A LOCATION VALUE RESPONSE SURFACE MODEL FOR MASS APPRAISING: AN "ITERATIVE" LOCATION ADJUSTMENT FACTOR IN BARI, ITALY

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ABSTRACT. The work is focused on a new model of mass appraising including location variable. A location adjustment factor derived from a mathematical iteration was compared to the location adjustment factor based on geostatistical techniques. The work compares three different linear MRA models. The first one uses the location blind linear MRA. The second integrates the linear MRA with a location adjustment factor calculated using spatial interpolation. The second alternative is an application of Location Value Response Surface Models (O'Connor, 1982). It represents the first application of these models for mass appraising in Italy. The third approach introduces the Iterative Location Adjustment Factor. This is a factor which measure the influence of location derived from a mathematical iteration. Empirical results seem to prove the validity of Iterative Location Adjustment Factors in specific context with few observations.

KEYWORDS: Mass appraisal; Automated valuation models; Location; Location value response surface; Location adjustment factor

1. INTRODUCTION

Several authors pointed out the role of externalities and location in property values (Krantz et al., 1982; Hoch and Waddell 1993; Des Rosiers et al., 1996). Previous research focused on the problem of variability of house prices which remains unexplained in multiple regression models (Anselin and Can 1986; Dubin 1998). The consequences are for example: the presence of excessive multicollinearity among attributes, spatial autocorrelation among residuals; diminuishing the stability of regression coefficients (Dubin 1988; Anselin and Rey 1991; Des Rosiers and Thériault, 1999). For this reason neighbourhood factors should consider submarket specifics (Adair et al., 1996). This problem is particularly relevant in real estate markets with a limited number of observations. This work proposes a different approach to location variable in mass appraising and automated valuation modelling. After the application of a traditional location blind MRA linear model, the works compare it with an application of Location Value Response Surface analysis in Italy. It is the first application of this kind of model to the Italian context. The third model derive the location factor from a mathematical iteration instead of geostatistic techniques. The empirical findings of the traditional LAF and the new Iterative Location Adjustment Factor converge on comparable solutions. The article is organized as follows: the first paragraph will give a brief outline of

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Location Value Response Surface Models, in the second paragraph will be proposed the application of an Iterative Location Adjustment Factor for mass appraising. After a comparison among the automated valuation methods applied final remarks will be offered at the end.

2. LOCATION VALUE RESPONSE SURFACE MODELS

Location Value Response Surface (LVRS) Analysis has been introduced in US (O'Connor, 1982) for the first time for the appraisal of single family houses in Lucas County, and is different approach to fixed neighbourhoods or composite submarkets analysis (Ward et al., 2002). The application of this method requires spatial interpolation of property prices or error term. This method has been applied in the U.S. (Eichenbaum, 1989; Eichenbaum, 1995; Ward et al., 1999), in England (Gallimore et al., 1996), and Northern Ireland (McCluskey et al., 2000). The application of LVRS allows the appraiser to analyze the effect of location using Geographical Information Systems (GIS). Among different possible classifications it is possible to observe three main approaches to LVRS. A first approach (McCluskey et al., 2000) consists in calculating a location adjustment factor based on the spatial distribution of the selling prices. A price per square metre is obtained dividing the actual price by the gross floor area of the dwelling. A contour plot overlying the area map portrays the peaks and troughs of property values which are also called value influence centres (VICs). In general term the VIC can be defined as point(s), line(s) or area(s) in a contour map where it is possible to observe a relative maximum (positive) or a minimum (negative) location values (errors). As a consequence VIC may affect the value of near properties. Therefore the distance from each VIC is calculated for each observation. The selling price per square meter is regressed on coordinates and the distance of each property to each VIC. The predicted price is then divided by the average estimated price. As a consequence will be determined a local adjustment factor having a mean of 1. In particular better locations will have a factor greater than 1, while poorer locations will have a factor less than 1. This local adjustment factor varying from -1 and 1 will become a measure of impact of location in the final regression model whose predictability will be improved. In the case of Bari there is one only VIC and the area is quite homogeneous therefore the measure of distance was the physical distance. A second approach is based on the measure of the variance between actual prices and predicted prices using a MRA model without location variable. This model will present greater value of forecasting error in some areas and lower value in other areas generating a contour map of errors instead of value. Using the error ratio related to under valuation or over valuation and the coordinates of each observation. The impact of each VIC on any property is determined using different possible measures of the distance from the property to the VIC (Eckert, 1990; Eckert et al., 1993). The response surface is depending on the VIC positions and the adopted distance measure. The third approach starts creates an interpolation grid, modelled to reflect the influence on each property of the location ratio factors within its proximity. The method has not been applied to residential flats. It has not been applied outside North America, Britain or Northern Ireland. This is the first application to Italian real estate market. A prerequisite is having sufficient amount of data in each zone of the area considered in order to produce the spatial interpolation. There are not a minimum number of observations but real estate market, especially in the Italian context presents a scarcity of data. Location Adjustment factor does not indicate the value of a certain location, but only the comparative location values for real property analysed. Spatial interpolation require the surface of the *z* variable (selling price or error term) to be continuous and the data value at any location can be estimated if sufficient information about the surface is given. In addition the *z* variable (selling price or error term) must be spatially dependent therefore the value at any specific location is related to the values of surrounding locations.

3. THE APPLICATION OF ITERATIVE LOCATION ADJUSTMENT FACTOR IN BARI, ITALY. DATA AND METHODS

In the residential real estate market of Bari the location factor have been built avoiding the construction of contour maps. In fact in some institutional context it may be not easy to collect data for several problems. In italian context neither real price nor characteristics are always clearly indicated in the transaction and the data are often incomplete. There are few organized databank of real transactions. Developing a Real Estate Market Observatory in order to test and apply mass appraisal-automated valuation models it is not a easy task in Italy. Real Estate Market Observatory founded in 1998 collects real transactions from several sources. It has groups of real estate transactions in several parts of the city of Bari in the south east of Italy. This kind of sample are often recurring in real estate markets without an institutional organization of property data. Although the number of observations are poor this works tries to explore the power of mathematical criterion of minimum square least of representing real estate market contexts like Italy with few data (Kauko and d'Amato, 2008). The work uses a sample of 20 observations in the administrative area of *Carrassi Poggiofranco* in Bari. These observations are related to residential dwellings in a semi-central location in the urban area of Bari. The list of 20 real observations is indicated in the paragraph 1.1 of the Appendix of this work. In this work the sample has been analysed considering the following variables indicated in the Table 1.

Table 1. Variable considered in mass appraisal modelling

PRICE	In Euro
DATE	Measured in month
ELEVATOR	Dichotomic variable assuming or not the presence of an elevator
BALCONY	Balcony measured in sq.m.
SQM	Square meters of the flat

The observations are located near an important park of the city of Bari. A first location blind linear multiple regression analysis has been selected among the possible forms to analyse the relationship between the *PRICE* as dependent variable and the other variables such as *BALCONY; ELEVATOR; SQM; and DATE* indicated in the Table 1. The linear model is the following formula (1).

$$\begin{aligned} PRICE &= 51.943,42 - 1545,46 \\ DATE &+ 1867,03 \ \ SQM + 1547,10 \\ BALCONY &+ 37898,76 \ \ ELEVATOR + \varepsilon \end{aligned} \tag{1}$$

The paragraph 1.2 of Appendix shows the output of linear regression model. It is possible to observe a good R^2 equal to 0.89 an acceptable test F of Fisher, a good performing t - Student Gossett test except for BALCONY variable. The output shows no presence of collinearity. The mean absolute percentage error whose formula is indicated in the formula (2) was calculated in order to test this first regression model.

$$MAPE = \sum_{i=1}^{n} \frac{\left| \frac{PS_i - AS_i}{AS_i} \right| \cdot 100}{n} \tag{2}$$

In the formula (2) *PS* means predicted selling price while *AS* indicated actual selling price, n is the number of observations. The proposed linear regression model has a MAPE of 15,261%. In order to improve the predictability of the model a location adjustment factor was considered in the model. The location of 20 observations in term of longitude and latitude in the area of Bari is indicated in the Table 2.

The geographic distribution of 20 observations in the urban context of Bari is indicated in the Figure 1. In the middle of area it is possible to observe the urban park "Largo 2 Giugno".

Spatial correlation among the 20 observations was preliminary detected using Moran's I (Moran, 1948; Moran, 1950) test. This index measures autocorrelation between values of the x vector. It ranges from -1 to +1 and each observation is only compared with its relevant neighbourhood. Positive Moran's I indicates positive autocorrelation which means that high values for x or (market basket value or price per square meters) should be located near other high values while lower market basket values should be located near other lower market basket values.

Table 2. Geographic coordinates of the 20 observations

		LATITUDE (Degrees)	LONGITUDE (Degrees)
1.	Kennedy 1d	41,100636	16,871099
2.	Morea 17	41,10471	16,86902
3.	Petroni 102d	41,103909	16,867173
4.	De Viti de Marco 20	41,105277	16,877635
5.	Gabrieli 7	41,106387	16,872217
6.	Morea 38	41,102328	16,870263
7.	Kennedy 6	41,100607	16,870826
8.	Benedetto XIII	41,103248	16,865226
9.	Fanelli 206b	41,098432	16,881172
10.	Fanelli 207	41,105981	16,878358
11.	Salvemini 68	41,102619	16,88289
12.	Gabrieli 12	41,106418	16,872018
13.	Podgora	41,105277	16,8709
14.	Petroni 91bis	41,102061	16,867097
15.	Pavoncelli	41,104203	16,877291
16.	via Podgora 83	41,10536	16,869171
17.	via A. De Gasperi 401	41,098898	16,871173
18.	v.le Resistenza 108	41,104311	16,875363
19.	via lacini 5	41,104854	16,878576
20.	via D. D'Orso 14	41,103131	16,880158

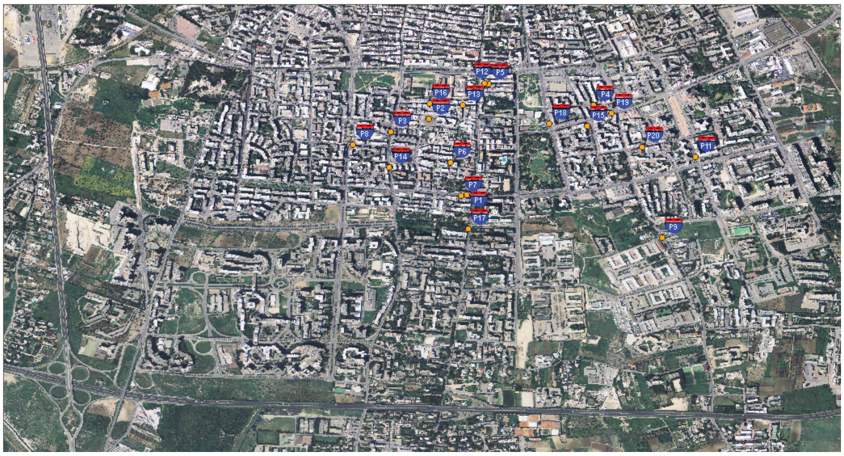

Figure 1. Map of observations

A significantly negative Moran's I implies spatial heterogeneity, or that high values are near low, or vice versa. Moran's test formula is indicated in the formula (3).

$$I = \frac{N \sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{\sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij}(x_i - \bar{x})^2} \quad (3)$$

where: x is the variable (the market basket value), and w_{ij} represents the set of neighbours j for observation i.

In this case, as in previous examples in literature, inverse squared distance among the observations has been considered (Des Rosiers and Thériault, 1999) The final result showed positive autocorrelation assuming a value of 0,7954. A market basket value (say price per unit) has been calculated in order to produce a contour map. Contour map is a map created joining all the points having similar measure (similar price per square meter). The market basket value has been obtained dividing the actual property price by the square meters. In the following Figure 2 is indicated the contour map.

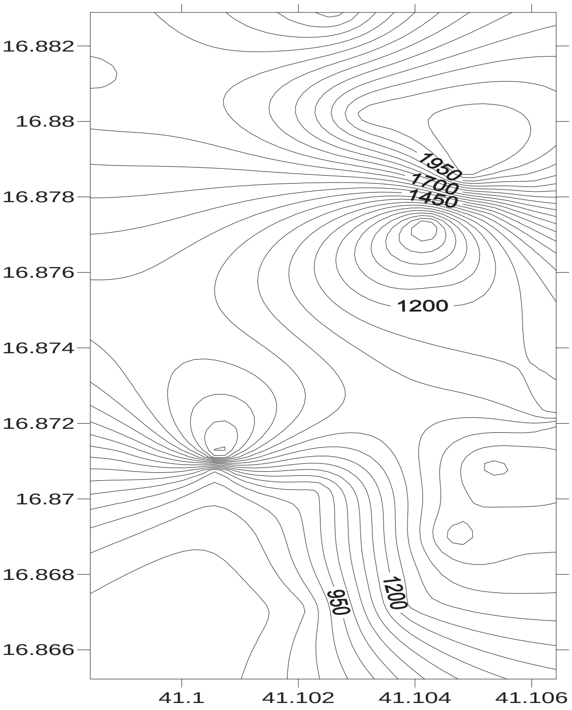

Figure 2. Contour map of market basket

Starting from the spatial distribution of the market basket value it has been possible to observe the relationship between the price per unit of observations and their location through a linear semivariogram. The surface obtained allowed the application of an universal kriging to generate a surface in order to model location variable in this residential property market. Kriging is a spatial interpolation technique which relies on analysis of the spatial variance of a phenomenon. Spatial variability is used to build experimental variogram and observe means differentials between values. In this application the "regional" variable is the price per square meter (Cressie, 1993). Variograms are then formally approximated with a formal function. In this case the theoretical function is linear to obtain the best adjustment for value variations resulting from proximity. The universal kriging was carried out using SURFER 8.

Therefore a second MRA has been runned considering the value influence center clearly individuated in the kriging whose coordinates are indicated in the Table 3.

Table 3. Coordinates of Location Adjustment Factor

LATITUDE	LONGITUDE
41,1063629	16,88000012

This second linear regression model includes the physical distance between each point and the VIC previsously individuated in the Table 3 in the variable LAF or Location Adjustement Factor. In the paragraph 1.3 of Appendix is indicated the formula of physical distance between the coordinates of two points. The second regression model indicated in the formula (4).

$$\begin{aligned} PRICE &= 112290{,}19 - 1524{,}46 \\ DATE &+ 1567{,}08\ SQM + 1463{,}55 \\ BALCONY &+ 42204{,}36\ ELEVATOR + \\ 51112{,}55 LAF &+ \varepsilon \end{aligned} \tag{4}$$

The output of this regression model is indicated in the paragraph 1.4 of Appendix. The R^2 is 0.93, the F di Fisher test and the t-test of Student Gossett are both satisfying. The mean absolute percentage error is 11.08 with a significative improvement compared to the first MRA model presented in the formula (1).

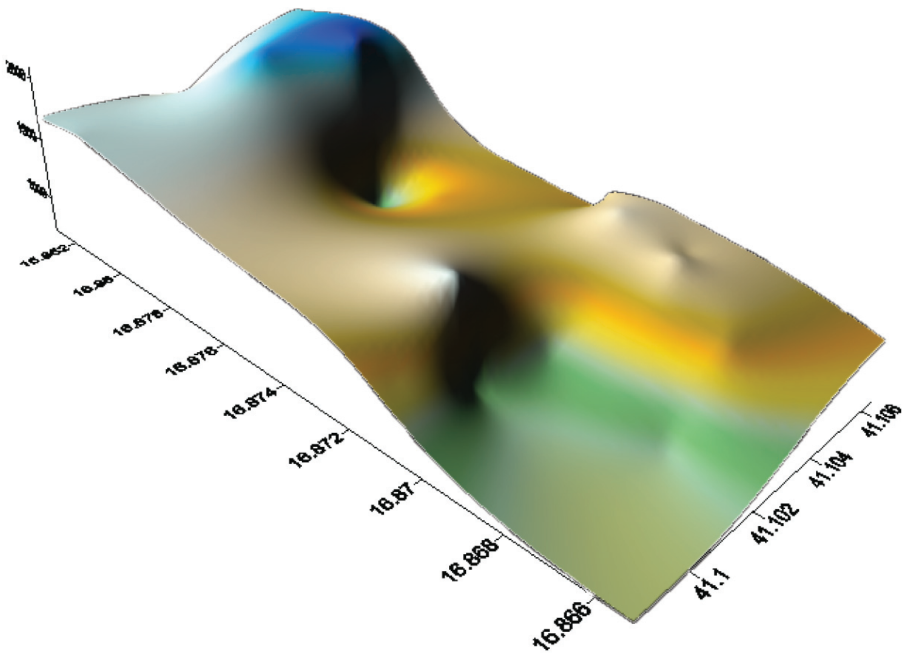

Figure 3. Universal kriging calculated on the Market Basket Value

This work proposed the research of a location adjustment factor without using geostatistical tehnique. For this reason a third linear regression model has been applied to the same sample of 20 observations selected in this work. The MRA model is indicated in the following formula (5).

$$PRICE = CONSTANT + X_1 DATE + X_2 SUI + X_3 BALCONY + X_4 ELEVATOR + X_5 ILAF + \varepsilon \quad (5)$$

The formula (5) has the same variables of formula (4) except for a new variable indicated as ILAF (Iterative Location Adjustment Factor) instead of LAF (Location Adjustment factor). This variable is the physical distance in km of the coordinates (longitude and latitude) of each point from a *virtual point* whose coordinates should be defined after a mathematical non linear iteration in order to reach the highest level of R^2. In the Appendix paragraph 1.3 is indicated the formula. After several iterations carried out through the command "Excel Solver" it has been possible to define an *Iterative Location Adjustment Factor*. It is Iterative because it is simply based on non linear iterations. The coordinates of this point (for this study we call it iterative location adjustment point) will varies in a mathematical iteration in order to select the appropriate Iterative Location Adjustment Factor. At this stage using solver command of Excel it is assumed the following goal function indicated in formula (6).

$$\max f(x);\ \max R^2 \quad (6)$$

where: R^2 is the well known coefficient of determination.

The constraints will regard the coordinates of the iterative location adjustment point. It will vary according to these *contraints* that must be applied to the coordinates. The value of these constraints are indicated in the Table 4.

Table 4. Constraints for iterative location adjustment factor point selection

Constraints for iterative location adjustment factor point selection	LATITUDE	LONGITUDE
min	41,098432	16,865226
max	41,106418	16,88289

In this way the virtual point to be individuated through non linear iterations is inside the area individuated by the coordinates of the points. Several iterations were carried out using the simple function Solver included in the well known MS Office Excel. The iterations selected an Iterative location Adjustment Point as VIC without using geostatistics techniques. The report of iterations is indicated in the Appendix with the paragraph 1.4. The iterative locatin adjustment factor has the coordinates indicated in the Table 5.

Table 5. Coordinates of iterative value influence center

	LATITUDE	LONGITUDE
ITERATIVE value influence center	41,106418	16,88289

Therefore a third linear regression model was runned considering the same variable of model 4. In this model the term ILAF – Iterative Location Adjustment Factor indicates the distance among each point of the sample and the coordinates of the Iterative Value Influence Center indicated in the Table 5. The formula (7) shows the linear multiple regression model obtained.

$$PRICE = 52.992{,}393 - 1528{,}46\ DATE + 1495{,}12\ SQM + 1763{,}11\ BALCONY + 36874{,}73\ ELEVATOR + 38093{,}64\ ILAF + \varepsilon \quad (7)$$

The model indicated in the formula 6 is linear having the same characteristics of the model indicated in the formula (4). The variable ILAF has a positive marginal price. The t-student Gossett test of ILAF variable shows a satisfying a 3.429. The iteration indicated an undesired place near a crossroad with problem of traffic, noise and pollution. This is the reason why the marginal is positive. The unpleasent place can be easily individuated in the kriging of market basket value in the Figure 3. It is worth to notice the convergence between empirical findings of kriging technique and the iterations proposed. In the Appendix paragraph 1.5 are indicated the statistics of this third regression containing ILAF – Iterative Location Adjustment Factor. The R^2 is 94.0 the Fisher and the t-student Gossett tests are encouraging. The mean absolute percentage error is equal to 11.07. It presents a small improvement compared to the first model and to the second – Location Value Response Surface Model. The final Table 6 compares the three mass appraising models.

Table 6. Final comparison among the three regression models

	I. Model location blind linear MRA	II. Model MRA integrated with LAF	III. Model MRA integrated with ILAF
R^2	0,89	0,93	0,94
MAPE	15,26	11,08	11,07

The comparison seems to confirm that the Iterative Location Adjustment Factor may represent an interesting tool to develop for implementing Mass Appraisal and Automated Valuation Systems.

4. FINAL REMARKS AND FUTURE DIRECTIONS OF RESEARCH

The works demonstrated that it is possble to produce an Iterative Location Adjustment Factor using a mathematical iteration instead of the well known geostatistical techniques. Among three different models the Iterative Location Adjustment Factor based on mathematical modelling showed and interesting performance. The iteration were carried out with a quite simple software like MS Office Excel using solver function. More complex analysis with more than one or two VICs may require the use of MathLab or Solver programming offered by Frontline. Further researches may verify the Iterative Location Adjustment Factor in area with more than one VIC and with different formal function from the linear one.

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SANTRAUKA

GEOGRAFINĖS PADĖTIES VERTĖS STEBIMOJO PAVIRŠIAUS MODELIS MASINIAM TURTO VERTINIMUI: ITERACINIS GEOGRAFINĖS PADĖTIES KOREKCIJOS VEIKSNYS BARYJE (ITALIJA)

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Darbe nagrinėjamas naujas masinio turto vertinimo modelis, apimantis geografinės padėties kintamąjį. Iteraciniu būdu apskaičiuotas geografinės padėties korekcijos veiksnys palygintas su geografinės padėties korekcijos veiksniu, gautu taikant geostatistinius metodus. Darbe lyginami trys skirtingi tiesiniai MRA modeliai. Pirmajame naudojamas geografinės padėties nevertinantis tiesinis MRA. Antrajame tiesinis MRA sujungiamas su geografinės padėties korekcijos veiksniu, apskaičiuotu pasitelkus erdvinę interpoliaciją. Antrojoje alternatyvoje pritaikomi geografinės padėties vertės stebimojo paviršiaus (angl. *Location Value Response Surface*) modeliai (O'Connor 1982). Italijoje šie modeliai masiniam turto vertinimui naudojami pirmą kartą. Trečiojoje alternatyvoje taikomas iteracinis geografinės padėties korekcijos veiksnys. Jis įvertina geografinės padėties įtaką, nustatytą iteraciniu būdu. Empiriniai rezultatai, regis, įrodo iteracinių geografinės padėties korekcijos veiksnių pagrįstumą konkrečiame kontekste, kai stebėjimų yra mažai.

APPENDIX

1.1. List of 20 observations, residential real estate transactions in the real estate market of Bari

SQM	BALCONY	ELEV	DATE	PRICE
100,00	25,00	1,00	85	€ 198.000,00
65,00	14,00	1,00	78	€ 113.620,00
85,00	16,70	1,00	92	€ 123.970,00
71,00	7,90	1,00	86	€ 110.000,00
54,00	9,50	1,00	108	€ 74.890,00
90,00	27,00	1,00	111	€ 103.000,00
62,50	23,00	1,00	103	€ 69.720,00
75,00	6,60	1,00	87	€ 74.890,00
90,00	7,00	1,00	90	€ 163.944,06
135,00	24,00	1,00	64	€ 293.000,00
130,00	10,00	1,00	86	€ 201.418,00
95,00	10,00	1,00	75	€ 144.607,93
72,00	17,00	1,00	62	€ 130.000,00
85,00	0,00	0,00	89	€ 65.000,00
75,60	21,00	0,00	107	€ 77.469,00
95,00	10,00	1,00	75	€ 144.608,00
85,00	9,45	0,00	79	€ 103.000,00
85,00	3,35	0,00	67	€ 103.290,00
80,00	10,00	1,00	62	€ 185.000,00
115,00	15,00	1,00	61	€ 260.000,00

1.2. SPSS ouput regression model on 20 observations in the residential real estate market of Bari

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	SUI, ELEVATOR, BALCONY, DATE[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: PRICE

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,944[a]	,890	,861	23626,431

a. Predictors: (Constant), SUI, ELEVATOR, BALCONY, DATE

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6,802E10	4	1,701E10	30,464	,000[a]
	Residual	8,373E9	15	5,582E8		
	Total	7,639E10	19			

a. Predictors: (Constant), SUI, ELEVATOR, BALCONY, DATE
b. Dependent Variable: PRICE

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	51943,420	49649,277		1,046	,312		
	DATE	-1545,465	400,908	-,385	-3,855	,002	,733	1,364
	ELEVATOR	37898,760	14178,096	,245	2,673	,017	,868	1,152
	BALCONY	1547,105	822,241	,184	1,882	,079	,762	1,312
	SUI	1867,037	296,974	,613	6,287	,000	,768	1,302

a. Dependent Variable: PRICE

Collinearity Diagnostics[a]

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions				
				(Constant)	DATE	ELEVATOR	BALCONY	SUI
1	1	4,615	1,000	,00	,00	,01	,01	,00
	2	,174	5,155	,01	,02	,15	,50	,02
	3	,146	5,628	,00	,01	,77	,39	,00
	4	,058	8,887	,00	,17	,02	,01	,39
	5	,007	25,096	,99	,81	,05	,10	,58

a. Dependent Variable: PRICE

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	41901,43	272453,03	136971,35	61395,277	20
Residual	-23490,285	32988,566	,000	15854,262	20
Std. Predicted Value	-1,548	2,207	,000	1,000	20
Std. Residual	-1,272	1,786	,000	,858	20

a. Dependent Variable: PRICE

1.3. Physycal distance between two points A and B whose coordinates are $A(a_1;b_1)$ and $B(a_2;b_2)$

$$d(A,B)=\left[\arccos(\cos(a_1-a_2)\cos(b_1)\cos(b_2)+\sin(b_1)\sin(b_2)\right]\times 6360$$

1.4. SPSS ouput regression model on 20 observations in the residential real estate market of Bari using location adjustment factor based on universal kriging

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,968[a]	,937	,915	18469,657

a. Predictors: (Constant), LAF, ELEVATOR, DATE, BALCONY, SUI

b. Dependent Variable: PRICE

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7,162E10	5	1,432E10	41,989	,000[a]
	Residual	4,776E9	14	3,411E8		
	Total	7,639E10	19			

a. Predictors: (Constant), LAF, ELEVATOR, DATE, BALCONY, SUI

b. Dependent Variable: PRICE

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	112290,196	43032,118		2,609	,021		
	DATE	-1524,141	313,474	-,380	-4,862	,000	,733	1,365
	ELEVATOR	42204,362	11162,566	,273	3,781	,002	,856	1,169
	BALCONY	1463,551	643,291	,174	2,275	,039	,761	1,314
	SUI	1567,088	249,856	,515	6,272	,000	,663	1,509
	LAF	-51112,559	15739,698	-,240	-3,247	,006	,817	1,223

a. Dependent Variable: PRICE

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	41901,43	272453,03	136971,35	61395,277	20
Residual	-23490,285	32988,566	,000	15854,262	20
Std. Predicted Value	-1,548	2,207	,000	1,000	20
Std. Residual	-1,272	1,786	,000	,858	20

a. Dependent Variable: PRICE

1.5. Excel report on iteration – iterative location adjustment point calculation

Microsoft Excel 11.0 Rapporto valori
Data di creazione: 05/06/2009 20.27.20

Cella obiettivo (Max)

Cella	Nome	Valori originali	Valore finale
$I$41	DATE	0,940471283	0,940471283

Celle variabili

Cella	Nome	Valori originali	Valore finale
$C$4	Parco 2 Giugno LATITUDINE (Degrees)	41,10353295	41,10353295
$D$4	Parco 2 Giugno LONGITUDINE (Degrees)	16,865226	16,865226

Vincoli

Cella	Nome	Valore della cella	Formula	Stato	Tolleranza
$C$4	Parco 2 Giugno LATITUDINE (Degrees)	41,10353295	$C$4>=$C$27	Non vincolante	0,005100945
$D$4	Parco 2 Giugno LONGITUDINE (Degrees)	16,865226	$D$4>=$D$27	Vincolante	0
$C$4	Parco 2 Giugno LATITUDINE (Degrees)	41,10353295	$C$4<=$C$28	Non vincolante	0,002885055
$D$4	Parco 2 Giugno LONGITUDINE (Degrees)	16,865226	$D$4<=$D$28	Non vincolante	0,017664

1.6. SPSS ouput regression model on 20 observations in the residential real estate market of Bari using iterative location adjustment factor

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,970[a]	,940	,919	18029,096

a. Predictors: (Constant), ILAF, BALCONY, DATE, ELEVATOR, SQM

b. Dependent Variable: PRICE

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7,184E10	5	1,437E10	44,205	,000[a]
	Residual	4,551E9	14	3,250E8		
	Total	7,639E10	19			

a. Predictors: (Constant), ILAF, BALCONY, DATE, ELEVATOR, SQM

b. Dependent Variable: PRICE

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	52992,393	37888,108		1,399	,184
	DATE	-1528,468	305,969	-,381	-4,995	,000
	ELEVATOR	36874,737	10823,285	,239	3,407	,004
	BALCONY	1763,112	630,598	,210	2,796	,014
	SQM	1495,121	251,233	,491	5,951	,000
	ILAF	38093,640	11108,496	,255	3,429	,004

a. Dependent Variable: PRICE

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	48254,72	279685,16	136971,35	61491,695	20
Residual	-25440,764	26635,277	,000	15476,088	20
Std. Predicted Value	-1,443	2,321	,000	1,000	20
Std. Residual	-1,411	1,477	,000	,858	20

a. Dependent Variable: PRICE