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The Determination of Capitalization Rate by the Remote Segments Approach: The Case of an Agricultural Land Appraisal

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Abstract: In the absence of comparative real estate data in the market segment of the property to be estimated, the appraiser may resort to income capitalization to estimate the market value. Often, however, the choice of which rate to apply is affected by subjective and arbitrary assessments. The estimation result can therefore be inaccurate and rather unclear. However, the Remote Segments Approach (RSA), through appropriate adjustments on the original values, prices, and incomes detected in the remote segments, makes it possible to arrive at an appraisal result consistent with estimative logic and real estate valuation standards. The proposed application illustrates the estimation of the market value of a specialized fruit orchard of avocado, which is to be considered new in relation to other fruit species already present in the reference area. The adjustments required by the RSA are solved with the General Appraisal System (GAS), defining the difference matrix based on relevant characters common to all segments considered. The application is carried out by comparing the segment in which the orchard being estimated falls (subject) with other remote market segments in which prices and incomes constituted by other tree crops are collected. The market value of the subject is derived by making adjustments to the prices and incomes observed in the remote segments of comparison with a comparison function constructed through relevant characters common to the segments considered. The comparison function makes it possible to arrive at the determination of the capitalization rate to be used in estimating the value of the fruit orchard by income approach. While it is based on the comparison of segments, the approach followed allows for a value judgment consistent with the estimation comparison and capable of providing a solution less conditioned by the appraiser's expertise in the presence of particularly pronounced limiting conditions.

Keywords: market value; fruit orchard; remote segments approach; general appraisal system; income approach

JEL Classification: D49; D89; E43; Q12; Q15; R39

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1. Introduction

In the market for real estate assets, in the estimation of agricultural land, often the limited availability of comparison data does not allow the application of estimation methods based on market comparison. It is therefore common to employ the estimation by income capitalization [1,2]. However, the use of this approach may present some disadvantages when the estimation involves lands devoted to crops that are not yet widespread in the survey area.

The disadvantages relate to the nature and complexity of the operations required to identify the capitalization rate, especially when the appraiser relies on arbitrary judgments (expertise) with negative consequences in terms of the replicability, transparency, and reliability of the estimated rate [3–5].

The absence of comparison data, in addition to justifying a procedure that does not meet valuation standards, also prevents appropriate checks on the validity of the choices made by the appraiser [6,7].

Even in the absence of purchases and sales of similar assets in the reference market, however, it is possible to objectively derive the capitalization rate using remote research by applying the Remote Segments Approach (RSA) [4]. This approach requires that, in order to determine the value of the capitalization rate, adjustments are made in the prices and incomes observed in the comparison segments ("remote segments").

The following is an application carried out with reference to the estimation of the market value of agricultural land intended for the cultivation of a specialized fruit orchard. The estimation is carried out in the presence of two restrictive conditions: the cultivation is to be considered new in relation to other fruit orchards already present in the reference area, and therefore in the absence of similar comparison fruit orchards, and the use of income capitalization is required to determine the value.

The application is carried out by comparing the segment in which the arboretum to be estimated (subject) is located with other remote market segments, consisting of other tree crops, in which prices and incomes are observed. The market value of the subject land is derived by adjusting the prices found in the remote segments of comparison with a comparison function constructed through relevant characters common to the segments considered. The required adjustments are solved with the General Appraisal System (GAS) [8], defining the difference matrix based on relevant characters common to all segments considered.

The adaptation and combination of the RSA and the GAS leads to the determination of the capitalization rate. The estimation methods used are recognised by the valuation standard [5,9]. The result can be considered acceptable with respect to the given extreme conditions and, in any case, conforms to the requirements of clarity and verifiability called for by the valuation standards [5,10,11].

In addition to being obtained by means of adjustments on the natural quantities expressed by the market (incomes and prices), the obtained rate is not conditioned by subjective value attributions made by the appraiser. The limits of the elaboration of an appraisal opinion characterised by an explicit prevalence of elements of a subjective nature ascribable to the appraiser's expertise may, in fact, also manifest themselves in the choice of the capitalisation rate [5,10–12].

The procedure described also makes it possible, with reference to the estimation of agricultural land, to avoid the choice of the capitalisation rate being made subjectively or by resorting to comparisons with investments of another nature, such as those of credit bonds [3,12]. Even in the application of the income approach procedures to the agricultural sector, the need to resort to objective reference elements cannot be overlooked. Explicit evidence must be provided in the formulation of the estimative judgement in line with the basic principles of estimative theory and the best practices recalled by valuation standards [5,9].

The paper is structured as follows. First, the RSA approach, originally proposed for remote research of capitalization essay in order to contain possible bias attributable to abuse of expertise, and the GAS are explained. Next, it is shown how to estimate the value of a fruit orchard with adjustments in prices and incomes using the GAS. Since it is possible to consider the collected income as continuous, the capitalization essay is identified and the estimation by income capitalization is applied. Some concluding remarks close the article.

2. The Remote Segments Approach

Where comparable data are missing from the same market segment as the asset to be valued, in order to apply the income approach, it is necessary to collect data (income and prices) in one or more different market segments.

In the absence of prices or incomes, the principle of comparison admits that surveying takes place in market segments other than that of the asset being appraised, as the comparison assets can be surveyed in the same market segment as the asset being appraised or in a different market segment [4,5]. The market segment is the non-further separable elementary unit of the economic-estimative analysis of the real estate market. For the pur-

pose of estimative analysis, in the agricultural sector, a market segment can be defined with respect to some main characters, among which are location; type of contract; destination; property type; size; type and species cultivated; age if there is a fruit arboretum; price level; and number of exchanges [3,5].

The RSA makes a comparison between different segments and determines the price/income ratio in the segment to which the subject belongs by making some adjustments to the data collected in the comparison segments.

Since the capitalisation rate is not a natural quantity expressed by the market but a quantity derived from the ratio between income and the market price of a property, the market segments considered must be close to and comparable with the segment of the property to be valued [5,12]. Although the search may extend to also include investments competing with that of the segment to which the subject belongs, according to estimative logic, preference should be given to segments close to that of the property being valued [13]. In this regard, international valuation standards also indicate the need for relevant comparison data collected in the market and relating to competitive and comparable properties [5,10].

Data collection in close market segments constitutes "remote capitalisation rate research", which considers character differences for the purpose of finding the capitalisation rate of the property to be valued [3,12,14]. This approach is also present in the Italian Valuation Code [5], and it is also recognised by [9].

RSA avoids resorting to solutions based on the reliance on estimative metadata or on the personal and subjective judgements of the appraiser regarding adjustments on estimative values in order to derive the capitalisation rate [15,16].

The logic of searching for the real estate data of estimative interest on segments other than that of the property to be estimated is applied to construct a comparison function between market segments through the relevant common characteristics and data (prices and incomes) found in each of the segments being compared.

The comparison between the market segments surveyed and that of the property to be valued is carried out according to the general rules of market-oriented procedures and is based on the corresponding characteristics of the segments considered [17]. Since the market segments are different from that of the asset to be valued, the market rents and prices surveyed in each of them require one or more adjustments [3,4].

Market prices and incomes detected in one or more market segments are subjected to systematic adjustments by reference to the marginal values of prices and incomes in the characters of the segments. These adjustments can be expressed in percentage and value terms. Finally, the relationship between these quantities makes it possible to inductively derive the capitalization rate, which can also be expressed in terms of the gross rent multiplier (GRM).

Adjustments are referred to as income and unit price (e.g., EUR/ha) and are taken with a positive or negative sign regarding their effect on income and price.

The adjustments with respect to unit income and unit price are therefore estimated by comparing the market segment surveyed with the market segment of the property to be valued and not by means of the valuer's expertise.

Therefore, the determination of the capitalization rate is performed through the inductive method, following the logic of remote search for the rate and making comparisons with market segments for which prices and incomes are available [4]. The capitalization rate is expressed as a quantity derived from the ratio of income to price found in the respective market segments being compared.

The adjustments follow the logic of comparing the characters deemed relevant by the appraiser and for which differences arise between the subject and remote segments [3,4,14].

Considering two segments (H) and (K), the RSA provides that the marginal price $\Delta_H^{par\ j}$ of the generic character j, expressed in percentage, and the marginal income $\delta_H^{par\ j}$ of the

general character j, also expressed in percentage, can be derived, respectively, from the following equations:

$$\Delta_H^{par\ k} = \frac{P_K^{par\ j} - P_H^{par\ j}}{P_H^{par\ j}} \quad (1)$$

$$\delta_H^{par\ j} = \frac{R_K^{par\ j} - R_H^{par\ j}}{R_H^{par\ j}} \quad (2)$$

With reference to different characteristics (e.g., location, destination, real estate typology, dimension, etc.), the adjusted price and income for all characteristics of the segment of the asset under assessment can therefore be determined by the following equations, which identify the prices [P_K (H)] and revenues [R_B (H)], which the asset belonging to comparable segment (H) would have if they fell into segment (K). See Equations (3) and (4):

$$P_K(H) = P_H\left(1 + \Delta_H^{location} + \Delta_H^{destination} + \Delta_H^{tipology} + \Delta_H^{dimension} + \ldots\right) \quad (3)$$

$$R_K(H) = R_H\left(1 + \Delta_H^{location} + \Delta_H^{destination} + \Delta_H^{tipology} + \Delta_H^{dimension} + \ldots\right) \quad (4)$$

The capitalization rate can be obtained by the inverse of the price–income ratio ρ_K (H):

$$\rho_K(H) = \frac{P_K(H)}{R_K(H)} \quad (5)$$

where P_K (H) and R_K (H) are the adjusted average unit prices and rent.

With reference to a number j of characters for two or more comparable segments (e.g., A and C, and up to the generic segment $X_{i\text{-}th}$), Equation (6) can be written as follows:

$$P_B(A) = P_A\left(1 + \sum_j \Delta_A^{parj}\right) \quad (6)$$

$$P_B(C) = P_C\left(1 + \sum_j \Delta_C^{parj}\right) \quad (7)$$

$$P_B(X_i) = \left(1 + \sum_j \Delta_{Xi}^{parj}\right) \quad (8)$$

And the Equation (6) can be written as follows:

$$R_B(A) = R_A\left(1 + \sum_j \delta_A^{parj}\right) \quad (9)$$

$$R_B(C) = R_C\left(1 + \sum_j \delta_C^{parj}\right) \quad (10)$$

$$R_B(X_i) = \left(1 + \sum_j \Delta_{Xi}^{parj}\right) \quad (11)$$

where the symbols used assume the meanings corresponding to those indicated in the previous Equations (1) and (2).

Considering only prices, the equation summarizing their adjustments is:

$$P_K = P_H \pm \sum_{i=1}^{n} \delta(H_i - K_i) \quad (12)$$

where P_K indicates the price that the property belonging to the remote comparable segment (H) would have if it fell into the same segment (K) as the property being estimated, and δ indicates the marginal value of the adjustments in the n characters in common between segments H and K in relation to the differences found.

Considering only incomes, the equation summarizing their adjustments, on the other hand, is as follows:

$$R_K = R_K \pm \sum_{i=1}^{n} \delta(H_i - K_i) \quad (13)$$

where R_K denotes the income that the property belonging to the remote comparable segment (H) would have if it fell into the same segment (K) as the property being estimated, and δ denotes the marginal value of the adjustments in the n characters in common between segments H and K in relation to the differences found.

Given n comparison segments $A, C, \ldots N$, the assessment ratio is identified through the expected value by this equation:

$$\rho_B(A) = \frac{P_B(A) + P_B(C) + \ldots + P_B(N)}{R_B(A) + R_B(C) + \ldots + R_B(N)} \quad (14)$$

The result achieved is the value that the prices and incomes of properties falling in a comparable segment would have if they belonged to the segment in which the property being estimated falls [4].

Adjustments of the characteristics of comparable market segments are therefore decisive and should preferably take place in an objective manner. In the case presented, the logic of searching for the property data of estimative interest on segments other than that of the property to be estimated is applied to construct a comparison function between remote market segments by means of the relevant common characteristics and data (prices and incomes) recorded in each of the segments being compared. The comparison performed conforms to the estimation method and is conducted in compliance with the principle of relevance through the use of the GAS [8]. To the best of our knowledge, this is the first application of an appraisal in the agricultural sector of RSA and GAS to determine the capitalisation rate.

3. The Comparison between Segments with the General Appraisal System

The above adjustments can be easily made, automatically and without subjective and indemonstrable attributions, through the application of the GAS [8,18,19]. This approach is commonly used to estimate the market value of a property in the presence of a small estimation sample and more than one relevant character.

In several estimation manuals, GAS is reported in the section devoted to market-oriented estimation procedures [14,20,21]. It is also described in the Italian real estate valuation guides that incorporate the International Valuation Standards [5] and in the Italian guidelines for the properties' valuations in a guarantee of credit exposures [9]. GAS is also in the manual for property valuations of the Agenzia del Territorio [22] for cadastral applications. The identification of little comparable data and the simplicity of the algorithm also make GAS suitable for the implementation of automatic valuations [5].

Numerous applications of this approach have involved the estimation of real estate, mainly urban real estate [19,23–26]. Only one application involved estimating the value of agricultural land [27].

According to the estimative "relevance principle", the price difference between two or more similar goods is generated by the different intensity with which the intensities of the relevant characteristics are manifested. The estimative comparison for finding the value of the asset can be represented by a system of linear equations which consists of m useful, nonredundant comparisons, taking the following configuration [8]:

$$\begin{array}{l} \mathrm{p}_1 = \mathrm{S} + \sum_{i=1}^{n} (a_{1i} - a_{0i})\, s_i \\ \mathrm{p}_2 = \mathrm{S} + \sum_{i=1}^{n} (a_{2i} - a_{0i})\, s_i \\ \mathrm{p}_m = \mathrm{S} + \sum_{i=1}^{n} (a_{mi} - a_{0i})\, s_i \end{array} \quad (15)$$

where S is the subject's value and s_i is the unit value related to the differences in the modes of the characters [8].

GAS is also referred to as the Appraisal System Model (ASM) and the Appraisal Division System (ADS) [23], and it is based on a system of nonhomogeneous linear equations formalized in symbols as follows [3,4,23,24]:

$$\bar{s}_h = D_h^{-1} \bar{p}_h \quad (16)$$

where:

$\bar{s}_h$ is the vector of unknown variables, in which the first element represents the value of the asset being estimated and the subsequent elements indicate the marginal value of the individual relevant characteristics; D_h^{-1} is the inverse matrix of the matrix of differences in the coefficients of the relevant characteristics; $\bar{p}_h$ is the vector of known terms represented by the prices of comparable goods existing in the same market as the subject [8].

The system, consisting of m linear equations in $n + 1$ unknown variables, can take on different configurations under different operating circumstances, the solution of which, when possible, is obtained by specific matrix calculations [8,23].

The SGS, designed and developed for systematic comparisons between comparables in the same market segment, can thus be adapted to solve systematic comparisons between one or more market segments that share the same relevant characteristics with the segment in which the subject is located. In the comparison function, we consider the intensities measured in the n characters in common of the m segments comparable to the one to which the asset being estimated belongs. The solution vector ($\bar{s}_h$) of the system of equations includes the market value of the subject and the marginal value of the relevant characters common to all segments considered when the comparison is developed considering the prices. When the comparison is developed with respect to the incomes, the solution vector ($\bar{s}_h$) of the system of equations includes the income value of the subject and the marginal value of the relevant characters common to all segments considered. In this case, the rent value can be considered as the income value.

In the proposed application, which, as far as we know, is the first in the field of agricultural land valuation with the RSA, the GAS is used because it automatically allows for the necessary adjustments in the differences in characteristics between the comparison segments, limiting the distorting effects of changes made subjectively by the appraiser. In addition, being indicated in the reference best practices [5,9] allows for greater reliability in terms of transparency and replicability provided by international standards [10,11]. It therefore reduces the risks of bias generated by the valuer's expertise [28].

4. Materials and Methods

The land to be estimated is for the cultivation of a specialized orchard of avocado (cv. Hass), extending about one hectare, with even-aged plants (9 years old) and a planting size of 6m x 8m. The orchard is cultivated with organic production techniques and is located in Sicily, in the territory of the "Piana di Mascali", a plain of alluvial origin located on the eastern part of the island between the Ionian coast and the slopes of the volcano Etna, at a distance of about 4 km from the local wholesale market of agricultural products (Figure 1). In this area, defined using the Corine Land Cover dataset [29], in the past, lemon groves prevailed over the cultivation of other fruit trees such as peach and cherry orchards. For a number of years, there has been a tendency to increase areas planted to other fruit trees, such as pomegranate, and, more recently, some tropical crops.

Avocado cultivation in this territory registers some interest as a possible alternative to traditional lemon cultivation. From the conduct of the market survey, there were no comparable data (prices and incomes) of similar orchards located in the same growing area, so the orchard to be estimated is to be considered devoid of similar orchards of the same species grown in the subject area. The market analysis was therefore extended by considering other fruit orchards grown in the area where the avocado crop is located and which represent possible comparison segments. As shown in Figure 1, in order to identify comparable segments, only orchards in the area surrounding the crop to be estimated were considered. According to the pan-European Corine Land Cover inventory [29], to delimit

this area, the territory within an area extending approximately 4 to 5 km from the avocado crop to be estimated was considered in order to refer to uniform cultivation conditions.

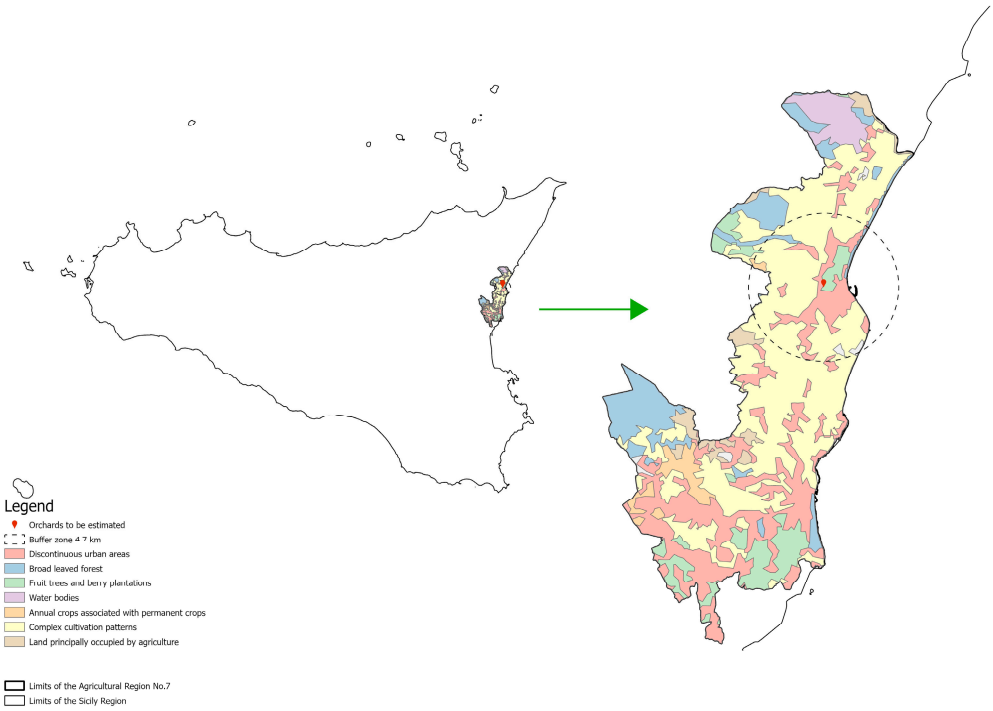

Figure 1. Identification of the territorial area where the avocado fruit orchard is located.

In this area, extended about 50 km^2, the following were found to be present: land occupied by urban areas (approx. 1.203 ha); agricultural land with complex cultivation patterns (approx. 3.505 ha) consisting of a heterogeneous mosaic of parcels with scattered plants and family crops; specialised orchards (approx. 0.253 ha) to an equivalent extent, as verified by field surveys, of lemon, cherry, pomegranate, and peach groves; and broad level forest (approx. 0.50 ha).

In this regard, it was possible to identify data useful for estimation purposes (characters and their intensities) with respect to the lemon, cherry, pomegranate, and peach fruit orchards that constitute the comparison set. Each of these orchards, being a crop with different characteristics, constitutes, in fact, a useful comparison segment for applying the RSA approach.

Unlike for urban real estate, for agricultural land appraisal, there is no uniform and standardised set of real estate characteristics to use for estimative comparison [27,30]. Generally, a reference is made to surface area; location in the territory with respect to structures or infrastructure; location, with respect to altitude and slope; type, with respect to soil fertility and irrigation water endowment; and economic, with respect to conditions or limitations of the property (e.g., whether it is rented, whether there are rights such as easements, etc.). For each quantitative or qualitative characteristic, an appropriate nomenclator and corresponding measure is identified [27,31].

In the application illustrated, the characteristics indicated (Table 1) were recorded, taking into consideration, for estimative comparison, those relevant for the determination of value and for which differences were noted.

In the comparison set, the segments that recorded differences in the relevant characteristics were taken into consideration as comparable. Through the market survey, the following three relevant characters were identified: location, measured in km distance from the wholesale fruit and vegetable market in the area; the cultivation regime adopted (distinguished as conventional or organic); and the age of the plantation (measured in years). For each of the comparison crops considered, the corresponding intensities of the

relevant characters were acquired. Data were collected for 20 orchards in addition to the one planted with avocados (n = 0) (Table 2). Having the comparison data available for four comparable segments with respect to three characteristics, the applicability conditions of GAS (*m* linear equations in $n + 1$ variables) were met.

Table 1. Relevant characteristics of the value of fruit orchards in the area.

Relevant Characteristics	Measure
Localization	km from local wholesale market
Dimension	Ha
Accessibility	Good; Sufficient; Scarce
Lying	Flat; Medium; Incline
Exposure	Good; Normal; Lacking
Shape	Regular; Irregular
Fertility	Very good; Good; Fair
Bioeconomic cycle stage	Years
Irrigation supply	Adequate; Inadequate
Farming regime	Conventional farming; Organic farming

Table 2. Relevant data in market segments.

Market Segments	Fruit Orchards	Surface Areas	Location	Farming Regime	Age
	Id.	(ha)	(km)	Conventional/Organic	(Years)
Avocado	0	0.94	3.8	Organic	9
Lemon	1	7.30	3.5	Organic	19
	2	10.90	4.8	Organic	16
	3	9.50	7.5	Organic	12
	4	2.30	9.2	Organic	16
	5	1.40	6.2	Organic	17
Cherry	6	0.9	2.8	Conventional	12
	7	1.7	3.9	Conventional	9
	8	2.3	2.2	Conventional	5
	9	1.26	1.8	Conventional	8
	10	0.80	3.8	Conventional	11
Pomegranate	11	2.1	3.1	Organic	8
	12	1.7	1.4	Organic	6
	13	1.9	2.3	Organic	7
	14	1.2	3.6	Organic	5
	15	1.1	1.2	Organic	5
Peach	16	2.5	6.9	Conventional	5
	17	1.2	7.6	Conventional	6
	18	3.4	6.3	Conventional	5
	19	1.4	7.2	Conventional	6
	20	3.2	9.4	Conventional	5

The availability of these data also made it possible to have a sufficient number of observations to be able to determine the average unit values of prices and rents in each of the comparison segments necessary to apply the RSA. Relative to the amount of the data used, given the rather low availability that generally occurs in the estimation of agricultural land, the consistency of the comparison data can be considered valid. The homogeneous conditions present in the agricultural territory of the area also make it possible to rely on a high level of land similarity in the comparable segments.

The comparison data, including prices and rents collected, were acquired and verified through privileged interlocutors present in the area under study and consisting of not only owners and other agricultural entrepreneurs but also real estate agents and other reliable interlocutors. From the informal verifications conducted with the contacted stakeholders in the area (brokers, real estate agents, and professionals), the characteristics considered are, moreover, representative of the variables considered by potential buyers of farmland in the area in which the land to be estimated falls.

For the application of the GAS, the average values of the relevant characters of the comparison segments (location; farming regime; and age of the fruit orchard), prices, and rents were taken into account.

The rate (i) to be used for estimating, by income capitalization, the avocado cultivation was obtained from the ratio of the results of the GAS applications. In this regard, in the first application, the average prices found in each comparison segment were used as the vector of known terms. In the second application, the average rents were used as the vector of known terms. It should be noted that, under the assumption that the considered fruit orchards are renewed at the end of the growing cycle, the rents used are to be considered as unchanged incomes during the entire growing cycle of the comparison orchards.

The annual cash flow of avocado cultivation was obtained through direct interviews with the owner and other farmers, by which technical and economic data were collected. Data were categorized into three different groups: structural data (e.g., farm size, farm investments), data on the production process (e.g., farming operations, inputs required for crop growing, human labour), and farmers' revenues (e.g., yield). Annual profits and costs incurred were calculated under the assumption that financial conditions remained constant over the entire period [32]. Net Present Value (NPV) was determined under the assumption of a 30-year crop cycle length according to this equation [33]:

$$NPV = \sum_{0}^{n} R_n q^{-n} \tag{17}$$

where R_n represents the annual income at n-th year (revenues minus costs), n stands for the economic life of the orchard, q equals (1 + i), and i denotes the capitalization rate.

Capitalizing the NPV with the coefficient $\frac{1}{q^n-1}$, where q = (1 + i) ed n = 30, the value of the land for avocado cultivation was derived assuming that the fruit cultivation cycle continues to be renewed at its end [3,21,34,35]. In other words, according to the methodology for the appraisal of fruit orchards by income capitalisation [21,36], the NPV corresponds to the sum of the incomes that can be achieved every 30 years. Therefore, considering that the avocado crop can be replaced at the end of the cultivation cycle by another crop of the same duration and with the same characteristics, from a financial point of view, within the limits attributable to this hypothesis [21], using the initial accumulation coefficient of polyannual, constant, and unlimited incomes, the value sought is obtained.

5. The Case Study: Results and Discussion

The case study considered refers to the estimation of the market value of a specialized avocado fruit orchard in the productive maturity stage, which constitutes a uniqueness in the reference territory. The absence of other avocado fruit crops in the area where the arboretum to be estimated is located prevents having available prices of land with fruit crops of the same species and extra data such as quotations, asking price, etc.

The appraisal is carried out by combining the logic and the procedures of the RSA and the GAS. The comparison is developed by taking into consideration relevant characters common to the segment to which the land to be estimated belongs and remote market segments.

In the absence of a well-defined set of features, in order to develop a more effective comparison between segments [30], the relevant common characteristics taken into consideration are (i) location, measured in km distance from the wholesale fruit and vegetable market present in the area; (ii) the cultivation regime adopted (distinguished as conventional or organic); and (iii) the age of the fruit cultivation (measured in years).

According to the aim of the appraisal, other specialized fruit orchards (lemon, cherry, pomegranate, and peach groves) present in the territory in which the land to be estimated is located are considered as remote market segments. Table 3 shows the average intensities assumed by each characteristic in the segments considered.

Table 3. Consistency of average values of relevant characteristics in the segments.

Segments	Surface Areas	Location	Farming Regime	Age
	(ha)	(km)	Conventional/Organic/	(Years)
Avocado	0.94	3.8	Organic	9
Lemon	6.28	6.24	Organic	16
Cherry	1.39	2.9	Conventional	9
Pomegranate	1.60	2.32	Organic	6.2
Peach	2.34	7.48	Conventional	5.4

In the comparable segments, in addition to the average values of the relevant characteristics, the average values of prices and rent were also calculated (Table 4).

According to the income approach's requirement to determine the rate as the ratio of income to the value attributable to avocado fruit cultivation, the application of the GAS was carried out using, as the vector of known terms, the average values of prices and the average values of rents surveyed. Applying the GAS to the vector of average prices yields the estimation vector shown in Table 5, in which the sought-after estimation value is represented by the first element (EUR 26,075.51). The other elements indicate the marginal values of the relevant characteristics considered, which represent the marginal adjustments needed to apply RSA.

Applying the GAS with the vector of average rents yields the estimation vector shown in Table 6, in which the value of the estimate sought is represented by the first element (EUR 1079.17), and the other elements indicate the marginal values of the relevant characters.

Through the adjustments made directly with the GAS on the comparable segments, it is possible to obtain the capitalization [12]. In the case examined, the value of the sought rate can then be obtained from the ratio between EUR 1079.17 and EUR 26,075.51, and it is equal to 0.04139. This is because the rate is derived from two quantities that can be considered constant: the rent, which does not vary during the growing cycle, and the prices, which, in turn, relate to sales of orchards that are in a state of productive maturity and to which a constant production capacity corresponds. Consequently, it is therefore possible to apply the appraisal by income capitalization [21,36].

In this regard, based on data and information acquired through direct interviews conducted with the fruit cultivation owner and other privileged stakeholders active in the agricultural sector in the area where the fruit orchard to be estimated is located, the annual cash flow of avocado cultivation was determined. The values of cultivation revenues and costs, shown in Table 7, are for a cultivation cycle duration of 30 years.

Table 4. Prices and rents in the remote segments.

Remote Segments				Average Price (EUR/ha)	Average Rent (EUR/ha)
Lemon					
Surveyed prices (EUR)	275,000.00	310,000.00	335,000.00	33,213.00	1,108.11
Surface area (ha)	7.3	10.9	9.5		
Surveyed rents (EUR/anno)	2500.00	1600.00			
Surface area (ha)	2.30	1.40			
Cherry					
Surveyed prices (EUR)	16,500.00	30,000.00	42,000.00	18,061.22	898.06
Surface area (ha)	0.9	1.7	2.3		
Surveyed rents (EUR/anno)	1100.00	750.00			
Surface area (ha)	1.26	0.80			
Pomegranate					
Surveyed prices (EUR)	40,000.00	38,000.00	35,000.00	19,824.56	1000.00
Surface area (ha)	2.1	1.7	1.9		
Surveyed rents (EUR/anno)	1300.00	1000.00			
Surface area (ha)	1.20	1.10			
Peach					
Surveyed prices (EUR)	70,000.00	28,000.00	85,000.00	25,774.65	750.00
Surface area (ha)	2.5	1.2	3.4		
Surveyed rents (EUR/anno)	950,00	2.500,00			
Surface area (ha)	1.4	3.2			

Table 5. Price estimation vector.

0.55	0.14	0.45	−0.14		33,213.00		26,075.51
0.06	−0.16	−0.06	0.16	x	18,061.22	=	2121.56
0.26	−0.91	0.74	−0.09		19,824.56		4570.58
0.07	0.06	−0.07	−0.06		25,774.65		511,44

Table 6. Rent estimation vector.

0.55	0.14	0.45	−0.14		1,108.13		1079.17
0.06	−0.16	−0.06	0.16	x	898,06	=	−17.01
0.26	−0.91	0.74	−0.09		1000.00		144.08
0.07	0.06	−0.07	−0.06		750.00		17.45

Using the 0.04139 rate, the NPV of the avocado fruit cultivation is EUR 68,622.76 (Table 8). However, considering that, at the end of the current cropping cycle on the land to be estimated, a new avocado fruit crop cultivation with similar technical and economic characteristics to the one currently underway may be repeated [21], the value of the land (V_0) is equal to the discounting NPV, assuming that it is an infinite and periodic income capitalization. More specifically, using the coefficient of anticipation for the initial accumulation of constant, polyannual financial income, postponed and unlimited ($\frac{1}{q^n-1}$ where q = 1 + 0.04139 and n = 30), the land value by income capitalization equals to EUR 28.88167 (Table 8).

Table 7. Estimated cash flow of avocado fruit orchard.

	Years				
	1–3	**4–10**	**11–20**	**21–27**	**28–30**
Revenues (EUR/ha)	5525.00	96,973.00	145,603.40	101.922,30	43,681.00
Costs (EUR/ha)	15,513.00	42,337.00	64,806.00	45.364,00	19,442.00
Deep tillage	950.00	-	-	-	-
Plants and plant setting	4800.00	-	-	-	-
Irrigation equipment	4200.00	-	-	-	-
Fertilizers	1155.00	3400.00	4004.87	2773.00	1133.00
Pesticides	578.00	2535.00	2327.50	1674.00	733.00
Irrigation water	685.00	4630.00	5604.21	3413.00	1767.00
Labour	1260.00	11,920.00	20133.55	14,894.00	6357.00
Farming operations	1885.00	7220.00	12,183.63	8700.00	3520.00
Boxes and transports	-	12,632.00	20,552.24	13,910.00	5932.00
Cash flow (EUR/ha)	9988.00	54,636.00	80,797.40	56,558.30	24,239.00

Table 8. Estimated values with income capitalization.

i.	**NPV**	$\frac{1}{q^n-1}$	V_0
0.04139	68,622.76	0.42088	28,881.67

This value is quite different from EUR 26,075.51, obtained by the GAS application when the vector of known terms consists of the average prices collected in the comparison segments. It must be considered, however, that proceeding to the remote search for the capitalisation rate inevitably introduces some additional evaluation elements compared to the analysis conducted exclusively on the basis of the comparison of average prices of the comparison segments. This is because the relationship between the characteristics considered and the estimated values may not be linear, as imposed in the GAS formulation [6]. Therefore, it is quite acceptable that the two values may be different. In particular, when comparing data in the rental market segment of agricultural land, although there are interrelations with the sales market, it is inevitable that some discordant elements appear that affect the estimated value.

In addition, it should be also considered that this is an inevitably different result because it is achieved through a different approach. In this regard, with respect to the different estimation criteria allowed by the traditional estimative theory of Italian origin (market value, complementary value surrogate value, cost value, transformation value, capitalization value), it is possible to state that the same asset could have different values depending on the approach followed. The valuation of economic goods must be interpreted as the attribution of different values dependent on many purposes and not as the determination or measurement of market price alone [3,21,37].

In the first case (Table 5), adjustments were made to the comparison segments. In the second case (Table 8), the periodic cash flow of cultivation was capitalized. However, by using an identified rate without resorting to subjective choices, even in the absence of comparables in the same segment as the asset to be appraised, the approach followed allows for an appraisal value to be arrived at without resorting to subjective choices on the part of the appraiser.

Although the capitalization rate is obtained through the comparison between segments and not between similar assets, the result achieved thus seems to confirm the possibility of estimating the value of agricultural land and the value of the annual rent in the absence of comparables belonging to the same market segment as the asset to be estimated.

From the result obtained, some considerations are derived. In the Italian context, over the past 20 years, the real estate valuation procedures adhered to standardised best practices [23]. Basically, these documents [5,9] identify assessment methods consistent with the reference standards [38,39] and with national and international best practices [5,10].

They are the key references for technicians, professionals, and investors interested in developing investments in this line of business.

Although the proposed methodological content is not different from that found in the estimation literature, these best practices, subject to periodic review, indicate that the use of the procedures followed is performed in a manner consistent with the estimation principles in use internationally [5]. In this context, one of the fundamental principles of this new approach is the application of intelligible and replicable methods, which is required to take place on the basis of objective economic-estimative elements and through the detection of quantitative and qualitative characteristics.

The relevance of this principle is of particular importance in the context of agricultural land valuation. With reference to the Italian context, the use of procedures that do not meet the principles adopted by international valuation standards continues to be non-negligible [40]. In this situation, there is still the possibility that the estimation of the market value of a parcel of land is performed by more or less explicitly resorting to the expertise of the appraiser. Relying on the personal and subjective judgment of the appraiser, the estimate made through expertise lacks the reliability and replicability required by international standards.

This is the case, for example, with the estimation carried out by market comparison using the monoparametric method which determines the value of the asset solely and only according to a single characteristic (usually the surface area), neglecting the possibility that there are other characteristics capable of influencing the value of the asset.

In symbols, the expression of monoparametric estimation can be schematized as follows (Salvo, 2023):

$$V_0 = \frac{\sum_{i=1}^{n} P_i}{\sum_{i=1}^{n} S_i} S_0$$

where V_0 is the market value of the property being appraised; P_i is the sale prices; and Si is the comparison parameters of n comparables, consisting, generally, of the area size, and S_0 is the intensity of the comparison parameter in the property being appraised.

Ignoring the impact of the other characteristics in the assessment leads to an approximation of the evaluation results [3,23].

The appraiser's expertise also appears no less deleterious in estimating income capitalization. The appraiser, in fact, by disregarding the indications of valuation standards, may be led to determine the rate to be used in the procedure on the basis of his or her own personal convictions. In such circumstances, the choice made subjectively is justified on the basis of indications that can be derived from the yield of government bonds with similar durations to those attributable to agricultural investment.

However, with regard to the determination of the capitalization rate, the valuation standards indicate different and well-defined procedures to be followed. In particular, they emphasize that the capitalization essay is derived from the quantities observed in the real estate market and not in the debt securities market. More specifically, it is derived from the rents and market prices of comparison properties in the same market segment as the property to be valued or comparable market segments (remote search) based on their respective characteristics. This is because the capitalization rate is not a quantity expressed by the market, such as the interest rate of money capital.

In addition to being consistent with the value that can be derived through segment comparison, it shows the possibility of estimating the value of agricultural land even in the absence of similar assets belonging to the same market segment in the illustrated case consisting of a fruit orchard of the same species. In addition, if income capitalization is strictly required, it allows the determination of the rate by limiting the use of the appraiser's expertise. This is of no secondary importance considering the effects generated by the capitalization rate on the value of an asset for the same amount of income to be capitalized. Applying the RSA, the capitalization rate, although derived from a comparison between segments, does not involve changes or adjustments on its magnitude but only on the original quantities, prices, and incomes detected on the market.

RSA does not, therefore, allow generic attributions on the rate value by the appraiser based on subjective and unverifiable beliefs. It therefore appears to be more in keeping with the indications of objectivity and transparency recalled by best practice [5,10,11]. The possibility of estimating the value of an asset with the RSA, despite the limitations highlighted, also allows for the use of an effective tool for verifying and controlling the validity of the results achieved by other methods. In this sense, potential benefits are configurable for credit and insurance operators [41]; public and private decision-makers [35,42], who need to acquire appraisal values appropriately without subjective conditioning based on the appraiser's expertise; or for other different appraisal uses, including applications by spatial econometric analysis [43–46].

In the absence of assets similar to the property to be estimated (in the case illustrated, consisting of tree crops of the same species and in the same territory in which the avocado orchard is located) and having to apply income capitalization, the capitalization rate was determined by comparison between segments. The comparison between market segments constitutes the process of remote search for the capitalization rate and is carried out according to the general rules of market-oriented procedures; thus, it is in compliance with the formulation of the comparison principle.

The condition examined appears to be quite frequent in the income-capitalization approach, which is generally used when data from the market segment of the property to be valued are not available. The method followed appears replicable in other contexts as well, as it provides for the possibility of segmenting the market even in the presence of high heterogeneity of characteristics, as is the case with the land market [47].

The characteristics considered for the purpose of segment comparison are those with respect to which there are differences between the crops examined in the relevant local area context and which are considered capable of affecting land values by local operators. In order to avoid possible negative effects caused by the personal biases of the appraiser, since the comparison requires one or more adjustments of the rents and market prices detected in market segments other than that of the property to be appraised, the GAS was applied. Through this procedure, these adjustments were made automatically by solving the linear equation system where the inverse matrix of the differences between the characteristics detected in the comparison segments and in the segment of the land to be estimated was used. Having carried out the estimation of adjustments not on the capitalization rates, which are derived quantities, but on the original quantities consisting of the rents and prices surveyed in the market, the method followed also appears to comply with the best practices identified by the valuation standards, which make constant reference to the data and information surveyed in the real estate market.

In reference to the determination of the capitalization rate for the purpose of estimating the market value of agricultural land, moreover, the proposed application confirms the possibility of being able to have real estate rates surveyed in market segments other than that of the property to be valued without resorting to derivations from the analysis of movable investments characterized, often, by pronounced instability factors.

6. Concluding Remarks

Although the result obtained in the illustrated application may be considered more reliable than estimation based on subjective value attributions, the results achieved can nevertheless be considered interesting and innovative for several reasons: (i) To the best of our knowledge, this is the first application of an appraisal in the agricultural sector using the RSA and GAS; (ii) the capitalization rate is derived through prices and incomes, and not by resorting to subjective choices made at the discretion of the appraiser; (iii) by using the GAS, the adjustments are made on the original quantities of the rate (prices and incomes); (iv) by using GAS, adjustments occur automatically, avoiding incurring the expertise of the appraiser; and (v) the result obtained is verifiable and more reliable than that which can be derived by using a capitalization rate chosen randomly or inappropriately by the appraiser. In circumstances where no comparables can be found in the market

segment of the subject, the appraiser may determine the market value by resorting to income capitalization. The lack of comparables, however, could lead the appraiser to use an inappropriate, ambiguously chosen, and opaque rate. Even with the limitations generated by the lack of similar assets, however, by searching for the necessary data in remote segments and by identifying and determining the relevant characteristics common to the different comparison segments, it is possible to reach a valid assessment. By making adjustments in the original quantities (prices and incomes), it is possible to calculate the capitalization rate, and the appraisal is carried out in a transparent and objective manner. Following the logic of comparative estimation, in particular, it is possible to apply the RSA by making the required adjustments directly through the GAS and to arrive at the determination of the capitalization rate in a way that is more appropriate and responsive to the estimation conditions.

The estimated value of the capitalization rate reached by comparing different segments and not between prices and income recorded in the same segment of the asset to be estimated seems not only consistent with the logic of comparison estimation and best practices but also less imprecise than the subjective adjustments made by the expert.

The result is effective and consistent with the principle of comparison, and it ensures transparency and verifiability as required by the standards for real estate valuation, limiting the use of undesired arbitrariness by the appraiser [5,10,11].

Although the comparison between different segments is limited in relation to the conditions under which the estimation takes place, the approach followed has allowed for an estimated value in the absence of a comparison between similar cultivations. As pointed out in the text, however, the segments considered in the case illustrated are close to that of the avocado crop to be estimated because they consist of other fruit crops in the same area. Having the prices and incomes of these segments available, it is therefore possible to make adjustments to the rates that can be determined for each segment. It is therefore a process also suitable for the valuation of unique assets, such as the avocado cultivation considered in the case study examined.

It should also be noted that by directly making the adjustments between the relevant characteristics in the set of segments taken for comparison in the absence of comparable assets, the procedure followed may allow the asset's value to be determined without applying the income approach.

Although additional applications are useful to test the validity of the procedure followed for the valuation of agricultural land and other types of real estate, the results also show potential benefits for different categories of operators interested in accurate property valuations [48,49]. However, the role of the appraiser involves the knowledge of the technical and economic characteristics of the property being appraised, the area in which the land is located, and the local land market. For this reasons, the identification of comparison segments is recommended to be close to that of the property to be estimated, so that the collection of data is useful for estimation purposes. The results obtained by this method appear more credible and verifiable than what can be achieved, approximately and subjectively, by relying on the use of the appraiser's expertise.

In order to achieve reliable results, however, it is certainly helpful if the market segments are close to that of the asset being appraised. The more similar the comparison segments are, therefore, the more reliable the attainable result is. Moreover, it has been shown that there is a clear relationship between the accuracy of the estimates made and the selection of comparables [50].

Therefore, it also seems essential that the appraiser have adequate knowledge of the technical and economic characteristics of the goods and of the local market, so as to be able to identify segments functional to the purpose of the estimate [51]. The advisability of segmenting the market into narrow segments within which it is possible to include assets with similar characteristics is well-known in estimation doctrine (Forte, De Rossi, 1979). With reference to the land market, in relation to the conditions of heterogeneity that characterize agricultural land in the same territory and to the reduced frequency of property

exchanges, the process of market segmentation in the face of the reduced variability of characteristics inevitably entails a relevant limitation on the number of comparison assets. The determination of the capitalization rate through the adjustments provided by the RSA and formulated objectively by employing GAS thus allows for the effective exploitation of the reduced availability of comparable data according to an appropriate methodology. Though the results achieved in the present application can be considered affidable, further verification should be carried out by preparing other estimation analyses of farmland in other areas and in other estimation contexts. The approach followed could also be validated and refined by carrying out further applications related to other categories of real estate with greater elements of variability among segments, both with respect to the intensity of features and to the prices and incomes.

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