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Reduced data table MCA and Estimate Integrating System. Another case in Bari

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Abstract An approach was recently suggested to improve prediction process of the value of the finished product within contexts featuring low amount of data (D'Amato, 2015a; D'Amato, 2015b). This is a main issue, since it affects the evaluation of developed lands as well as investment properties under construction. The lack of data is one of the difficulties encountered in the evaluation process. The assessor may happen to face lacking data in a market segment even in a transparent market. Unlike exact science observations, real estate information is not repeatable, either in time or space. Therefore, approaches providing value judgments, even with low amount of information, are scientifically and professionally effective. This paper describes the operating application of a procedure called MCA, used to determine the estimating equation through a low number of comparable data (D'Amato, 2015), to a reduced data table for the prediction of the placement value of properties under construction. Starting with the MCA application, the estimating equation is determined by using procedures for the determination of marginal prices (Simonotti, 1997). This application concerns the determination of the estimating equation related to the residential apartment market in Santo Spirito district in Bari.

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INTRODUCTION

One of the main issues occurring in the valuation of developed lands, as well as in the estimation investment property under construction, is the prediction of real estate placement values resulting from a property investment. A similar issue also occurs in other values, such as future value or hope value. Similarly, this same issue occurs in feasibility studies needed for assessment of worth. The problem is usually solved through market surveys featuring an uncertain methodological structure and often resulting in an average price. In other cases, simulation methods are used, which relate the variability of the placement price to the operation result. Whether the placement value of a property can be qualified as an indeterminable event requiring simulations, raises some doubts. This article suggests an approach to determine the future value of constructed properties. The application of the Sales Comparison Approach for this purpose has already been pointed out in literature (Prizzon, 2001). This paper, consistently with a previous work published in this review (D'Amato, 2015a), suggests to adapt MCA to the value estimation of a contingent asset, such as a real estate under construction. This type of assets exists depending on the choice of doing a specific property investment or not (Saltari, 2011).

With reference to the previous article, a methodological improvement is introduced consisting of the Estimate Integrating System, which accounts for inestimable variables and provides a more stable measurement of the localization variable. This paper is structured as follows: the second paragraph provides a comparison between MCA and MCA applied to a reduced data table and a following paragraph describes the application of the approach to the determination of the estimating equation, in order to define the placement price of 15 properties under construction in a condominium building in Santo Spirito district in Bari. Conclusions and future research perspectives close the paper.

REDUCED DATA TABLE MCA AND ESTIMATE INTEGRATING SYSTEM

Market Comparison Approach is a property evaluating procedure included in market approach and aiming at determining the value of a real estate asset. This approach consists in the comparison between an asset under evaluation called subject, having known features and unknown price, and a group of assets having known features and price. For a better understanding of the MCA, the relation shall be taken into account, existing between a property price and its features defined in the following estimating equation:

$$S = L_0 + p_{1,j'}^{'} x_{1,j} + p_{2,j'}^{'} x_{2,j} + \ldots \qquad (1)$$

In equation 1, the term on the first side consists of the subject value; the second side includes the constant localization variable or L_0 (regression constant), followed by all the terms consisting of the product of the marginal price and its feature. Formally, in Market Comparison Approach, the subject value is achieved by performing a term by term subtraction of two linear and additive estimating functions (Simonotti, 2003), as shown in equation 2, as follows:

$$S - P_j = \cancel{L_0} - \cancel{L_0} + p_{1,j'}^{'}(x_{S,1} - x_{J,1}) + \ldots + p_{n,j'}^{'}(x_{S,n} - x_{J,n}) \qquad (2)$$

The localization term can be simplified because both the property assets used in the comparison process are included in the same market segment, making it identical.

In equation 2, **S** is always the asset under estimation, P_j consists of the comparable **j^** of known features and price, and the second side includes the marginal price multiplied by the difference between the subject features and those of the comparable asset considered.

If the comparable item is taken to the other side, the subject value will result, as shown in equation 3 below:

$$S = P_j + p_{1,j'}^{'}(x_{S,1} - x_{J,1}) + ... + p_{n,j'}^{'}(x_{S,n} - x_{J,n}) \quad (3)$$

Equation 3 formally represents the professional evaluating process performed by the assessor who chooses to apply MCA. The reduced data table MCA is introduced in this methodological pattern. This evaluating procedure does not aim at determining the subject value but it rather aims at using the analysis of marginal prices in order to re-construct both the estimating equation and the incidence of the localization variable in the evaluating process, resulting in equation 4, as follows:

$$S = L_0 + p_{1,j'}^{'}x_{1,j} + p_{2,j'}^{'}x_{2,j} + ... \quad (4)$$

The Market Comparison Approach evaluating procedure includes three steps. First, a data table is built, *i.e.* a two way table whose lines include features and columns include comparable items. Secondly, marginal prices of selected variables are analyzed according to the marginal pricing method. Finally, an evaluating table is created, including assessed prices. After they have been adjusted, these prices allow to quantify an adjusted price as equal to the value that any comparable item would have had if it had not been in the same conditions as subject's ones. This process is formally resumed in equation 3 in this paper. Reduced data table MCA determines an estimating equation which can be adapted to a contingent asset. In financial economics (Saltari, 2011) a contingent asset is an asset that can be realized depending on some conditions. A property resulting from a possible development is a contingent asset, because it can exist depending on the fulfillment of the assessment of worth. Formally, the deriving value, or $\mathbf{V_{BT}}$ or development value consists of the following relation:

$$V_{BT} = L_0 + \sum_{j=1}^{n} V_{fjaest} + \sum_{i=1}^{n} V_{finaest} \quad (5)$$

In equation 5, the first term is the value of the finished product, the second term is the localization variable, the third term is the product between the marginal prices and the estimable features described in the first article (D'Amato, 2005). The fourth and last term is the product between the marginal price and the inestimable features. In order to quantify the relation reported in equation 5, a regular data table shall be created, without referring to a subject under estimation. Then, marginal prices are determined, like in a regular MCA. The quantification of partial values from estimating equation **Vfj** is then performed. The difference between partial values from estimating equation **Vfj** and the price, isolates the localization variable as well as other contingent partial values from estimating equation resulting from inestimable variables. Eventually, once all the variables are quantified, an evaluating table is created; in this case a table listing and quantifying all marginal prices with their relevant acronym. In this application, the determination of inestimable variables is added to the reduced table MCA procedure, through the estimate integrating system. This tool will prove its effectiveness not only for detecting the marginal price of inestimable variables. It will also play a strategic role in determining the localization variable. The integrating system of the estimating equation relates the difference between the assessed prices ($\mathbf{P_A}$;$\mathbf{P_B}$;$\mathbf{P_C}$;...) and the partial value from the estimating equation, with reference to estimable variables ($\mathbf{Vfaest_A}$;$\mathbf{Vfaest_B}$;$\mathbf{Vfaest_C}$;...), localization variable and contingent inestimable variables.

AN APPLICATION IN BARI

The Case described is the third application of reduced data table MCA. The first time, it was applied in the market of second houses in the province of Bari (D'Amato, 2015a), the second time its application occurred during an intervention on a condominium building (D'Amato, 2015b) and the current application refers to another condominium building located not far from the second one. This third case involves the prediction of the future value of properties which could be built in a peripheral area of Bari Santo Spirito district. The volume of the land enables the creation of 15 property units. For this purpose, 5 comparable items were detected in the same area of Bari Santo Spirito, included in the same market segment of the properties under construction.
Table 1 below lists the five comparable items

	A	B	C	D	E
PRZ	€ 150,000.00	€ 124,000.00	€ 102,000.00	€ 170,000.00	€ 140,000.00
DAT	15	12	13	14	18
SUP	95	92	95	100	95
SUB	10	5	15	10	10
SUBX	15	13	17	13	13
PROSP	1	1	0	0	0
LUM	1	0	1	1	1

Table 1 Reduced Data Table MCA

In this case, the data table is "reduced" because it does not include the subject, *i.e.* the asset under estimation. It is worth to remember that the object of this approach is the estimating equation and not the determination of the value of a specific asset. Columns include comparable items **A**, **B**, **C**, **D** and **E** and lines include the features that are supposed to affect the price determination process. These features were defined "price sensitive" (Graaskamp, 1977) and were described in the literature by several articles (Ting, 2008). DAT variable refers to months and it is measured in a retrospective way with reference to the evaluation date; SUP variable is the acronym referring to the main surface and is a variable cardinally computed in square meters; SUB variable refers to balcony surface and it is cardinally computed in square meters; SUBX variable is the cardinal measurement in square meters of the relevant covered car box. In this article two other variables are introduced, which are measured with a dicothomic scale and are reported with the acronym PROSP, standing for adjacency, and the acronym LUM, standing for lightness. It is interesting to observe how reduced table MCA enables the determination of the estimating equation in these conditions as well. Selected comparable items are in an area similar to the intervention object and have similar features on a functional design basis, i.e. condominium buildings built in a reinforced concrete autonomous skeleton. Market relationships detected in the market segment, identified in two real estate agencies, can be approximated to:

π balcony	0.3
π box	0.4
s rev	0.01

Table 2 Market Relationships and Revaluation Rate

The marginal price of the main surface is determined through the marginal price method, which is acknowledged both academically (Simonotti, 1997; Simonotti, 2004) and professionally (ABI, 2011; Tecnoborsa, 2013). The marginal price of the main surface results from the ratio between the price and the relevant surfaces, multiplied by their market relationships:

$$p_A'(SUP) = \frac{150{,}000€}{95+10*0.3+15*0.4} = 1{,}442.31€/mq$$

$$p_B'(SUP) = \frac{124{,}000€}{95+5*0.3+13*0.4} = 1{,}256.33€/mq$$

$$p_C'(SUP) = \frac{102{,}000€}{95+15*0.3+17*0.4} = 959.55€/mq$$

(6)

$$p_D'(SUP) = \frac{170{,}000€}{100+10*0.3+13*0.4} = 1{,}571.16€/mq$$

$$p_E'(SUP) = \frac{140{,}000€}{95+10*0.3+13*0.4} = 1{,}356.59€/mq$$

The marginal price is the lowest one amongst the three average prices calculated. The determination occurs in equation 7, as follows:

$$p_{SUP}' = \min(1{,}442.31€/mq;1{,}256.33€/mq;959.55€/mq;1{,}571.16€/mq;1{,}356{,}59€/mq) = 959.55€/mq \quad (7)$$

Once the marginal price of the main surface is calculated, the marginal price of the balcony surface can be easily obtained, as described in equation 8 below:

$$p'(SUP) = 959.55€/mq * 0.3 = 287.86€ \quad (8)$$

And the surface of car boxes can be obtained as described in equation 9, as follows:

$$p'(SUPX) = 959.55€/mq * 0.4 = 382.82€ \quad (9)$$

The date is retrospectively calculated in months and has a negative value if a moderate growth by 0.01 is assumed, as shown in equation 10 below:

$$p^{'}(\mathrm{DAT}) = -\frac{0.01}{12} = -0.00083 \qquad (10)$$

This is a percentage adjustment, which is applied to the comparable price. The next step is the determination of a partial value resulting from the estimating equation for the comparable item **A**. Its marginal prices were previously determined and are indicated by the amounts reported below:

	A	
PRZ	€ 150,000.00	
DAT	-1,875.00 €	15*-0.00083*150,000€ = -1,875.00€
SUP	91,157.10 €	95*959.55€ = 91,157.10€
SUB	2,878.65 €	10*287.86€ = 2.878.65€
SUBX	5,757.29 €	15*383.82€ = 5,757.29€
PROSP	1	-
LUM	1	

Table 3 Determination of **VfA**

Table 3 highlights the determination of partial value resulting from the estimating equation or **VfA** of the comparable item **A**. It is worth to point out that it is partial because it only takes into account estimable variables. The same table reports two variables PROSP and LUM, introduced above, *i.e.* Adjacency and Lightness, which will be quantified later. For the moment, the sum of all the adjustments amounts to 97,918.04 €. The difference between the assessed price and the partial value resulting from the estimating equation of comparable item **A** or **VfA** is equal to the amount reported in equation 11, as follows:

$$P_A - VfA_{aestim} = 150{,}000€ - 97{,}918.04€ = 52{,}081.96€ \qquad (11)$$

Intuitively, three variables play a main role in this difference: the localization variable, the Adjacency variable and the Lightness variable. A similar logic occurs for comparable item **B**, *i.e.*:

	B	
PRZ	€ 124,000.00	
DAT	-€ 1,240.00	12*-0.00083*124000 = -1,240€
SUP	€ 88,278.46	92*959.55 = 88,278.46€
SUB	€ 1,439.32	5*287.86€ = 1,439.32€
SUBX	€ 4,989.65	13*383.82€ = 4,989.65€
PROSP	1	-
LUM	0	

Table 4 Determination **VfB**

Table 4 highlights the determination of partial value resulting from the estimating equation or **VfB** of comparable item **B**. This is a partial value because it only takes into account estimable variables. The same table reports two variables PROSP and LUM, introduced above, *i.e.* Adjacency and Lightness, which will be quantified later. For the moment, the sum of all the adjustments amounts to 93,467.43 €. The difference between the assessed price and the partial value resulting from the estimating equation of comparable item **B** or **VfB** is equal to the amount reported in equation 12, as follows:

$$P_B - VfB_{aestim} = 124{,}000€ - 93{,}467.43€ = 30{,}532.57 \tag{12}$$

As in the previous case, three variables play a main role in the difference: the localization variable, the Adjacency variable and the Lightness variable. A similar logic occurs for comparable item **C**, *i.e.*:

	C	
PRZ	€ 102,000.00	
DAT	-€ 1,105.00000	13*-0.00083*102000 = -1,105.00€
SUP	€ 91,157.10254	95*959.55€ = 91,157.10€
SUB	€ 4,317.96802	15*287.86€ = 4,317.96€
SUBX	€ 6,524.92944	17*383.82€ = 6,524.92€
PROSP	0	-
LUM	1	

Table 5 Determination **VfC**

Table 5 highlights the determination of partial value resulting from the estimating equation or VfC of comparable item **C**. This is a partial value because it only takes into account estimable variables. Table 5 reports two variables PROSP and LUM, highlighted in grey, *i.e.* Adjacency and Lightness, which will be quantified later. For the moment, the sum of all the adjustments amounts to 100,895.00 €.

The difference between the assessed price and the partial value resulting from the estimating equation of comparable item **C** or **VfC** is equal to the amount reported in equation 13, as follows:

$$P_C - VfC_{aestim} = 102{,}000€ - 100{,}895.00€ = 1{,}105.00€ \quad (13)$$

As for comparable items **A** and **B**, three variables play a main role in the difference: the localization variable, the Adjacency variable and the Lightness variable. A similar logic occurs for comparable item **D**, *i.e.*:

	D	
PRZ	€ 170,000.00	
DAT	-€ 1,983.33333	14*-0.00083*170000 = -1,983.33€
SUP	€ 95,954.84478	100*959.55€ = 95954.84€
SUB	€ 2,878.64534	10*287.86€ = 2.878.64€
SUBX	€ 4,989.65193	13*383.82€ = 4,989.65€
PROSP	0	-
LUM	1	

Table 6 Determination **VfD**

Table 6 highlights the quantification of partial value resulting from the estimating equation or **VfD** of comparable item **D**. This is a partial value because it only takes into account estimable variables. Table 6 reports two variables PROSP and LUM, highlighted in grey, *i.e.* Adjacency and Lightness, which will be quantified later. For the moment, the sum of all the adjustments amounts to 101,839.81 €. The difference between the assessed price and the partial value resulting from the estimating equation of comparable item **D** or **VfD** is equal to the amount reported in equation 14, as follows:

$$P_D - VfD_{aestim} = 170{,}000€ - 101{,}839.81€ = 68{,}160.19€ \quad (14)$$

As for comparable items **A**, **B** and **C**, three variables play a main role in the difference: the localization variable, the Adjacency variable and the Lightness variable. A similar logic occurs for the last comparable item **E**, *i.e.*:

	E	
PRZ	€ 140,000.00	
DAT	-€ 2,100.00000	18*-0.00083*140000 = -2,100€
SUP	€ 91,157.10254	95*959.55€ = 91,157.10€
SUB	€ 2,878.64534	10*287.86€ = 2.878.64€
SUBX	€ 4,989.65193	13*383.82€ = 4,989.65€
PROSP	0	-
LUM	1	

Table 7 Determination **VfE**

Table 7 highlights the quantification of partial value resulting from the estimating equation or **VfE** of comparable item **E**. This is a partial value because it only takes into account estimable variables. Table 7 reports two variables PROSP and LUM, highlighted in grey, *i.e.* Adjacency and Lightness, which will be quantified later. For the moment, the sum of all the adjustments amounts to 96,925.40 €. The difference between the assessed price and the partial value resulting from the estimating equation of comparable item **E** or **VfE** is equal to the amount reported in equation 15, as follows:

$$P_E - VfE_{aestim} = 140{,}000€ - 96{,}925.40€ = 43{,}074.60€ \quad (15)$$

Since the first application (D'Amato, 2015a) a percentage divergence threshold was introduced in order to avoid partial values resulting from strongly divergent estimating equations. First experiments of this approach suggest a 0.1 threshold. The percentage divergence formula is reported below:

$$d_{MTR} = \frac{\max(VfA; VfB; VfC; VfD; VfE) - \min(VfA; VfB; VfC; VfD; VfE)}{\min(VfA; VfB; VfC; VfD; VfE)} \leq 0{,}1 \quad (16)$$

In this specific case the threshold is proven valid. Indeed, the five observations have a value of partial estimating equation with a divergence equal to 0.0895, which is lower than the threshold suggested in the first work published in this review. Then, in order to quantify the two inestimable variables, the reduced table MCA shall be integrated into the estimate integrating system. In the estimate integrating system, the differences identified between partial values of the estimating equation **A**, **B**, **C**, **D** and **E** and reported in formulas 11, 12, 13, 14, 15, shall be related to the three variables: localization (LOC), adjacency (PROSP) and lightness (LUM) with the following matrix product:

$$\begin{bmatrix} P_A - VfA_{aestim} \\ P_B - VfB_{aestim} \\ P_C - VfC_{aestim} \\ P_D - VfD_{aestim} \\ P_E - VfE_{aestim} \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 0 \\ 1 & 0 & 1 \\ 1 & 0 & 1 \\ 1 & 0 & 1 \end{bmatrix} \begin{bmatrix} LOC \\ PROSP \\ LUM \end{bmatrix} \quad (17)$$

Which is solved in the product 18, as follows:

$$\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 0 \\ 1 & 0 & 1 \\ 1 & 0 & 1 \\ 1 & 0 & 1 \end{bmatrix}^{-1} \begin{bmatrix} P_A - VfA_{aestim} \\ P_B - VfB_{aestim} \\ P_C - VfC_{aestim} \\ P_D - VfD_{aestim} \\ P_E - VfE_{aestim} \end{bmatrix} = \begin{bmatrix} LOC \\ PROSP \\ LUM \end{bmatrix} \quad (18)$$

Using Ordinary Least Squares (OLS) criteria, the following solutions result:

€	15,897.20	Localization Variable
€	14,635.36	Adjacency Variable
€	21,549.39	Lightness Variable

Table 8 Quantification of Localization, Adjacency and Lightness variables through the estimate integrating system

The solution of the integrating system determines the completion of the process of quantification for marginal prices, which constitute the estimating equation, defined by the approach valuating table, as follows:

ACRONYM	VARIABLE	AMOUNT
LOC	LOCALIZATION VARIABLE	€ 15,897.20
PROSP	ADJACENCY	€ 14,635.36
LUM	LIGHTNESS	€ 21,549.39
SUP	MAIN SURFACE	€ 959.55
SUB	BALCONY SURFACE	€ 287.86
SUBX	CAR BOX SURFACE	€ 383.82
DAT	DATE	-0.00083*P

Table 9 Evaluating Table for Reduced Data Table MCA

The variables highlighted in grey were determined with the estimate integrating system, whereas the other non-highlighted variables were determined through the marginal price method, on which any Market Comparison Approach is founded. The DATE (DAT) is a percentage adjustment on the placement value appearing both in the first and second side. The problem can be easily solved with a little math step completing the final determination. Indeed, basing on the data table, if it is possible to write the equation 19, which represents the determination of the estimating equation including the marginal price of the localization variable, the marginal price of estimable variables and the marginal price of inestimable variables,

$$V_{fs}=15{,}897.20€+14{,}635.36€\cdot PROSP+21{,}549.39\cdot LUM-0.00083\cdot v_{fs}\cdot DAT+959.55€\cdot SUP+287.86\cdot SUB+383.82€\cdot SUBX \quad (19)$$

then, the above mentioned value of the estimating equation can be approximated to equation 20, as follows:

$$V_{fs}=\frac{15{,}897.20€ + 14{,}635.36€\cdot PROSP + 21{,}549.39\cdot LUM + 959.55€\cdot SUP + 287.86\cdot SUB + 383.82€\cdot SUBX}{(1 + 0.00083)\cdot DAT} \quad (20)$$

This operation allows to determine the value of the fifteen buildings under construction reported in Table 10 below, keeping into account the localization variable and other quality variables such as Adjacency and Lightness, which are specific for the buildings under placement. Since it is placed in the future, the given variable describes the duration of placement time.

	LOC	SUP	SUB	SUBX	PROSP	LUM	DAT	VALUE
1	1	90	9	10	1	1	6	€ 145,595.36
2	1	92	8	10	1	0	6	€ 125,577.51
3	1	90	10	12	1	0	6	€ 124,998.90
4	1	95	10	10	1	0	12	€ 129,698.30
5	1	102	8	12	0	0	6	€ 121,283.89
6	1	102	8	10	0	1	6	€ 142,169.65
7	1	90	10	15	0	1	12	€ 133,774.29
8	1	95	8	12	0	1	12	€ 136,875.73
9	1	97	8	12	1	1	15	€ 153,984.01
10	1	102	9	12	1	0	15	€ 137,312.67
11	1	98	7	5	1	0	13	€ 129,904.13
12	1	105	5	8	0	0	12	€ 122,378.56
13	1	104	6	10	0	0	14	€ 122,681.18
14	1	110	7	9	1	1	14	€ 165,019.24
15	1	109	12	10	0	1	10	€ 150,579.76

Table 10 Application of marginal prices to the features of properties whose placement value shall be estimated

It is shown that the calculation includes any single variable and, unlike it usually happens in professional practice, no wide exemplifications exist that provide almost identical values to the square meters produced. There is not any parade of average prices “resulting from market surveys”, usually related to inconsistent information gathered from real estate agents or catalogs which are mutually contradictory. There is not the math exercise of simulation of a reality which only requires interpretation and modelling. It seems fruitless and inadequate to apply to the real estate sector the simulating procedures usually applied for investments in other sectors, which lack the specific features of the property asset. Each property has its expected value, depending on its specific features. It is like going through the definition process of a regression equation. And it is so. Indeed, the connection between Sales Comparison Approach and econometric modelling was highlighted long ago (Cannady, 1989).

CONCLUSIONS

The third application of the reduced data table MCA is proposed, together with the use of an “estimate integrating system”, in order to determinate not only quantitative variables but also the role and impact of inestimable variables. As in the second application, the estimate integrating system solves the issue of the determination of the localization variable, which is not calculated by using the arithmetical average of differences between partial estimating equation values and the assessed price. The application confirms good potential applications, even if further research is required for the exploration of the divergence threshold amongst all values resulting from the estimating equation **Vfj**, which is currently equal to 0.1. In order to be confirmed, this threshold shall be experimented on a wider range of cases. A further interesting comparison might occur between the determination of the localization variable through the reduced data table MCA and that resulting from a multiple regression model. Such a comparison would determine an indirect falsification of the proposed model. The estimating equation allows to normalize data and apply to this procedure statistical tests which are usually applied for multiple regression. In this case, the limits shall be studied, within which traditional estimating tests can be adjusted to reduced samples, which are typical of some estimating applications. A further interesting perspective is the segmentation of the estimating equation basing on different properties built within the same property investment. It is possible that if building units which belong to more than one real estate segment are built in a construction site, the problem of identifying more than one estimating equation for a better interpretation of the market would arise. A possible further application might lead to observe whether also derived MCA, used by the Revenue Agency in their evaluations, might be used in the same way. In the next paper, variability thresholds will be applied to proposed values in order to investigate the variability of the final suggested result.

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