An Application of Short Tab MCA to Podgorica

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Abstract The work is based on the application of particular version of an Italian approach to Sales Comparison Approach (Simonotti 1997) to define an "hedonic" relationship between property price and characteristics. This version is also known as Short Tab Market Comparison Approach (d'Amato 2015a, b, c). The method was originally proposed to provide a forecast for the price of residential properties to be built on underdeveloped land. In this case will be used to provide an estimation of an appraisal function and relative hedonic prices based on few data. The proposed methodology may be useful to try to create an appraisal "function" in emerging real estate market where few comparables are available. The model will be applied to a small group of comparables in the city of Podgorica in Montenegro.

Keywords Market comparison approach · Appraisal system · Automated valuation methods

1 Introduction

The interest in developing techniques for automated valuation methodologies is increasing because of their wider application in property taxation, insurance and mortgage management. The contribution propose the application of an AVM methodology for an emerging market like Montenegro. The method is based on the

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determination of an appraisal function based on a specific theory of marginal prices (Simonotti 1997). In the application of the method it is possible to determine marginal prices having few data. The idea is the definition of an appraisal function and therefore the valuation is derived by the product between marginal prices and the characteristics of the property to be estimated. The method may be useful in those countries whose data are not (Kauko and d'Amato 2008) precise and well organized. The contribution is organized as follows. In the next paragraph Short Tab Sales Comparison Approach is presented. In the following paragraph an application of this method is proposed to the residential real estate market of Podgorica in Montenegro. Final remarks will be offered at the end.

2   Short Tab Sales Comparison Approach

Short Tab Market Comparison Approach is based on the theory of marginal prices determination (Simonotti 1997; Ciuna 2010, 2011; Ciuna and Simonotti 2014; Ciuna et al. 2014a, b, 2015a, b, 2016). The most important concept of this theory are illustrated in a contribution in this book (Ciuna et al. 2016). Normally this theory is used in Italy to determine a specific Sales Comparison Approach (also defined by the professional document Market Comparison Approach). In this context the appraisal function is built to estimate a property having few and not well organized data. Scarce and not ordered data can be considered a problem recurring mainly in the emerging market but can be also a problem in specific urban context with several specific different market segments (Biłozor and Renigier-Biłozor 2016; Renigier-Biłozor et al. 2014a, b; Renigier-Biłozor and Biłozor 2016a, b). The Short Tab Sales Comparison Approach starts from the definition of hedonic prices. In this case each comparable allow the appraiser to define an appraisal function. Normally, in the first part of the method are determined only the quantitative characteristics of the property. Therefore in a second method the difference between the actual price and the price expressed by quantitative characteristics is related to qualitative variables using simple matrix calculation (Sistema Integrativo di Stima). In this second part the location variable is also defined. The marginal prices determined in the two different parts form the appraisal function.

Therefore in the former phase of the method is calculated a partial equation having only the quantitative variable like square meters or data.

$$\text{Vpfs} = p'_{\text{DAT}} \cdot \text{DAT} + p'_{\text{SUI}} \cdot \text{SUI} + p'_{\text{SUB}} \cdot \text{SUB} \qquad (1)$$

In the Formula 1 the partial appraisal function Vpfs for quantitative variables. The dependent variable is the final result summing up the marginal prices for the quantitative characteristics. The latter phase will consider the remaining difference between the price and the partial appraisal function to determine the marginal prices of the remaining qualitative variables:

$$\begin{bmatrix} P_j - Vpfs_j \\ P_m - Vpfs_m \end{bmatrix} = \begin{bmatrix} 1 & \ldots & \ldots \\ 1 & \ldots & \ldots \\ 1 & \ldots & \ldots \end{bmatrix} \begin{bmatrix} LOC \\ \ldots \\ \ldots \end{bmatrix} \tag{2}$$

A practical example will clarify the concept. The proposed model have been tested on a small sample of property provided by one author of this work. All the data are in a specific area of Podgorica called Zabjelo In Montenegro there are problems to have the exact price in transaction because of tax burden The data obtained have been divided in two different samples the first one is indicated in the Table 1.

In the Table 1 the first column identifies the comparable with a latin letter (A, B, C, D) the second column identifies the date measured in month from the moment of transaction to the moment of valuation. The third column indicates the measure in square meters of the apartments, the fourth column is the square meters of balcony. Finally it is possible to observe both the presence or the absence of a elevator and the presence or the absence of a park. All these are the elements of comparison taken into account to determine the appraisal function. The last two columns indicates both the property price and the are of the city in Podgorica. A further small sample of three properties sold in the same area is reported in the Table 2 below.

Table 1 A first small sample of four real estate transactions in Podgorica

Acronym	Date	SUI	Sub	ELEV	PARK	Price	Area of the city
	Month	Square meters	Square meters	Dummy	Dummy		
A	11	48	3	0	0	€52,000.00	Podgorica, Zabjelo
B	24	60	3	1	1	€65,589.30	Podgorica, Zabjelo
C	36	70	5	1	1	€77,000.00	Podgorica, Zabjelo
D	27	75	6	1	1	€82,332.80	Podgorica, Zabjelo

Table 2 A second small sample of three real estate transactions in Podgorica

Acronym	Date	SUI	SUB	ELEV	PARK	Price	AREA of the city
	Month	Square meters	Square meters	Dummy	Dummy		
E	4	31	0	0	1	€39,000.00	Podgorica Zabjelo
F	6	68	4	1	1	€82,000.00	Podgorica, Zabjelo
G	7	45	7	1	1	€57,000.00	Podgorica, Zabjelo

Table 3 Sales summary grid of short table sales comparison approach

	A	B	C	D
Price	52000	65589,3	77000	82332,8
DAT (Month)	5	18	30	21
SUI (Sq.Meter)	45	60	70	75
SUB (Sq.Meter Balcony)	3	0	5	6
ELEV (Elevator)	0	1	1	0
PARK (Parking)	1	0	0	0

Table 4 Marginal price of internal area

Comparable	Medium price calculated	Lowest medium price	Highest medium price
A	1154.78 €/sqm	1080.48 €/sqm	1154.78 €/sqm
B	1093.15 €/sqm		
C	1084.5 €/sqm		
D	1080.48 €/sqm		

The method proposed will be applied to the fourth properties in order to determine the appraisal function, therefore the calculated appraisal function will be applied to the three properties of the second small sample in the same area (Table 2) in order to calculate the percentage error between the actual prices and the estimated prices. The application of Short Tab Sales Comparison Approach starts with the specific sales summary grid indicated in the Table 3. In the following Table 4 the marginal price of real estate surface is calculated.

It is worth to notice that in this sales summary grid there is not the column of subject. In fact the purpose of the method is not determining the value of a specific property but defining an appraisal function in those context with limited information. In the second phase the calculation of hedonic price will follow the theoretical background of the Italian Market Comparison Approach (Salvo et al. 2013a, b; Salvo and De Ruggiero 2011, 2013). Therefore the marginal price of the date will be calculated as an adjustment percentage per each months:

$$p'(DAT) = -\frac{0.01}{12} = -0.00083 \tag{3}$$

The marginal price of internal area is indicated below (Simonotti 1997). Assuming the other characteristics constant the appraisal function should be equal to:

$$p = \overline{p_{SUI}}SUI + \overline{p_{SUB}}SUB \tag{4}$$

The following ratio (market ratio) is obtained by the market:

$$\pi = \frac{\overline{p_{SUB}}}{\overline{p_{SUI}}} = 0.20 \tag{5}$$

Knowing the marginal prices the relations 4 and 5 becomes.

$$P = p'_{SUI}SUI + p'_{SUB}SUB \Rightarrow \pi = \frac{p'_{SUI}}{p'_{SUB}} \Rightarrow p'_{SUB} = \pi p'_{SUI} \qquad (6)$$

Therefore the part of the appraisal function indicated in the Formula 4 will be rewritten as follows:

$$P = \overline{p_{SUI}}SUI + \overline{p_{SUI}} \cdot \pi \cdot SUB \qquad (7)$$

Therefore it will be possible to write:

$$\bar{p}_{SUI} = \frac{P}{SUI + \cdot \pi \cdot SUB} \qquad (8)$$

It is possible to transform a medium price in a marginal price through the product between the Formula 8 and the following ratio:

$$\sigma = \frac{p'_{SUI}}{p_{SUI}} \qquad (9)$$

In order to calculate the following ratio it is necessary define a criteria for the calculation of marginal price and medium price. In this case we have four properties and the calculation will have the following results showing four different medium prices.

In the Table 4 it is possible to observe the lowest and the highest medium price. In the following graphic 1 it is possible to observe the shape of the mathematical relationship between the square meters and the property price (Di Pasquale and Wheaton 1996).

As a consequence if we imagine the medium price of four comparables there will be a correspondent graphic relationship between price and square meters in the curve b. Therefore there will be four different dots in the curve c representing the correspondent marginal prices (Simonotti 1997; d'Amato 2004, 2010, 2015a, b).

Graphic 1 Price and square meter relation, marginal price and medium price of internal area
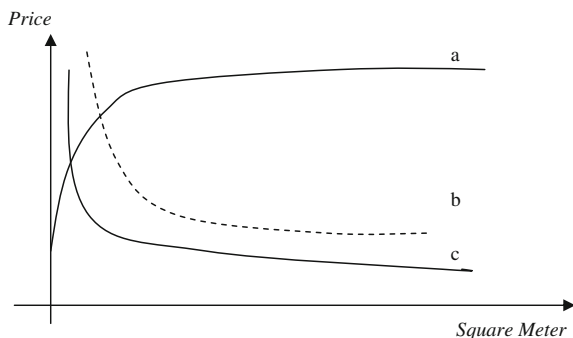
In order to determine the marginal prices it is possible to select the minimum of medium prices because it will be closer to the curve of the marginal prices (curve c) in the specific market segment. On the other hand the maximum of medium prices will be closer to the curve b and will represent the medium price in the market segment. Therefore the ratio indicated in the Formula 9 can be calculated as follows:

$$\sigma = \frac{p'_{SUI}}{p_{SUI}} = \frac{\min(\overline{p_j})}{\max(\overline{p_j})} = \frac{1{,}080.48 \text{€/mq}}{1{,}154.78 \text{€/mq}} = 0.9356 \tag{10}$$

This ratio allow the appraiser to determine the marginal price in fact:

$$p'_{SUI} = \overline{p_{SUI}}\sigma = \cancel{p_{SUI}} \frac{p'_{SUI}}{\cancel{p_{SUI}}} = \frac{P}{SUI + \cdot\pi\cdot SUB}\sigma \tag{11}$$

According to the theory expressed in the Graphic 1 a possible determination of marginal price of square meters will be possible. In the following Table 5 it is possible to observe the product between the product between the medium prices calculated in the second column of Table 4 and the ratio between the third and the fourth column of the Table 4 indicated in the Formula 9:

Therefore the marginal price will be the lower among the different marginal prices calculated for each comparable property. Once the marginal price of the SUI or internal area is calculated the marginal price of SUB balcony will be easily calculated using the Formula 6, therefore:

$$P = p'_{SUI}SUI + p'_{SUB}SUB \Rightarrow \pi = \frac{p'_{SUI}}{p'_{SUB}} \Rightarrow p'_{SUB} = \pi p'_{SUI} = 0.20 \cdot 1010.96\,\text{€}$$
$$= 216.09\,\text{€} \tag{12}$$

Now it is possible to calculate the value using the marginal price of Market Comparison Approach previously calculated. Table 6 indicated the value of the property A:

In a similar way it is possible to calculate the value of comparable B, C and D.

There is a difference between the actual price and the value estimated using the marginal prices of DATA (date) SUI (internal area) SUB (internal area balcony) (d'Amato 2015c; d'Amato and Kauko 2008, 2012; Kauko and d'Amato 2008, 2011). This difference is motivated by the location variable (LOC) and two further elements of comparison the presence or the absence of parking (PARK) and the

Table 5 Marginal price of internal area

Comparables	Marginal prices	Marginal price
A	€1,080.48	€1,010.96
B	€1,022.82	
C	€1,014.73	
D	€1,010.96	

Table 6 Determination of marginal prices for comparable A

Description	Acronym	A	
Price	PRC	€52,000.00	
Month	DAT	−€216.67	−0,000833*5*52,000 €
Sq.Meter	SUI	€45,493.25	45*1,010.96 €
Sq.Meter Balcony	SUB	€648.29	3*216.09 €
		€45,924.87	

presence or the absence of elevator (ELEV). For this reason the difference between the value obtained using the marginal prices and the actual price is considered directly related to the three missing variables. Therefore it is possible to write the following relationship:

$$\begin{bmatrix} PRICE_A - VALUE_A \\ PRICE_B - VALUE_B \\ PRICE_C - VALUE_C \\ PRICE_D - VALUE_D \end{bmatrix} = \begin{bmatrix} 1 & 1 & 0 \\ 1 & 0 & 1 \\ 1 & 0 & 0 \\ 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} p'_{LOC} \\ p'_{PARK} \\ p'_{ELEV} \end{bmatrix} \quad (13)$$

In the mathematical relationship provided by the Formula 13 the difference of each price of the comparables and the presence or the absence of parking (second column) elevator (third column). The first column indicates the location variable always constant in all the comparables. In a similar way it is possible to calculate the value of comparable B, C and D as in the Tables 6, 7, 8 and 9 below:

$$\begin{bmatrix} 52,000\,€ - 45,924.87\,€ \\ 65,589.30\,€ - 59,673.82\,€ \\ 77,000\,€ - 74,789.29\,€ \\ 82,332.80\,€ - 80,891.98\,€ \end{bmatrix} = \begin{bmatrix} 1 & 1 & 0 \\ 1 & 0 & 1 \\ 1 & 0 & 0 \\ 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} p'_{LOC} \\ p'_{PARK} \\ p'_{ELEV} \end{bmatrix} \quad (14)$$

The final result will be obtained as follows:

$$\begin{bmatrix} 1440.82\,€ \\ 4634.30\,€ \\ 2622.26\,€ \end{bmatrix} = \begin{bmatrix} p'_{LOC} \\ p'_{PARE} \\ p'_{ELEV} \end{bmatrix} \quad (15)$$

In the Table 10 it is possible to observe the marginal price determination based on the theory previously indicated. These marginal prices has been tested on three further real transactions observed in Podgorica. This second small sample is composed by the transactions indicated in the Table 11.

In order to test the validity of the marginal prices obtained and exposed in the Table 10 they have been applied to determine the price of the three properties E, F and G in order to calculate the percentage error between the actual price and the

Table 7 Determination of marginal prices for comparable B

Acronym	B	
PRC	€65,589.30	
DAT	−€983.84	−0.000833*18*65,589.30 €
SUI	€60,658	60*1,010.96 €
SUB	0	3*216.09 €
	€59,673.82	

Table 8 Determination of marginal prices for comparable C

Acronym	**C**	
PRC	€77,000,00	
DAT	−€1,925.00	−0.000833*30*77,000.00 €
SUI	€75,633.81	70*1,010.96 €
SUB	€1,080.48	5*216.09 €
	€74,789.29	

Table 9 Determination of marginal prices for comparable D

Acronym	D	
PRC	€82,332.80	
DAT	−€1,440.82	−0.000833*21*82,332.80 €
SUI	€81,036.22	75*1,010.96 €
SUB	€1,296.58	6*216.09 €
	€80,891.98	

Table 10 Determination of valuation function

Variable	Marginal price
DAT	−0.00083*P
SUI	€1,080.48
SUB	€216.10
LOC	€1,440.82
PARK	€4,634.30
ELEV	€2,622.27

estimated price. Therefore we will have for the comparable E the following calculation indicated in the Table 12.

In the Table 12 the first column list the elements of comparisons the second column the product between the marginal prices and the characteristics of the property E. Summing up the product the final value will be 39,570.10 €. The real price is 37,000 € therefore it is possible to calculate the percentage error considering also the DAT adjustment. The appraised value considers also the variable DAT. In fact similar adjustment has been done taking into account the difference between the date of transaction and the date of the valuation therefore (Table 13):

Table 11 Three observations E, F, and G

	E	F	G
PRICE	39000	82000	57000
DAT (Month)	4	6	7
SUI (Sq.Meter)	31	68	45
SUB (Sq.Meter Balcony)	0	4	7
ELEV (Elevator)	0	1	1
PARK (Parking)	1	1	1

Table 12 Opinion of value of property E based on the short tab MCA

Property E		
LOC	€1,440.82	€1,440.82
SUI	€33,497.97	31*1,080.48 €
SUB	€-	0*216.10 €
ELEV	€-	0*2,622.27 €
PARK	€4,634.30	1*4,634.30 €
	€39,570.10	

Table 13 Property E percentage error between actual price and appraised value

Property E percentage error		
Appraised value	€39,702.00	0.0177
Actual price	€39,000.00	

$$P = 39,570.10\,€ \ + \ DAT \cdot 39,570.10\,€$$
$$P = 39,570.10\,€(1+DAT) \tag{16}$$

For the comparable F the following calculation indicated in the Table 14.

In the Table 14 the first column list the elements of comparisons the second column the product between the marginal prices and the characteristics of the property F. Summing up the product the final value will be 80,412.35 €. The real price is 82,000 € therefore it is possible to calculate the percentage error considering also the DAT adjustment. The appraised value considers also the variable DAT. In fact similar adjustment has been done taking into account the difference between the date of transaction and the date of the valuation therefore (Table 15).

$$P = 80,412.35\,€ \ + \ DAT \cdot 80,412.35\,€$$
$$P = 80,412.35\,€(1+DAT) \tag{17}$$

As a consequence it will be possible to write:

Table 14 Property F percentage error between actual price and appraised value

Property F		
LOC	€1,440.82	€1,440.82
SUI	€73,472.84	68*1,080.48 €
SUB	€864.39	4*216.10 €
ELEV	€-	0*2,622.27 €
PARK	€4,634.30	1*4,634.30 €
	€80,412.35	

Table 15 Property F percentage error between actual price and appraised value

Property F percentage error		
Appraised value	€80,814.41	0.0147
Actual price	€82,000.00	

Table 16 Property G percentage error between actual price and appraised value

Property G		
LOC	€1,440.82	€1,440.82
SUI	€48,621.73	45*1,080.48€
SUB	€1,512.68	7*216.10 €
ELEV	€2,622.27	1*2,622.27 €
PARK	€4,634.30	1*4,634.30 €
	€58,831.80	

To test the validity of the marginal prices obtained and exposed in the Table 10 they have been applied to determine the price of the three property G in order to calculate the percentage error between the actual price and the estimated price. Therefore we will have for the comparable G the following calculation indicated in the Table 16.

In the table the first column list the elements of comparisons the second column the product between the marginal prices and the characteristics of the property G. Summing up the product the final value will be 58,831.80 €. The real price is 57,000 € therefore it is possible to calculate the percentage error considering also the DAT adjustment. The appraised value considers also the variable DAT. In fact similar adjustment has been done taking into account the difference between the date of transaction and the date of the valuation therefore:

$$P = 58,831.80 € + DAT \cdot 58,831.80 €$$
$$P = 58,831.80 €(1 + DAT) \tag{18}$$

In all the three cases the percentage error is less than 0.05 therefore the mathematical method proposed seems to be interesting for future analysis and further

Table 17 Property G percentage error between actual price and appraised value

Property G percentage error		
Appraised value	€ 59,174.99	0,0368
Actual price	€ 57,000.00	

studies especially in those cases with real estate market contexts with high variability prices or specific property markets without a significant number of property data (Table 17).

3 Conclusions

The paper tested a valuation methodology to deliver an opinion of value on properties using an appraisal function based on the early studies of Italian literature on marginal prices determination (Simonotti 1997). The use of Short Tab MCA can be useful in those real estate market without a precise information on comparables or real estate data. In these cases it may difficult a direct comparison among properties without an accurate description of data. In context without a precise information the construction of a appraisal function based on the theory of marginal prices exposed previously may replace the traditional methods of Automated Valuation Methodology based on the Sales Comparison Approach and the multiple regression analysis. Short Tab MCA has been applied several times to real cases in Italy and demonstrates a primary use in providing a forecast for the price of the property to be built on underdeveloped land (d'Amato 2015a, b). In this case the application of Sales Comparison Approach appears to be problematic because of the lack of a subject. In this case Short Tab MCA allow the appraiser to use comparable to determine the appraisal function. Once the appraisal function has been calculated each marginal price will be multiplied for the characteristics of the property to be built which may be also generic. Further studies may improve the analysis on a greater sample analysing the difference between the actual prices and the predicted prices.

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