An Assessment Model for the Periodic Reviews of the Market Values of Property Assets

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Abstract. In this paper a mass appraisal methodology for the periodic reviews of the market values of special properties that constitute the asset balance of relevant real estate portfolios has been developed. Using the information published by Italian databases, a study sample of office properties of medium and large size, located in the city of Milan (Italy) and sold in the last decade, has been obtained. After having identified the main characteristics that contribute to the formation of property prices for the study sample considered, a model for the "quick" assessment of similar properties for intended use and explanatory variables of the prices and located in the same territorial context has been defined through the implementation of a genetic algorithm. The methodology developed satisfies the need to perform repetitive valuations, that should be not only contextualized to the spatial characteristics, but also timed to the different stages of evolution of the property cycles.

Keywords: Real Estate Funds · Market value · Mass appraisal · Investment management company · Independent advisor · Genetic algorithm

1 Introduction

The current global economic situation has been characterized by high uncertainties about the future trends. Although the forecasts in the GDP annual changes in the main countries show a positive sign, as a consequence of the widespread growth expectations, there are strong doubts about the size of real improvements. According to the OECD [17], the Brexit should cause −0.5% on the UK growth in 2017 and 2018, and −1.5% in 2019, with cascading effects on the rest of Europe.

In Italy, Greece and Spain, in particular, the uncertainty of the property market is structural. In recent years, social, economic and fiscal factors have produced deep

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modifications in the property market, that currently appears as a fragile system characterized by continuous transformations. Despite the efforts of the European Central Bank, the attitude of the banks remains cautious and it is characterized by financial products that favor borrowers with appropriate liquidity and strong guarantees. Moreover, taxes on real estate have reached in a few years unprecedented levels. The formation of anomalous prices, the contraction in sales and the lengthening of the sale time are the main consequences [14].

In this context, the major market difficulties are related to the special properties, i.e. properties that, on the one hand, are characterized by large sizes, on the other hand, incorporate market values which complicate their commercialization, due to the high risk associated with the costs for the purchase, the eventual transformation and the relative management [11].

In recent years, the widespread diffusion of innovative financial instruments, such as the Real Estate Funds, has allowed the activation of a sales market for these types of properties, overcoming the generalized problem of scarcity of public and private resources [12, 19, 21] and ensuring a better management and the possible reactivation of complex properties.

Long time used in other countries as a diversification tool in pension investments [8, 9], in Italy the Real Estate Funds have been also spreading through *(i)* a favorable tax regime, *(ii)* the possibility that the promoters can be territorial Entities and/or private subjects, *(iii)* the establishment of an asset underlying the Real Estate Fund constituted by public and/or private properties.

With Arts. 33 and 33-bis of Decree Law No. 98/2011 new financial vehicles to increase the economic and social value of public properties have been introduced. Art. 33 provides for the creation of an *integrated* system of Real Estate Funds, with the aim of increasing the efficiency of the redevelopment and valorization processes concerning properties owned by the State and by the local Communities. Specifically, by Decree of the Minister of Economy and Finance, the constitution of an Asset Management Company has been provided for the establishment and the management of one or more Real Estate Investment Funds, that pursue strategic objectives, including the reduction of public debt.

Overall, the number of Real Estate Funds authorized by the Bank of Italy has increased from 312 in 2011 to 395 in 2016 [20]. Given that these are medium-long term investments - the minimum expected duration of Real Estate Funds is ten years, whereas the maximum duration can reach up to thirty years - there is the evident need for highly reliable valuations of the market value of the assets in the Real Estate Funds [6]: not surprisingly, the legislation provides for a periodic semi-annual review of the valuations, highlighting the central role of the independent advisor [18].

In this framework, the use of tools for the evaluation of property values is essential for the operators involved in Real Estate Funds (buyers, sellers, institutions, insurance companies, banks, etc.). The continuing uncertainty causes the need to use models which, besides being characterized by a strong theoretical and methodological basis, are able to provide consistently reliable valuations in the short term [4, 7, 10].

2 Aim

In the Measure dated January 19th, 2015, the Bank of Italy [2] emphasizes the peremptoriness that the Management Companies of Real Estate Funds acquire policies, procedures, information tools, techniques and professional resources that constantly ensure a "true and fair representation of the asset value" of the managed Fund. In the cited Measure the need to forecast the "current and future trend of the real estate market for the location of each property" of the investment Fund is highlighted.

Taking into account the extra-ordinary characters of the properties that usually compose the Real Estate Funds (structured offices, shopping malls, hotels, nursing homes, etc.), the absence of a significant market of transactions of similar properties leads to prefer, among the evaluative procedures, the *income approach* through the development of a Discounted Cash Flow Analysis (DCFA). As known, the preliminary determination of the variables that contribute to the definition of the market value to be estimated (cash flows, time horizon, actualization rate, going out cap rate, terminal value, growth rates, etc.) is preparatory for the implementation of a DCFA. In particular, each of the estimated rates inevitably takes into account a share of uncertainties that significantly affects the output of the property valuation, related to the experience and the sensitivity of the evaluator in the appreciation of the different risk components.

With reference to the market value assessments of properties that constitute Real Estate Funds, aimed to periodic reviews of the asset values of the financial tool, in this research a methodology for mass appraisal of special properties has been developed. Starting from the information published by Italian databases, a study sample of 122 office properties characterized by medium and large size, located in the city of Milan (Italy) and sold in the period 2004–2015, has been obtained. For each property, the main technological, locational and economic characteristics that contribute to the formation of property prices have been detected, in order to define, through the use of an hybrid data-driven technique that combines the effectiveness of genetic programming with the advantage of classical numerical regression, a model for the "quick" assessment of similar properties in terms of intended use and explanatory variables of the selling prices and located in the same territorial context.

The model developed could be used for the determination of "comparative" values with the estimates values obtained by the analytical procedure of a DCFA, in order to ensure a further control instrument of the results from the subjects involved, that are *(i)* the independent advisors, which are responsible of producing highly reliable economic judgments about the properties of the Real Estate Funds, *(ii)* the Management Company, in order to monitor in detail the consistency of the values estimated by the independent advisors, *(iii)* the investors in the Real Estate Funds and any institutions involved (banks, Public Administrations, insurance companies, etc.), for which it will be possible to directly and transparently check the evolution over time of the assets market values of the Real Estate Fund and consequently the performance of the own investment.

The paper is structured as follows. In Sect. 3, the database used for the implementation of the methodology developed is described, by specifying the variables considered. In Sect. 4, the method applied for the elaboration of the model is explained, the

calculation for the case study is carried out and the results are illustrated. Finally, in Sect. 5 the conclusions of the work are discussed.

3 The Case Study

The case study concerns a sample of 122 office properties characterized by medium and large size, located in the city of Milan (Italy) and sold in the period 2004–2015. The choice of reporting the analysis to the office intended use was influenced by the composition of the borrowed database [16], in which the number of transactions relating to properties of different intended uses from the office one with medium and large size was small for the present research purposes. In the databases published, for each property different information are reported, including the selling price and the year of sale, the intended use, the exact location, the total gross floor surface, the year of construction and the year of the last renovation. In Fig. 1 the localization of each property of the study sample in the city of Milan is represented.

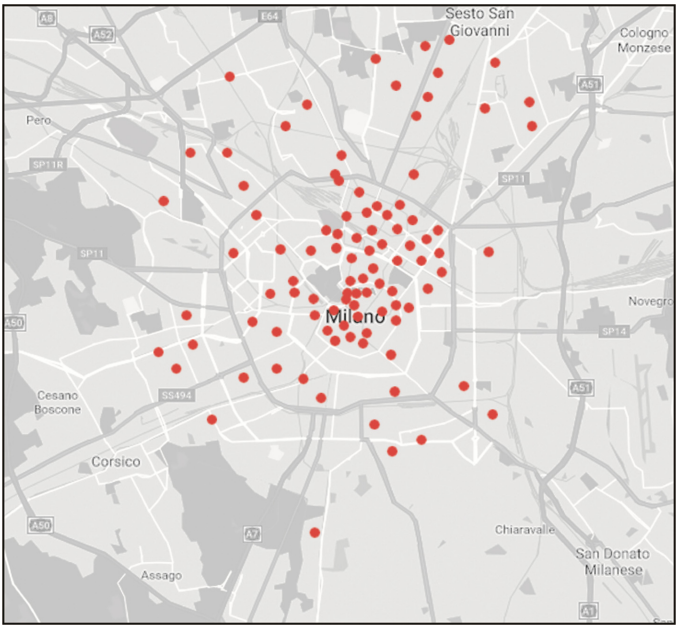

Fig. 1. Localization of the properties of the study sample in the city of Milan

With regard to the timing of the transactions considered, the individuals of the study sample are more or less "spread" within the period of analysis. The highly cyclical trend of the real estate market in the last decades does not allow to consider an uniformity of the economic factors that contribute to the formation of the selling prices in a period of over two years. Therefore, in order to consider the entire sample of 122 detected properties sufficiently consistent for mass appraisal analysis, two "market" variables have

been introduced among the characteristics that contribute to the formation of the selling price. These variables are able to take into account in the final model the real estate market trends and to adequately represent the phase of real estate cycle that pertains to the homogeneous zone in which each property is located. These two economic variables are the *average market value* and the *average market rent* published by the Real Estate Observatory (OMISE) of the Italian Revenue Agency [1], and relative to the "structural offices" intended use, to the OMISE Micro-zone in which the property is located and to the year of sale. In particular, the "Micro-zone", defined according to the Presidential Decree No. 138/1998 and ensuing Regulation issued by the Ministry of Finance, for the Italian regulation, is a part of the urban area that must be urbanistically homogeneous and at the same time must constitute a homogeneous real estate market segment. Finally, the inclusion of the two economic variables described allows to borrow the logic of a *static* econometric analysis, applied on the study sample of 122 detected properties, and to simultaneously obtain an adaptable model to the economic evolutions related to different time of evaluation.

3.1 The Variables of the Model

For each property of the selected sample, the main characteristics involved in the explanation of the selling prices (P) have been detected. In particular, the explanatory variables considered are the following:

- *technological* characteristics: the total *surface* (S) of the property, expressed in square meters of gross floor area; the quality of the *maintenance conditions* (A), taken as a qualitative variable and differentiated, through a synthetic evaluation, by the categories "to be restructured", "good" and "excellent". In the model, for this explanatory variable two dummies have been considered, respectively for the state "good" (Ag) and "excellent" (Ae);
- *locational* characteristics: the *distance from the nearest subway* (W), expressed in minutes it takes to walk to it; the *distance from the Central Station* of Milan (T), expressed in minutes it takes to walk to it; the *distance from the nearest highway* (G), expressed in minutes it takes to get there by car; the *distance from the nearest urban park* (V), expressed in minutes it takes to walk to it; the *distance from the Milan Cathedral* (C), expressed in minutes it takes to walk to it; the *number of the accommodation facilities* (H) within 300 m from the property;
- *economic* characteristics: the *average market value* (Q), expressed in euro per square meter of gross floor area, published by the OMISE of the Italian Revenue Agency, relative to the "structural offices" intended use, to the OMISE Micro-zone in which the property is located and to the year of sale; the *average market rent* (L), expressed in euro per square meter of gross floor area and per month, published by the OMISE of the Italian Revenue Agency, relative to the "structural offices" intended use, to the OMISE Micro-zone in which the property is located and to the year of sale.

For the definition of the quality of the *maintenance conditions* (A), the information obtained from the databases consulted about the year of construction and the year of last renovation have been integrated through surveys conducted on site and by web. In

particular, the "good" state indicates immediately usable office properties, whereas the "excellent" state refers to properties characterized by high architectural values (*trophy* properties). With reference to the data of the locational characteristics timed to the year of sale of each property, thematic maps published on web sites, reports, street maps, planning documents of the city of Milan have been consulted, in order to "photograph" the real situation to the period of interest.

As regards the main statistics of the values of the variables for the database considered, given the extra-ordinariness of the properties of the database, the mean of the *selling prices* is equal to 28,050,000 €, with values ranging between 1,100,000 € and 175,200,000 €, whereas the mean of the total *surface* is equal to 8,518 m^2, with minimum and maximum values respectively equal to 950 m^2 and 35,000 m^2. In Figs. 2 and 3 two thematic maps are represented, that describe the spatial distribution of the *selling prices* and of the total *surfaces* of the sample study in the city of Milan.

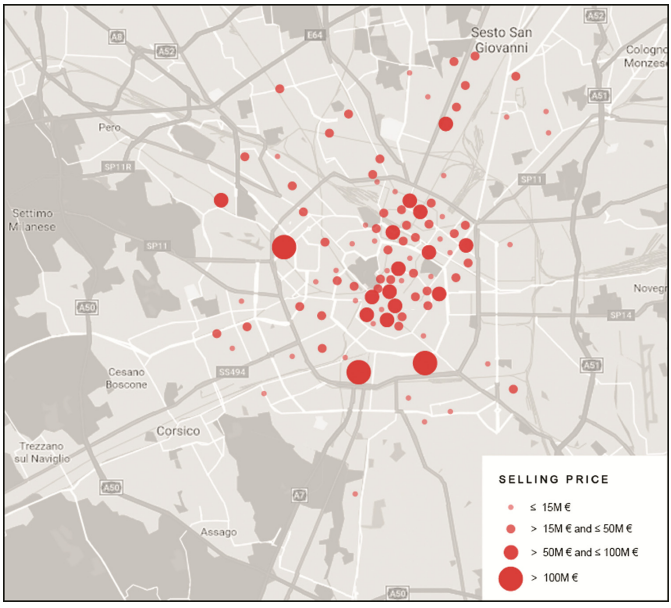

Fig. 2. Spatial distribution of the selling prices of the sample study in the city of Milan

All the properties of the study sample are relatively close to a metro station and a highway: the mean values of the variables *distance from the nearest subway* and *distance from the nearest highway* are respectively equal to seven minutes walking - value range: [1–30] - and eight minutes by car - value range: [1–20]. Higher mean values are instead reported for the *distance from the nearest urban park* - the mean value is equal to eleven minutes walking, and the maximum value arrives at fifty-two minutes walking -, for the *distance from the Central Station* - the mean value is equal to fifteen minutes walking, and the maximum fair arrives at fifty-one minutes walking -, for *the number of the accommodation facilities* within 300 m - the mean value is equal to twenty-one, and the

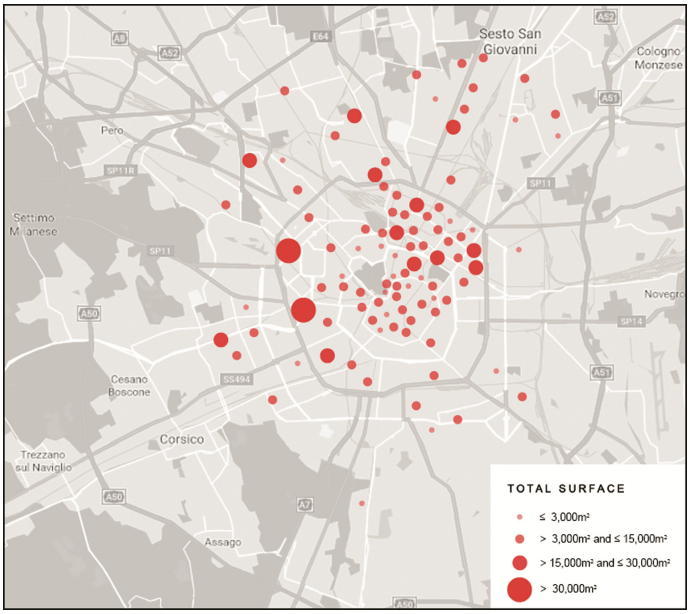

Fig. 3. Spatial distribution of the total surfaces of the sample study in the city of Milan

maximum value arrives at sixty-five. Larger distances are recorded *from the Milan Cathedral*, characterized by a mean value equal to twenty-one minutes walking and a maximum value equal to one hundred and two minutes walking.

The mean values for the dummy variables related to the quality of the *maintenance conditions* (*A*) show that 57% of the properties of the study sample is characterized by a "good" state, 26% are *trophy* properties and, consequently, 17% requires renovation investments. Finally, the economic variables *average market value* and *average market rent* are characterized by mean values respectively equal to 4,228 €/m^2 and 20.33 €/m^2 for month, with maximum values up to 14,575 €/m^2 and 75.13 €/m^2 for month.

4 Methodology

The econometric methodology implemented for the elaboration of the model to be used for the "quick" assessment of special properties located in the city of Milan is an hybrid data-driven technique, called *Evolutionary Polynomial Regression*. Implemented in the real estate sector in different applications for forecasting purposes [13, 15, 22], the method proposed can be considered as a generalization of the stepwise regression, that is linear with respect to regression parameters, but it is non-linear in the model structures. Equation (1) shows a generic non-linear model structure of the methodology:

$$Y = a_0 + \sum_{i=1}^{n} [a_i \cdot (X_1)^{(i,1)} \cdot \ldots \cdot (X_j)^{(i,j)} \cdot f((X_1)^{(i,j+1)} \cdot \ldots \cdot (X_j)^{(i,2j)})] \quad (1)$$

where n is the number of additive terms, a_i are numerical parameters to be valued, X_i are candidate explanatory variables, *(i, l)* - with $l = (1,\ldots, 2j)$ - is the exponent of the l-th input within the i-th term in Eq. (1), f is a function selected by the user among a set of possible mathematical expressions. The exponents *(i, l)* are also selected by the user from a set of candidate values (real numbers).

The iterative investigation of model mathematical structures, implemented by exploring the combinations of exponents to be attributed to each candidate input of Eq. (1), is performed through a population based strategy that employs a genetic algorithm, whose individuals are constituted by the sets of exponents in Eq. (1) and chosen by the user. In particular, the methodology does not require the exogenous definition of the mathematical expression and the number of parameters that fit better the data collected, since it is the iterative process of the genetic algorithm that returns the best solution.

The accuracy of each equation returned is checked through its Coefficient of Determination (COD), defined in Eq. (2):

$$COD = 1 - \frac{N-1}{N} \cdot \frac{\sum_{N} (y_{estimated} - y_{detected})^2}{\sum_{N} (y_{detected} - mean(y_{detected}))^2}, \tag{2}$$

where $y_{estimated}$ are the values of the dependent variable estimated by the methodology, $y_{detected}$ are the collected values of the dependent variable, N is the sample size in analysis. The fitting of a model is greater when the COD is close to the unit value.

Therefore, the methodology leads to a range of solutions for the user, among which it is possible to select the most appropriate solution according to the specific needs, the knowledge of the phenomenon in analysis and the type of experimental data used.

4.1 The Model: Application of the Methodology to the Case Study

The methodology is implemented considering the base model structure reported in Eq. (1) with no function f selected and, taking into account the results obtained in several studies [3], the dependent variable is represented by the natural logarithm of the selling price ($Y = ln\ (P)$). Each additive monomial term is assumed to be a combination of the inputs (i.e. the explanatory variables) raised to the proper exponents. Candidate exponents belong to the set (−2; −1; −0.5; 0; 0.5; 1; 2), in order to have a wide range of solutions, among which the best compromise between performance statistics and the empirical reliability of the relationships between candidate inputs and the dependent variable should be defined. The maximum number n of additive terms in final expressions is assumed to be eleven, that is equal to the number of explanatory variables considered.

The analysis carried out has allowed to identify the most appropriate model, characterized by the functional form in Eq. (3), that links the selling prices with all the explanatory variables considered:

$$\begin{aligned} ln(P) = {} & 14.0925 - 10.185 \cdot \frac{C}{S} - 0.00020569 \cdot H^{0.5} \cdot Q^{0.5} \cdot L^{0.5} + 0.0060682 \cdot T^{0.5} \cdot Ae \cdot Q^{0.5} + \\ & + 0.01838 \cdot \frac{W \cdot T^2}{C^2} + 0.049377 \cdot \frac{S^{0.5}}{T^2} + 0.02679 \cdot S^{0.5} - 0.00004398 \cdot S^{0.5} \cdot W \cdot T \cdot Ae + \\ & + 1.2183 \cdot 10^{-12} \cdot V^2 \cdot C^{0.5} \cdot H \cdot Ag \cdot Q^2 + 1.0816 \cdot 10^{-10} \cdot G^2 \cdot C \cdot Ag^{0.5} \cdot Q \cdot L^2 + \\ & - 4.2123 \cdot 10^{-10} \cdot S^2 \cdot W^{0.5}. \end{aligned} \tag{3}$$

The performance indicators show a high statistical reliability of the model obtained: the COD is equal to 88.82%; the Root Mean Square Error, that is the square root of the mean of the squared errors between the prices of the original sample and the values estimated through the model, is equal to 2.96%; the Mean Absolute Percentage Error, that is the average percentage error between the detected prices and the values estimated, is equal to 1.98%; the Maximum Absolute Percentage Error, that is the maximum percentage error between the detected prices and the values estimated through the model, is equal to 13.07%.

Therefore, with reference to office properties characterized by medium and large size located in the city of Milan, the assessment of the market values of properties similar to the sample study analyzed may be developed entering into Eq. (4), that is the exponential transformation of Eq. (3), the amount of detected features.

$$\begin{aligned} P = exp(& 14.0925 - 10.185 \cdot \frac{C}{S} - 0.00020569 \cdot H^{0.5} \cdot Q^{0.5} \cdot L^{0.5} + 0.0060682 \cdot T^{0.5} \cdot Ae \cdot Q^{0.5} + \\ & + 0.01838 \cdot \frac{W \cdot T^2}{C^2} + 0.049377 \cdot \frac{S^{0.5}}{T^2} + 0.02679 \cdot S^{0.5} - 0.00004398 \cdot S^{0.5} \cdot W \cdot T \cdot Ae + \\ & + 1.2183 \cdot 10^{-12} \cdot V^2 \cdot C^{0.5} \cdot H \cdot Ag \cdot Q^2 + 1.0816 \cdot 10^{-10} \cdot G^2 \cdot C \cdot Ag^{0.5} \cdot Q \cdot L^2 + \\ & - 4.2123 \cdot 10^{-10} \cdot S^2 \cdot W^{0.5}). \end{aligned} \tag{4}$$

In Fig. 4 the detected prices of the sample analyzed are compared with the prices estimated by the model of Eq. (3). The graphical representation shows the statistical goodness of the results: an almost exact match of the values is widely verified.

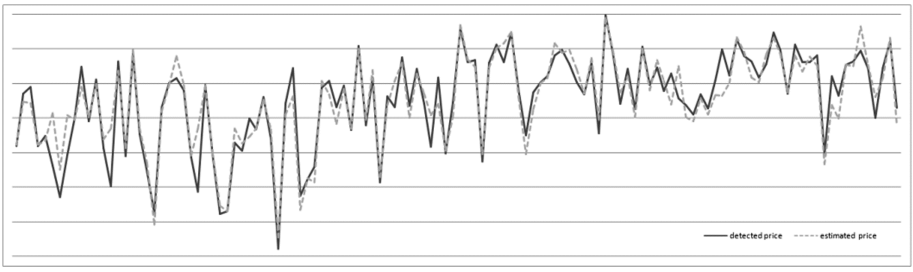

Fig. 4. Comparison between the detected prices (continuous line) and the estimated prices (broken line)

5 Conclusions

The high volatility of the financial market, related to the uncertainties about the real dimension of the non-performing bank loans and to the delicate geo-political

international balances, the continuing crisis in the real estate sector, generated by the subprime market and by the banking credit crunch, and the general lack of resources, have led private and public entities to a growing interest in alternative investment forms, such as the Real Estate Funds. By investing primarily in corporate real estate, characterized by large sizes and located in highly attractive locations for potential tenants, these tools allow to ensure, on the one hand, a good profitability at a rather low risk for investors, on the other hand, the reactivation of a market of special properties, that would be alternatively characterized by an absolute stagnation [5].

However, the experiences of recent years have highlighted the main weaknesses of these financial products, related to the frequent lack of expertise able to ensure assessments of the property assets that reflect the actual market trends. For this reason, several regulations have been promulgated (among all, the UNI 11558:2014) aimed at certifying the independent advisor figure, responsible for the periodic assessments of the properties that constitute the asset of the Real Estate Funds.

The methodology developed in this research, tested using the model obtained for the case study of the city of Milan, represents an evaluative support characterized by "quick" implementation for the various subjects involved in the periodic reviews of the asset values of the Real Estate Fund. This method could accompany the classical analytical approaches (DCFA), in order to provide an additional control tool of the results obtained. In particular, the inclusion of the economic variables *average market value* and *average market rent*, regularly published and updated by the Italian Revenue Agency for all the municipal micro-zones of the country, satisfies the need to perform repetitive valuations, that are not only contextualized to the spatial characteristics, but also timed to the different evolution stages of the real estate cycles.

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