoepli, 2010.

M. Iannotta, "Real Estate nell'era Digitale: PropTech", 2017.

M. Lizam, "Digital Technology and the Real Estate Industry", Sinergi, 2019.

M. Sklarz, N. Miller, "IBuyers: A new choice for home sellers but at what cost?", Collateral Analytics, 2019.

P. Lecomte, "What is smart? A real estate introduction to cities and buildings in the digital era", Journal of General Management, 2018.

P. Stieninger, "The Smart Building in the Smart City", Springer International Publishing, 2016.
Politecnico di Milano, "4° Rapporto italiano sul Crowdfunding", 2019.

Politecnico di Milano, "Smart Building Report", 2020.

PROPTECH1, "European PropTech Trends", 2020.

S. Kejriwal, S. Mahajan, "Smart buildings: How IoT technology aims to add value for real estate companies", Deloitte University Press.

S. Scheurwater, "The Future of Valuations", RICS, 2017.

Unissu, "Global Proptech Analysis", 2020.

V. Albino, R.M. Dangelico, U. Berardi, "Smart Cities: Definitions, Dimensions, Performance and Initiatives", Journal of Urban Technology, 2015.

SUMMARY

The real estate sector is huge, the Federal Reserve estimates that the entire industry is worth more than $ 273 trillion, with the property representing about one third of a family's wealth, making its proper functioning fundamental for the largest aim of the stability of society.

However, the real estate sector has always been characterized by numerous limits which partially hinder its growth and development, making it highly vulnerable to potential threats, including periods of market downturn. Among the major limits connected to the real estate industry we can find:

-*The high unit value*: real estate activities are characterized by a high unit value, with direct investments that require large amounts of capital.

-*Heterogeneity*: properties are an exclusive and non-standardized asset. As regards its technical characteristics, its temporal value and its position, each property is subject to own evaluation and as such is not susceptible of any seriality or substitutability. The characteristic of the heterogeneity of the properties entails limits in the evaluation phases, which have always been characterized by great subjectivity and uncertainty.

-*Illiquidity*: one of the main characteristic of real estate activities is their low liquidity; it often takes a long time to sell a property at the market price. The illiquidity of the properties derives from their high unit value and their heterogeneity, which do not give real estate investments a fungibility characteristic. According to the studies, the average time to sale a property in Europe varies between six and seven months, thus making this class of activity highly inefficient and difficult to trade.

-*Opacity*: generally the transactions on the real estate market take place through private negotiations between two counterparties who, for various reasons and in some cases, are reluctant to communicate the value of the transaction transparently. Indeed, the information obtainable regarding real estate assets is not always reliable, since in some cases the amount provided deviate from the actual sum exchanged, leading to the construction of inaccurate indices and market benchmarks. In addition, a real estate transaction is characterized by an information asymmetry between the counterparties, in which the seller is often better informed of the relevant aspects of the property than the buyer.

The technological development of the last decade has had a strong impact in almost all sectors, including real estate, which has always been characterized by a conservative and not prone to change philosophy.

However, following the subprime mortgage crisis that broke out in America in 2007 and expanded in the main world economies, real estate, among the main sectors affected, was at the centre of a strong renewal driven by a larger change in the technological ecosystem, giving life to proptech neologism, used to underline the growth of a close relationship between property and technology, which promises to eliminate some of the limits that currently characterize the real estate industry.

Although the concept of proptech has only recently been introduced, the use of technologies in the real estate sector is not new, but dates back to the last century. In particular, we can indicate three periods of progress in the real estate industry, which in turn reflect a wider transformation of the technological ecosystem. The beginning of the first forms of technology related to the real estate sector dates back to 1980 with the introduction of personal computer and database management systems, whose daily use, driven by the ability to digitize a variety of information, has revolutionized the way to analyse and store real estate data and information. Excel and other IT systems for the management of real estate portfolios became, in that period, essential tools for the real estate professionals, who started to adopt a more quantitative approach to investments and portfolio management. We can therefore speak of a first form of proptech already in the last century. However, it is good to underline that the innovations belonging to this historical phase have been characterized by a *"closed form"*, connected to internal improvements but with limited integration and communication skills with the outside. The subsequent evolution of proptech began after the 2008 financial crisis, a period characterized by a continuous waves of innovations, investments and entrepreneurial activities.

We have witnessed a strong evolution of the market passing from very simple applications of technologies to the real estate sector *(Proptech 1.0)* to more advanced scenarios in which the main added value derives from the technology applied to the property, made possible from a wider technological revolution taking place in the world, with the introduction of technologies such as *websites and smartphone apps*, *internet of things (IoT)*, *artificial intelligence* and *machine learnings*. The biggest shift

in the real estate market, which marked the beginning of the second wave of real estate technology, called Proptech 2.0, was the transition from a digitized to a digitalized real estate system.

Specifically, the term digitization refers to the conversion of paper hard copies into unintelligent digital soft copies; the data contained in the digitized documents cannot be extracted through computer programs and require human interpretation. In practice, digitization can be considered as scanning a page, uploading a photo or creating a pdf, in order to have a digital copy of an original document.

On the contrary, "digitalization" is the act of converting anything into a digitally readable format. The digitalized data allow the software to automatically perform activities without the need for human intervention, being able to collect, analyse and respond independently to the available data.

This shift was the starting point for the development of proptech 2.0, which produced an unprecedented growth of startups operating in the sector, supported by huge investments by venture capital funds and accelerators. Specifically, the proliferation of real estate startups has represented an important acceleration engine for innovation in the sector, capable of introducing disruptive and not only incremental solutions.

In addition, the birth of Proptech 2.0 has led to the development of new business models, characterized by a different approach to real estate transactions, such as the instant buyer (IBuyer), who through algorithms evaluate the price of a house and subsequently release a purchase proposal in short time and real estate crowdfunding platforms, the introduction of which has made possible investments also for a part of the population previously excluded from the sector, thus expanding the public of investors and promoting a boost to investments.

Although the third wave of proptech has not yet happened, according to the major experts in the next decade we will see this new technological chapter in the real estate sector, driven by technologies that have been recently available, such as Blockchain technology and 3D printers in the development phase.

The proptech industry is made up of numerous business models, with the aim to make the entire real estate sector more efficient, minimizing all the limits that hinder its correct development. Proptech is a young industry, constantly evolving and characterized by wide boundaries that make difficult to precisely classify its individual

subsectors. Over the years, numerous proptech classifications have been made, which differ from each other according to the criteria used; in particular we can find three types of classifications:

one-level classification: which presents a grouping by type of activity with the aim of accurately describing the different areas of proptech innovation;

two-level classification: proposes a differentiation of proptech into asset class: residential, commercial, receptive, office and industrial;

matrix classification: which proposes a matrix between vertical and horizontal characteristics.

Among the most interesting and innovative classifications of the proptech there is the matrix of professor A.Baum, whose representation of the industry, through a multiplicity of reading criteria, allows in my opinion a deep understanding of the effective influence of technological innovations on the real estate industry.

Andrew Baum, professor of the University of Oxford, in his work entitled *"Proptech 3.0: the future of the real estate sector"*, classifies the main segments of the sector by enclosing its operating fields in a matrix made up of three criteria, defined as

"vertical ", which identifies the different functions or phases of the real estate life cycle and three business segments, defined as" horizontal", which instead identify the different business areas of proptech. In particular, the vertical components are:

I) Information: technologies that support a more efficient exchange of data between the players in the real estate market, making this process faster and safer.

II) Transactions: technological solutions that aim to make the intermediation process simpler and more transparent.

III) Management: digital technologies that regulate a more accurate monitoring of properties, including their management.

As for the three horizontal components, or areas of activity, they are:

-*Smart Real Estate*: describes a series of technology-based platforms that automate, simplify and make the operation and *management* of real estate activities more efficient. Smart real estate consists of several components, the union of which creates an integrated system based on technology, which offers consumers a series of systems to improve their quality of life.

Among the main applications we can find smart building, consisting of a series of technological tools with the aim of improving building management, as digital solutions for energy optimization and home automation.

-*Sharing Economy*: it's the second area of proptech activity identified by Baum, which is focused on simplifying the *use* of real estate assets and is represented by a new economic model based on alternative processes of resources distribution and income generation, such as short-term housing rental, a new model of space sharing supported by technology. Among the main models relating to this area there's co-working, a rapidly growing business model, which implies the sharing of a workplaces among multiple companies and professionals; the positive aspects of co-working spaces are, in addition to the reduction of rental and utilities costs, the synergies created through the sharing of knowledge between multiple professionals.

-*Real Estate FinTech*: it is represented by a series of digital platforms capable of simplifying the transaction on the real estate market. Within Real Estate Fintech there are also companies engaged in the secondary market which, through the use of technology, guarantee greater transparency, divisibility, liquidity and market negotiability. The Real Estate FinTech can be considered as an extension of the largest Fintech area, defined as "*the use of technology and innovative business models in financial services"*. Several business models fall within the Fintech industry, such as online payment systems, crowdfunding equity and debt platforms and online exchange, which in turn have also been adapted to the real estate sector. From all this it follows that the development of the Fintech industry has provided the basis for the growth of Proptech, which however must be understood as a distinct area of activity. We can therefore define Proptech and Fintech as two separate groups that share one overlap area of activity that is the Real Estate Fintech.

However, the matrix classification shown omits to indicate among the areas of proptech activity that relating to the technology applied to the real estate development phase; in particular, *Contech* can be defined as the introduction of technologies in order to innovate the ways in which buildings are designed and built, as well as the production and installation of their components.

Just as the word proptech is very young, the development of this technological sub-sector is still in its infancy and only in recent years have we observed strong growth in

the interest of markets and governments, also driven by the work of numerous networks and hubs. They, that operate in the form of private companies or non-profit associations, have helped to create an environment of education and market inspiration, in which proptech startups can build relationships with each other and achieve important synergies.

Thousands of startups are currently operating in the real estate value chain, redefining the products and services offered in the sector, optimizing the ways in which real estate professionals works and changing how consumers interacts with the market.

New job are being created in the real estate sector, closer to the world of technology, as *"Chief Transformation Officer*", *"Chief Digital Officer"* and *"Chief Innovation Officer"*. There are currently 22 unicorn proptech startups, ten of which are located in the United States and twelve in China, with a market valuation of over $ 70 billion. To date, unicorn proptech startups are not yet present in Europe, this for two main reasons: the strong fragmentation of the European market and the low presence of venture capital funds.

One of the metrics that can be used to understand proptech's real growth is related to the volume of investments; indeed: "*how much money gets poured into an industry is often seen as a sign of health*" (Faraudo, 2019). As a result, most attempts to size the proptech market look at the growth in funding achieved year after year.

In recent years the industry has attracted numerous capitals, driven by a huge size of the real estate market equal to a share of the world GDP between 17% and 20%. According to research conducted by Venture Scanner, while in 2014 the global investments dedicated to the digitization of the sector amounted to about 8 billion dollars, these in 2019 reached the share of 28 billion, with an average annual growth of 30%.

The growth of investments in proptech is attributable to the transition of the industry from a take-off phase to a first phase of consolidation, which emerges from an analysis of the type of investments made, that in the 2018-2019 period decreased in the overall number of rounds completed (-25%) but increased in the size of each individual investment. In particular, by distinguishing investments in start-ups in the initial phase (focused on the development of the product and service offered and for production and first sales) and in the subsequent phase (capital necessary for working capital and

business growth) we can observe a reduction of overall investments in the initial phases and an increase in the following phases, demonstrating the fact that the proptech industry has entered a consolidation phase with investors willing to put more capital but in specific areas deemed potentially profitable. According to experts, in the next five years the proptech market will undergo a maturity phase with an increasing number of IPO and M&A operations, pushing the birth of large global proptech players. Analyzing the investment activities, we can see that the capital flowed into the proptech industry comes from different sources, the main ones are:

1) Cross-industry VCs: they represent the category of investors who have placed the largest amount of capital in the proptech industry. This class of investors are active in at least four different sectors without a specific focus on real estate. Several research organizations have tried to quantify the amount of capital placed in the sector by Cross industry VCs, with results that differ from each other due to the lack of clarity in defining the proptech universe. According to Venture Scanner, cross-industry VCs invested approximately $ 30 billion in industry between the 2014-2018 period.

2) Accelerators: also known as seed accelerators and often coordinated by important universities, they are programs focused on supporting startups in the initial phase of activity, offering not only capital, but also mentoring, business guidance and expertise. Among the main European accelerators supporting the proptech industry are: Seedcamp (United Kingdom), Impact Accelerator (Spain), The Faculty PropTech Accelerator (United Kingdom).

***3) Corporate Venture Capitalism (CVC)*:** represents one of the main tools used by companies to invest indirectly in new technologies and business models such as those belonging to the proptech industry. CVC is a type of investment made by consortia of medium and large traditional companies on one or more startups through a dedicated fund. CVC funds acquire a share of capital, generally in the minority, of new innovative startups in the same sector or in a related one, with the aim of gaining privileged access to innovations and developed technologies. According to Altus Group, approximately 53% of the main real estate companies are directly investing at least in one type of proptech firm.

Among the main companies, not only involved in the real estate sector but also belonging to other sectors such as telecommunications and the energy, active in

investments through CVC funds we find: Saint-Gobain (FR), Duval (FR), Kärcher New Ventures (DE) and Countrywide PLC (United Kingdom).

4) PropTech VC: these are venture capital funds focused on the proptech industry, most of which located in Silicon Valley. Eight proptech VCs are active in Europe, mainly based in the United Kingdom, Germany and France.

The proptech industry is characterized by the presence of numerous operators located in different geographical areas, with a strong relevance in the American (38.9%) and European (45.1%) markets. In particular, the main areas of the proptech industry are California, the US coast, western Europe (in particular the United Kingdom) and some regions of the Asian continent, such as China, India and Singapore.

Taking up the Baum matrix classification, we can analyze the proptech industry in its three different areas of activity. The smart real estate which, as previously described, includes all those technological platforms and applications responsible for collecting and supplying data to customers, agents and real estate managers, with the aim of promoting efficient management of assets and resources. The characteristics of this model are focused on the user, on sustainability and on the use of innovative and disruptive technologies in order to obtain benefits that would otherwise not be possible. In particular, four disruptive technologies used in the Smart Real Estate area can be identified, which are Cloud Computing, Big data and data analysis, artificial intelligence (AI) and Internet of Things (IoT). The development of sustainability and smartness within society is a recent topic, driven by changing demand, increasingly focused on a sustainable and efficient economy. The smart real estate sector operates in close relationship with the green economy: the change in climatic conditions due to pollution and intense global urbanization has been one of the main triggers of the recent real estate revolution. According to studies conducted by the European Commission, buildings are responsible for around 40% of the total energy consumed worldwide and 36% of CO2 emissions, representing the sector with the highest waste of resources. This is because about 35% of the existing buildings are more than 50 years old and about 75% are considered inefficient from the point of view of current energy standards. For these reasons, in recent years there has been a common awareness of the society towards a new frontier in the sector called smart real estate, focused on smart devices and systems capable of bringing numerous benefits, including efficient management of

energy consumption with the goal of generating a positive impact on the environment. The integration of these technologies in the real estate sector will lead to the creation of building management systems (BMS) capable of performing numerous autonomous tasks in a more efficient and economical way, including:

- *Operating systems based on actual use*: which through the use of sensors and artificial intelligence software will allow optimal use of the energy resources of buildings. For example, balance the heating and lighting system based on the number of people in a specific room.
- *Operating systems based on predictive use*: through continuous data collection, the BMS will be able to learn which areas of a building will generally be used at certain times of the day, managing the heating of the area in advance and avoiding unnecessary stress of the system and peaks in energy demand.
-*Operating systems based on environmental factors*: the connection between multiple devices and sensors allows the system to autonomously adjust the lighting and heating level according to the climatic conditions.
-*Preventive maintenance*: an BMS is able to learn the energy consumption requirements of the individual units of a system. For example, if a unit shows an anomaly, the system will notify the manager, allowing him to take appropriate corrective actions before the problem occurs.

According to the leading experts in the sector, although twenty years ago the characteristics of connectivity and efficiency were considered an added value, today they are among the main drivers of the price of a property, with the increase in standardized certification systems to classify the level of intelligence of buildings, such as "Intelligent Building Index", developed in collaboration with Microsoft, Investa Property Group, Willow, University of Technology Sydney and EG, and which represents the first technological standard of the real estate industry which, through the use of qualitative and quantitative measures, is able to evaluate the relative intelligence level of a building.

As you can understand, the area of the intelligent real estate sector is certainly one of the main proptech models in terms of number of operators and volume of investments; in addition, it can also be divided into three specific business models: smart home, smart building and smart city. The second area of proptech activity identified by Baum is the

Sharing Economy, which can be defined as a particular economic model born in the early 90s but officially established on the markets after the financial crisis of 2008 and characterized by a different execution compared to the traditional models of business represented by the production and sale of goods and services. In the sharing economy, the distributed ownership of a resource allows to divide its use among several subjects, as well as the purchase cost, shared by a larger group of users or recovered by a single owner through the rental of a portion of the asset. Proptech is among the main fields of application of this new economic concept, whose recent technological development has made data on real estate assets available and transparent for individuals and companies and has reduced transaction costs in the sector, opening up the way to this new models based on the use of underutilized assets.

The proliferation of the internet in the daily use of the population via smartphones and the introduction of digital technologies has simplified the relationship of consumers with products and services offered digitally through online platforms and markets, allowing property owners to transform unused or underutilized assets in revenue generators.

Through digital platforms, property owners can find potential users who rent an additional bedroom, an unused space in a commercial store or an unused desk in their office; today through proptech and more precisely the economy of real estate sharing, individuals can optimize the use of their property by finding users for any excess of capacity. Although the development of the sharing economy in the real estate sector was made possible by the proliferation of innovations, its spread is due to a number of factors, among which the main ones are:

Social elements: in the first place it is good to clarify that this economic model can be seen as a mindset, led mainly by the millennials, subjects born between 1990 and 2000, who currently represent the growing economic strength, prone to a lighter and more flexible lifestyle, characterized by loan, rent and sharing; indeed, these subjects, having first grown up in an era characterized by strong consumerism and an abundance of goods, then living in a strong economic recession characterized by high unemployment and witnessing the negative footprint of excessive consumerism, today prefer live in a flexible way, owning as little as possible, but borrowing and subscribing, having everything accessible thanks to technologies.

State of economy: austerity, crisis, high house prices in major global cities and an increase in the unemployment rate have redirected consumers behavior towards more cost-efficient models, such as the sharing of goods and services.

Political: the increase in political instability, the promotion of entrepreneurship and the constant replacement of institutions by global companies has created a shared channel for idealism and social enterprise.

Technology: the proliferation of the internet in the daily life of the population has made easier for companies to aggregate supply and demand and has transformed consumer relationships with products and services. Smartphones have revolutionized market access for both consumers and producers. Satellite positioning functions help to find nearby markets and social media networks and recommendation systems have helped to establish a bilateral trust system. Finally, electronic payment systems have made market transactions easier and safer.

Today, almost every real estate segment is part of the sharing economy: the sharing of housing, often single rooms, in the residential sector (co-living) or the sharing of properties within residential complexes (co-housing), shared workplaces in the office segment (co-working) and the rental of short-term spaces in the commercial segment (pop-up stores).

The last area of activity is Real Estate FinTech, the third vertical sub-sector of PropTech, which supports the sale and rental of real estate, as well as shares or funds, debt and equity. Within this area there are numerous operators focused on offering different services, such as brokerage platforms, which provide useful information to potential buyers and sellers, or investment and financing platforms, which support real estate transactions. Real Estate Fintech represents the largest of the three vertical models of the Baum matrix and its development is driven by the wider revolution of the financial technology ecosystem, which refers to the software and innovative technologies used by companies in the financial sector. Operators active in real estate fintech not only ensure that multiple factors are considered in the investment decision, but also provide data in a digitized format, allowing machine learning programs to make investment decisions more accurately.

With the development of real estate fintech new technology applications have emerged including the automatic valuation models (AVM) defined *as: "statistic-based software,*

which use a series of artificial intelligence algorithms capable of performing rapid and precise assessments of a real estate property through the analysis of a large data set, with minimal error margins ".

Today many important operators, including the main financial institutions, use automatic valuation models within their business; the ability to accurately determine the value of a property can simplify the process of issuing mortgages and loans, reducing the costs and time needed to assess a property.

We can identify a number of benefits in using automated valuation models, including:

-a saving in time, costs and resources used during the valuation process

-the removal of the human factor, which eliminates the subjective element inherent in the traditional valuation process, also reducing the potential risks of fraud. The main models analyzed in real estate fintech include research and information platforms, which aggregate a large amount of real estate data converting them into information that can be used by potential buyers; real estate crowdfunding platforms which, in addition to making investments less expensive and complex, open up real estate investment opportunities to a wider audience of investors and, finally, the real estate ibuyer a recent business model that promises to revolutionize the sector by creating a secondary market for real estate transactions. In particular, the ibuyer represents one of the most interesting business models of real estate fintech; ibuyer companies, mainly active in the residential sector, through the use of technologies such as automated valuation models (AVM), manage to industrialize the real estate purchase process by releasing a price offer and completing the transaction in a short time; after a renovation of the property they plan to sell it, through online and offline marketing campaigns, autonomous customer visits and the use of innovative technologies such as virtual home tours, obtaining a small profit margin.

Although this sector is still in its infancy and represents a small part of the real estate market, it cannot be ignored, especially if the transactions carried out by operators have a growth rate of 25% per year. The recent success of the ibuyers goes well beyond the release of an instant offer for a property, but includes a massive use of technology with the aim of offering an excellent customer experience. Through the use of the Internet of Things, operators allow potential customers to enjoy unaccompanied property views at any time of the day. Once registered through their app, geolocation technology will

guide people to the property before remote access is granted through an electronic lock. A remote security monitoring system is enabled by the installation of motion sensors associated with the location data of the customer's mobile phone. Transparent demand statistics on the number of views, and therefore on the level of interest, can be published in real time.

Big Data algorithms are also used to identify potential sellers through targeted marketing strategies on the main real estate brokerage platforms. Furthermore, the use of automated technological systems helps to identify the optimal capital market structure available at the time of purchase, simplifying the number of properties to be kept in the portfolio that will optimize their financial position. The ibuyer model originated in the United States from Opendoor, founded in 2014 and currently the market leader in terms of annual transactions. The United States is now the main market by number of transactions, with approximately 60,000 purchases made in 2019 against the total real estate transaction of 5.57 million, which therefore represent around 1% of the national market share.

The ibuyer model has also developed on the European continent with different degrees of development and nuances of business in each country. We can find three different models of ibuyer currently operating in the European market. The first is similar to the classic ibuyer created in the United States by Opendoor, summarized as "*purchase, renewal and resale*"; properties are purchased and sellers paid immediately, which requires a huge amount of capital to finance the process; the appreciation of the property through refurbishment and marketing campaigns represents a large portion of the profit margin.

The second model is characterized by a hybrid form between ibuyer and property management, with operators that doesn’t needs large amount of capital but act on behalf of institutional investors with a buy-to-let strategy, such as sovereign wealth funds and pension funds. Among the main companies present in this model is IMMO, founded in 2017 in London, its core business is represented by the "instantaneous purchase" of residential properties, the refurbishment and subsequent rent on the long-term rental market.

The activity of this category of ibuyer is based on the consumer-to-business (C2B) model which, unlike the traditional ibuyer based on a consumer-to-consumer (C2C)

model, is less exposed to temporary market crisis events, thanks to the stability of long-term rents characterized by a predictable return.

The latest model mentioned is also a hybrid, but this time between the ibuyer and the money lender. The operators in this model aim to allow chain-free transactions, with an advance amount guaranteed to the seller, that offers him the opportunity to buy the next property before his own is sold. This model of ibuyer manages the sale of the property but acts more as a broker than as a real buyer. With this model, capital is rapidly made available to the client and is only required in the event that the client needs access to the funds before the property is sold. Unlike any other IBuyer model, customers enjoy full advantage when their property is sold at a premium greater than the advance.

Nested is a company founded in London in 2015 operating in this business model, indeed, in addition to managing the evaluation, marketing and sale of the property, it also offers an advance to customers, guaranteed by the property offered for sale, aimed at buying of the next house.

Although the growth of these models is useful to indicate that ibuyer's expansion trend in Europe is much slower than in America, this is due to a number of reasons. First of all in some European countries, especially the southern ones, the real estate data are not transparent, making the various published market analyzes difficult and often contradictory. This lack of transparency and accessibility in data inevitably makes automatic evaluation models less reliable as they have a reduced pool of market data.

Another important factor is the lack of harmonization of real estate transaction costs in the European area, with various types and amounts of taxation in individual countries which make it difficult to implement a standardized model on a large geographical scale; an example is Germany, where to date there is no successful ibuyer operator in the area due to too high taxation on the transfer of ownership.

Casavo is an Italian startup operating in the residential segment and today is one of the largest ibuyer operators by number of transactions in Europe. Its success is mainly due to the extraordinary added value offered on the national real estate market, historically characterized by substantial inefficiencies. Founded in 2017 in Milan, today Casavo has achieved important milestones, representing the largest ibuyer operator in Europe with over 300 transactions carried out for a total market value of over 85 million euros.

Casavo's activities have grown rapidly over the years, first on the national market, through expansion in the main Italian urban centers such as Rome, Florence, Turin, Bologna and Verona and then in southern Europe, with the opening of a branch in Madrid. The huge collection of shares and debts is proof of investors' confidence in this innovative business model; Casavo has in fact raised over 100 million in two years, thus becoming the Italian startup to have raised more capital, through large venture capital funds that support its growth and the enhancement of the offer, including Greenoaks, Project A Venture, 360 Capital and Picus Capital.