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Original Articles – Urban, land, environmental appraisal and economics

The assessment of the forced sale value in the Italian residential market

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Abstract. The present research has focused on the development and experimentation of a model for the forced sale value determination. With reference to six study samples consisting of residential properties sold through judicial auctions between November 2020 and May 2021 and each of them located in an Italian region, the forced sale price, the market value assessed by a judicial valuer and the main influencing factors have been detected. The implementation of an econometric technique has allowed to obtain models for the forced sale value assessment and for the analysis of the factors that mostly influence the final hammer price and, therefore, the discount between the market value evaluated and the judicial price. In the context of the existing literature, the study represents the first attempt that proposes a quantification of the discount/premium coefficient based on the specific factors of the property, in order to provide a reliable assessment of the forced sale value.

Keywords: Auction market, Forced sale value, Econometric methods.
JEL codes: R31, R15, K25, D81.

1. INTRODUCTION

The volume of real estate investments in Italy, although in contraction due to the impact of the Covid-19 pandemic, reveals the crucial role of the sector in the national economy (Locurcio et al., 2021; Morano et al., 2019). The macroeconomic situation had an impact, albeit partial, on purchase intentions, supported by the low interest rates applied to bank loan agreements and by forms of government support. Among the various real estate sub-markets, the judicial auction sector suffered an immediate repercussion due to the suspension of bankruptcy judicial procedures, which resulted in a significant reduction in offers. However, there was an increase in user interactions compared to auction ads, favoured by the progressive digitalization

of the sector as well as by its attractiveness due to savings offered by the sector (Nomisma, 2021). The extraordinary elements of the auction sub-market were linked to *i*) the excessive length of the procedures, thus aggravating the obsolescence of properties placed as collateral; *ii*) greater conditions of uncertainty related to obtaining a bank loan compared to buying and selling on the free market; *iii*) the scepticism of potential buyers due to lower levels of information transparency; *iv*) the absence of warranty for hidden defects; *v*) the risk of the auction market itself. These factors combine to determine a final hammer price which is significantly lower than the market value estimated by the valuer engaged by the court Judge, i.e. the "judicial valuer" (Italian Banking Association, 2018).

Recent macroeconomic conditions have had an effect on sector trends recorded last year since the health emergency from Covid-19 resulted in a court activity general suspension. A total of 95,329 lots were auctioned off in Italy in 2020, for a total of 117,376 auctions, with each lot accordingly put up for auction on average 1.23 times, resulting in impoverishment of the sale value. In fact, procedures determine that in the situation of a deserted auction, the asset is put up for auction again, usually after approximately six months, with the value reduced further compared to the initial minimum bid value. A comparison with data related to 2019 showed an overall reduction of 40.6% in the number of lots on auction and a decrease of 53.9% in auctions held, due to the protracted inactivity of the courts. However, two months prior to the outbreak of the pandemic an increase of the 15% in the volumes of scheduled auctions compared to the previous year has been observed, indicative of an initial increase in judicial system efficiency. The impact of the measures adopted to deal with the Covid-19 pandemic caused an 86% decrease in auctions set for the period between March and September compared to the same period in 2019. From October to December, although activity had fully resumed, there was a decrease of 24% compared to the same period of the previous year. Against a minimum value of the lots at auction of € 11.6 billion – determined as the sum of the minimum bids -, an estimated loss of € 1.1 billion was generated in 2020, considering the related write-down at auctions which were deserted (Report Reviva, 2020).

The data related to the first half of 2021 have shown a recovery in the sector, with a total number of 93,129 auctions held, approximately equivalent to the total number of auctions held throughout 2020, although with a permanent decrease of 29% compared to the same semester of 2019. The economic value of auctions held in the first six months of 2021, given by the total of minimum bids, was equal to € 12 billion, confirming a new growth phase following on from the initial impact of the pandemic. However, the contraction of the residential asset class persists, as a result of suspension of judicial procedures of "first home" properties – i.e. those linked to the buyer by the existence of specific requirements, as envisaged until 31 October by the Italian "Refreshments" Decree – with a reduction of 22% compared to the first half of 2019. A variation in auction sales methods, with an increase in asynchronous and synchronous telematic approaches, in line with restrictions imposed in recent months, has also been detected (Reviva, 2021).

The worsening of the uncomfortable conditions induced by the emergency has underlined some limits relating to auction procedures, characterized by excessively prolonged and complex sales times for goods under guarantee. In order to reduce procedural time and limit the uncertainty related to the discrepancy between market value and hammer price, relevant legislation has introduced significant initiatives since 2015, with law no. 132/2015 containing "Urgent measures in bankruptcy, civil and civil procedural matters and the organization and functioning of the judicial administration", amending art. 568 cpc. This initiative has established the maximum reduction of "minimum" offers at 25% (art. 13, par. 1, lett. R of Law No.132/2015) compared to the base price indicated in the sales order, thus generating a greater depreciation of properties on auction, although the primary purpose has concerned the expansion of the number of potential investors. In addition, it has extended the settlement-price term of the property awarded in the auction from sixty to one hundred and twenty days, with the aim of favouring the potential obtainment of a bank loan. Higher disclosure transparency has also been promoted, in order to attract ordinary investors through online platforms where legal advertising of real estate auctions banned in Italy can converge, by limiting the speculative behaviour of restricted groups of professional operators who dominate the sub-market, even if this phenomenon is a recurring factor in foreign contexts as well (Donner, 2017; Fontana and Vigorito, 2007). However, the achievement of the expected results was strongly influenced by the volume of the previous stock of goods at auction, which inevitably slowed down the liveliness of the sub-market. A further limit to the attractiveness of the sector is applied by the time required to obtain the assets sold at auction, typically postponed in reference to the time of the award.

The aforementioned criticalities have found an initial confirmation in the National Recovery and Resilience Plan (PNRR) which includes two proposals on

this topic: *i*) to implement the obligation of property abandonment by the debtor, even before the award of the property on auction; and *ii*) to encourage the direct sale of the property by the debtor. The twofold objective is to protect the creditor and to support sales and prices in anticipation of an increase in the supply of properties at auction in the face of a contraction in demand due to the economic crisis.

On the other hand, with the aim of continuing to protect creditors in the recovery of the amounts due, out-of-court alternatives have already been promoted since 2015, in order to avoid excessive reductions in the properties' market value as collateral and to reduce the volumes of auctioned goods. In this regard, the legislator has introduced securitization (Law no.130 of 30 April 1999, – Provisions on the securitization of credits, amended by Law no.8 of 28 February 2020). In particular, here the real estate version is a typical form of financing aimed at the purchase of Non Performing Loans (NPLs) portfolios, through the establishment of a vehicle company (Special Purpose Vehicle – SPV), which finances the purchase of assets by using funds raised by the issue of securities called Asset Backed Securities (ABS). The cash flow generated by the sale of the properties provides the necessary coverage for reimbursement of securities. Thus, assets subject to disposal are segregated with respect to the remaining real estate portfolio of the company. Following the changes introduced by the D.L. no.50/2017 and subsequent amendments pursuant to Legislative Decree no.34/2019 – "Growth" Decree -, the use of Real Estate Owned Company (ReoCo) is contemplated in securitization structures. These are defined as support vehicles for the SPV aimed at increasing credit recovery, promoting the acquisition, management and enhancement of real estate assets (e.g. restructuring, urban conversion, development and renegotiation of lease contracts) in order to guarantee securitized credit.

Given the initiatives promoted over the last decade, social repercussions of the real estate auction sector can be summarized in terms of a double aspect: *i*) creditors' difficulty in recovering sums due; *ii*) difficulty in recovering a certain amount beyond the resolution of the debt position if the final realization price is excessively lower. The position of the debtor is at times burdened by the social function that the property fulfils – if it is the principal residence of the debtor rather than a place of work.

On the basis of what has been clarified, the limits connected to the judicial procedure understood as a solution to the recovery of credits with real estate guarantee, not only have a purely economic character connected to the destruction of value, but also represent an

element of social disadvantage, if considered in terms of the function that the asset has for the debtor and the resulting consequences for this subject, currently already at a disadvantage due to an uncertain economic and social context.

2. AIMS AND PARTS OF THE WORK

The present research is part of the framework outlined. The aim concerns the development and experimentation of a model for the determination of the forced sale values. The analysis has been carried out with reference to six study samples – each related to an Italian region (Lombardy and Piedmont for the Northern Italy, Tuscany and Lazio for the Central Italy and Campania and Apulia for the Southern Italy and Islands) – and by considering the housing properties sold through judicial auctions between November 2020 and May 2021. In particular, for each residential unit, the forced sale price, the market value assessed by the judicial valuer and the main influencing factors have been detected. The choice to consider the three macro-areas in which commonly the Italian territory is divided is aimed at verifying the existence of differences in influencing factors on final selling prices and at examining the different contributions of variables on the differential of value.

The implementation of econometric analysis allows to point out the contribution of explanatory factors in the forced sale processes for each Italian region considered. In addition to the assessment of the forced sale value, the models obtained could also be used to analyse the factors that mostly influence the final clearing hammer price and, therefore, on the discount between the judicial valuer's assessed value and the final hammer price.

It should be outlined that the present study constitutes an innovative attempt aimed at the quantification of the differential coefficients – in terms of discount/premium – in the forced sale values, by taking into account the specific property factors. In this sense, the analysis is intended to provide a model for reliable assessments of the forced sale value able to support the definition of adequate hammer prices in the judicial auction market context. Thus, the model obtained allows to identify the influencing determinants in the buyers and seller's decision processes in order to make more transparent the dynamics related to the real estate auctions. Furthermore, the mathematical form in which the model is expressed makes it possible a continuous and rapid check of the forced sale values trend and, at the same time, the verification of the relevance between the value

assessed by the appraiser with reference to a potential sale in the free market and the final hammer price.

Therefore, the regressive model obtained can be a support for the investors and judges activity in determining the forced sale value in order to define a tool for monitoring the final selling prices starting from the market value estimated by the judicial valuer. This model could be used by the subjects involved in real estate judicial procedures to assess a likely clearing value on the basis of the intrinsic characteristics of the property (total area, presence of exclusive and condominium appurtenances, etc.), of the urban area in which the property is located and the duration of the procedure. Specifically, the proposed tool will be able to support *i*) the judicial authorities, at the start of the auction procedures, to operate the rational reduction of the market value estimated by the judicial valuer, and to monitor the offers during the entire procedure, so as not to reach a hammer price too far from the value obtained with the methodology proposed in this work; *ii*) the participants in the auctions, to strategically weight the offers and have a reference on the convenience threshold of the hammer price, based on the profitability and risks of the reference market; *iii*) the court consultants, in the situations in which an indication of the forced sale value is also requested by the judge. It is also specified that a hypothesis introduced for the elaboration of the proposed model regards the value assessed by the judicial valuer that actually represents the most likely market value of the property and therefore that the assessed value constitutes a reliable indication, as a starting point for the parties involved in the auction procedures.

The paper is structured as follows: in Section 3 an analysis of the existing literature related to the most influencing factors on the discount/premium definition is carried out. In Section 4 the case study relating to the six property samples located in the three macroareas mentioned is introduced: the explanatory variables considered are presented and the main descriptive statistics are analysed. Furthermore, with reference to the collected data, a descriptive analysis is illustrated in order to provide a framework of discounts (or premium) according to *i*) the city, *ii*) the urban area, *iii*) the property maintenance conditions, *iv*) the presence of specific characteristics and *v*) the range of duration of the judicial procedure. In Section 5 the methodology adopted for the analysis is described and its application to the case study is illustrated. Moreover, the results are interpreted and the functional relationships between the factors considered in the analysis and the final price are examined. Finally, in Section 6 the conclusions of the work are discussed.

3. BACKGROUND

In Italy, the real estate auction sector has historically been characterized by a constant downward trend compared to the initial assessed market value, with the determination of a certain discount on the final hammer price as a recurring aspect in foreign contexts as well. For this reason, in existing literature numerous studies have examined the possible causes at the origin of the mechanism for forming the discount / premium on the final forced sale price.

Given the uncertainty related to the discrepancy between estimated market value and hammer price, the Royal Institution of Chartered Surveyors (RICS) on 2017 and successively also on 2020 has introduced the definition of "forced sale value", i.e. a market value that is generated in a particular condition of sale with a limited amount of time available, in which the seller is subject to external legal or commercial factors, and the possible failure to conclude a sale affecting the determination of the realization price.

Although the discount on the assessed value in the judicial procedures is a recurring element in various international markets, the reference local regulatory context conditions the process of forming the final sale price (Donner, 2017). By comparing different international markets, Susilawati and Lin (2006) have shown that in most cases analysed a discount on the hammer price is detected, with the exception of the Australian and Irish contexts, characterized, instead, by the formation of a value bonus in the selling price. The relationship between the forced sales segment and the free market has often been examined in literature in an attempt to understand the dynamics behind the formation of the award price in terms of premium / discount (Mayer, 2003; Marcus, 2001; Quan, 2002).

Specifically, by comparing the Australian and US markets, Dotzour et al. (1998) have shown that in the US market the investor perceives this sector as characterized by a lack of transparency, thus resulting only in the competence of professional operators. The hostility attributed to the auction market is identified as the main reason for the creation of a discount. On the other hand, Lusht (1996) has examined the Australian market and attributed the origin of the creation of a "premium" on the estimated value to the nationwide diffusion of the sub-market of real estate auctions: since investors consider this segment to be equal to the free market, the volumes of sales at auction are equivalent to free trading.

Analysis of the markets characterized by "discounted" hammer prices have revealed that this circumstance negatively affects the value of properties that fall within

areas – up to 0.05 miles – neighbouring the location of the properties at auction (Campbell et al., 2011). With reference to the specificities of the assets, many Authors have investigated the effects of the properties physical characteristics on the final hammer price (Carroll et al., 1997; Clauretie and Daneshvary, 2009; Forgey et al., 1994; Hardin and Wolverton, 1996), by noting as potential discriminating factors *i)* the intended use, in particular the negative effects generated on sales times by atypical properties (Ong, 2006); *ii)* the maintenance state (Allen and Swisher, 2000). On the other hand, Wong (2017) has studied the influence exerted by the specific urban context and other extrinsic factors, showing that proximity to the city centre and numbers of potential investors (Hungria-Gunnelin, 2013) have a positive correlation with the final sale price.

With reference to the Italian context, existing literature has often focused on the analysis of local market segments, and it is thus strongly dependent on specific urban areas.

Canesi et al. (2016) have analysed the discount existing between estimated and forced sale values, implementing an empirical survey based on a sample of properties awarded at auction in Northern Italy. In a later study (2017), the same authors have examined the executive procedures in the Veneto region, by pointing out a systemic nature of the discount on final sale price. When selecting the variables, the Authors have considered, on the one hand, factors specific to the properties and the sub-market referred to, and, on the other hand, to elements that distinguish the urban and social context within which the assets are located: *i)* socio-economic aspects and demographic factors (location, profitability in terms of employment, number of normalized transactions, population, real estate market intensity index); *ii)* intrinsic factors of the assets (state of maintenance, technological characteristics, gross area); *iii)* aspects relating to the auction sector (days spent at auction, number of auctions, discount, premium and evaluation dates).

A recent study conducted on the national market by the Bank of Italy (Loberto, 2021) has led to results which are similar to those highlighted by Campbell (2011), by underling the negative influence given by the real estate auctions sector on properties offered for sale in the free market, in terms of reducing the asking price. This result goes beyond the traditional interpretation of the sector as a distinct segment, at the same time giving it a competitive character, although to the detriment of the real estate sector performance.

In a study carried out on the segment of judicial auctions in Southern Italy, Amoruso et al. (2020) have started from the analysis of a sample of proper-

ties awarded at auction in the Apulia region to identify the excessive length of judicial procedures as the main cause of the erosion of value at auction. Del Giudice et al. (2020) have implemented an analysis of the real estate auction sector in the Campania region, including variables that described the scenario generated following the Covid-19 pandemic – unemployment rate, family and per capita incomes, real estate dynamics – and evaluating their impact on medium and short-term trends in residential property prices, recording a reduction of 4.16% in the short term and 6.49% in the medium term (late 2020-early 2021). An initial experience aimed at determining a model for estimating forced sale value based on risks inherent in the reference market of various Italian macro-areas has been carried out by Tajani et al. (2021). The analysis has been implemented by applying Ellwood's logic to the real estate sector, by integrating it with the investment risk assessment approach of the Real Options Analysis.

4. CASE STUDY

The case study concerns six samples constituted by total 918 residential properties sold through judicial auction procedure between November 2020 and May 2021 and distributed on the Italian territory as follows: Lombardy and Piedmont for the Northern Italy, Tuscany and Lazio for the Central Italy and Campania and Apulia for the Southern Italy and Islands. Within each Italian region considered, the existing law-courts are analysed. In Figure 1 the six Italian regions are highlighted and the related law-courts are reported.

4.1 Variables

For each residential unit, the unit final selling price expressed in €/m^2 (P) related to the judicial procedures concluded in the Italian context – obtained by consulting the real estate auctions website (*Public Sales Portal*) – and the main intrinsic and extrinsic factors that characterize the properties and considered by buyers and sellers in the auction negotiation phases have been detected. These factors constitute the main characteristics reported in each property website paperwork related to its conditions and location. The variables considered are listed and described below:

- the total surface [S] of the property, expressed in m^2 of gross floor area of the property;
- the presence of the lift [L]. In the model this variable is considered as a dummy variable, where the absence of the service is indicated with the value
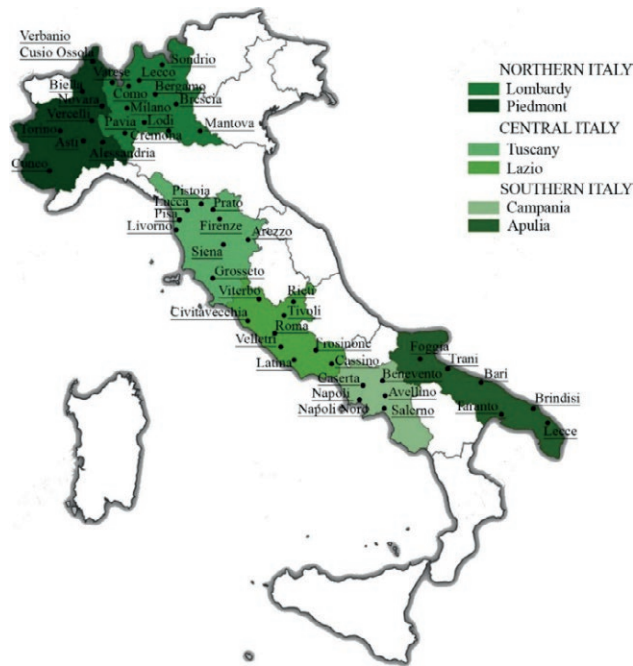
Figure 1. The law-courts located in the six Italian regions considered in the analysis.

"zero", whereas the presence is represented by the value "one";

- the presence of private appliances [Se], i.e. car box, outdoor parking space, storage room, attic, own garden and courtyard. The variable is assessed as a dummy variable, by which the vale "one" indicates the presence of at least one service, whereas the value "zero" the absence of all of them;
- the presence of condominium areas [Co], i.e. common courtyard, atrium, external green spaces and common laundry room. If for the dummy variable the "zero" value is reported, the presence of one service is shown, vice versa if the "one" value is included the presence of one or more condominium appliances is verified;
- the property maintenance conditions, assessed according to the rating "to be restructured" [Mb], "normal" [Md], "good" [Mg] and "excellent" [Me]. The score "one" indicates that the specific conservative state is present, whereas the score "zero" is assigned to the other conditions. In this sense, among the variables considered, the "to be restructured" property state is not included, as the presence of all three variables "zero" implies these maintenance conditions;
- the time on auction [T], measured in days and determined as the temporal difference between the first day of bidding and auction clearing date;

- the municipal trade area in which the property is located, considering the geographical distribution developed by the Italian Revenue Agency (http://www.agenziaentrate.gov.it). By taking into account that the different location characteristics contribute to the formation of the selling prices, three of the five Italian Revenue Agency trade areas are analysed: "central" [C], "semi-central" [Sc], "peripheral" [P]. For each property, the score "one" is assigned if the property belong to the specific trade area, whereas the score "zero" is reported for all the remaining locational factors. The values "zero" for all trade areas imply the property localization in suburban or extra-urban ones;
- the market value [Vm], assessed by the judicial valuer, included in the expert estimate in which is expressed in €.

Table 1 shows the main descriptive statistics of the final total selling prices and the influencing factors for the six Italian regions analysed. In particular, some considerations related to the total hammer price and the quantitative factors (Vm, S and T) can be useful. The data analysis highlights that the maximum value of final selling price is detected for the Lazio region (= 750,630.00 €) followed by the region of Campania (= 660,500.00 €), whereas the minimum value of final selling price is detected is observed for the study sample collected in the Piedmont region (= 7,500.00 €) and, immediately after, in Lombardy (= 10,510.00 €). With reference to the average values of the hammer prices, the range recorded is [49,505.12 €; 102,914.85 €], with the minimum boundary found in the Piedmont region and the maximum one in the territory of Lazio, by attesting the coherence with the minimum and maximum values identified in absolute terms. In line with the average values of the final selling price, the average market values assessed by the judicial valuer vary from 154,786.80 € in Lazio region and 89,860.20 € in Piedmont. However, the maximum assessed market value is noted for the Campania study sample (= 1,545,534.72 €) and the minimum one for the Piedmont (= 15,000.00 €), differently to what shown for the final selling prices for which the maximum value is observed in the Lazio region.

Regarding the "total surface of the property" variable, it should be noted that the highest arithmetic mean value is collected for the sample located in Tuscany region (= 112.43 m^2), whereas the lowest average value is reported in the Italian region of Lazio (= 98.07 m^2). For the "time on auction" factor, the minimum days number between the first day of bidding and auction clearing date is pointed out for Tuscany (= 63 days) and the maximum one is revealed for Campania region (= 6,530 days). In particular, it should be highlighted that the

Table 1. Descriptive statistics variables for the six Italian regions analysed.

Variable		Lombardy	Piedmont	Tuscany	Lazio	Campania	Apulia
Final selling price [€]	Mean	65,668.53	49,505.12	76,005.72	102,914.85	85,497.64	65,261.42
	Standard deviation	55,514.57	38,953.24	53,219.29	97,665.54	88,837.28	64,646.35
	Minimum value	10,510.00	7,500.00	16,580.00	11,151.60	12,450.00	10,750.00
	Max value	450,000.00	220,000.00	310,000.00	750,630.00	660,500.00	328,000.00
Total surface of the property [m²]	Mean	103.33	108.34	112.43	98.07	108.06	106.02
	Standard deviation	47.26	66.52	99.61	56.23	45.74	62.44
	Minimum value	35.00	25.00	32.00	31.23	14.48	31.95
	Max value	378.90	367.30	924.91	498.70	336.95	440.30
Presence of the lift	Mean	0.23	0.32	0.22	0.45	0.37	0.34
	Standard deviation	0.42	0.47	0.42	0.49	0.48	0.48
Presence of private appliances	Mean	0.79	0.86	0.88	0.67	0.49	0.58
	Standard deviation	0.41	0.34	0.40	0.47	0.50	0.50
Presence of condominium areas	Mean	0.43	0.47	0.40	0.28	0.55	0.38
	Standard deviation	0.50	0.50	0.49	0.45	0.49	0.49
"To be restructured" maintenance conditions	Mean	0.21	0.21	0.21	0.14	0.19	0.18
	Standard deviation	0.41	0.40	0.40	0.31	0.39	0.38
"Normal" maintenance conditions	Mean	0.35	0.27	0.27	0.21	0.45	0.17
	Standard deviation	0.48	0.45	0.44	0.41	0.50	0.38
"Good" maintenance conditions	Mean	0.42	0.50	0.45	0.63	0.30	0.57
	Standard deviation	0.50	0.50	0.50	0.48	0.46	0.50
"Excellent" maintenance conditions	Mean	0.02	0.02	0.07	0.02	0.06	0.08
	Standard deviation	0.14	0.13	0.26	0.15	0.24	0.28
"Central" urban area	Mean	0.65	0.29	0.27	0.17	0.30	0.21
	Standard deviation	0.48	0.45	0.44	0.38	0.46	0.41
"Semi-central" urban area	Mean	0.08	0.26	0.09	0.15	0.20	0.22
	Standard deviation	0.28	0.44	0.28	0.35	0.36	0.42
"Peripheral" urban area	Mean	0.18	0.30	0.21	0.08	0.31	0.31
	Standard deviation	0.38	0.46	0.41	0.28	0.46	0.46
Time on auction [days]	Mean	517	583	662	552	948	867
	Standard deviation	446	487	523	474	943	817
	Minimum value	70	67	63	69	74	78
	Max value	2,653	2,648	2,173	2,583	6,530	3,546
Market value assessed by the judicial valuer [€]	Mean	92,684.50	89,860.20	126,778.21	154,786.80	138,202.20	119,755.85
	Standard deviation	54,657.41	65,500.99	89,603.95	128,892.48	154,061.31	115,198.83
	Minimum value	30,000.00	15,000.00	28,800.00	22,500.00	22,000.00	17,000.00
	Max value	418,216.36	351,680.00	870,000.00	1,000,000.00	1,545,534.72	668,000.00

minimum values range is limited, i.e. contained between two close values (from 67 days detected in Tuscany to 78 in Apulia), whereas that of the maximum values is larger (from 2,173 days in Tuscany to 6,530 in Campania).

4.2 Sample data analysis

In Figures 2 and 3 the distribution on the national territory of the unit final selling prices and of the discounts between the assessed market value and the final price are represented. In particular, for each Italian regional law-court studied the average unit final selling price and the percentage differential between the forced sale prices and the market values deducted from the valuation reports associated with each dataset property have been determined. This operation can provide a framework of the auction clearing prices in the six Italian regions and, in general, in the national context.
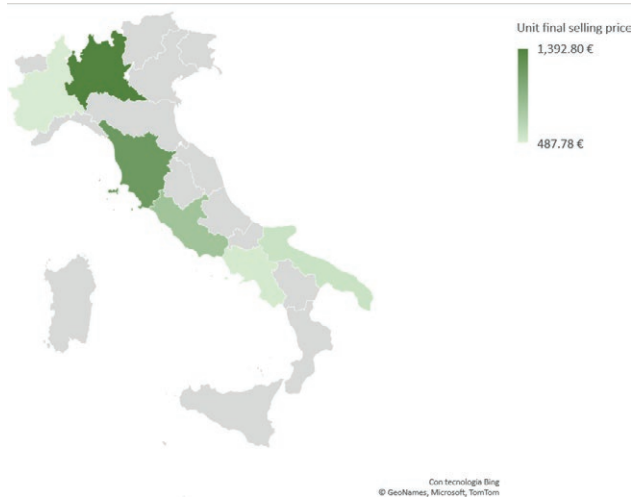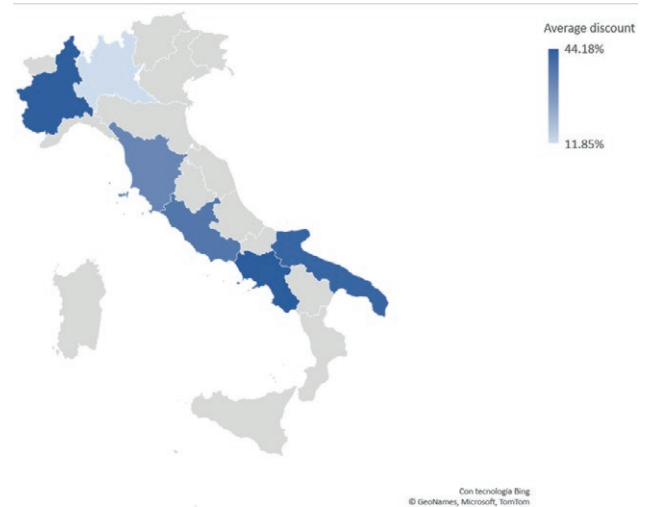
Figure 2. Distribution on the national territory of the unit final selling prices.

Figure 3. Distribution on the national territory of the discounts between the assessed market value and the final price.

The analysis of the unit final selling prices within each law-court studied shows that within the macro-area of Northern Italy (Italian regions of Piedmont and Lombardy), the law-court of Milan is characterized by the maximum unit final selling prices, equal to 3,743.56 €/m², whereas Vercelli is the provincial capital for which the lowest unit final selling prices are recorded (267.47 €/m²). For the macro-area of Central Italy consisting of the region of Tuscany and Lazio, the maximum unit final selling price of 2,475.72 €/m² is recorded in the city of Florence, which differs by +86% compared to the lowest unit final selling price found in the capital of Cassino in the Lazio region, equal to 335.92 €/m², and shows a difference of +59% compared to the average unit final price of the macro-area (1,004.48 €/m²).

Finally, the macro-area of Southern Italy and Islands has the maximum unit final selling price in the city of Naples with 931.57 €/m², equal to +83% compared to the lowest one, recorded for the city of Caserta (157.49 €/m²), and different of +42% compared to the average unit data of the macro area (543.70 €/m²). At national level, this city is also the one for which the minimum average final selling price, equal to 157.50 €/m² is found.

With reference to the discount between the market value assessed and the final selling price, for each law-court the average percentage one is calculated. In particular, according to the study samples detected, the highest average discount is found for the residential properties collected in the city of Caserta located in the region of Campania (+60.10%), that is +26.48% compared to the average discount observed at regional level (+ 44.18%).

Furthermore, for the Apulia the average discount found with regards to the study sample collected is equal

to +41.85% and the city of Bari is the city for which the lowest discount is detected (+3.41%).

The macro-area of Central Italy has the maximum discount in the city of Cassino for the region of Lazio (+58.43%) and of Pisa for the region of Tuscany (43.06%). Finally, with reference to the macro-area of Northern Italy, for the law-court of Vercelli in Piedmont region the highest discount is determined, different of +23.89% compared to the average regional value (+43.77%) and of +79.40% compared to the average discount observed for the Lombardy region (+11.85%). In Table 2 the average values found for each law-court are specified.

5. THE METHODOLOGY

In the present research the methodology applied – called Evolutionary Polynomial Regression (EPR) – uses a genetic algorithm and integrates the best features of the numerical regression with the genetic programming. Furthermore, this data-driven method generates models characterized by polynomial structures by using the simple genetic algorithm engine. Each term included in the mathematical expression is the combinations of the input variables selected by the user with numerical coefficients. The Equation (1) reports the general symbolic expression generated by EPR:

$$Y = \sum_{i-n}^{l} [a_i \cdot (X_n)^{(i,n)} \cdot \ldots \cdot (X_j)^{(i,j)} \cdot f((X_n)^{(i,j+n)} \cdot \ldots \cdot (X_j)^{(i,2j)})] + a_0 \qquad (1)$$

where l is the number of additive terms, a_i are numerical parameters to be valued, Xi are candidate explanatory

Table 2. Average values observed for each law-court analysed.

Region	Law-courts	Average unit final selling price	Average differential between the assessed market value and the final price
Lombardy	Bergamo	659.3 €/m²	33.2%
	Brescia	665.5 €/m²	33.9%
	Mantova	502.9 €/m²	33.5%
	Milan	3,743.6 €/m²	-53.2%
Piedmont	Asti	428.1 €/m²	48.5%
	Cuneo	580.4 €/m²	48.6%
	Novara	453.5 €/m²	40.8%
	Vercelli	709.6 €/m²	57.5%
	Turin	267.5 €/m²	23.5%
Tuscany	Florence	2,475.7 €/m²	10.7%
	Livorno	863.5 €/m²	33.9%
	Pisa	749.0 €/m²	43.1%
	Pistoia	654.8 €/m²	42.0%
Lazio	Latina	764.1 €/m²	38.8%
	Rome	1,640.4 €/m²	21.6%
	Cassino	335.9 €/m²	58.4%
	Civitavecchia	1,023.4 €/m²	29.5%
	Frosinone	420.5 €/m²	54.6%
	Rieti	718.9 €/m²	19.5%
	Tivoli	782.2 €/m²	27.6%
	Velletri	900.2 €/m²	43.7%
Campania	Santa maria capua vetere	414.9 €/m²	42.2%
	Naples	931.6 €/m²	35.9%
	Salerno	554.0 €/m²	38.6%
	Caserta	157.49 €/m²	60.1%
Apulia	Bari	767.1 €/m²	30.4%
	Taranto	499.5 €/m²	48.0%
	Trani	681.1 €/m²	31.3%
	Foggia	344.0 €/m²	57.7%

variables, (i, n) – with $n = (1, ..., 2j)$ – is the exponent of the n-th input within the i-th term in Equation (1), selected by the user from a set of real numbers, f is a function selected by the user between a set of different mathematical expressions.

The outputs of EPR implementation are represented by different models whose functional form is the best combination of the explanatory variables X_i, defining for each one the exponents (i, n) and the numerical coefficients a_i. Among the several models identified by the technique, the "best" one is chosen for the analysis of the phenomenon to examine by taking into account i) the

algebraic complexity and ii) the statistical performance of each equation. In particular, the first condition depends on the maximum number of terms and on the possible exponents through which the variables are elevated, set during the preliminary phase of the EPR technique.

The statistical accuracy of each model is determined by calculating by the Coefficient of Determination (COD), that is defined in Equation (2). It varies between the value 0 and the value: the fitting of a model is higher when the COD value is close to the unit value:

$$CoD = 1 - \frac{N-1}{N} \cdot \frac{\sum_N (y_e - y_d)^2}{\sum_N (y_d - mean(y_d))^2} \tag{2}$$

where y_e are the values of the dependent variable assessed, y_d are the detected values of the dependent variable, N is the sample size considered.

Finally, the most suitable model among those generated by EPR is selected according to the specific aim of the analysis, the knowledge of the phenomenon and the type and quantity of experimental input data collected and included.

5.1 Implementation of the EPR methodology

The EPR methodology has been implemented six times, by considering the following inputs: for all models i) a static regression is carried out, ii) the structure of the generic model is that identified in Equation (1) without function f selected, iii) the maximum number of terms is equal to 8, that is, the number of independent variables, iv) the set of candidate exponents of the independent variables are positive and belongs to the range (0; 0.5; 1; 2), v) no bias included. In Table 3 the main different basis assumptions for the EPR implementation for each study sample are reported.

Each model obtained is constituted by a mathematical expression in which the additive monomial terms are combination of the explanatory variables Xi raised to the proper numerical exponents. At the end of the processing carried out, the CoD levels and the algebraic form of the several models generated have been analysed and compared in order to allow to select the best model for each study sample related to an Italian region.

In particular, the six models chosen between those provided by the EPR technique are shown below in the Table 4.

To determine the influence of each independent variable on the formation of the selling price according to the EPR models, the function shown below has been applied:

Table 3. Main different basis assumptions for the EPR implementation for each study sample.

Model setting	Lombardy model	Piedmont model	Tuscany model	Lazio model	Campania model	Apulia model
Dependent variable – unit final selling price	$Y = LN(P)$	P	$Y = LN(P)$	P	$Y = LN(P)$	P
Indipendent variable – market value assessed by the asset valuer [Vm]	$LN(Vm_{unit})$	Vm_{unit} normalized to the maximum value detected	$LN(Vm_{unit})$	Vm_{unit} normalized to the maximum value detected	$LN(Vm_{unit})$	Vm_{unit} normalized to the maximum value detected

Table 4. Six models chosen for the study samples.

Lombardy	$Y = 1.0494 \cdot Vm - 2.1463 \cdot T^2 \cdot C^{0.5} + 0.0092356 \cdot Mg^2 \cdot Co \cdot T^{0.5} \cdot Vm^2 - + 0.27834 \cdot S^{0.5} \cdot Vm + 2.6144 \cdot S \cdot Se^{0.5} \cdot T^{0.5}$
Piedmont	$P = 2284.0962 \cdot Vm + 931.1367 \cdot T^2 \cdot P^{0.5} - 2097.0845 \cdot L \cdot T \cdot Vm + 4810.0006 \cdot L^2 \cdot Se^{0.5} \cdot T^{0.5} \cdot Vm^2 + + 8668.7819 \cdot Mg \cdot Co^2 \cdot T^{0.5} \cdot Sc \cdot Vm^2 - 11016.2758 \cdot S^{0.5} \cdot T \cdot Vm^2 - 189.0699 \cdot S$
Tuscany	$Y = + 0.94342 \cdot Vm + 0.59547 \cdot T^{0.5} \cdot Vm^{0.5} + 0.2607 \cdot Se^2 \cdot T \cdot Vm^{0.5} - 9.2464 \cdot S^{0.5} \cdot T^{0.5} + + 0.049221 \cdot S^{0.5} \cdot T \cdot P^{0.5} \cdot Vm^2 + 3.5453 \cdot S - 0.11583 \cdot S \cdot Md \cdot Co^{0.5} \cdot Se \cdot T^{0.5} \cdot Vm^2$
Lazio	$P = + 3265.4651 \cdot Vm - 1284.3963 \cdot Co \cdot P^2 \cdot Vm^2 + 1085.228 \cdot L \cdot Sc \cdot Vm - + 3247.4747 \cdot S^{0.5} \cdot T^{0.5} \cdot Vm + 3423.1418 \cdot S^{0.5} \cdot L \cdot P^2 \cdot Vm + 21097.8687 \cdot S \cdot Co^{0.5} \cdot Se^{0.5} \cdot T \cdot Vm^2 - + 5667.2263 \cdot S \cdot Mg^2 \cdot L^2 \cdot Se^2 \cdot Vm^2$
Campania	$Y = + 0.94844 \cdot Vm - 0.048992 \cdot T \cdot Vm^2 + 0.19626 \cdot T \cdot C^{0.5} \cdot Vm + 0.052527 \cdot T^2 \cdot Sc^{0.5} \cdot Vm^2 + + 7.2587 \cdot S^2 \cdot L^{0.5} \cdot Co^{0.5} \cdot T^{0.5}$
Apulia	$P = + 1399.0734 \cdot Vm^{0.5} - 1971.1142 \cdot Se^{0.5} \cdot T \cdot Vm^{0.5} - 3630.2467 \cdot Mg^{0.5} \cdot L^{0.5} \cdot Vm^2 + + 390.001 \cdot Md^{0.5} \cdot Se^2 + 19377.3491 \cdot S^{0.5} \cdot T^2 \cdot Vm^2 + 2219.931 \cdot S^{0.5} \cdot Me \cdot T^{0.5} - + 1572.7074 \cdot S^{0.5} \cdot Md^{0.5} \cdot Vm^{0.5} + 176554.2012 \cdot S^2 \cdot Mg^2 \cdot L^{0.5} \cdot Se^{0.5} \cdot Vm^2$

$$Y_{EPR}(Xi) = f(X_1, X_2, X_3, \ldots, X_l, X_8)$$

where Xi represents the explanatory variable to be analyzed, X_l is the constant and average value of the other variables in the variation interval in the observed sample. Therefore, the contribution of each input factor has been determined by taking into account an exogenous approach and the differential variation in the values range detected for each variable for each database has been calculated.

The models chosen are characterized by a different COD level, equal to 65.44% for the Lombardy region, 79.77% for Piedmont, 79.29% for Tuscany, 80.75% for Lazio, 73.97% for Campania, 79.52% for Apulia.

For each model the factors included in the equation among those analyzed, have been specified and the functional relationships between the dependent variable (unit final selling price) and the independent variables have been studied. It should be highlighted that the variables simultaneously selected by the methodology for the six Italian regions as the most influential on the final selling prices are the market value assessed by the valuer (Vm), the total surface (S), and the time on auction (T).

The other variables selected for each Italian region considered in the present research, in addition to the previous ones, are specified in the Table 5.

5.2 Results interpretation

The verification of the empirical coherence of the functional relationships between the unit final selling prices and the factors selected by each model has been carried with reference to the expected market phenomena and the signs of the coefficients of explanatory variables have confirmed the existing residential auction market dynamics.

Firstly, with reference to the variable related to the time on auction (T), according to the six models generated, the functional correlations between the dependent variable (unit selling price) and this factor attest an inverse link for which an increase in the days between the first day of bidding and auction clearing date determine a decrease in the property final price. Moreover, as expected, for all samples collected, a growth in the dependent variable values is associated to the increase of

Table 5. Variables selected by the EPR technique for each study sample.

	Lombardy	Piedmont	Tuscany	Lazio	Campania	Apulia
Presence of the lift [L]		●		●	●	●
Presence of private appliances [Se]	●	●	●	●		●
Presence of condominium areas [Co]	●	●	●	●	●	
"To be restructured" property maintenance conditions [Mb]						
"Normal" property maintenance conditions [Md]			●			●
"Good" property maintenance conditions [Mg]	●	●		●		●
"Excellent" property maintenance conditions [Me]						●
Central urban area [C]	●				●	
Semi-central urban area [Sc]		●		●	●	
Peripheral urban area [P]		●	●	●		

properties forced sale prices: in fact, a direct relationship is observed between the market values determined in the expert estimate analyzed (Vm) and the corresponding final prices. The trends that express the selling price evolution for an increase of the property surface are heterogeneous: for the samples related to the regions of Lombardy, Piedmont, Tuscany, Lazio and Apulia a decrease in unit selling prices is found in correspondence of the increase of property surface (S), whereas for the region of Campania an opposite functional relationship is recorded, for which the smallest property of the study sample selected are characterized by the highest unit selling prices. This trend could be justified by taking into account that there may be other property factors – positional, socio-economic and technological – that can be more relevant on the final prices' formation processes compared to the property size. In this sense, in the sample collected for the region of Campania the smallest properties (with a surface less than 50 m²) are characterized by i) "to be restructured" or "normal" conservative state (Mb or Md = 1), ii) the absence of lift, iii) the lack of condominium areas.

For all models related to the Italian regions for which the presence of the lift (L), the private appliances (Se) and of the condominium areas (Co) are among the most influencing factors on unit selling prices, an increase in selling prices is detected in correspondence of these services presence. In addition, the models indicate that for a property maintenance conditions improvement a growth in selling prices is observed. In particular, the passage from a worse conservative state to a better one determines a unit selling prices rise for all study samples, by pointing out that the residential units characterized by aesthetic and construction high quality, likely affected by recent renovation initiatives (Me = 1), are those mostly appreciated by potential buyers in the Italian housing auction market.

Among the contributions provided by the characteristics of the urban context in which the property is located (extrinsic factors), such as the presence of green spaces, the accessibility, the security level, etc. a significant positive influence is given by the property localization in central area (C) compared to the semi-central (Sc) or peripheral ones (P) of the regions of Piedmont, Lazio, Campania, Conversely, for the regions of Lombardy and Tuscany an inverse correlation between the variable related to the central urban area localization and the final selling prices is found, by attesting a residential auction market preference for properties in semi-central or peripheral urban contexts.

The analysis of the models obtained through the implementation of the EPR technique has allowed to determine the percentage marginal contribution of the different factors selected on the unit forced sale prices, i.e. for the quantitative variables (Vm, S and T) in terms of an increase of i) one euro for the variable related to the market value (Vm), ii) one m² of property surface (S), iii) one day for the variable concerned the time on auction (T), whereas for the dummy ones (Co, Se, L, Md, Mg, Me, C, Sc, P) by considering the already calculated percentage variations between the value 0 and the value 1. Furthermore, for all the quantitative variables analyzed in the research, the average marginal contribution of the influencing factors considered on selling prices formation has been calculated, by weighting the percentage values on 100 in order to i) identify the marginal contribution compared to the sum of the marginal contributions related to the two variables categories (dummy and quantitative) and ii) analyze the incidence of the different factors among them, i.e. of each variable in relation to others.

By taking into account the distinction between the quantitative variables and the dummy ones, for each Italian region considered, the graphs of Figures 4, 5, 6,
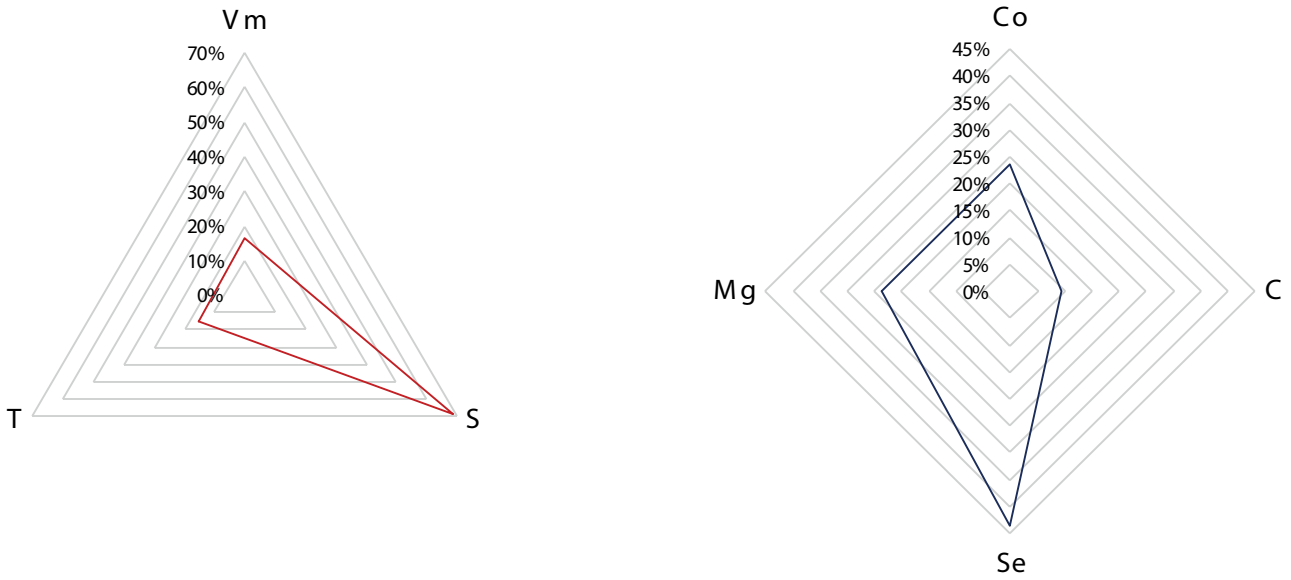
Figure 4. Average percentage marginal contribution of the quantitative variables (red line) and dummy ones (blue line) selected by the model for the region of Lombardy.
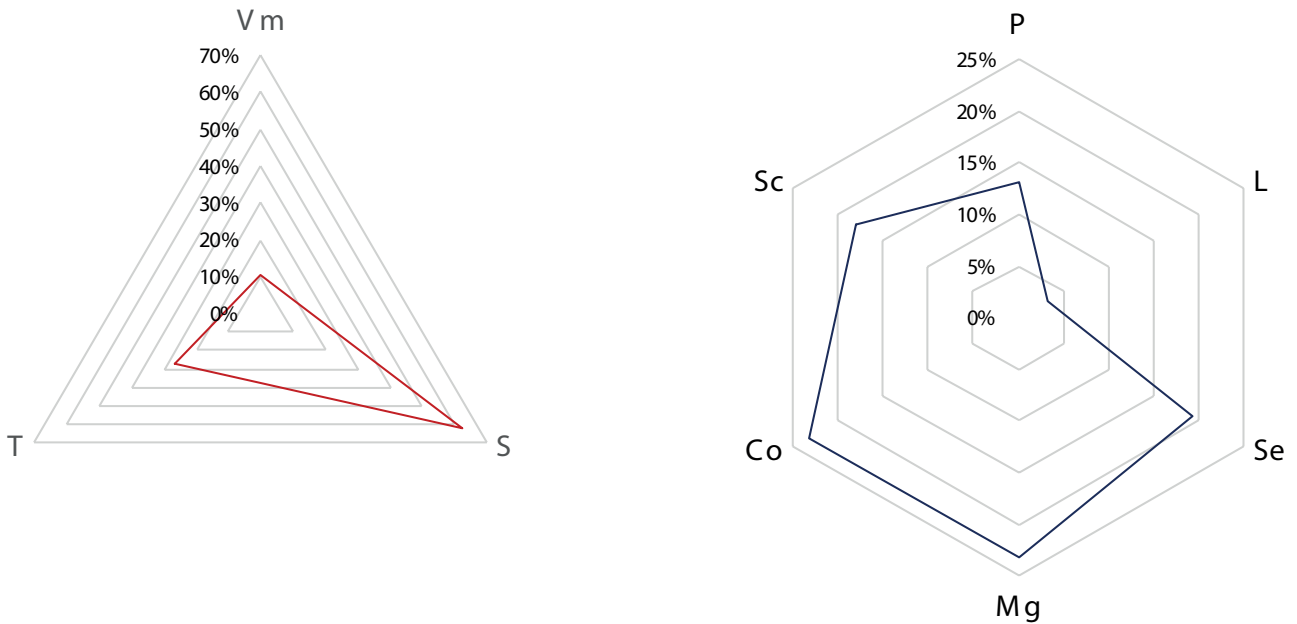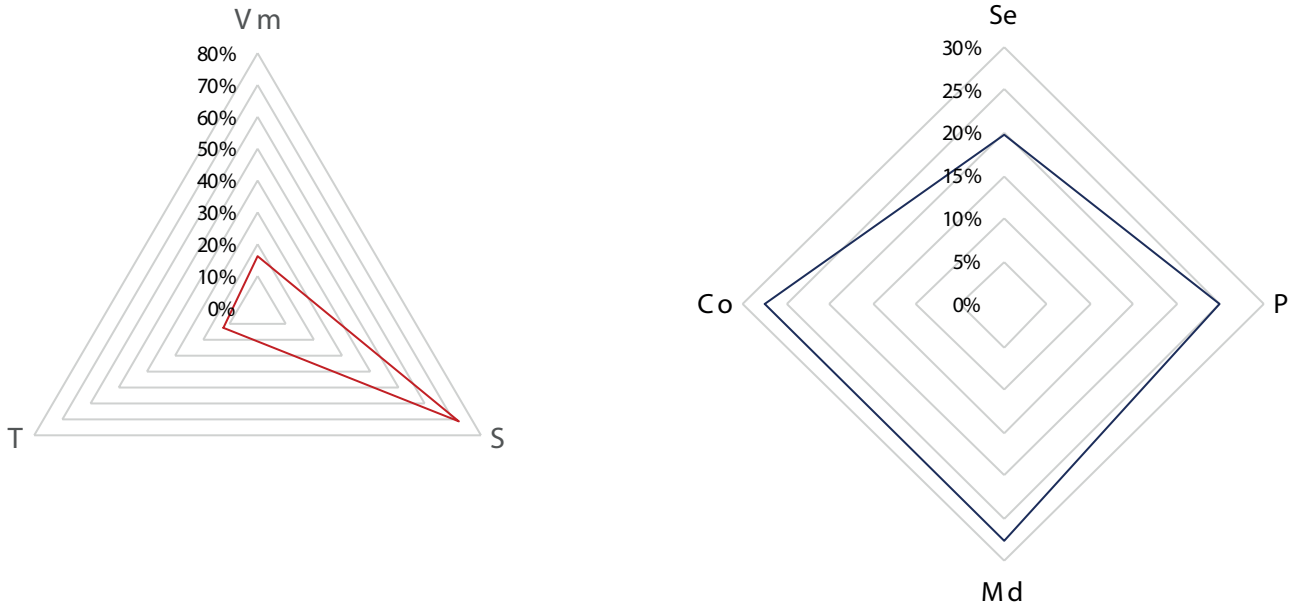

Figure 5. Average percentage marginal contribution of the quantitative variables (red line) and dummy ones (blue line) selected by the model for the region of Piedmont.

7, 8 and 9 show the average marginal influence of the quantitative and dummy factors selected by the models on the unit forced sale prices for each region considered and expressed in percentage terms.

Moreover, for each explanatory variable included in the analysis, the average marginal percentage contri-

bution on final prices formation dynamics is reported in graphs of Figures 10 (quantitative variables) and 11 (dummy variables).

The outputs obtained are consistent with the expected ones. Firstly, with reference to the quantitative variables selected by the models, all factors considered in the
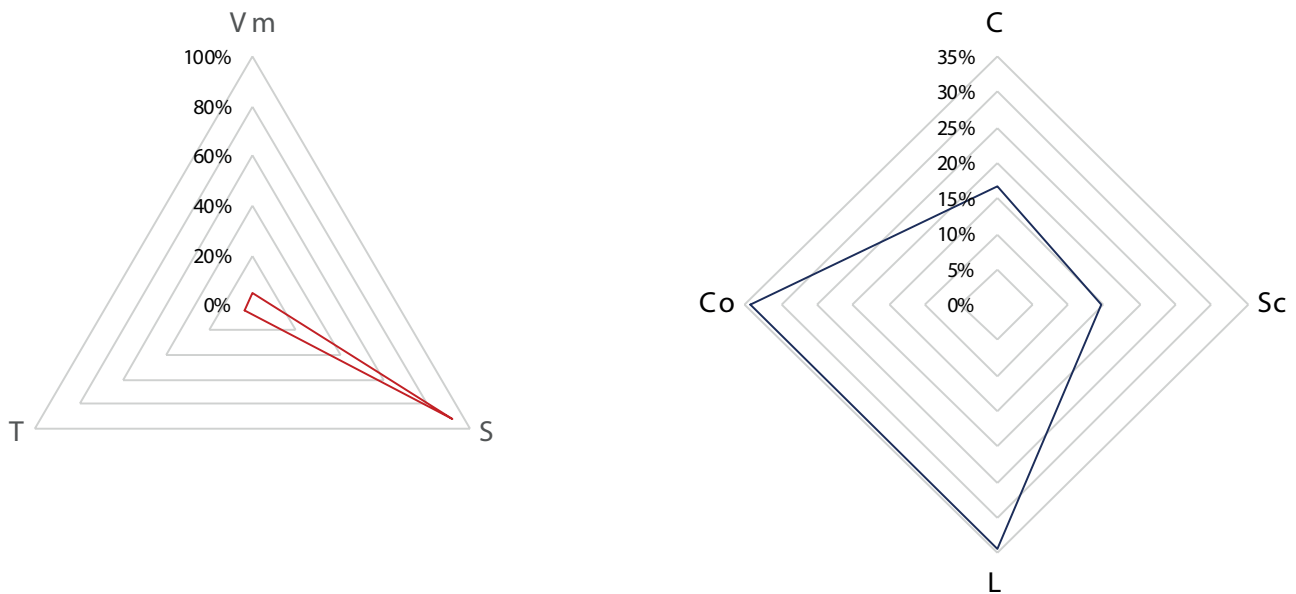
Figure 6. Average percentage marginal contribution of the quantitative variables (red line) and dummy ones (blue line) selected by the model for the region of Tuscany.
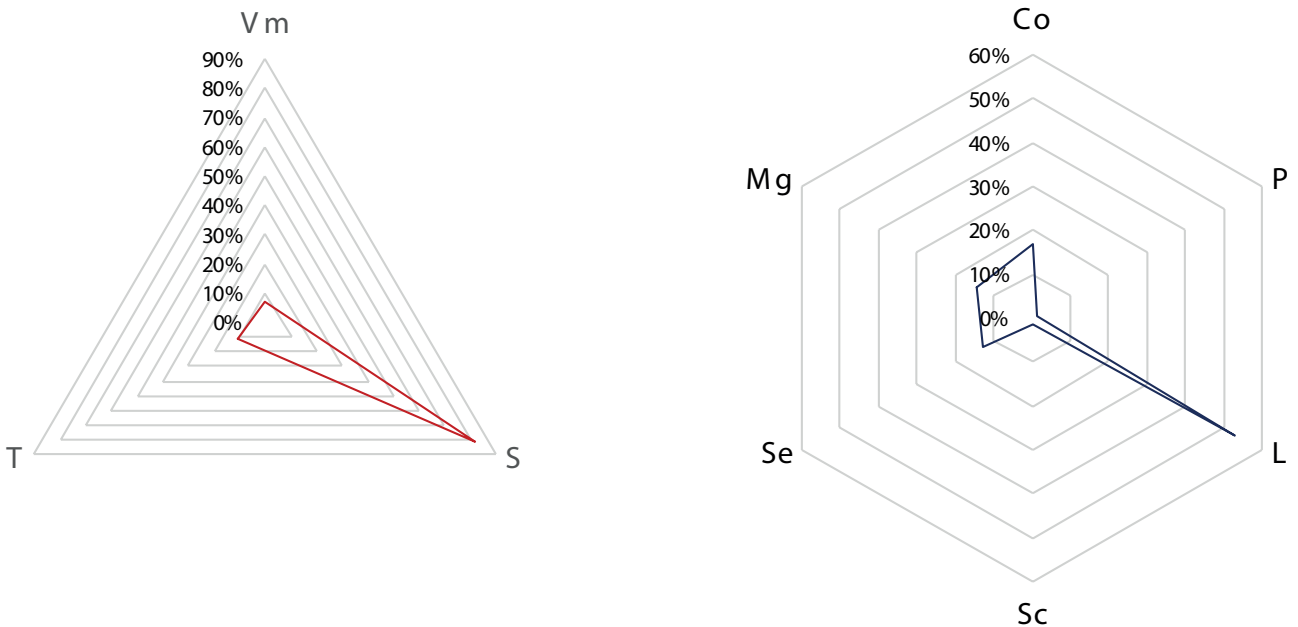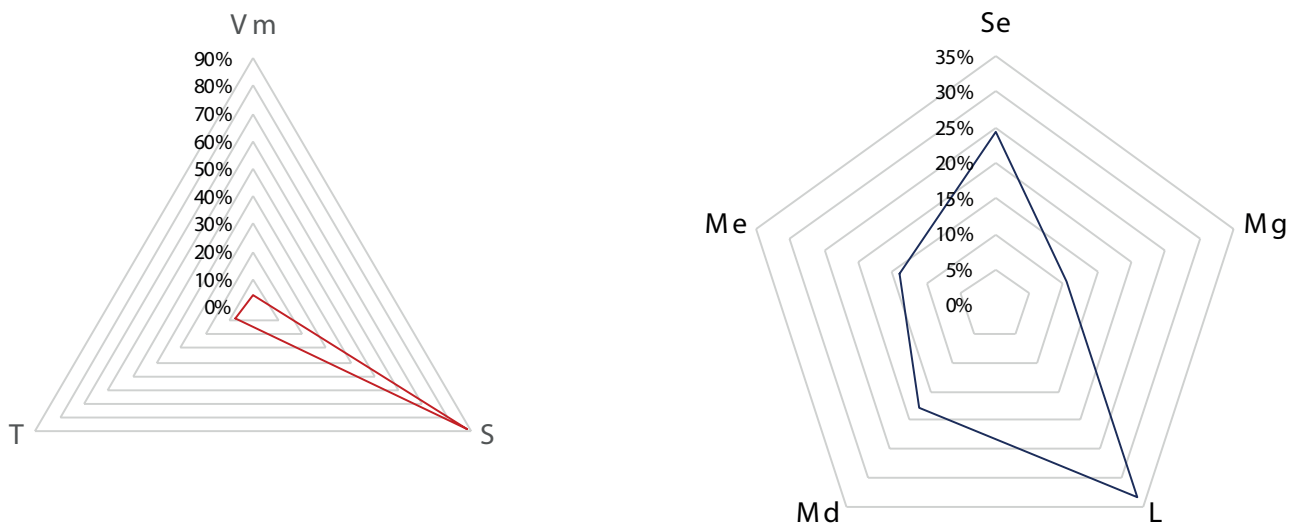

Figure 7. Average percentage marginal contribution of the quantitative variables (red line) and dummy ones (blue line) selected by the model for the region of Lazio.

analysis (S, Vm and T) are included in the models generated by the EPR implementation. Then, for all models, the property surface (S) represents the most influencing factor among those belonging to the quantitative category. It should be noted that for the region of Campania

the highest average weighted marginal contribution of this factor on selling prices compared to the other variables influences has been observed (91.64%), whereas the lowest influence is recorded for the region of Piedmont (62.34%). For the study sample detected for this region,

Figure 8. Average percentage marginal contribution of the quantitative variables (red line) and dummy ones (blue line) selected by the model for the region of Campania.

Figure 9. Average percentage marginal contribution of the quantitative variables (red line) and dummy ones (blue line) selected by the model for the region of Apulia.

the time on auction (T) constitutes a relevant factor on final prices (26.88% compared to the other quantitative factors analyzed), by attesting a significant variation in terms of depreciation in selling prices in correspondence of longer auction time. It should be highlighted that this output is consistent with the existing geopolitical differences among the Italian macro-areas: the variable "time on auction" shows a higher weight in the territories in which the judicial procedures are quicker (North-West-

ern Italy, characterized by an average value of T equal to 4 years), compared to those in which an "addicted market behavior" to the ordinary procedural delays (in particular Southern Italy and Islands, with an average value of T equal to 6.5 years) can be generally detected (Cerved Group Spa and La Scala – società tra avvocati).

Finally, the results analysis outline that the market value (Vm) is the factor for which the highest average weighted marginal contribution found is equal to 16.45%
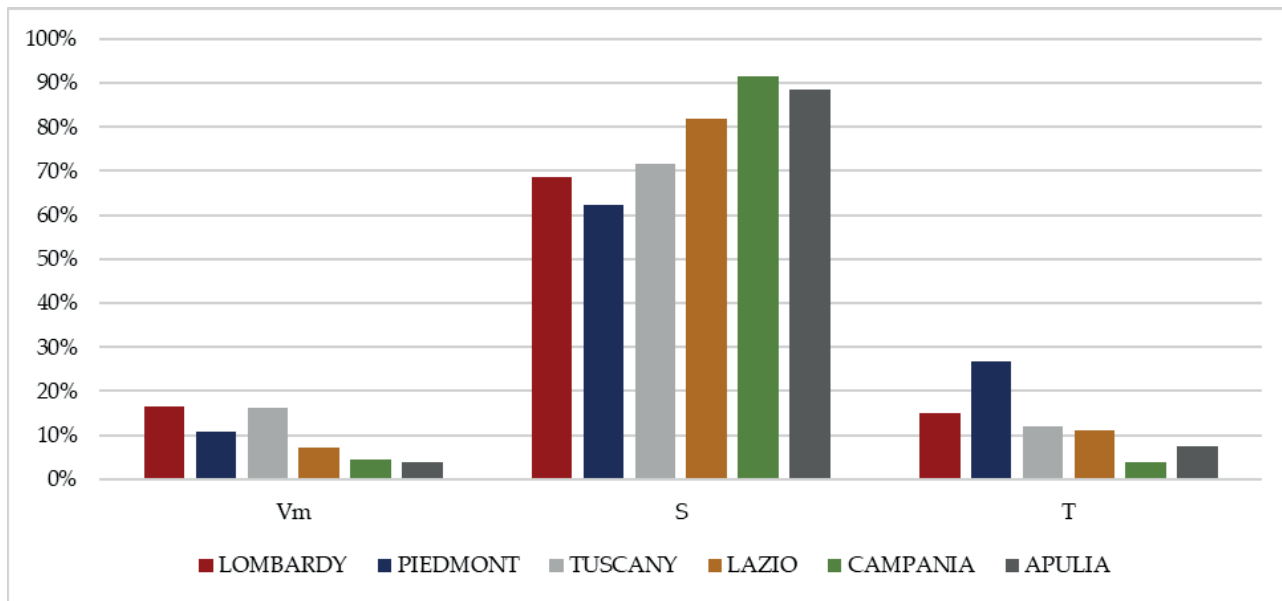
Figure 10. Comparison between the average percentage marginal contributions of the quantitative variables selected by the models on the unit forced sale prices.
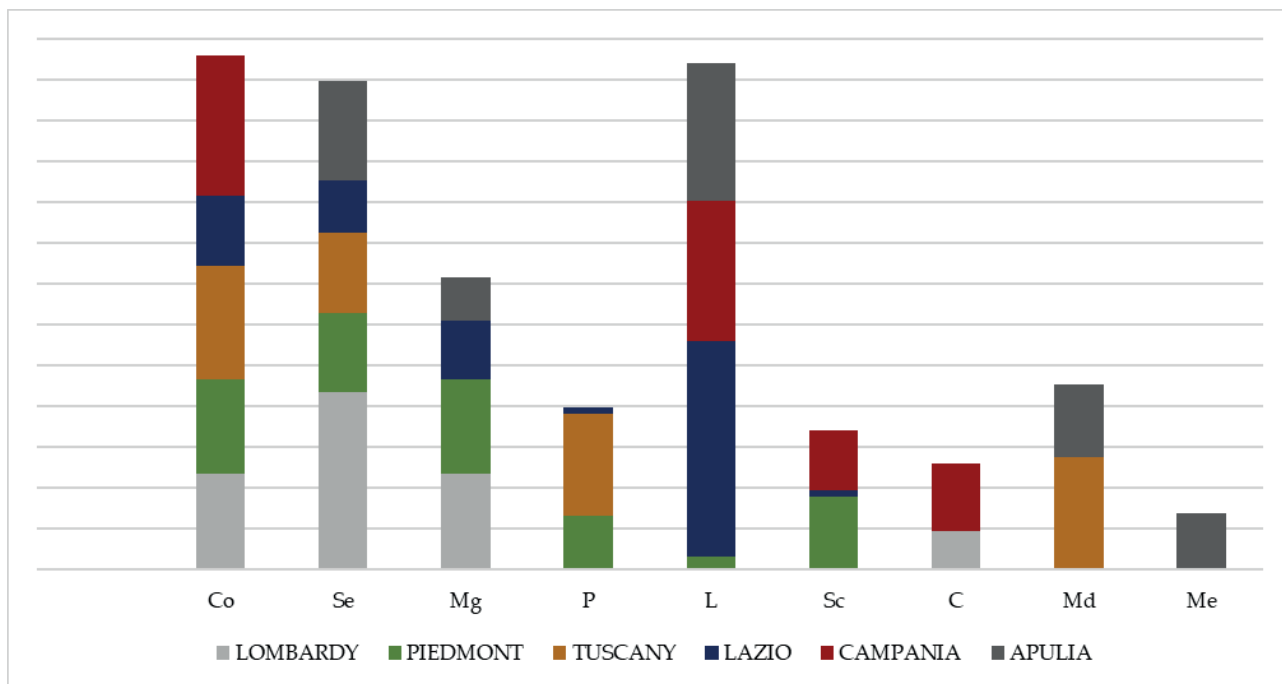

Figure 11. Comparison between the average percentage marginal contributions of the dummy variables selected by the models on the unit forced sale prices.

for the region of Lombardy. The lowest average value of the weighted marginal contribution of this variable is verified for the region of Apulia (4.00%), for which the lowest values have been also detected at national level.

With reference to the dummy variables, it should be highlighted that the highest weighted contribution is observed for the variable related to the presence of the lift in the building in which the property is located
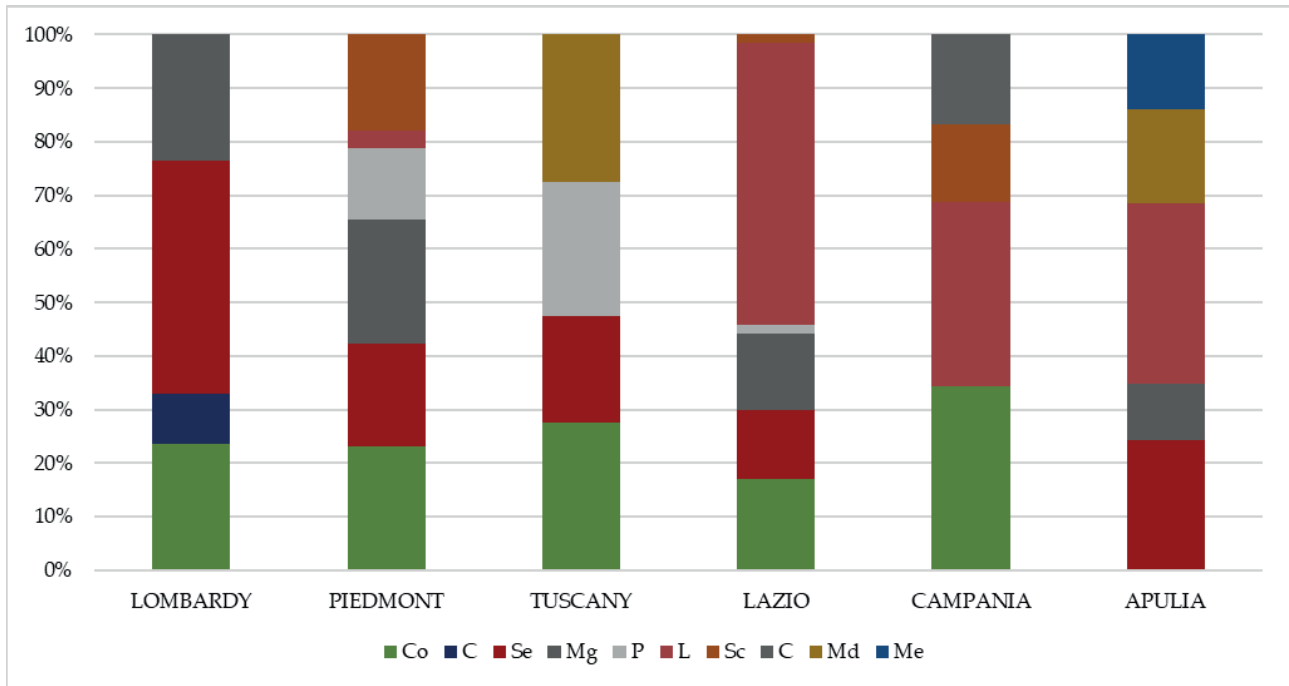
Figure 12. Distribution of the average percentage marginal contributions compared to the 100% of the dummy variables for each Italian region.
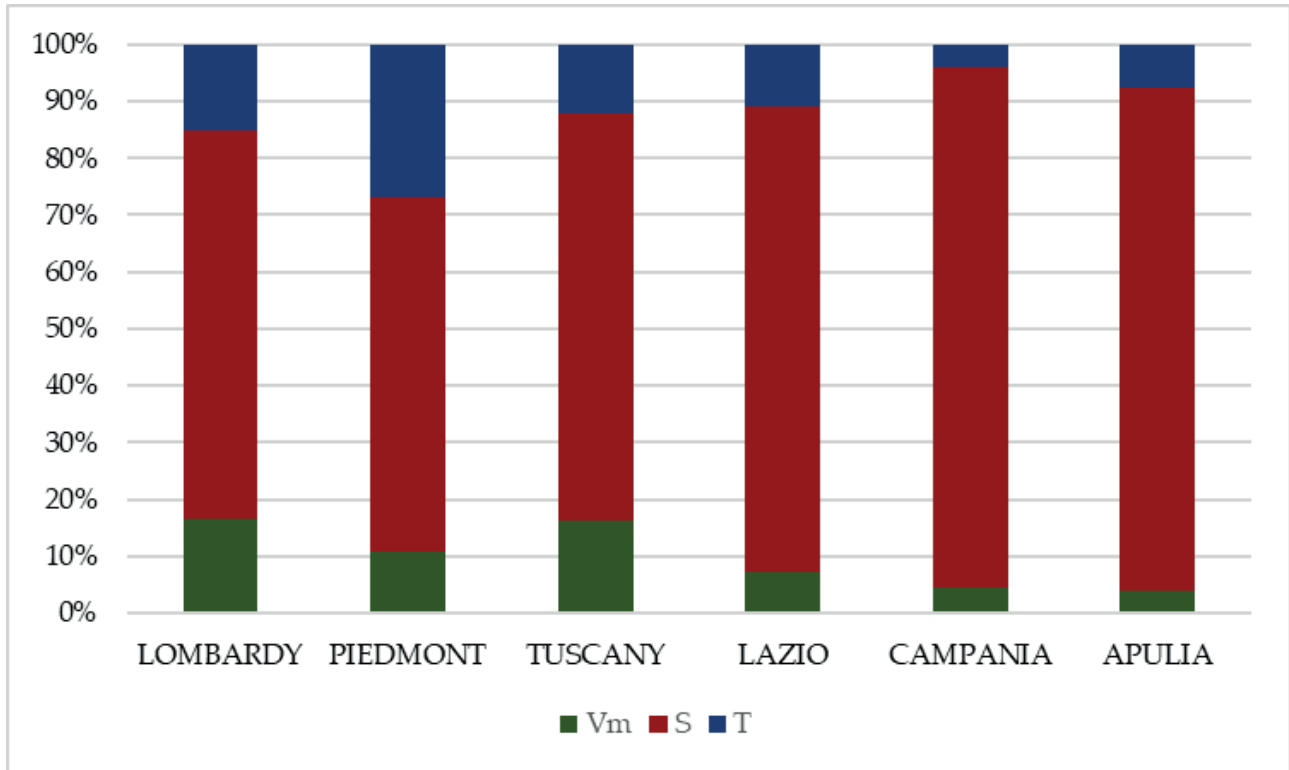

Figure 13. Distribution of the average percentage marginal contributions compared to the 100% of the quantitative variables for each Italian region.

(L) for the region of Lazio (52.86%), whereas the lowest influence obtained concerns the region of Apulia and the incidence of the variable of the "excellent" maintenance conditions (Me) in relation to the others selected by the model (13.88%).

With reference to the two categories of variables considered in the analysis (dummy and quantitative), for each Italian region the distribution of the contributions compared to the 100% are reported in Figures 12 (dummy variables) and 13 (quantitative variables).

6. CONCLUSIONS

In the context of the residential property auctions market segment, the difference between the forced price and the market value assessed by the judicial valuer represents a relevant issue, particularly discussed in the international context.

With reference to the Italian territory, six study samples constituted by total 918 residential properties sold through judicial auctions between November 2020 and May 2021 and each of them located in an Italian region of Lombardy and Piedmont for the Northern Italy, Tuscany and Lazio for the Central Italy and Campania and Apulia for the Southern Italy and Islands have been collected.

For each property, the unit final selling price expressed, the market value assessed by the judicial valuer and the main quantitative and dummy factors have been detected for the implementation of an econometric analysis. The research has intended to develop a model for the assessment of the forced sale value able to determine the functional relationships between the final selling prices and the factors considered.

Among the models provided by the proposed methodology, the six ones selected respectively for the Italian regions have allowed both to identify the most influencing factors on the auction clearing prices and, therefore, those that mainly affect the discount between the market value and the forced sale price. With reference to each model chosen for each Italian region, the most relevant variables have been studied in terms of the (average and marginal) contribution on the unit forced sale prices.

The results of the research could represent a useful reference for monitoring the housing auction market trend in terms of *i*) the auction prices, *ii*) the discounts between the market values and the final prices, and *iii*) the auction time. Furthermore, the analysis could support the judicial authorities, at the start of the auction procedures to check the amount in the reduction of market values assessed by experts and to avoid relevant

variation that could cause unreliable discount dynamics and the presence of unsold properties. The significance of the present work concerns the definition of immediate reading models for the assessment of the forced sale value by which the analysis the most influencing factors on the final hammer price can be carried out. In this sense, on the basis of the specific property factors the model obtained – as a valid practical tool – allows to define the reliable forced sale value and its relevance with the market value assessed by the appraiser and, therefore, to help to make more transparent the dynamics underlying the real estate auction market mechanisms.

Future insights of this research may concern the application of the same methodology proposed to other territorial contexts to investigate the heterogeneity of the auction market and the relative main dynamics. Moreover, the analysis could be iteratively implemented with reference to the same territory in order to compare the outputs obtained in different times and to update the corresponding results (Tajani et al., 2015).

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