which are the key factors influencing real estate development mode? Empirical analysis based on a group of data from China

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Abstract: According to the profitability evolution of real estate development projects, it is necessary and meaningful to conduct an analysis of the development mode of the real estate using some quantitative and empirical methods. To achieve this goal, a full-cycle index model (FCIM) of real estate development and construction investment is used to generate a series of data at first, which includes 40 samples (key factors) with their internal rate of return (IRR) as the output and 38 influencing factors as the input. In addition, three strategies (i.e., correlation, representativeness of dimensions and bottom of factors) are applied to filter the sample data and thus getting 10 key influencing factors of the IRR. Then, a regression model that treats IRR as the output and key influencing factors as the input is constructed to determine the weights of these factors. Finally, multiple combinations of factors with higher weights are considered to lead to the innovation basis for the real estate development mode. In conclusion, three factors have the strongest impacts on IRR: land transfer fee, sales promotion, and stamp tax and three development modes referring to different real estate enterprises are summarized, which are L&H Mode, L&P Mode, and H&B Mode.

1. Introduction
The goal of studying the real estate development mode is to find the approaches to achieve the profitability of project development. As the internal rate of return (IRR) presents the macro effect of real estate project investment and also shows its endogenous character on profitability, it can be regarded as the representative index to reflect the profitability of real estate (Evans and Forbes, 1993) [10]. In order to explore the development mode of real estate, an effective method is to seek relevant key factors influencing the IRR and further investigate risk control capability and profitability of such projects under different combinations of these factors. For instance, Geltner (2013) [13] utilized actual cash flow of commercial property between 1977 and 2004 to make a performance simulation of investment portfolio, and compared the portfolio during the same period through the IRR, which demonstrated the profitability mode of commercial property with different investment portfolio.

Moreover, IRR, as the indicator of profitability measurement, is affected by various factors of production. For example, Lohmann and Baksh (1993) [16] adopted the Monte Carlo method to explore the effects of devaluation on IRR. Also, sale price, business revenue, cost and the developing period are treated as influencing factors of IRR (Wu 2018 [22]; Ding 2018 [7]). Based on cash flow and the data of real estate in United Kingdom, Crosby et al. (2018) [4] indicated that land cost, construction cost, and construction period would affect IRR. In addition, the sensibility levels of IRR on these influencing factors are different, which implies that different development modes are more suitable for different real estate enterprises.
factors are also different. For a project with traditional cash flow, Danielson (2016)[8] found the weight relationship between expected IRR and every potential IRR using Macaulay duration functions. Similarly, Zhang (2018)[23] selected a real estate development project in Qingdao, China, and adopted the Monte Carlo simulation method to analyze the changes of uncertain factors influencing IRR and net present value (NPV) of the studied project. From the existing research, it shows IRR of real estate projects is affected by such factors like sale price, business revenue and land cost etc., and different levels of sensibility of IRR are reflected on these factors.

Generally, the measurement methods of IRR primarily include cash flow statement and numerical simulation. For instance, Kim and Reinschmidt (2012)[14] used the Second Moment Algorithm to randomly generate cash flow values and further developed a method for estimating IRR, which can be seen as a fast and simple calculation tool. Furthermore, Sdino et al. (2016)[20] adopted the discounted cash flow analysis method to estimate NPV and IRR, in order to evaluate the economic and financial sustainability of a real estate project in Italy. Danielson (2018)[9] appended a small outflow to conventional cash flow stream to obtain a simple and intuitive method for calculating IRR.

With the trend of data-driven today, sample data is analyzed with multiple regression, artificial neural network (ANN), and other relative methods in various measurements of the real estate development field. To measure the NPV and IRR of two cases, a real estate and a hydropower station, Chaveesuk and Smith (2003)[3] established polynomial regression and an ANN model respectively, the result of which revealed that the prediction accuracy of the ANN was more precise for multivariate data. Padhi et al. (2015)[18] integrated artificial neural networks, the analytical network process (AHP), and multi-objective genetic algorithms to forecast the profit of the real estate projects. As such, an approach was developed in their study that can be used to help strategic revenue management under the uncertainty of real estate projects. Also, on the basis of the real economic data in Canberra, Sydney, Brisbane, Adelaide, Melbourne and Perth, Perera et al. (2018)[19] assessed office building market in Australia using the multiple regression analysis, which found a causality between variables. Tang and Wang (2019)[21] randomly drew evaluation data of 20 housing in a city and established a real estate evaluation model by using the multiple linear regression analysis.

In a summary, at the macro level, the direct or indirect relations between IRR and multiple factors of production can provide ideas and methods for studying the rules of real estate market. Furthermore, at the micro level, the methods can be developed for improving profitability measurement of project development. Under the context, this paper will focus on IRR of real estate project and put forward a new data-driven based method for measuring IRR, integrating simulation of sample data and exploration of the relation between IRR and key factors. As such, the relation discovered by the proposed method can provide a basis for investors to establish the real estate development mode.

This paper is organized as follows: Section 2 is research methodology; Section 3 is results; Section 4 is discussion; the final section is conclusion.

2. Research Methodology

2.1 Analysis of influencing factors

Bleyl et al. (2018)[1] applied a dynamic life cycle cost-benefit analysis to model cash flow and achieved the multi-parameter sensibility analysis of IRR and NPV. The data of their study was derived from a case regarding economic and financial issues of an office building retrofitting to housing standard. Similarly, from the perspective of data-driven and real estate life cycle, this paper uses the initial information of a typical real estate project in Chengdu, China as the raw data and then build a Full Period Index Calculating Model (FPICM) of real estate project construction investment. Especially, this project includes information of office buildings, residential buildings and commercial real estate. Basically, the FPICM is composed of two modules: basic elements of each department and cash flow table of the projects. The following task is to generate sample data that will be used in the present study. Firstly, multiple basic elements are multiplied by random numbers in (0, 1) and (1, 2) to obtain the samples value of the influencing factors. Then, these samples values are imported into the
cash flow table to calculate multiple sets of IRR. In this way, the factors that affecting IRR in the cash flow table can be found by changing the data of basic elements. The analytic hierarchy table that summarizes IRR and its influencing factors can be seen as in Table 1.

Table 1. Influencing factors of IRR in the FPICM

| Cash flow | Economic elements | Production elements | Department |
|-----------|-------------------|---------------------|------------|
| 1. Cash inflow from operating activities | 1.1 Sales refund | 1.1.1 Marketable floorage with plot ratio calculation | Design |
| | | 1.1.2 Average price of the first opening | |
| | | 1.1.3 Quarterly growth rate | |
| | | 1.1.4 Destocking cycles | |
| | 1.2 Rent and property income | 1.2.1.1 First year’s rent | Business management |
| | | 1.2.1.2 Rental rate | |
| | | 1.2.1.3 Lease growth rate | |
| | | 1.2.1.4 Lease term (quarterly) | |
| 2. Cash outflow from Operating activities | 2.1 Land cost | 2.1.1 Land transfer fee | Investment |
| | | 2.1.2 Other stipulated cost of land | |
| | | 2.1.3 Land deed tax amount | |
| | 2.2 Development cost | 2.2.1 Initial cost | |
| | | 2.2.2 Construction and installation cost | |
| | | 2.2.3 Other cost | |
| | 2.3 Periodical cost | 2.3.1 Management expense | Finance |
| | | 2.3.1.1 Labor expense | |
| | | 2.3.1.2 Administrative expense | |
| | | 2.3.1.3 Departmental expense | |
| | | 2.3.1.4 Special expense | |
| | | 2.3.2.1 Labor cost | |
| | | 2.3.2.2 Administrative expense | |
| | 2.3.3 Financial expense | 2.3.2.3 Departmental expense | |
| | | 2.3.2.4 Sale promotion expense | |
| | | 2.3.2.5 Marketing engineering expense | |
| | | 2.3.3.1 Financial consultant, | |
| | | commission and other expense | |
| | | 2.3.4.1 Other capitalized expenses | |
| | | 2.3.4.2 Capitalized interest expense | |
| | | 2.4.1.1 Urban construction tax | |
| | | 2.4.1.2 Education tax and surtax | |
| | | 2.4.1.3 Other surtax | |
| | | 2.4.1.4 Pre-collection rate of VAT | |
| | | 2.4.2 Pre-collection rate of land value-added tax | |
| | | 2.4.3 Corporate | |
| | | 2.4.3.1 Income tax rate | |
2.2 Selection of influencing factors

The influencing factors of IRR in Table 1 need to be selected, according to the following step.

(1) Screen out insensitive fixed factors, including VAT rate (residence), urban construction tax, education tax and surtax, and income tax rate.

(2) Screen out the factors with strong collinearity. Because land deed tax amount is equal to land transfer fee multiplied by land deed tax rate, to avoid collinearity, this study did not choose land deed tax amount as a variable. Similarly, screening out the capitalized interest expense. After preliminary screening, 32 influencing factors are finally used for the correlation analysis.

(3) Select factors based on correlation results. After normalizing sample data of 32 factors, Pearson was used to conduct the correlation analysis in order to find the correlation degree between each factor and IRR. The higher the correlation degree, the greater the possibility of this factor is selected as the key influencing factor.

The data are normalized before correlation analysis. Assume \( y \) is the dependent variable (IRR), \( X_j (j = 1, 2 \ldots m) \) are independent variables (i.e., influencing factors), and there are \( n \) sample observations. As for each influencing factor, equation (1) is used to normalize the values of all sample observations. The linear normalization formula proposed by Dutka and Hanson (1989)\cite{6} can convert the raw values into \([-1, 1]\).

\[
x_{ij} = -1 + \frac{2 \ast (x_{ij}' - x_{j(min)})}{(x_{j(max)} - x_{j(min)})}
\]  

(1)

(4) Select based on representativeness of dimensions. From the FPICM, it can be seen that IRR is affected by multiple dimensions, that is, every responsible department controls the corresponding factors of production. Thus, it is important to consider the representativeness and comprehensiveness when selecting key influencing factors, in order to make sure that each dimension at least has a corresponding influencing factor.

(5) Select the bottom factors as much as possible. From Table 1, it can be seen that the influencing factors of IRR are refined from economic aspect to production. Also, bottom factors may be closer to production and life, which seems the profit mode can be more controllable for investors. Hence, bottom factors are supposed to be considered as many as possible during selection process.

2.3 Identify key influencing factors and explore the development mode

First, the multiple linear regression method (Noone 2001\cite{17}; Eberly 2007\cite{11}) is used to establish the relation between IRR and influencing factors.

\[
\hat{Y} = \sum_{j=1}^{m} \beta_j X_j + \epsilon
\]  

(2)

where, \( \beta_j \) are the linear regression coefficients; \( \epsilon \) is the random error term of the regression equation. Second, sort the regression coefficients in a descending order. Finally, generate multiple combinations of the influencing factors that correspond to the coefficients with larger values. Based on this, the corresponding development mode of real estate can be determined and the feasibility of these combinations will be verified by the real cases.
3. Results

3.1 10 key influencing factors

Through the FPICM simulation model, 38 influencing factors of IRR are established as Table 1. After eliminating insensitive factors, a Pearson correlation analysis was conducted for the remaining 32 factors based on 40 groups samples. From correlation results, 10 key factors are selected following the selection principle. Table 2 displays the Pearson correlation between each influencing factor and IRR, as well as the selection results.

| No. | Influencing factors                                      | Pearson correlation | selection (√) |
|-----|----------------------------------------------------------|---------------------|---------------|
| 1   | Marketable floorage with plot ratio calculation          | -0.104              |               |
| 2   | Average price of the first opening                      | -0.457**            |               |
| 3   | Quarterly growth rate                                   | -0.531**            | √             |
| 4   | Destocking cycle (quarterly)                           | -0.371*             |               |
| 5   | First year’s rent                                       | -0.369*             |               |
| 6   | Rental rate                                             | -0.560**            |               |
| 7   | lease growth rate                                       | -0.429**            |               |
| 8   | Lease term (quarterly)                                 | -0.532**            | √             |
| 9   | Rentable floorage with plot ratio calculation           | -0.581**            | √             |
| 10  | Land transfer fee                                       | -0.756**            |               |
| 11  | Other stipulated cost of land                           | -0.546**            |               |
| 12  | Initial cost                                            | -0.393*             |               |
| 13  | Construction and installation cost                      | -0.320*             |               |
| 14  | Other cost                                              | -0.352*             |               |
| 15  | Labor expense (management)                             | -0.358*             |               |
| 16  | Administrative expense (management)                    | -0.465**            |               |
| 17  | Departmental expense (management)                      | -0.422**            |               |
| 18  | Special expense (management)                           | -0.490**            | √             |
| 19  | Labor expense (marketing)                              | -0.385*             |               |
| 20  | Administrative expense (marketing)                     | -0.390*             |               |
| 21  | Departmental expense (marketing)                       | -0.405**            |               |
| 22  | Sales promotion expense                                | -0.550**            | √             |
| 23  | Marketing engineering expense                          | -0.496**            |               |
| 24  | Financial consultant, commission and other expense      | -0.384*             |               |
| 25  | Other capitalized expense                               | -0.408**            |               |
| 26  | VAT rate (service)                                     | -0.521**            | √             |
| 27  | Pre-collection rate of VAT                              | -0.494**            |               |
| 28  | Other additional taxes                                  | -0.446**            |               |
| 29  | Pre-collection rate of land VAT                         | -0.393*             |               |
| 30  | Pre-collection Gross Profit Rate                        | -0.512**            | √             |
| 31  | Stamp tax                                              | -0.448**            |               |
| 32  | Land deed tax                                          | -0.345*             |               |

Note: ** and * are at the 0.01 and 0.05 significance level, respectively.

3.2 Regression results

40 groups of sample observation values \( \{x_{ij}, y_i\} (i = 1, 2 \ldots n; j = 1, 2 \ldots m; n = 40, m = 10) \) are imported into equation (2) for the multiple linear regression analysis (Table 3). It can be seen that the fitness of the regression models is good, since the value of R-square and adjusted R-square exceeds
60%, P<0.001 (Probability value of significance), which means there is a significant linear regression relationship between IRR (dependent variables) and 10 key influencing factors (independent variables).

| R          | R²   | Adjusted R² | Standard estimate error | Sig.     |
|------------|------|-------------|-------------------------|----------|
| 0.834a     | 0.696| 0.591       | 11.322%                 | 0.000b   |

The results of a variable collinearity analysis are shown in Table 4, including each influencing factor and its corresponding β value. VIF values of all influencing factors are less than 10, which indicates there is no serious multicollinearity between variables within the tolerance range.

Table 4. Key influencing factors and corresponding β values

| Factor                                      | Standardization coefficient | Beta (β values) | Xi representativeness of dimensions | Collinearity statistics |
|---------------------------------------------|-----------------------------|-----------------|-------------------------------------|-------------------------|
| Quarterly growth rate                       | -.043                       | X₁              | Marketing                           | 3.917                   |
| Lease term (quarterly)                      | .152                        | X₂              | Property management                 | 7.463                   |
| Rentable floorage with plot ratio calculation | -.219                      | X₃              | Design                              | 3.963                   |
| Land transfer fee                           | -1.235                      | X₄              | Investment                          | 5.754                   |
| Initial cost                                | .016                        | X₅              | Cost                                | 2.936                   |
| Special expense (management)                | -.077                       | X₆              | Cost                                | 4.544                   |
| Sales promotion expense                     | .604                        | X₇              | Finance                             | 6.475                   |
| VAT rate (service)                          | -.077                       | X₈              | Finance                             | 4.446                   |
| Pre-collection Gross Profit Rate            | -.375                       | X₉              |                                      | 7.180                   |
| Stamp tax                                   | .532                        | X₁₀             |                                      | 5.177                   |

From Table 4, the multiple linear regression mode can be developed as equation (3).

\[
\hat{Y}(IRR) = -0.043X_1 + 0.152X_2 - 0.219X_3 - 1.235X_4 + 0.016X_5 - 0.077X_6 + 0.604X_7 - 0.077X_8 - 0.375X_9 + 0.532X_{10}
\] (3)

4. Discussion

From the sequence of β coefficient in the regression model (equation (3)), land transfer fee has the supreme influence on IRR, which belongs to an investment dimension with a negative correlation. By contrast, initial cost has a minimal influence on IRR, which belongs to the cost dimension and is positively correlated with IRR. Accordingly, different profitability development modes of estate enterprises can be established by combining the factors effectively in order to improve IRR. Three kinds of development modes are concluded and explained in Table 5 with the cases of practical real estate.

Table 5. The relationship between development modes and combined factors

| Development mode                             | Combined factors                                                                 | Real estate type                                                                 | Case       |
|----------------------------------------------|----------------------------------------------------------------------------------|----------------------------------------------------------------------------------|------------|
| Low price and high turnover mode (L&H Mode)  | Sales promotion expense, land transfer cost. Stamp tax, lease term(quarterly), pre-collection gross profit rate, rentable floorage with plot ratio calculation, VAT rate (service). | all real estate projects, especially for real estate projects sold purely        | Country Garden (China) |
| Long cycle portfolio mode (L&P Mode)         |                                                                                  | Suitable for commercial real estate projects with lease and sale                 | Wanda (China) |
High quality and brand effect development mode (H&B Mode) | Initial cost, special expense (management), quarterly growth rate | Suitable for real estate projects that focus on sales and build brands and pursue refinement | Vanke (China)

1. L&H Mode: it mainly appears as low-priced land acquisition and high-priced marketing, which can be applied to all real estate projects, especially for the projects for pure sale. If a real estate project adopts this mode, it should pay attention to two factors: marketing promotion and land transfer fee. Liu et al. (2018)\cite{15} conducted a cluster analysis of 117 real estate enterprises in China, which concluded five typical strategic business modes of Chinese real property, including high turnover mode. Typically, Country Garden was such a case for using this mode. Thus, with the principle of low-priced land acquisition and rapid development, the purposes of increasing IRR and profit will be achieved.

2. L&P Mode: it embodied as reducing the area of rentable capacity, extending the lease term, and establishing friendly partnerships with government, so it is suitable for commercial real estate projects with the combination of lease and sale. Adopting this mode, real estate projects should pay attention to five factors: stamp duty, lease term, pre-collection gross profit rate, rentable floor area with plot ratio calculation, and VAT rate (service). For instance, the development mode of Wanda in China may give a solid proof. It gains strong supports from the government despite high taxes, thus acquiring core areas at low price, attracting merchants through low rents, offering job opportunities for the area and further improving the business development level and the city image. Attracting merchants firstly, then building an order-oriented commercial development mode, the project of Wanda may be immediately put into use and build the long-term lease when development is complete, which not only reduces risks but helps money return, which is also a way to make profits by increasing the rental rate (Bond et al. 2019)\cite{2}.

3. H&B Mode: the main performance of this mode is that high initial cost at the early stage and efficient management cooperate with low quarterly growth rate (unit price of sales). It is appropriate for the real estate projects which focus on sales and brands in order to pursue exquisite quality. The projects working with this mode are better to pay more attention to three factors: initial cost, administrative special expense, and quarterly growth rate. Taking the case of China Vanke as an example, this enterprise has always been a leader in residential fields of real estate industry. With the stable and ordered business rhythm, it has won the favor of the household by their great residential management and supporting service (Guo et al. 2019)\cite{12}. Namely that buyers who desire new housing must search for a property with the service flow that meets with their tastes and preferences. (Hayunga and Pace 2019)\cite{5}. Under the context, with high-quality housing and efficient property management, Vanke has built brand effect and formed a specific profit mode.

5. Conclusion
Based on the simulation data of FPICM of real estate project construction investment, this paper adopted three-level selection strategies to find the key factors influencing IRR, and built a regression model for IRR and its relative factors. Thus, a new method is provided for the continuous calculation of IRR and the investigate of the key influencing factors on IRR. Specifically, relying on the weights of various factors, three factors have the strongest impacts on IRR, that is, land transfer fee, sales promotion, and stamp tax. According to the combinations of these key factors, three development modes referring to different real estate enterprises are summarized, which are L&H Mode, L&P Mode, and H&B Mode. The research findings may provide a set of methods for management science in terms of the development mode selection for data-driven real estate projects. Also, there are still some limitations in the present study. For instance, the developed regression model did not have a quite good performance, so future study can consider to adopt other approaches such as the nonlinear regression analysis. Furthermore, in consideration of multiple factors, like the type of enterprise, an
intelligent selection and decision making system could be developed for the development mode of real estate.

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