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THE IMPACT OF ADMINISTRATIVE CHARACTERISTICS AND RESIDENTIAL TYPES ON INCOME CAPITALIZATION RATES IN TAIPEI, TAIWAN

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ABSTRACT

This paper examines several factors that impact income capitalization rates, and applies the hierarchical linear model as an analytical method. The empirical results suggest that: (1) the average income capitalization rates in different administrative areas of Taipei vary widely; (2) differences in attributes and types of residential properties have a significant impact on income capitalization rates; (3) the influence coefficients in different administrative areas show significant variation; (4) population density has a significantly negative impact on an income capitalization rate and (5) the proportion of commercial property in a given district has a significantly positive impact on income capitalization rate.

Keywords: Income capitalization rate, Residential types, Hierarchical linear model, Random effect, Administrative areas, Population density.
JEL Classification: A20, R23, R30.

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1. INTRODUCTION

The adjustment of income capitalization rates in Taiwan has long been a largely subjective process based on the past experience of appraisers. This is a questionable practice. Therefore, a rigorous and objective measurement model for estimating income capitalization rates is desirable to provide consistency to the process, resolve disputes, and help to reduce appraiser moral hazard and personal subjective judgments.

The housing market includes a number of sub markets, according to homogeneity type. Taking these divisions into account can improve the accuracy of estimates of real estate values and can play an important role in the analysis and decision-making process regarding real estate investments. Nelson and Rabianski (1988) indicated that division into homogeneous housing sub markets using consumers' preference to the house similarity might help to estimate the price of the property. Bourassa *et al.* (2003) suggested that division into different housing sub markets could improve the reliability of housing market data and reduce the biased error of the hedonic price model in price estimates. Dokko *et al.* (1991) proposed that location differences have a significant impact on rates of return on real estate. Sivitanidou and Sivitanides (1999) argued that income capitalization rates are affected by regional effects, time-variance regional effects and nationwide capital and economic effects.

Hendershott and Turner (1999) investigated the residential and commercial real estate market in Stockholm, Sweden, and suggested that the different types of real estate may affect income capitalization rates. The empirical

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results obtained by Pivo and Fisher (2011) showed that residential, industrial, office space and retail store real estate are negatively correlated to property age, and income capitalization rate, and area is significantly positively correlated with return rate. Empirical results obtained by Peng (2013) indicate that building characteristics, as well as the area of industrial, office and retail store properties have significantly negative impacts on income capitalization rates. Obviously, residential attributes, type and location have an important impact on the income capitalization rate of properties.

The hedonic price model is widely used in research literature to estimate the price of real estate. However, in such studies impact factors are considered as independent variables, and error term is assumed to be independent identical distribution (IID). The most important assumption in a traditional regression analysis is that of independence. When the impact of independent variables on the dependent variables is from group characteristics (such as companies or schools) rather than individual characteristics, hierarchical differences will be neglected, and the impact may inadvertently be classified into the same hierarchy, resulting in inaccurate inference results. Case and Mayer (1996) indicated that the space location of housing is unique, and the regional characteristics of the housing cannot be duplicated. Thibodeau (1998) proposed that the result of parameter estimation in hedonic price calculation models may be biased when space autocorrelation is inaccurate. The independent variable in the model has an incorrect coefficient, resulting in a false conclusion.

The hierarchical linear model (HLM) is useful for solving the above issues: it can independently take into account the individual sub-hierarchy units (employees, students or individual houses) of each hierarchy unit (companies, school or region), and the independent variables are then classified into different hierarchies to further examine their impact on dependent variables. As the individual residential houses are located in administrative areas, a two-level HLM is used for estimation: the first level consists of individual residential houses, and the second level consists of administrative areas.

Income capitalization rates can facilitate the price estimation of real estate and give a glimpse of housing price bubbles. However, price estimation in Taiwan has historically been focused on the market comparison method as opposed to theory-based income methods. At the same time, the National Association of Appraisers does not disclose income capitalization rates, and thus the persons concerned cannot know the impacts of residential houses and hierarchy on income capitalization rates. The purposes of this study are: 1) to discuss how and why the average income capitalization rates vary significantly by administrative district; 2) to discuss the impact of residential property characteristics (e.g., area, floors, number of floors, age, age square and residential types) on income capitalization rates, as well as whether the influence coefficient shows significant variation in different administrative areas; and 3) to discuss the immediate cross-level impact of characteristic variables (e.g., number of department stores, population density, area proportion of business district and public facilities) of the administrative areas on income capitalization rates.

2. LITERATURE REVIEW

DiPasquale and Wheaton (1996) indicated that the income capitalization rate is the income rate of the current period that the residential house investors intend to hold the property. For the purposes of this study, the income capitalization rate has the same meaning as income rate.

Research on income capitalization rates can be divided into the macro approach and micro approach. The macro approach focuses on large cities and/or changes with time series, such as Chen *et al.* (2004); Hendershott and MacGregor (2005); Froland (1987); Clayton *et al.* (2009); Chaney and Hoesli (2012); Chervachidze *et al.* (2010); Plazzi *et al.* (2010); Elliehausen and Nichols (2012) with the impact factors of stock market, government bond interest rate, loan rate, tax system, economic growth rate, inflation rate, GDP and investor emotional factors.

The micro approach emphasizes the impact of the characteristic change of real estate on income capitalization rate, such as Peng (2013); Pivo and Fisher (2011); McDonald and Dermisi (2008;2009); Leung (2004); Chen *et al.* (2004); the impact factors being location, residential type, age, area, housing vacancy rate, and rent growth rate. Elliehausen and Nichols (2012) analyzed over 8000 samples of offices between 2001 and 2009 in the Real Capital Analytic (RCA) database to find the relationship between the capitalization rate and macro fundamentals, property characteristics, type of buyers, type of sellers and local market conditions. The empirical results show that macro fundamentals and local market conditions can explain changes in capitalization rate. In the actual market, macro factors and individual factors are important influences on capitalization rate.

This study is focused on the micro approach of analysis. Phillips (1988) analyzed the income capitalization rate of 12 metropolitan areas in the U.S. between 1974 and 1979. The empirical results show the income capitalization rate of the 12 metropolitan areas significantly varied. Many research studies suggested cap rates of different locations or submarkets in the metropolitan areas may have different space factors (Grissom *et al.*, 1987; Hartzell *et al.*, 1987; Saderion *et al.*, 1994; Sirmans *et al.*, 1996). Gunnelin *et al.* (2004) found that suburban areas have higher discount rates and vacancy rates, and lower market rent. Netzell (2009) confirming the findings of Gunnelin *et al.* (2004).

Saderion *et al.* (1994) analyzed information of 500 apartment complexes in Huston between 1978 and 1988, and found that capitalization rate may differ due to apartment conditions, such as area, age and region. That study also indicated distance of the apartment complexes to the downtown and apartment age are positively correlated with capitalization rate. However, the impact of distance is smaller compared that of property age.

Hendershott and Turner (1999) analyzed 403 transactions in Stockholm, Sweden between 1990 and 1992, in which capitalization rates were estimated under constant-quality, and suggested cap rate will increase with increase of use density. The study found that the cap rates of apartments are lower than those of commercial properties, those of offices are lower than those of retail properties, and those of better regions are lower than those of depressed regions.

Janssen *et al.* (2001) analyzed data from 351 income properties in downtown Stockholm between 1992 and 1994, as provided by the Swedish Land Data Bank System, and established a hedonic equation of rent and price to estimate cap rates of the transactions, and then used OLS (ordinary least squares) and RLMS (reweighted least median squares) to estimate and compare whether the implicit prices of the properties differed between dissimilar estimation methods. The empirical results showed that the greater the age of the apartment, the higher the cap rate, because the requirement of substantial maintenance costs and a shorter service life decrease the property value. The risk is increased, and, thus, cap rates are higher.

Leung (2004) conducted empirical analysis using the multiple-regression model to study the cap rates of different types of properties (residential, office, retail stores and industrial properties) against building characteristics and location. The empirical results show the building characteristics of the properties, namely those of age and the top floor, have a significantly positive impact on cap rates, and "age squares of properties", "1F", "number of floors" and "living area" have a significantly negative impact on cap rates.

McDonald and Dermisi (2008;2009) investigated sales data of 132 offices in Chicago between 1996 and 2007. The empirical results showed lower risk-free interest rate, Class-A offices, newer buildings, building renovation and decrease in market housing vacancy rate reduce cap rates. Pivo and Fisher (2011) discussed the relationship between return rate and property characteristics: the empirical result showed that the age of properties is significantly negatively correlated with the return rate, and area is significantly positively correlated with return rate; Peng (2013) studied how cap rates of US properties (residential, industrial, office and retail properties) are affected by property characteristics. The empirical results show age of the properties has significantly positive impact on cap rates, and the living area of the properties has significantly negative impact on cap rates.

3. RESEARCH METHOD

The samples for social sciences research are characterized by their nested structure. For example, the organization hierarchy has an organization hierarchy construct, and micro hierarchy has a micro hierarchy constructs. The two constructs are interacted, thus resulting in contextual effects and cross-level interactions. Houses are located in a region, and therefore, housing price data has a nested structure. This indicates that the residential characteristics are nested within region (Jones and Bullen, 1994; Goodman and Thibodeau, 1998; Orford, 2000).

The HLM can solve the contextual effects and cross-level interaction neglected by the general linear and structural equation models (Wen and Chiou, 2009). Due to the nested structure of housing data structures, the HLM has been applied in conducting housing price research. Brown and Uyar (2004) used HLM to discuss the impact of residential characteristics and adjacent area characteristics on housing price. Nguyen (2010) analyzed the impact of urban sprawl on social capital, and used a three-level HLM for empirical analysis. Brisson and Usher (2007) used the HLM to analyze the relationship between social capital and property ownership in low-income districts; Lee (2009); Lee (2010); Lee and Ton (2010); Lee and Lin (2012) and Lee *et al.* (2013) applied the HLM to estimate housing price.

3.1. Setting the Empirical Model

The three sub-models of HLM are used to examine whether income capitalization rates in the 20 administrative areas in Taipei exhibit regional differences and to study the impact of characteristic variables and housing characteristics on income capitalization rates. In this study, the selected explanatory variables include age of property (AGE), age squares of properties (AGE2), living area (AREA), located floor (FLOOR), number of floor levels (TFLOOR), housing type1 (TYPE1) (indicate buildings) and housing type2 (TYPE2) (suites). The macro-level characteristic variables include area proportion of public facilities (FACILITY), number of department stores (STORE), area proportion of commercial districts (COMMERCE) and population density (PEOPLE).

3.1.1. Null Model

First, the null model analysis is conducted. The null model can be used to test whether the income capitalization rate of the groups varies and estimate how many variances in total are caused by inter-group variance. Further, preliminary information is provided as reference in comparison of other models (Kreft and De Leeuw, 1998). The models are set as follows:

Level 1:

$$CAP_{ij} = \beta_{0j} + r_{ij}, r_{ij} \sim N\left(0, \sigma^2\right) \quad (1)$$

Level 2:

$$\beta_{0j} = \gamma_{00} + \mu_{0j}, \mu_{0j} \sim N\left(0, \tau_{00}\right) \quad (2)$$

The null model is derived by adding equation [2] to equation [1] as follows:

$$Mixed: CAP_{ij} = \gamma_{00} + \mu_{0j} + r_{ij} \quad (3)$$

where CAP_{ij} is the price of the i^{th} house in administrative area j; β_{0j} is the group mean of the housing prices in the j^{th} administrative area; σ^2 is the variance of the error term, r_{ij} (i.e., variances within groups); γ_{00} is the grand mean

income capitalization rate for all of the dwellings in the sample; and the error term, u_{0j} represents the random effects associated with administrative area j and is assumed to have a mean zero and variance of τ_{00}.

This is the standard one-way ANOVA model with mean γ_{00} with an administrative area effect u_{0j} and a house effect r_{ij}. Therefore, it is possible to treat equation (3) as an ANOVA model when examining whether there are variances in the average income capitalization rate in the respective administrative area. In other words, it is used to validate "the differences between individual income capitalization rate and the average income capitalization rate of the administrative areas. If the variance between groups, the random component, yields a significant test result, the average income capitalization rate differs between administrative areas. Therefore, it is necessary to consider differences between administrative areas. If the test result is not significant, it is acceptable to ignore the differences between the administrative areas. This operation implies that the data can be treated as a single level and can be estimated with equation (1). However, if there are differences in the average income capitalization rate of respective administrative areas, it is necessary to use equation (3) so that different regression equations are applied for respective administrative areas.

In the null model, $Var(P_{ij}) = Var(u_{oj} + r_{ij}) = \tau_{00} + \sigma^2$. If $\rho = \tau_{00} / (\tau_{00} + \sigma^2)$, ρ is called the intra-class correlation coefficient (*ICC*) or cluster effect (Raudenbush and Bryk, 2002). The *ICC* measures the proportion of variance in the dependent variable that is accounted for by the group (i.e., level 2 units). This coefficient shows the proportion of variance in income capitalization rate that is attributable to differences at the administrative areas level. For example, this paper uses the intra-class correlation coefficient (*ICC or ρ)* to represent the variance between the factors that influence income capitalization rate in administrative areas as a percentage of the total variance of income capitalization rate. As soon as the variances of the average income capitalization rate of different administrative areas are confirmed, further discussion of the variables concerning administrative areas, which can explain such variances, becomes possible.

3.1.2. Random Coefficients Regression Model

When the null model confirms that the inter-group variation in dependent variables is significant, the explanatory variables of house characteristics are added at the micro level, including living area (*Area*), house age (*Age*), age squares of houses (AGE2), located floor (FLOOR), number of floors, type1 (TYPE1), and type2 (TYPE2) and setting the intercept and slope as random effects. The purpose of doing so is to test whether the variation of intercepts and slopes between groups is significant. The model settings are as follows:

Level 1:
$$CAP_{ij} = \beta_{0j} + \beta_{1j} AREA_{ij} + \beta_{2j} FLOOR_{ij} + \beta_{3j} TFLOOR_{ij} + \beta_{4j} AGE_{ij} + \beta_{5j} AGE2_{ij} + \beta_{6j} TYPE1_{ij} + \beta_{7j} TYPE2_{ij} + r_{ij}, r_{ij} \sim N(0, \sigma^2) \quad (4)$$

Level 2:

$$\beta_{\ell j} = \gamma_{\ell 0} + \mu_{\ell j}, \mu_{\ell j} \sim N(0, \tau_{\ell\ell}), \ell = 0,1.....,7 \quad (5)$$

Eq. (5) is substituted into Eq. (4), and the mixed model is as follows:

$$CAP_{ij} = \gamma_{00} + \gamma_{10}AREA_{ij} + \gamma_{20}FLOOR_{ij} + \gamma_{30}TFLOOR_{ij} + \gamma_{40}AGE_{ij} + \gamma_{50}AGE2_{ij} + \gamma_{60}TYPE1_{ij} + \gamma_{70}TYPE2_{ij} + \mu_{0j} + \mu_{1j}AREA_{ij} + \mu_{2j}FLOOR_{ij} + \mu_{3j}TFLOOR_{ij} + \mu_{4j}AGE_{ij} + \mu_{5j}AGE2_{ij} + \mu_{6j}TYPE1_{ij} + \mu_{7j}TYPE2_{ij} + r_{ij} \quad (6)$$

No level 2 explanatory variable (administrative areas characteristics) is added in the random coefficients regression model, and only the impact of level 1 explanatory variables (house characteristics) on dependent variables is taken into consideration. In the proposed model, level 1 variables will be added to understand whether level 1 explanatory variables have a significant impact on dependent variables. A significant level of random error variance means the marginal values of level 1 house characteristics are not fixed but random, indicating there are other factors of influence causing the differences in income capitalization rate in various administrative areas.

3.1.3. Intercepts-as-Outcomes Regression Model

In the intercepts-as-outcomes regression model, the level 1 intercept serves as the level 2 outcome variable, and the level 2 characteristic variable is substituted into the model. The level 2 administrative area characteristic variables include number of stores (STORE), area proportion of commercial area (COMMERCE), population density (PEOPLE), and area proportion of public facilities (FACILITY). The model setting is as follows:

Level 1:

$$CAP_{ij} = \beta_{0j} + \beta_{1j}AREA_{ij} + \beta_{2j}FLOOR_{ij} + \beta_{3j}TFLOOR_{ij} + \beta_{4j}AGE_{ij} + \beta_{5j}AGE2_{ij} + \beta_{6j}TYPE1_{ij} + \beta_{7j}TYPE2_{ij} + r_{ij}, r_{ij} \sim N(0, \sigma^2) \quad (7)$$

Level 2:

$$\beta_{0j} = \gamma_{00} + \gamma_{01}STORE_{1j} + \gamma_{02}PEOPLE_{2j} + \gamma_{03}COMMERCE_{3j} + \gamma_{04}FACILITY_{4j} + \mu_{0j}$$
$$\beta_{\ell j} = \gamma_{\ell 0} + \mu_{\ell j}, \ell = 1,2\cdots\cdots,7 \quad (8)$$

A mixed model can be obtained by substituting Eq. (8) into Eq. (7). This model can be used to test: 1) whether the level 1 explanatory variables affect income capitalization rate of the properties, and whether the coefficients are random, namely whether coefficients in the administrative areas differ; 2) whether the level 2 characteristic variables have a direct impact on income capitalization rate.

3.2. Variable Setting and Explanations

The variables selected for this study are defined in Table 1. The rent and price hedonic equation is used to evaluate income capitalization rate. The dependent variable of the rent hedonic equation is the annual rental income, which is equal to the one-year rent plus deposit interests in the leases. The dependent variable of the price hedonic equation is the total transaction price of houses. The selected independent variables in this study include located floor, number of floors, age, age squares, residential type and location to control heterogeneity of individual house characteristics and regional characteristic difference to calculate the income capitalization rate of houses. The location includes 20 administrative areas of Taipei. The Wanhua District serves as reference base, and 19 dummy variables are set.

Next, the HLM is used to analyze factors affecting income capitalization rate. The level 1 independent variables include age of property, age squares, area, located floor, number of floors and residential type. The level 2 characteristic variables include number of department stores, population density, area proportion of the commercial area, and area proportion of public facilities.

3.2.1. Level 1 Variables

As for age of property, the impact of building depreciation on income capitalization rate is considered. Peng (2013) discussed the impact of income capitalization rate of the different US properties (residential, industrial, office and retail store properties) between 1980 and 2012 as it is affected by property characteristic. The empirical results show that the age of residential and retail store properties have a significantly positive impact on income capitalization rate. Specifically, the income capitalization rate is significantly positively correlated with property age (Saderion *et al.*, 1994; Leung, 2004; McDonald and Dermisi, 2008). It is expected that property age has a positive impact on income capitalization rate. The empirical results by Geltner and Fisher (2007); Smith (2004); Malpezzi *et al.* (1987) and Cannaday and Sunderman (1986) show depreciation may present nonlinear change with an increase in property age. The age of a property and its income capitalization rate may have a nonlinear relationship, and thus the age square of property is added. It is expected that the age squares of properties have a negative impact on income capitalization rate.

Saderion *et al.* (1994) indicated that income capitalization rate may differ due to apartment conditions such as living area, age and location. Peng (2013) suggested that industrial areas, offices and retail store properties have a significantly negative impact on income capitalization rate. Leung (2004) studied impact factors of Hong Kong's income capitalization rate and found that income capitalization rates of residential or retail, industrial, and office properties are significantly negatively correlated with area. It is anticipated that area has a negative impact on income capitalization rate.

Leung (2004) found the income capitalization rate of retail properties is significantly negatively correlated with whether or not the house is located on 1F. In this study, whether or not the house is located on 1F is set as dummy variable. The dummy variable is set as 1 if it is located on 1F, and 0 if it is not. It is expected that the located floor has a negative impact on income capitalization rate.

Hendershott and Turner (1999) proposed that income capitalization rate might increase with an increase in use density. More floors have a positive impact on income capitalization rate. In relation to this, the empirical results by Leung (2004) indicated the income capitalization rate of residential properties is significantly negatively impacted by the number of floors. Pivo and Fisher (2011) argued that with unchanged building technology, the building costs increase with increased building area, and the building area per unit is lower. This implies that the number of floors is more, and the income capitalization rate is lower. It is expected that the impact of number of floors on income capitalization rate is not confirmed.

Hendershott and Turner (1999) suggested property type may affect income capitalization rate, and the income capitalization rate of commercial properties is greater than that of residential properties. It is expected that the income capitalization rate of suites is the highest, followed by apartments and buildings. The residential types have two dummy variables. Apartments serve as a benchmark. If the type is building, the variable is set as 1, and if not, it is set as 0. It is expected the coefficient is negative; if the type is suite, it is set as 1, and if not, it is set as 0. It is expected that the coefficient is positive.

3.2.2. Level 2 Variables

For a given administrative area, the greater the amount of commercial area that is planned, the higher the development potential. However, in some administrative areas there is a gap between commercial area planning and actual development. In this study, the number of department stores within the administrative areas represents the commercial scale. The higher the number of department stores, the greater the commercial scale of the administrative area. This can promote business district area prosperity and provide greater convenience for residents in entertainment and shopping. Furthermore, the department stores are often located in areas with complete commercial

facilities. This means high use density of the commercial area, which can result in a rise in house values. In this study, the greater the number of department stores, the smaller the income capitalization rate.

The empirical results by Sivitanidou and Sivitanides (1999) show that population growth has significant negative impact on income capitalization rate. The empirical results by Ebertz (2008) show that growth rate and population density have a significantly positive impact on land price. The higher the population density, the greater the demand for residential houses, and the lower the income capitalization rate is predicted to be. It is expected that population density has a negative impact on income capitalization rate. In this study, population density is defined as population per kilometer in each administrative area.

Sivitanidou and Sivitanides (1999) found that the average income capitalization rate of metropolitan areas is positively correlated with the central business district (CBD). The proportion land in the commercial area represents the use status of planned land. Generally, floor area ratio and coverage ratio of commercial areas are higher than that of residential areas. Also, the price of land in commercial areas is higher than that of residential areas. Additionally, the larger (percentage-wise) the total commercial area, the higher the economic efficiency. It is expected that the impact on income capitalization rate is negative if the percentage of the commercial areas is higher. In this study, the proportional area of commercial areas is measured by the proportion of the commercial area in the urban development zone.

Table-1. Description of variables at different levels in HLM

Variable		Expected sign	Description
Dependent variable			
CAP			Income capitalization rate, expressed by annual rent /total transaction price (%)
Level 1 independent variable			
AGE		+	House age, referring to the period from the completion of the house or the registration of the house to 2011.
AGE2		--	Age squares of property
AREA		--	House area, the area of a house as registered with land authorities (including major construction, additions, public facilities, parking spaces (covered regardless of whether it is an independent parking space or not). A ping is a unit of measurement (1 ping= 35.5833 square feet)
FLOOR		--	Residential floors. This is set as a dummy variable, representing the registered number of floors in the house. In the case of one floor, it is set as 1, otherwise, it is set as 0.
TFLOOR		+/--	Number of floors, expressed by number of floors on the ground.
TYPE1		--	Residential type 1, type including building, apartments and suites. The apartments serve as benchmark. If the type is building, it is set as 1 and if not, it is 0.
TYPE2		+	Residential type 2, if the type is suites, it is set as 1, and if not, it is 0.
Level 2 characteristic variable			
STORE		--	Number of stores, number of stores in each administrative area.
PEOPLE		--	Population density, number of people per kilometer in each administrative area
COMMERCE		--	Area proportion of commercial area, area proportion (%) of the commercial area in urban development zone in each administrative area
FACILITY		--	Area proportion of public facilities, area proportion (%) of public facilities in urban development zone in each administrative area

Source: This table aggregated by author.

The greater the number of types and total area of public facilities, the greater the city scale is, and, correspondingly, the quality of life increases, and an environment and social price premium arises. This can reduce investment risk. Ebertz (2008) studied the effect of public service and facilities on price capitalization in a district of

Germany. The empirical results show pubic traffic, hospitals, doctors and entertainment have a positive impact on housing price, while higher levels of precipitation and crime have an inverse impact on housing price. It is expected that the proportional area of public facilities has a negative impact on the income capitalization rate. In this study, land considered in use as public facilities include roads, park green space, plazas, schools, parking lots, children playground, markets, stadiums, schools, social educational institutions, medical care institutions and offices. It is measured by using proportional area of public facilities in the urban development zones.

4. DATA COLLECTION AND DESCRIPTION OF SAMPLE STATISTICS

4.1. Data Collection

This study investigated the suites, apartments and buildings in Taipei between 2008 and 2011. The rent and characteristic data were collected from the landlord database of the Tsuei Ma-Ma Housing Center between 2008 and 2011, totaling to 19,173 housing units. The housing price and characteristic data were collected from rehouses transaction data of the "Taiwan Real Estate Transaction Center", totaling to 24,491. The Taiwan Real Estate Transaction Center provided transaction data for query since 2005. The data were collected from performance bond transactions of famous real estate agents across Taiwan, including Sinyi, Pacific Rehouse, Century 21, Chinatrust Real Estate, H&B Business, DFF Housing, Good Morning Housing, ERA, Ever Spring Real Estate and Chiau-Mau Realty. The data for proportional area of public facilities and commercial areas were collected from the average data between 2008 and 2011 issued by the Bureau of Urban Development, Taipei City Government, Bureau of Urban Development, New Taipei City Government, and Construction and Planning Agency. Data for population density were collected from Taipei city's statistical database and New Taipei City's statistics, issued between 2008 and 2011. Data concerning the number of department stores were collected from average data of annual promotional events of department stores from the Yahoo.com website between 2008 and 2011 (http://tw.myblog.yahoo.com).

4.2. Description of Sample Statistics

In this study, the income capitalization rate is expressed by rent divided by housing price. However, the rent and price of a given house can be difficult to obtain at the same time. Further, houses are heterogeneous products: each building has its own, unique characteristics. Thus, quality control is an important link in the discussion of price and rent. In the discussion of constant quality, the repeat sales method and hedonic price methods are used. Repeat sales data is not easily obtained. As a result, most studies apply the hedonic price method to discuss housing price. In lease and transaction cases, the hedonic price method is used to control constant quality and heterogeneity to estimate standard rent and housing prices, and the extraction method is used to determine the income capitalization rate of each house. The independent variables include age of property (AGE), age squares of property (AGE2), number of floors (TELOOR), area (AREA), located floor (Floor), residential types (TYPE 1 and TYPE 2) and location (LOC). *F* estimated by housing hedonic price equation and hedonic rent equation is 2,942 and 1,654 respectively. R^2 is 0.758 and 0.692, respectively, showing the good fit of the two models and high ability to explain variation.

From the Level 1 variables in the Table 2, average income capitalization rate is 2.72%; the average area is 29.4 ping (1 ping= 35.5833 square feet); the average number of floors is 8.99; the average age of properties is 21.69 years; only 2039 houses are located on 1F, accounting for 8.33%, and other floors above 1F account for 91.67%. For residential type, buildings are 11850, accounting for 48.39%; suites are 1895, accounting for 7.74%, and apartments account for 43.87%. From the Level 2 variables in Table 3, average number of stores is 1.65; average population density is 16287.25; average proportional area of the commercial districts is 16.78%, and average proportional area of the public facilities is 49.35%.

Table-2. Descriptive statistics for Level 1 variables (N=24491)

Variables	Mean	S.d.	Min.	Max.	Count	%
Continuous variables:						
CAP	2.72	1.13	1.40	10.48		
AREA	29.40	13.03	4.51	225.11		
TFLOOR	8.99	5.46	3.00	43.00		
AGE	21.69	11.25	0.08	50.00		
AGE2	529.27	468.56	0.01	2840.89		
Nominal variables:						
FLOOR	0.08	0.28	0.00	1.00	2039	8.33
TYPE1	0.48	0.50	0.00	1.00	11850	48.39
TYPE2	0.08	0.27	0.00	1.00	1895	7.74

Source: This table aggregated by author.

Table-3. Descriptive statistics for Level 2 variables (N=20)

Continuous variables:	Mean	S.d.	Min.	Max.
STORE	1.65	2.03	0.00	7.00
PEOPLE	16287.25	10250.54	2077.03	40671.01
COMMERCE	16.78	14.36	0.00	49.98
FACILITY	49.35	13.06	32.03	75.74

Source: This table aggregated by author.

5. EMPIRICAL RESULTS AND ANALYSIS

5.1. Null Model

This paper uses the null model to test the variation in "mean income capitalization rate" between various administrative areas. As shown in Table 3, in terms of fixed effects, the average γ_{00} estimated value of the mean income capitalization rate of various administrative areas is 2.751. In terms of random effects, the estimated value of τ_{00} is 0.397, and the statistics of χ^2 is 9891.321, the degree of freedom is 19 (J =20 administrative areas), reaching a significance level of 1%. This result indicates that the mean income capitalization rate varies significantly in various administrative areas. By the variance τ_{00} in the administrative areas mean price β_{0j} and the micro-level intra-group variance σ^2, we can calculate the intra-group correlation coefficient $\rho = \tau_{00}/(\tau_{00}+\sigma^2)$ =0.397/(0.397+0.916) =0.302. According to the criteria proposed by Cohen (1988) it is a strong correlation, indicating that 30.2% of the variance in the mean capitalization rate is caused by administrative area differences; therefore, general regression models cannot be used for estimation and differences caused by various administrative area characteristics should be considered.

Table-3. Analysis results of the Null Model

Fixed effects	Coe.	S.E.	t -ratio	p-value
Total mean CAP, γ_{00}	2.751^{***}	0.141	19.512	0.001
Random effects	Variance	d.f.	Chi-square	p-value
β_{0j}, τ_{00}	0.397^{***}	19	9891.321	0.001
Level 1 σ^2	0.91604			
Deviance (-2LL)	67476.149			
Number of estimated parameters	3			

Notes: * indicates p<0.1, * * indicates p<0.05, * * * indicates p<0.01

5.2. Random Coefficients Regression Model

This model is used to test change of Level 1 intercepts and slopes in the administrative areas. The coefficient of the age squares of the properties is not random.

The fixed effect in Table 4 shows the estimated value of the level 1 "area" coefficient γ_{10} is -0.0421, and the estimated value of "located floor" coefficient γ_{20} is -0.4012. Both values reach 1% of significance level. The estimated value of the "number of floors" coefficient γ_{30} is 0.0049, which reaches 10% of significant level. The estimated value of "age of properties" coefficient γ_{40} is 0.0175, and "age square of properties" coefficient γ_{40} is -0.0010. Both values reach 1% of significance level. The estimated value of "residential type 1" coefficient γ_{60} is -0.0899, reaching 5% of significance level; the estimated value of "residential type 2" coefficient γ_{70} is 1.1435, reaching 1% of significance level. The detailed explanation of Level 1 independent variables for detailed income capitalization rate is described in the intercepts-as-outcomes regression model.

The random effect of Table 5 shows variance τ_{00} of income capitalization rate in various administrative areas is 2.440, reaching 1% of significance level. This reveals that the income capitalization rates of various administrative areas have significant difference after the explanation of Level 1 independent variables is controlled. The variance τ_{11} of estimated value of "area of properties" coefficient is 0.0008, the variance τ_{22} of estimated value of "located floor" coefficient is 0.0682, the variance τ_{33} of estimated value of "number of floors" coefficient is 0.0001, the variance τ_{44} of estimated value of "age of properties" is 0.0001, the variance τ_{66} of estimated value of "type 1" is 0.0242, and variance τ_{77} of estimated value of "type 2" coefficient is 0.8856, all reaching 1% of significance level. This reveals that impacts of level 1 independent variables on income capitalization rates show significant difference in various administrative areas. In other words, coefficients of Level 1 independent variables are random.

σ^2 of the null model in Table 4 is 0.9160. σ^2 of the random coefficients regression model in Table 4 is 0.3374, decreased by 63.17% (R^2 =(0.9160-0.3374)/ 0.9160=63.17%). This reveals that income capitalization rate in various administrative areas has decreased by 63.17% of variation after introduction of Level 1 independent variables.

Additionally, deviance of the null model is reduced from 67476.149 to 43246.946 in the random coefficients regression model. The chi-square statistics for differences of the two models is 24229.203, which conform to chi-square distribution with freedom of 34(37-3=34). In 5% of significance level, the critical value is 48.6, reaching significance level. This reveals the goodness of fit of the random coefficients regression model is better than the null model.

Table-4. Analysis results of the random coefficients regression model

Fixed effects	Coe.	S.E.	t -ratio	p-value
Total mean CAP, γ_{00}	4.177228***	0.32842	12.719	0.001
AREA γ_{10}	-0.042123***	0.006554	-6.427	0.001
FLOOR γ_{20}	-0.401161***	0.058772	-6.826	0.001
TFLOOR γ_{30}	0.004931*	0.002383	2.069	0.052
AGE γ_{40}	0.017533***	0.005583	3.141	0.006
AGE2 γ_{50}	-0.000984***	0.000163	-5.822	0.001
TYPE1 γ_{60}	-0.089884**	0.038215	-2.352	0.030
TYPE2 γ_{70}	1.143509***	0.206738	5.531	0.001
Random effects	Variance	d.f.	Chi-square	p-value
β_{0j}, τ_{00}	2.44020***	18	4172.004	0.001
AREA τ_{11}	0.00084***	18	6414.54	0.001
FLOOR τ_{22}	0.06818***	18	308.5385	0.001
TFLOOR τ_{33}	0.000008***	18	80.53978	0.001
AGE τ_{44}	0.000003***	18	159.7213	0.001
TYPE1 τ_{66}	0.02416***	18	98.07863	0.001
TYPE2 τ_{77}	0.88564***	18	2364.655	0.001
Level 1 σ^2	0.33737			
Deviance (-2LL)	43246.94551			
Number of estimated parameters	37			

Notes: * indicates p<0.1, ** indicates p<0.05, *** indicates p<0.01

5.3. Intercepts-as-Outcomes Regression Model

In this model, Level 1 regression model is set as full model. In the Level 2 regression model setting, Level 1 linear regression intercepts are used as outcome variables of Level 2, and other Level 1 slope is random. In this model, the Level 2 characteristic variable and Level 1 explanatory variable can be used to effectively and directly affect income capitalization rate in various administrative areas.

The fixed effect of Table 5 shows that the estimated value of Level 2 "population density" coefficient γ_{02} is -0.0001, which reaches 1% of significance level. In other words, the higher the "population density" in the administrative areas, the lower income capitalization rate. This matches the expectations of this study. The higher density of people, the greater demand for residential houses. The empirical results by Sivitanidou and Sivitanides (1999) show that the growth rate of the population has a significantly negative impact on income capitalization rate. The estimated value of "area proportion of commercial district" coefficient γ_{03} is 0.0157, reaching 1% of significance level. Namely, the larger, "area of the commercial district" is, the higher the income capitalization rate. This is opposite to the expectations of this study. The "area proportion of commercial district" is higher, but these may be old commercial districts (such as Datong and Wanhua districts) in Taipei, where development and commercial activity

are in decline. That is, they are commercial districts but are no longer prosperous. Accordingly, the impact of number of stores and area proportion of public facilities on income capitalization rate fails to reach significance level.

The estimated value of Level 1 "area of properties" coefficient γ_{10} is -0.0422, and estimated value of "located floor" coefficient is -0.4004. Both values reach 1% of significance level. This meets the theoretical expectation of this study. The larger the "area of properties", the lower the income capitalization rate. The empirical results of many studies have shown that the area of industrial, office and retail properties has a significantly negative impact on income capitalization rate (Leung, 2004; Peng, 2013). The residential houses on 1F are convenient to use for residential and commercial purposes. The holding cost is lower, and thus the income capitalization rate is anticipated to be lower. Leung (2004) studied impact factors of Hong Kong's income capitalization rate and found they are significantly negatively correlated with whether the houses are located on 1F. The estimated value of the "number of floors" coefficient γ_{30} is 0.0047, which reaches 10% of significant level. The number of floors has a positive impact on income capitalization rate: the higher the number of floors, the higher the income capitalization rate. Hendershott and Turner (1999) indicated that the income capitalization rate increases with use density: the higher the number of floors, the higher the income capitalization rate. The empirical result supports the opinions of Hendershott and Turner (1999).

The estimated value of "age of properties" coefficient γ_{40} is 0.1762, and "age squares of properties" coefficient γ_{50} is -0.0009. Both reach 1% of significant level. The higher age of properties, the greater the income capitalization rate. Furthermore, increases in the income capitalization rate are smaller with increased property age. The empirical result meets theoretical expectations. As for the age of properties, the impact of building depreciation on income capitalization rate is considered. The payment of substantial maintenance costs and shorter service life cause a dramatic decrease in housing price. Thus, income capitalization rate is expected to be higher. Depreciation may fluctuate in a non-linear trend with the increase property age. Previous studies support this view (e.g. (Cannaday and Sunderman, 1986; Malpezzi *et al.*, 1987; Smith, 2004; Geltner and Fisher, 2007).

The estimated value of "Type 1" coefficient γ_{60} is -0.0554, and reaches 5% of significance level. The estimated value of "Type 2" coefficient γ_{70} is 1.1581, and reaches 1% of significance level. The empirical result shows the income capitalization rate of "buildings" is lower than that of "apartments", and the income capitalization rate of "suites" is higher than "apartments". The income capitalization rates of buildings are lower than those of apartments because the latter were built during early stages of urban development. These properties are older, and they tend to be located in depressed areas, and so risk factors of sanitation, security, management and fire are higher than for buildings. The empirical results by Hendershott and Turner (1999) indicate the income capitalization rate of the better areas is lower than that of the declining areas. In general, suites have higher construction costs and are located in the areas with high land price. Thus, the costs incurred by builders are higher. In addition, the loan to value ratio of suites is not high, and the mortgage interest rate is higher than for buildings and apartments. Suites are high-risk products. Generally, income capitalization rate of suites is the highest, followed by apartments and buildings.

The empirical results of this study indicate that the level 2 variables, "population density", "area proportion of commercial district", and level 1 variables, "age of properties", "age squares of properties", "area", "located floor", "number of floors", "type 1" and "type 2", are the effective variables used for predictive income capitalization rate.

The random effect in Table 5 shows variance τ_{00} of income capitalization rate in the various administrative areas is 2.6024, and reaches 1% of significance level. This reveals that average income capitalization rates still significantly differ in various administrative areas after explanation of the level 1 independent variables is controlled. The variance τ_{11} of estimated value of the "area" coefficient is 0.0008, the variance τ_{22} of estimated value of "located floor" coefficient is 0.0694, the variance τ_{33} of estimated value of "number of floors" coefficient is 0.0001, variance τ_{44} of estimated value of "age of properties" coefficient is 0.0001, the variance τ_{66} of estimated value of "type 1" coefficient is 0.0250, and variance τ_{77} of estimated value of "type 2" coefficient is 0.9613. These values reach 1% of significance level. This indicates that the impacts of the level 1 independent variables on income capitalization rate still significantly differ across various administrative areas.

The deviance of the random coefficients regression model is reduced by 17.459 from 43246.946 to 43229.487 in the intercepts-as-outcomes regression model. The difference in deviance of the two models conforms to chi-square distribution with freedom of 4 (41-37=4). At significance level of 5%, the critical value is 9.48, which reaches significance level. This reveals goodness of fit of intercepts-as-outcomes regression model is better than that of the random coefficients regression model.

Table-5. Analysis results of the intercepts-as-outcomes regression model

Fixed effects	**Coe.**	**S.E.**	**t -ratio**	**p-value**
Total mean CAP, γ_{00}	4.108756***	0.313464	13.108	0.001
STORE γ_{01}	0.015772	0.012442	1.268	0.225
PEOPLE γ_{02}	-0.0000012***	0.000002	-6.272	0.001
COMMERCE γ_{03}	0.01573***	0.003052	5.154	0.001
FACILITY γ_{04}	0.02617	0.001556	1.682	0.113
AREA γ_{10}	-0.042152***	0.006439	-6.546	0.001
FLOOR γ_{20}	-0.400403***	0.058039	-6.899	0.001
TFLOOR γ_{30}	0.004725*	0.002649	1.784	0.090
AGE γ_{40}	0.17619***	0.005603	3.145	0.006
AGE2 γ_{50}	-0.000948***	0.000163	-5.789	0.001
TYPE1 γ_{60}	-0.05541**	0.039714	-2.154	0.044
TYPE2 γ_{70}	1.158116***	0.210022	5.514	0.001
Random effects	Variance	d.f.	Chi-square	p-value
β_{0j}, τ_{00}	2.60235***	14	4571.3945	0.001
AREA τ_{11}	0.00084***	18	6421.1834	0.001
FLOOR τ_{22}	0.06944***	18	308.68266	0.001
TFLOOR τ_{33}	0.00010***	18	79.81348	0.001
AGE τ_{44}	0.00003***	18	158.27281	0.001
				Continue

TYPE1 τ_{66}	0.02501***	18	96.25213	0.001
TYPE2 τ_{77}	0.96130***	18	2391.5828	0.001
Level 1 σ^2	0.33724			
Deviance (-2LL)	43229.4874			
Number of estimated parameters	41			

Notes: * indicates p<0.1, ** indicates p<0.05, *** indicates p<0.01

6. CONCLUSIONS AND SUGGESTIONS

In this study, the hedonic price model and market extraction technique were used to extract the income capitalization rate data, and the HLM was used for empirical analysis. An attempt was made to clarify the income capitalization rate of properties with hierarchical characteristics and restore fundamental price resulting from the use value of properties. This provides an understanding of the difference between market price and fundamental price to, in effect, reduce the investment or purchase risk of houses, and correct the subjective views of appraisers. This study also proposes a more suitable and objective analysis method than those previously employed. In terms of the empirical results, several major conclusions can be made, as follows: first, the average income capitalization rates significantly differ in the administrative areas; second, the residential characteristics, "area", "located floor" and "type 1" have a significantly negative impact on income capitalization rates; "number of floors", "age of properties" and "type 2" have a significantly positive impact on income capitalization rate; third, the "population density" of an administrative area a has cross-level negative impact on income capitalization rates, and "area proportion of the commercial districts" has significantly positive cross-level impact on income capitalization rates. The level 1 intercepts and the impact coefficients are random. Additionally, intercepts and slope coefficients have significant differences across various administrative areas.

6.1. Theoretical Implications

In order to discuss the impact of characteristics of the administrative areas and residential types on income capitalization rates, an empirical model is constructed with HLM. In the past studies, due to statistical research and technology limitations, the hierarchical structure in the data could not be considered. The data with different hierarchical characteristics were regarded at the same level for processing. In various hierarchies, processing of the same hierarchy has no great estimate bias if the hierarchical impacts of high and low levels are not significant. Thus, the estimated parameters may have great deficiency if the inter-hierarchical data differ.

The HLM is a statistical technique developed to identify both micro and macro levels, and inter-group information (at the macro level) is also considered. The HLM is different from the basic assumption of OLS regression. It allows random error to be independent in various groups and to vary across different groups. HLM and OLS are both regression models. However, OLS regards all data as data of the same level. Thus, intercepts and slopes are not affected by errors in high-level variables. Only a fixed effect is used to estimate intercepts and slopes. In HLM, intercepts and slopes in the individual hierarchical regression equation are used as dependent variables at the macro level. Thus, the impact of micro level errors can be considered. Furthermore, the random effect is used to estimate individual hierarchical intercepts and slopes and test whether the variance of residual error is significant. If it is significant, the individual hierarchical (low level) intercepts and slopes are affected by the hierarchy of variables at the macro level (high level).

Hsiao (1986) suggested that the hedonic price indexes at constant quality of the different areas might have bias errors caused by assumptions of the values of the fixed coefficients. In this study, the income capitalization rate is the rate of rent to price. HLM is used to test impacts of characteristics of the different areas and different residential types

on income capitalization rate, and whether the impacts change with different areas and different residential types. As mentioned by Jones (1991) the single level model is used to assume data have no hierarchical characteristics, and change with time or space. Thus, all the correlation variance occurs in single level. In the model setting, geographical and historical difference is not considered, and is the same regardless of location or time. In HLM, micro and macro levels may be simultaneously considered. It is closer to the actual model setting, and also reflects the hierarchical organization in actual life (Orford, 2000). The empirical results show values of the houses may change due to different administrative areas and different residential types. This study suggested considerable bias errors may occur when hierarchical variables in characteristics of different areas and different residential types are neglected in the estimate of income capitalization rate, and when OLS regression is used in making such estimates. Namely, the hierarchical effect of the administrative areas and attribute effect of different residential types are factors in income capitalization rates in the districts of Taipei.

6.2. Practice Implications

In this study, HLM is used to discuss the degree and direction of the impact of different administrative characteristic variables and residential attributes on income capitalization rates. The main purpose is to establish a property income capitalization rate database with transaction data and release cases that can serve as reference for future study or as a basis for house buyers, investors, governments and appraisers in estimating property prices and evaluating risk.

The empirical results indicated a 30% variation in income capitalization rates is caused by differences across various administrative areas. Obviously, the impact of differences in the administrative areas should not be neglected in the adjustment of income capitalization rates. It should be noted that a bias towards one factor is not recommended in adjustment of income capitalization rates. For example, appraisers often pay attention to property characteristics in their assessment of income capitalization rates. Consequently, the problem of appraisal-smoothing occurs. That is, estimated values may not change greatly. Investors pay more attention to macroeconomic change than appraisers. This results in fluctuation of income capitalization rates in accordance with changes in macroeconomic factors.

6.3. Suggestions for Future Studies

In this study, cross-sectional data were used to discuss the impacts of area proportion of public facilities, number of stores, area proportion of commercial districts and population density on income capitalization rates. However, the property macroeconomic variable of time has not been discussed. In future research, time series of income capitalization rates may be collected for establishing the data features in which residential attributes and macroeconomic factors can be obtained at the same time. In the future, the linear growth model can be used to construct an estimation algorithm.

In this study, the income capitalization rate is measured by using the gross income capitalization rate expressed by rent divided by housing price. In the future, the researchers will use total income adjusted by relevant expenses (namely, effective total income as numerator) to increase the accuracy of the estimation of the net income capitalization rate. Income capitalization rates vary with to differences in geographic areas and residential types due to the importance those variations have in the context of local customs and culture. Thus, differences in the income capitalization rate in different cultural areas, such as northern and southern regions will be discussed in the future.

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