The Effects of Covid-19 Pandemic on the Housing Market: A Case Study in Rome (Italy)

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Abstract. The present study is part of a wider research line focused on the analysis of the effects caused by the pandemic of the Coronavirus disease (Covid-19) on the Italian residential property market. The paper aims to propose a methodology for the assessment of the effects of this abnormal event on the housing price mechanisms. The research could be an operational support for the Public Administration and private investors in their decision making processes. In particular, with reference to the city of Rome (Italy), two datasets of residential properties have been collected and processed through an econometric technique, in order to identify the variations occurred in terms of market appreciation for specific housing factors. The outputs highlight changes in market demand concerning a preference for outdoor spaces, both condominiums and private (terraces and balconies) and for properties located in peripheral areas of the city.

Keywords: Covid-19 · Pandemic · Housing market · Residential selling prices · Econometric technique

1 Introduction

The acute respiratory syndrome caused by Sars-Cov-2 (Covid-19) has started from China in December 2019, becoming a pandemic within few months with more than 122 million infection cases (March 2021) [27]. With reference to the market variations assessment, the Covid-19 pandemic can be considered an unpredictable anomalous event [1]. As a consequence of this event an economic crisis has emerged worldwide: it is observed that in 2020 the global Gross Domestic Product (GDP) has decreased 3.5% compared to 2019 [26]. In the Eurozone (referred to composition in 27 States) the GDP has dropped by 4.8% in 2020 [7], and it is expected to recover by 4.6% in 2021, as the restrictions have been eased and the impact of monetary and fiscal incentive have been activated [6]. In Italy the GDP decrease in 2020, compared to the previous year, has been equal to 8.9% [12].

O. Gervasi et al. (Eds.): ICCSA 2021, LNCS 12954, pp. 50–62, 2021.
https://doi.org/10.1007/978-3-030-86979-3_4

In addition to economic and financial crisis, the pandemic has globally changed many aspects of daily life, causing effects on both the social dynamics and the mental well-being of the population [3, 4, 8, 11, 13, 25]. Since the end of 2019, collective preventive measures have been taken throughout the world and with several restrictions, such as: social distancing, compulsory confinement, reduction or complete banning of access to public places, interruption of theatre, cinema or concert programmes, and reduction of national and international trade. These preventive measures have forced almost all the world's population to carry out different functions in their homes, i.e. smart working and distance learning activities, or sports and recreational activities, by leading to considerable variation in the ways of using domestic spaces and residential condominium areas. With reference to the labour market, the Italian National Institute of Statistics (ISTAT) reports that in Italy in 2019 were about 570,000 remote workers, and during 2020 the workers involved by this job typology have increased of 16.4% for women and 12.8% for men. Moreover, the number of companies using smart working have enlarged from 28.7% in 2019 to 82.3% in 2020 [2, 5, 10]. Therefore, the health emergency has forced a sudden shift to work to be performed at home in many job sectors. It is likely that this condition, though in smaller numbers, may become a permanent change in the dynamics of the labour market, with consequent modifications in the housing demand [15].

The mandatory confinement phase in the spring 2020 (lockdown) has also determined significant variations in the use of urban spaces. The impossibility of leaving homes and the closure of almost all commercial activities during the emergency phases has suspended city daily life. Since it has not longer been possible to use public areas, intermediate condominium spaces such as courtyards, terraces and gardens for leisure and relaxation or sports activities, have become effective in managing domestic temporary overcrowding [16]. In the post lockdown phase from June 2020 there have also been modifications in the way and frequency of using public and private transport. Due to the fear of contagion, the use of private vehicles and the widespread use of electric micro-mobility, both private and shared, has been favored. In Italy, in 2020 there have been 65,000 shared light vehicles (27,000 scooters and 35,000 bicycles), with 86 services activated in the provincial capitals: 14 in Milan, followed by Rome (11) and Turin (7). In detail, scooter-sharing between December 2019 and September 2020 have increased from 4,900 to 27,150, and in the same period the active mobility companies on the national territory have increased from 12 to 38. In this sense, the scooter sharing, like bike sharing, represents the fastest growing micro-mobility service in the current post-lockdown period [19]. The Covid-19 pandemic has changed (and probably will change) the urban dynamics influencing the whole real estate market, also in terms of the quantity of transactions.

2 Aim

In the present study a methodology that could be a valid reference to define the emerging new framework of residential needs has been developed: the modifications that have arisen during the emergency phase will likely persist, permanently modifying the housing factors' appreciation. The present study is part of a wider line of research aimed to analyze

and quantify the effects generated on the property market by the pandemic Covid-19. The analysis focuses on the possible changes in the residential market appreciation of intrinsic factors. In particular, a methodological protocol organized in subsequent phases has been developed to assess the modifications that have occurred in the housing property market in the city of Rome between the second semester of 2019 (Phase I – *ante Covid-19*) and the first semester of 2021 (Phase II – *in itinere Covid-19*). The proposed methodology represents an operational tool to support Public Administrations and private investors in the drafting of planning strategies in the residential segment. In this sense, the analysis of the variations in the market demand is carried out through the comparison of the results of the two phases (Phase I and Phase II), in order to define a framework for the future investment choices of private and public operators and in the design phases related to the individual housing units. In particular, the methodology includes two application phases: the first one (Phase I) with data referring to the second half of 2019, which can be considered free from the influence of the effects of the pandemic; the second one (Phase II) with data referring to the first half of 2021, a period in which the effects of the pandemic on the residential market are already evident and the changes are still underway. The structure of the methodology makes it possible to monitor the effects of the pandemic on the residential market by considering successive evaluation steps *in itinere*. Moreover, the methodology can be used to check the impacts of other types of anomalous events on the territory, such as earthquakes or environmental disasters of various typology.

The paper is structured as follows. Section 3 introduces the case study with reference to the residential market in the city of Rome and introduces the variables chosen to structure the databases. Section 4 illustrates the methodology and the econometric technique adopted. Section 5 describes the implementation of the technique with references to the Phase I and summarizes the results obtained. In Sect. 6 the implementation of the same econometric technique to the data collected in Phase II is carried out. Section 7 explains the comparisons between the outputs of the two phases and, finally, in Sect. 8 the conclusions of the work are reported.

3 Case Study

3.1 The Housing Market of the City of Rome

For the implementation of the proposed methodology, the two datasets, both composed by 165 residential properties, sold in the city of Rome, have been detected. For each property, the main intrinsic positional and technological factors - i.e. internal surface area, floor level, number of bathrooms, presence and consistency of balconies or terraces, presence of green condominium areas, etc. - have been collected. In order to select the variables, for the implementation of the econometric technique, an analysis of the Italian residential segment has carried out.

In Italy, according to data detected by the Italian Revenue Agency [22], in 2019, the volume of residential sales has amounted to 603,541 housing units with an increase of 4.2% year-on-year, continuing a positive trend since 2014. In the second half of 2019, the residential market segment, in the ten largest Italian cities by volume of sales, has shown a preference for the three-room apartments (40.6%), followed by the two-room

apartments (23.1%) and the four-room apartments (23.8%) [21]. As regards the province of Rome, in 2019 the volume of houses sold has amounted to 48,809 units, and the highest number of transactions has been recorded in the area of the urban city center (67.1% of the total provincial market), with an overall trend change equal to +3%. With reference to selling prices observed, contrary to the volumes of sales, in 2019, a negative trend (−2.5%) has been found compared to the previous year, due to above all by the overall downward trend of the economic-financial framework of the real estate market, as well as by the difficult access to bank loans. In the context of the municipality of Rome, in the historic center macro-area the highest selling prices have been recorded (5.748 €/m^2), followed by the semi-central macro-areas in detail known as: "Parioli–Flaminio" (5.192 €/m^2), "Prati–Trionfale" (4.157 €/m^2), "Salaria–Trieste–Nomentana" (4.111 €/m^2). In the first two quarter of 2020 in Italy, residential sales volumes have reduced: however, a positive trend has emerged in the third and the fourth quarter, with an increase equal to +8.8%. The national trend of residential sales, compared to 2019, has dropped of 7.7%, with a reduction of approximately 46 thousand units. In the context outlined, the city of Rome represents an exception, with an increase in transactions number of +7.9%. As regards the preferences relating to the size of the residential properties, the highest growth has been recorded for the largest housing units size, between 115 and 145 m^2 (+10.7%) and over 145 m^2 (+14%); however, in the city of Rome, the change is positive in all size classes, and it is less significant for smaller units. Furthermore, referring to the selling prices, on average, in the first three quarters of 2020, compared to the same period in 2019, housing prices has raised by 2.1%. The housing market in the city of Rome is characterized by a strong heterogeneity both in terms of the size of the properties and of the average selling price [23].

Figure 1 shows the municipal trade areas according to the geographical distribution developed by the Real Estate Market Observatory (OMI) of the Italian Revenue Agency [20] and the localization of the residential properties selected for both phases (2019 and 2021).

3.2 Variables of the Model

On the basis of the residential market in the sample city analysis, 13 independent variables (X_n) have been selected (Table 1). These are detected taking into account the indications provided by the local market operators, with reference to the most influencing factors in the negotiation phases for sellers and buyers.

Furthermore, with reference to the aim of the present research the selected factors could be subject to significant variations in terms of market appreciation in the comparison between the Phase I and the Phase II.

In order to implement the econometric technique, the selling price has been chosen as dependent variable (Pr), by considering its natural logarithm ($Y = \ln(Pr)$), in coherence with the results obtained in several studies [14].

The explanatory variables selected have been described in Table 1. The factors considered can be divided into: binary variables, whose assessment could be variable between the score "0" (absence of the characteristic) and "1" (presence of the characteristic); cardinal variables expressed in the reference unit of measurement. For processing

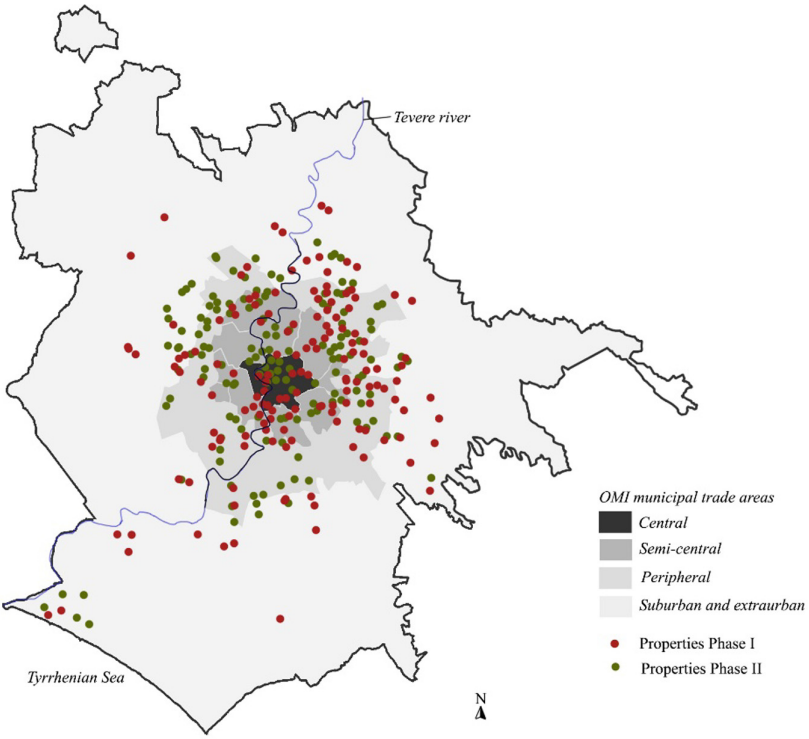

Fig. 1. The localization of residential properties considered for the two phases and the OMI municipal trade areas.

through the econometric technique, all data have been normalized with respect to their maximum value detected.

4 Methodology

The methodology proposed is articulated in two phases. The first one (Phase I) is referred to the second semester of 2019 and it is considered as the condition "*ante* Covid-19" because in this semester the pandemic was not spread worldwide, and the real estate market could be considered as free from the abnormal influences. The second one (Phase II) is referred to the first semester of 2021 and should be considered as a condition "*in itinere*", because the effects of pandemic have already emerged worldwide in the real estate market, but the pandemic is still going on and it is not possible to consider it finished. Both the phases are divided into preparatory and follow-up actions: *i)* data collection and structuring of the database; *ii)* normalization of the collected data and first correlation analyses; *iii)* implementation of the econometric technique and identification of the price function; *iv)* analysis of the outputs in terms of the functional links between the dependent variable (selling price) and the explanatory variables considered.

Table 1. Description of the explanatory variables of the selling price (Pr)

Categories	Acronynim	Denomination	Description	Unite of measure	Variable's type
Surfaces	Si	Internal Surface	Internal surface for the exclusive use of the property	m^2	*Quantitative continous*
	Sb	Surface of the balcony/terrace	Net external area of balconies or terraces directly accessible from the residential unit	m^2	*Quantitative continous*
	Sg	Surface of the private garden	Net external surface area of gardens directly accessible from the residential unit	m^2	*Quantitative continous*
	Se	External condominium area surface	Outdoor areas accessible from the common parts of the building and not for the exclusive use of the residential unit	–	*Binary (1 or 0)*
Maintenance conditions of the property	Me	Excellent	Properties characterized by high aesthetic and structural values with quality finishes great level	–	*Binary (1 or 0)*
	Mg	Good	Houses characterized by good quality finishes that are immediately usable	–	*Binary (1 or 0)*

(*continued*)

Table 1. (*continued*)

Categories	Acronynim	Denomination	Description	Unite of measure	Variable's type
Property's characteristics	B	Number of bathrooms	Number of bathrooms for the exclusive use of the residential unit	nr.	*Quantitative discrete*
	L	Floor level	Floor level on which the property is located	nr.	*Quantitative discrete*
Building's characteristics	Yc	Construction year	Year of construction of the building in which the residential unit is located (Assessed as the difference between the year 2019 (Phase I) or 2021 (Phase II) and the construction year)	nr.	*Quantitative continous*
OMI's municipal area	C	Central	Municipal trade area in which the property is located	–	*Binary(1 or 0)*
	Sc	Semi-central		–	*Binary(1 or 0)*
	P	Peripheral		–	*Binary(1 or 0)*
OMI's quotation	Vm	Average market value	Average price for the *ante Covid-19* and *in itinere Covid-19* phases	€/m^2	*Quantitative continous*

In particular, the econometric technique used to analyze the data collected is *Evolutionary Polynomial Regression* (EPR). This technique is structured by integrating the characteristics of a numerical regression system with genetic programming techniques [9]; with reference to the real estate sector, EPR has been ordinarily implemented to determine the price function, identifying the most influential factors in the mechanisms of the housing prices formation and analyzing the marginal contribution of each of them on the prices [17, 18, 24].

Having fixed a dependent variable (Y) and n independent variables (X_n), the technique allows to identify the price function (model) whose polynomial expression is a combination of the independent variables and numerical coefficients. The generic mathematical expression of the non-linear model implemented in EPR is summarized by Eq. (1):

$$Y = a_0 + \sum_{i=1}^{n} \left[a_i \cdot (X_i)^{(i,1)} \ \ldots \ (X_j)^{(i,j)} \cdot f\left((X_j)^{(i,j+1)} \ \ldots \ (X_j)^{(i,2j)} \right) \right] \tag{1}$$

where a_0 is an optional bias, n is the number of additive terms, the length of the polynomial expression (bias excluded), a_i represents numeric parameters to be identified, X_i are the explanatory variables candidate to be selected by the model, *(i, l)* - with $l = (1,\ldots, 2j)$ - is the exponent of the *l-th* input variable within the *i-th* term, f is a function chosen by the user among a set of possible mathematical expressions.

The outcome function is able to satisfy different conflictual objectives in a Pareto's frontier such as: maximizing the accuracy of the model; minimizing the number of polynomial coefficients; minimizing the number of inputs for each variable [9]. For each model, a series of indicators are calculated to immediately determine the statistical performance of the function and the accuracy of each algebraic expression, i.e. the Coefficient of Determination (CoD) defined in Eq. (2):

$$COD = 1 - \frac{N-1}{N} \cdot \frac{\sum_{N} (y_{detected} - y_{estimated})^2}{\sum_{N} (y_{detected} - mean(y_{detected}))^2} \tag{2}$$

where $y_{estimated}$ are the values of the dependent variable estimated by the methodology, $y_{detected}$ are the collected values of the dependent variable, N is the sample size in analysis. The CoD value varies between 0% and 100%. The closer the CoD value is to 100%, the higher the statistical performance of the model returned by EPR.

Once the model that best satisfies the different objectives described above has been identified, the empirical consistency of the functional links between the independent variables selected by the model and the dependent variable is checked.

With reference to the case study the implementation of EPR has allowed to identify the two models (one for each phase) and to verify the functional correlations between the explanatory variables selected and the selling prices.

5 Phase I: Implementation of the Econometric Technique to the Data Referring to the Second Half of 2019 (*Ante Covid-19*)

The model generated by the application of the econometric technique EPR, and selected as the best in terms of statistical accuracy and mathematical complexity to the reference dataset, assumes the expression in Eq. (3):

$$\begin{aligned} Y = &+ 2.0813\ Vm^{0.5} + 0.77051\ L^{0.5} B\, Me^{0.5} + 7.5564\, L^{0.5} B^2 Yc \\ &+ 2833.437\, Sg\, L^2 Mg^{0.5} Vm^2 + 2.6857\, Si^{0.5} + 579.0223\, S^{0.5} Sb^2 L\, 2\, B^{0.5} C^{0.5} Mg^{0.5} + 9.7199 \end{aligned} \tag{3}$$

The CoD is equal to 86.23%, which expresses a high statistical performance and robustness of the chosen model. The selected variables are 8 among the 13 considered. In particular, the variables identified by the model as the most influencing in the selling prices formation mechanism are listed below: for each of them, a synthetic comment about the functional correlation between the specific factor and the selling prices is reported:

- *Internal surface.* The functional link between the selling price and the variable is direct (in average an appreciation of +25% is found).
- *Number of bathrooms.* The correlation between the dependent variable and this factor is direct: in particular, the positive variation is about +15% per bath.
- *Floor level*. The functional relationship is direct, with greater appreciation for the building highest floors and an average appreciation for each floor from the lower floors to the higher ones, equal to +6%. The most significant variations is found in correspondence to the passage from the ground floor to the first floor level (+16%).
- *Construction year of the building*. The functional link is direct and constant at 6%.
- *Maintenance conditions of the property*. The functional correlations are empirically verified. For an excellent conservative state, the positive variation from "good" one is equal to +17%. Furthermore, the variation from "bad" to "good" maintenance property conditions is equal to +10%; this growth increases if the property is located in the OMI central municipal area (+24%).
- *OMI's quotation and municipal area.* The OMI average market values variable shows an increasing functional link, particularly in the variations between € 2,285.00 and € 3,427.50 (+23%). This trend decreases for subsequent values. The significant appreciation is due to the properties located in the OMI central municipal area, for which a positive change of +19% is observed, instead of an average variation of +15%.

6 Phase II: Implementation of the Econometric Technique to Data Referring to the First Half of 2021 (*in Itinere Covid-19*)

With reference to the first half of 2021, 165 properties distributed homogeneously throughout the municipality have been collected (Fig. 1). The model generated by the application of the econometric technique EPR assumes the formulation expressed in Eq. (4):

$$Y = +2.3773\ Vm^{0.5} + 0.27166\ Me\ - 0.66914\ Yc^{0.5}\ Me^2 + 9.5008\ Se\ Yc^2\ P^2 + 1.7449\ Sb\ L^{0.5}\ B + 3.0846\ Si^{0.5} + 2.5818\ Si^{0.5}\ L^{0.5}\ Yc^2\ Me^2 + 9.402 \quad (4)$$

The CoD is equal to 89.84%: it confirms that the model selected is the best in terms of statistical accuracy and mathematical complexity for the reference dataset used. The model selects 9 variables among the 13 considered. The variables identified by the model as the most influencing on the selling prices are reported below: moreover, for each of them, a synthetic analysis related to the typology of the functional link between the specific factor and the selling prices is carried out:

- *Internal surface.* The functional link between the selling price and the variable is direct with an average appreciation equal to +23%; the most significant variation is found for property internal surface from 60 m^2 to 90 m^2 (+36%).
- *Surface of the balcony/terrace.* The functional correlation is direct: the variation is positive, equal to about +3%.
- *External condominium area surface.* The functional relationship is direct and, in the situation in which an external area is detected, a growth in selling prices is observed (+19%).
- *Number of bathrooms.* A positive variation in selling prices is recorded equal to about +1%.
- *Floor level.* The functional link is direct, with a constant positive variation passing from the lower floor to higher ones (+1%).
- *Construction year of the building.* The contribution of the present variable is significant if the maintenance conditions of the property is excellent, by attesting a relevant market appreciation for the most recent buildings (+19%).
- *Maintenance conditions of the property.* The functional links are empirically verified: for an excellent conservative state, the positive variation from "good" state is equal to +3%.
- *OMI's quotation and municipal area.* The OMI value variable shows an increasing functional link with selling prices (+15%). This considerable appreciation is due to the properties located in the OMI peripheral municipal area, for which a positive variation of +19% is found.

The analysis of the functional links described above confirms the high representativeness of both models with respect to real existing phenomena.

7 Comparison of the Outcomes of the Two Phases

By comparing the results of the two analyses carried out, significant variations in residential market appreciations have already emerged at the current ongoing (*in itinere*) stage of analysis, able to may identify future new trends in market demand.

The two outcomes related to the Phase I and the Phase II differ both in the selection and in the different appreciation values for the variables selected by models. With reference to the factors identified by model of Eq. (4), in comparison to the Phase I, the Phase II outputs show the relevance of the *surface of the balcony/terrace* and the *external condominium area surface*. It should be pointed out that the significant variation in the appreciation of these factors attests how the changes in the dynamics of daily life caused by the pandemic have affected the need for open spaces, both private and condominium ones, which could be used as recreational spaces during the lockdown period.

Another variable for which a relevant change in the influence on selling prices is found is the property localization in the *peripheral* OMI's *municipal area* rather than in the *central* one: this contingence denotes how the possibility of working remotely for the most of the population and, on the contrary, the impossibility to move daily for work to the more central areas of the city, makes people prefer houses (mainly at the same price, ordinarily larger in surfaces) in less congested and chaotic outer areas. In Table 2 the variables selected by the two models (Phase I and Phase II) are reported.

Table 2. Variables selected by the two models

	Si	Sb	Sg	Se	Me	Mg	B	L	Yc	C	Sc	P	Vm
Phase I	✔				✔	✔	✔	✔	✔	✔			✔
Phase II	✔	✔		✔	✔		✔	✔	✔			✔	✔

A detailed analysis of the results obtained shows considerable differences in each variable contribution in the selling price formation (Fig. 2). In particular, it should be observed that for the *internal surface*, the *OMI's quotation*, the *number of bathrooms* and the *construction year of the building* the contribution in terms of average percentage variation remains similar or with a not very wide gap between the Phase I and the Phase II elaborations; on the other hand, for the *maintenance conditions of the property* - both "good" and "excellent"- the difference in the contribution on the selling prices is more significant. For the Phase II this shows the preference of buyers for properties to be renovated that allow the house to be customized to specific needs. The Covid-19 has already generated a higher attention for the domestic spaces comfort, whereas currently strong differences in the appreciation for the floor level have not yet evident. This situation testifies a scarce perception of the importance related to the acoustic comfort deriving from the properties localization on the highest floors. In Fig. 2 the comparison between the average percentage contributions for the variables for which a relevant variation in the market appreciation has been detected by the analysis is reported.

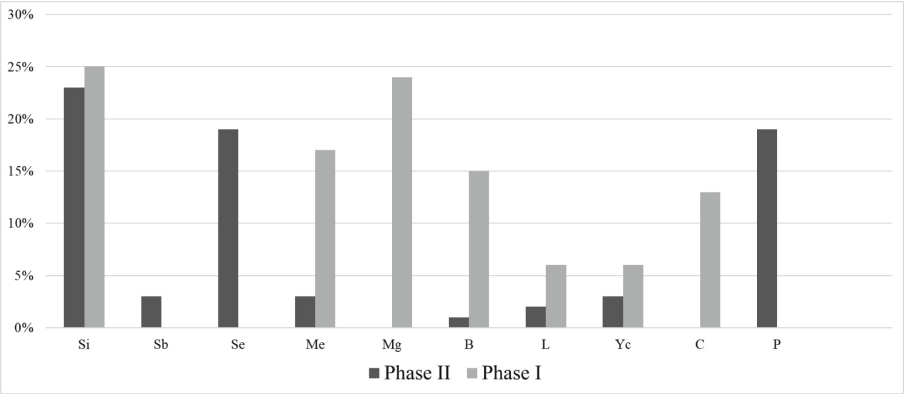

Fig. 2. Comparison between the average percentage contributions found the variables for which greater variation between the Phase I and the Phase II has been found

8 Conclusions

The effects of the Covid-19 pandemic could determine changes in the property market appreciation. The methodology proposed in the present analysis could be useful i) for public subjects, to plan building strategies consistent with the needs of the population and ii) for private investors, to plan investments for which a positive result in the real estate market is expected. This study provides interesting results, defining for the city of Rome a first frame related to the possible variations in the property market appreciation for intrinsic factors. The methodology has been implemented in two phases - *ante* Covid-19 and meanwhile the pandemic is still underway -, in order to identify which are the main effects of the pandemic on the phenomena of housing price formation. The results obtained by the analysis show significant changes in market demand for the city of Rome in the period considered, with a preference for outer areas of the city and a particular emphasis on outdoor surfaces, both private and condominiums. These initial outputs should be monitored, in order to verify whether these variations will persist even after the pandemic or they are a temporary effect linked to the contingent needs of living with it. The proposed methodology is an effective tool for monitoring the effects of pandemic on the real estate market, for this reason consequent developments of the research foresee subsequent applications both *in itinere* and when the pandemic will be concluded. Furthermore, in order to define a framework for the future investment choices of private investors and public operators, after the case pilot proposed in this study, it is planned to proceed with applications at national level.

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