INTERNATIONAL REAL ESTATE REVIEW

2019 Vol. 22 No. 1: pp. 109 – 129

# House Price Dispersion in Taipei Residential Communities

**Ying-Hui Chiang**
Assistant Professor of Department of Land Economics, National Chengchi University, Address: NO.64, Sec.2, ZhiNan Rd., Wenshan District, Taipei City 11605, Taiwan (R.O.C.). Email: yinghui@nccu.edu.tw.

**Yuan Ku**
Land Administration Assistant of Hong Qing Conveyancing Office, Email: nccu101103037@gmail.com

**Feng Liu**
Senior Economist of US Bureau of Consumer Financial Protection.*
Email:fengliuecon@gmail.com

**Chin-Oh Chang†**
Distinguished Professor of Department of Land Economics, National ChengChi University, Address: NO.64, Sec.2, ZhiNan Rd., Wenshan District, Taipei City 11605, Taiwan (R.O.C.). Email:jachang@nccu.edu.tw

Due to housing stock heterogeneity, most academic discussions on price dispersion in the housing market have traditionally focused on the search behavior of consumers and neglected the housing and neighborhood characteristics that are related to price dispersion. This study applies a rich empirical data set from Taipei to explore the neighborhood characteristics that are associated with a higher degree of dispersion in housing price and associated likelihood of such. We track the housing transactions at the residential community level, and group the communities based on the coefficient of variation of the transaction prices in each community after controlling for community and housing characteristics. We apply a multinomial logistic regression to examine which neighborhood characteristics are more likely to be associated with higher price dispersion. We find that communities with

* The views expressed here are those of the authors and not necessarily those of the Bureau of Consumer Financial Protection or the United States.
† Corresponding author

higher price levels and built by government agencies are less likely to have high price dispersion, while those that are older, priced lower or have a minimum floor area of 50 pings[1] are more likely to have higher price dispersion.

**Keywords**

Residential Communities, Price Dispersion, Multinomial Logistic Regression

## 1. Introduction

The law of one price dictates that identical commodities or assets should be traded at the same price at around the same time under the same market conditions. In practice, most of the prices of commodities differ even though they are identical. A higher degree of price dispersion, represented by the larger gap between the prices of identical goods, can facilitate the entry of more merchants into the market (Salop and Stiglitz, 1982). Nevertheless, excessive price dispersion may negatively affect market efficiency and operations (Leung et al., 2006).

Real estate properties are highly heterogeneous. There is a well-known saying that no two properties are ever identical. It is not only difficult to appraise the value of a property, but also impossible to judge the reasonableness of the property dispersion without appropriately adjusting for the characteristics of the properties. This paper will address this challenge by focusing on housing transactions in the same residential community because properties in the same neighborhood, as will be explained in detail in the following sections, share many important and common characteristics. For instance, they were built by the same developer and used the same material, and are the same age and under the same management organization, not to mention clustered around the same location. Such similar characteristics within the same neighborhood/ residential community should naturally limit the extent of the price dispersion among the properties, and thus an ideal starting place for our discussion on price dispersion in the housing market.

One potential impact of price dispersion lies in the so-called anchoring effect. Large price dispersions in transaction histories may lead consumers to misjudge the fair value of properties, and such misperceptions of housing value may be anchored in the minds of the buyers, thus causing long term harm. This is the key reason why economists care about price dispersion and its causes. Most relevant studies in the real estate literature have focused on the relationship between price and housing characteristics, based on the value that consumers

[1] 1 ping is equal to 3.305 square meters.

place on each characteristic. With that in mind, this paper explores the types of neighborhoods that tend to have a higher degree of price dispersion within themselves, and link the neighborhood characteristics to the probability that a large price dispersion will occur.

In terms of price dispersion in the housing market, there is an extensive body of literature that focuses on the search behaviors of consumers and the characteristics of buyers and sellers rather than the characteristics of real estate properties. Among a few exceptions, the research on price dispersion of new housing projects by Hsu et al. (2011) shows that properties located in highly valued city areas have lower price dispersion due to the price rigidity associated with superior locations. Bourassa et al. (2009) and Haurin (1988) study different reasons for the price variation within the housing market. The former recognize that the scarcity of properties, which are new, small in size, and located in the city areas, conveys higher bargaining power to the sellers of such units. The latter finds that more atypical dwellings means greater variations in the housing price of such units.

The modern day residential housing market in Taiwan is segmented by communities. The housing units within each community are highly homogeneous; they are either very similar or in many cases, exactly the same. Therefore, it makes sense to form the basic unit of our study on house price dispersion at the community level, because homogeneous products would generally have a lower degree of price dispersion driven by the differences in the search and information cost to consumers (Adams, 1997). After tracking housing unit transactions at the community level, it is natural to then proceed and ask about the neighborhood characteristics that may have contributed to the high price dispersion in cases where certain neighborhoods still have a high degree of price dispersion. Therefore, the purpose of this study is to explore the types of community characteristics associated with the probability of higher price dispersion.

This paper is organized as follows: the first section is the introduction; second section reviews the literature; third section presents the data and model setup; fourth section discusses the empirical results, and fifth section concludes.

## 2. Literature Review

Price dispersion could be the result of the information asymmetry between buyers and sellers (Deng et al. 2012, Burdett and Jude 1983), as well as the bargaining power of the two sides who are sitting at the transactions (Harding et al. 2003). Empirical studies on price dispersion are relatively rare. Of the few, Borenstein and Rose (1994) study the variation in air fares for passengers who take the same flight route by examining an air fare sample of US airlines in the second quarter of 1986. They find that when the competition of the flight route

intensifies or demand for the routes is low, the variations in the air fares offered for the same route increase. Chandra et al. (2017) study the price dispersion in new automobile sales in the North American market and find that price variation increases within certain age and gender groups. In particular, they conclude that older or female buyers contribute to the price dispersion in the new automobile market as they pay a higher price premium than other groups of individuals for the same cars. Burdett and Jude (1983) conclude that price dispersion is not influenced by the short-term cost of production or product features, but rather a long-term phenomenon.

Real estate properties are heterogonous goods that lack liquidity and transact infrequently. As a result, few studies in the literature are found that examine price dispersion in the housing market. (Dang and Yang 2017). Van Nieuwerburgh and Weill (2010) study house price dispersion in the US market between 1975 and 2007. They attribute the house price dispersion to labor force migration. As certain cities grew and other cities declined, the house prices in the inflow and outflow areas move in the opposite directions, which caused an increase in house price variation. Therefore, they consider that house price dispersion is not only influenced by locality and construction costs, but also by the labor productivity of different cities. High price dispersion leads to inflated expectations around transaction price. If price dispersion in the sub-market increases by 1 percent, the final transaction price could see as much as a 20 percent increase according to Deng et al. (2012). If price dispersion becomes excessively high, the housing price may deviate from its fundamental value. Shen et al. (2014) find that with such higher deviations, the risk of banks that face moral hazards would increase and their performance would suffer.

Londerville (1996) attributes most price dispersion as an idiosyncratic risk caused by the different cognitive biases between the buyer and seller. Harding et al. (2003) recognize that when one party of a transaction has a weak bargaining position, the final transaction price might deviate from the original fair transaction value. Leung and Tsang (2013) suggest that the anchoring effects from buyers and loss aversion by sellers together lead to the occurrence of price dispersion. On the other hand, Peng and Thibodeau (2017) find a U-shaped relationship between price dispersion and household income, in which price dispersion tends to be higher among both high and low income households than among the middle class. Leung et al. (2006) surmise that buyers/sellers with inadequate experience in the second-hand housing market give rise to price dispersion.

Price dispersion in the housing market is related to economic conditions as well. Bourassa et al. (2009) note that sellers of older, small and centrally-located properties in a buoyant market have more bargaining power which might lead to higher price dispersion. Haurin (1988) compares atypical to typical dwelling units and observes that the sellers of atypical residential properties generally expect a higher value, which results in a longer listing time for such units on the market, and their final transaction price is also subject to large volatility.

Yiu et al. (2009) further find that square footage and house age are positively correlated with price dispersion in the housing market.

Consumers generally search on the housing market with a reserved price in mind. Lin (1994) regards the real estate market as non-monopolistic in which everyone in the market can be a seller or a buyer. Consumers search to meet their individual needs, which in turn reduces price dispersion. In comparing the initial offered price (prior to the search) with transaction price (post search), Lin (1994) finds that price dispersion after searching is reduced, regardless of how the housing market is subdivided. Chou and Chang (2005) conclude that the searching behavior of consumers result in a reduction in the degree of price dispersion at the cost of a longer search period. Due to the high search costs, buyers often turn to realtors or real estate agents for help. Liao and Chang (2004) find that the price dispersion of transactions with the help of real estate agents is lower than that in which consumers do their own search instead. They conclude that agent-assisted buyers pay a lower price premium.

# 3. Data Description and Model Setup

## 3.1 Data Source and Description

The data used for this study originate from two sources. The first dataset is derived from information on multifamily residential building communities[2] in Taipei filed by homeowner associations of multifamily buildings at the time of registration. The second dataset was obtained from the transaction price registration platform of the Ministry of the Interior. The period of interest of the Ministry of the Interior data was from July 2012 to June 2017, which defines our study period.

To avoid outliers and the introduction of bias due to the mixed use of the properties, we have removed certain communities from the sample, including those with incomplete property information, extremely small square footage, and on the first floor, property records with special notations, commercial properties, and office buildings. We have also removed sparse observations, defined as communities in which only three or fewer transactions occurred during the study period, to calculate the within-community coefficient of variation, which is the key measurement of price dispersion in this study. All remaining communities have four or more transactions in the sample period. We further remove the communities that show very large variations even after the adjustments mentioned above were made to avoid outliers. In the end, we have 1,274 communities as our final sample.

[2] Throughout this paper, we define the residential community as a small area that consists of one or a few multifamily residential buildings that have formed one homeowner association.

Many other researchers have adopted hedonic equations to control for the varying characteristics of housing stocks. By using the hedonic approach, Hui et al. (2010) estimate the appraised value at the unit level. They obtain very precise results because their data contain very detailed housing characteristics, including the exact location (neighborhood, building, floor and apartment number) of each unit. The data used in our study are all de-identified with no specific details to allow the use of their approach. In another research study, Fang (2016) controls for the timing of the transactions, floor level and square footage to demonstrate the existence of irrational prices.

Since within each community as defined in this paper the housing units were built by the same developer at the same time and can be essentially regarded as the same or very similar, the differences in the timing of the transactions, floor level and square footage are the most common factors that affect the price differences within each community. Any discussion on price dispersion would be biased without controlling for these factors. Tsou et al. (2007) control for the timing effects by adjusting the housing price index. Similarly this paper adjusts the data by first relying on the housing price index provided by House+[3], a major non-profit real estate appraisal platform in Taiwan. We adjust all transaction prices at different times to the equivalent values in June 2017 by using the House$^+$ housing price index.

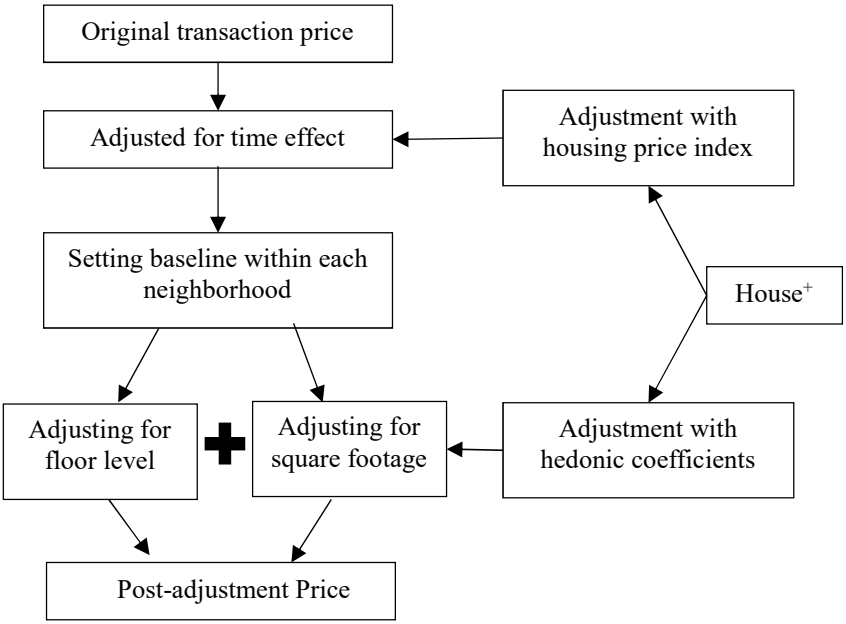
We also adjust for the floor level and square footage by using the house price hedonic coefficients provided by House$^+$. Specifically, as implied by the House$^+$ hedonic coefficient, the price per ping of the unit would increase by approximately 1% as the floor level of a housing unit increases by one; on the other hand, after taking the natural log of the floor area, a one-unit increase of the log of the floor area leads to 4% decline in the price per ping.

Figure 1 illustrates the steps taken to adjust the data. Step 1 involves matching the transactions to the residential community, as the first attempt to control for the housing characteristics. Step 2 applies the housing price index and hedonic coefficients, so that the transaction prices used are not unduly influenced by economic conditions and timing of the transactions, and also adjusted for the floor levels of the units and square footage.

In theory, price dispersion is bounded by fundamental forces and the degree of dispersion should not be excessive. One drawback of the measured price dispersion could be the omitted variables that are not in our data but might affect the housing prices, such as the exact location or improvements to the interior. The difference in the bargaining power of the buyer and seller in a transaction could also contribute to the high price dispersion observed.

[3] The non- profit automatic appraisal platform House$^+$ is a reputable provider known for its large sample and quality standards, and its house price index and hedonic coefficients are commonly regarded as more reliable than the ones of other providers in Taiwan.

**Figure 1 Steps for Price Adjustment**




To measure the price variation, we use the coefficient of variation, i.e. standard deviation of housing prices within a community relative to its mean. Table 1 shows the basic descriptive statistics before and after the price adjustments are made. The difference between the pre and post adjustment statistics is about one percentage point. The variations after the adjustments are not significantly less than those prior to the adjustments, thus implying that either the quality adjustments are insufficient due to the high heterogeneity of the housing stocks that were not fully controlled for due to the data limitations, or the price dispersion is largely driven by the difference in the bargaining powers of the parties involved in the transactions. According to Table 1, the coefficient of variation of housing prices within most communities is less than 10%, and only a small percentage of communities have a price dispersion that is over 15%. Accordingly, this paper categorizes the residential communities in Taipei into three groups: the communities with a price coefficient of variation less than 10% make up our reference group with lower price dispersion; the communities with a coefficient of variation between 10% and 15% form the second group with moderate price dispersion; and the communities with price coefficient variation that is over 15% are in the third group, which is classified as the one with the highest price dispersion.

**Table 1 Basic Descriptive Statistics of Coefficient of Variation of Home Price within a Community**

| Within-Community Coefficient of Variation of Home Prices | | | |
|---|---|---|---|
| | | Before Adjustment | Post Adjustment |
| Mean | | 10.50% | 9.54% |
| Median | | 10.04% | 8.88% |
| Percentile | 25th | 7.34% | 6.38% |
| | 50th | 10.04% | 8.88% |
| | 75th | 13.12% | 11.96% |

Table 2 provides the basic descriptive statistics of the key characteristics of the communities grouped by a within-community coefficient of variation of housing price as categorized above. The table shows that 61% of the communities in our final sample belong to the low price dispersion group, and only 11% are in the high price dispersion group. Among the communities built by the government, 71% are low price dispersion, while 70% of the communities built by listed developers are low price dispersion, which is essentially identical. In terms of the age of the housing units, the units in the low price dispersion group are the newest. A higher price dispersion means more older units in the communities, which in a way, contradicts the popular perception that market speculation in a new housing market may lead to larger price variations. On the other hand, the group of communities with the smallest price deviation has much more higher prices than the communities in the moderate and high price dispersion groups. Home price dispersion appears to be negatively correlated with the price levels of the communities. Lastly, studios and units with large floor areas (over 50 pings) make up the majority among the low price dispersion group.

### 3.2 Model Setup

We apply a multinomial logistics regression framework to our study. Multinomial logistic regression is often used to study the probability of event happenings or preferences over different choices, and a common tool in the social sciences (McFadden, 1975). We define the dependent variable as zero if the coefficient of variation of home prices within a given community is less than 10%, 1 if between 10% and 15%, and 2 if over 15%.

**Table 2 Basic Characteristics of Housing Stocks by Price Dispersion**

| | Small Price Dispersion | Moderate Price Dispersion | Large Price Dispersion |
|---|---|---|---|
| Age of Housing Unit (Mean) | 16.31 | 21.98 | 22.92 |
| (Standard Deviation) | 11.72 | 12.67 | 12.52 |
| (Median) | 12 | 22 | 22 |
| Number of Units per Community | | | |
| (Mean) | 115 | 135 | 129 |
| (Standard Deviation) | 150 | 186 | 129 |
| (Median) | 80 | 95 | 89 |
| Price per Unit (Mean) | 684,044 | 606,867 | 562,387 |
| (Standard Deviation) | 228,491 | 191,881 | 226,414 |
| (Median) | 651,181 | 572,186 | 492,035 |
| Number of Communities | 777(61%) | 357(28%) | 140(11%) |
| Number of Communities that are High Rise (over 11 stories) buildings | 467(61.9%) | 207(27.4%) | 81(10.7%) |
| Number of communities Built by Listed Developers | 107(69.9%) | 29(19%) | 17(11.1%) |
| Number of Communities Built by Government | 78(69.7%) | 22(19.6%) | 12(10.7%) |
| Number of Communities in which Main Design is Studio | 219(57.2%) | 125(32.6%) | 39(10.2%) |
| Number of Communities in which Main Design is Large Floor Area Unit | 100(60.2%) | 37(22.3%) | 29(17.5%) |

The basic model is as follows:

$$\ln\left[\frac{p(y=1\mid x)}{p(y=0\mid x)}\right]=\alpha_1+\sum_{k=1}^{13}\beta_{k1}X_k$$

$$\ln\left[\frac{p(y=2\mid x)}{p(y=0\mid x)}\right]=\alpha_1+\sum_{k=1}^{13}\beta_{k2}X_k$$

For the independent variables, we consider the factors that could directly contribute to the price dispersion in the housing market, such as square footage, type of building, and community characteristics. The following section discusses these in detail. The basic model is as follows:

$$\begin{aligned}\Pr(\mathrm{EXP}) = {} & \beta_0 + \beta_1(Lower\ Price\ Level\ Dummy^4) \\ & + \beta_2(Moderate\ Price\ Level\ Dummy^5) \\ & + \beta_3(High\ Price\ Level\ Dummy) + \beta_4(Inner\ City) \\ & + \beta_5(Suburbs) + \beta_6(\#of\ transations > 8) \\ & + \beta_7(Age\ of\ Housing\ Unit) \\ & + \beta_8(Number\ of\ Residential\ Households > 150) \\ & + \beta_9(High\ Rise\ Building) \\ & + \beta_{10}(Built\ by\ Listed\ Developer) \\ & + \beta_{11}(Built\ by\ Government) + \beta_{12}(Studio) \\ & + \beta_{13}(floor\ area > 50\ ping)\end{aligned}$$

(1) Price Level

Pratt et al. (1979) find that higher prices are correlated with higher price dispersion based on an analysis of 30 commodities. The price level in this paper is measured by the post adjustment average unit price within a community. The communities in Taipei are grouped into 4 different price tiers by using the Cathay Real Estate Index, with the average price per unit less than 400,00 TWD as the lowest-price tier, average price per unit between 400,000 and 700,000 TWD and 700,000 and 1 million TWD as the two moderately price tiers, respectively, and over 1 million TWD as the highest price tier. We set the price tier between 400,000 and 700,000 TWD as the reference group.

(2) Transaction Volume

Yiu et al. (2009) find that the transaction volume is negatively correlated with price dispersion. They suggest that a higher transaction volume might result in more comparable deals that consumers use as reference points which leads to reductions in price variations. However, their results are only weakly significant. Theoretically, it is also possible that some other forces may have the opposite result. For instance, more noise associated with a higher transaction volume may increase the price dispersion. This could be particularly relevant in opaque markets where information is lacking. The median transaction volume among the 1,274 communities is 8. Therefore, we examine the effect of a transaction volume that is higher than 8 in a community on the price dispersion. We set the communities with a transaction volume that is lower than 8 as the reference group.

[4] Price per ping under 400,000 TWD.
[5] Price per ping between 700,000 and 1 million TWD.

(3) Location

Hsu et al. (2011) note that price dispersion in the exurbs of metropolitan areas have a higher price dispersion. Using the grouping process in Chiang (2009), we divide the geographic area in Taipei into the inner city (Zhongzheng, Da'an, Zhongshan, Songshan and Xinyi Districts), suburbs (Shilin, Beitou, Neihu, Nangang and Wenshan Districts) and old towns (Wanhua and Datong Districts). The reference group is the old towns in the multinomial logistic regression.

(4) Population/Household Density

Lin et al. (1996) consider that more densely populated communities have an inferior quality of life. On the other hand, Tang and Yiu (2010) conclude in their study that the relationship between housing price and population density is non-monotonic in Hong Kong. They state that housing price increases with number of units in a neighborhood until it reaches optimal density, and then declines with further increases in density. One explanation for the positive correlation between housing prices and the number of households before the housing density exceeds its optimal density is due to the economy of scale which allows hiring of property management companies only if the number of households within a community is sufficiently large enough (Chu and Chang, 2013). Therefore, we categorize communities into two groups in this study: those that have over 150 households and others, to examine the impact of population density on price dispersion in the housing market.

(5) Building Height/Number of Floors

Lin et al. (1996) note that a taller building, i.e. more floors, means higher construction costs; hence, buildings with more floors often have higher prices. However, Lee et al. (2006) point out that the number of floors affect housing price non-linearly. Buildings with more floors represent higher density but may incur negative externalities (Wong et al., 2011). We allocate our sample into two groups based on the type of building and number of floors: apartment and high-rise residential buildings. We consider the apartment as the reference group in the logistic regression.

(6) Built by listed developers

Developers could be among one of the considerations of consumers when shopping for a home, as the post-sale services of developers whose shares are listed in the stock market are generally superior to those of a single project developer. The housing prices in communities built by listed developers are generally less elastic than those by other types of builders, thanks to their reputation, post-sale services and more impactful marketing efforts (Heil and Helsen, 2001). Therefore, we need to consider the impact of listed developers on price dispersion. In our sample, we identify 73 listed developers. In total, they built 153 of the 1,274 communities in the sample.

(7) Floor area

Cheung et al. (2015) find that larger square footage results in higher price of a residential unit. On the other hand, Chang and Farr (1993) find that the square footage positively affects the total price of residential units, but not the price per ping. They also note that among all of the factors that affect the sale price of a housing unit, the square footage is the least important. The choice of square footage in itself embodies both the preference and affordability of the buyers. It may also reflect the strategy of builders who diversify the risk by building a multitude of units with different floor plans, thus catering to various demands (Chen et al., 2014). Studios and units over 50 pings have a special niche market. Studios are more likely to be traded for speculation purposes, while the large floor area units (over 50 pings) are commonly considered to be luxury units. Therefore, this paper considers the possibility that these two types of units may have a higher price dispersion. Among all of the communities that we studied, all of the units in 383 communities are studios, and all of the units in 166 communities are larger than 50 pings.

(8) Age of Housing Units

Usually older housing units depreciate more in physical value. However, remodeling and renovations may increase their value. Expectations around urban renewals in recent years may have also rendered older units more desirable and priced higher than in the past. Consequently, it is difficult to determine the direction of the effects of age on housing prices ex ante. We treat the housing age as a continuous variable in the multinomial logistic regression, in order to test the impact of the age of the communities on price dispersion in the community.

(9) Built by Government Agencies

Most residential communities built by government agencies were initially available for purchase through a lottery system, with some others assigned by the government itself. Most parking spaces in those communities are obtained through periodic lotteries. Therefore, these communities differ from conventional communities in significant ways. The designs of the housing units within such communities are generally homogeneous. Due to their uniqueness, it is important to understand whether such communities face price dispersion differently than others. At the outset, we cannot assign the sign on such influence ex ante. We define communities as built by government agencies if the builders are the Taipei Municipal Government, Department of Defense or other agencies with government ties.

Table 3 lists the expected sign of each explanatory variable that affects the price dispersion.

**Table 3 Expected Signs of Explanatory Variables**

| Explanatory Variable | | Expected Sign |
|---|---|---|
| Price Level | Under 400K TWD | - |
| | 400 – 700K TWD | Reference Group |
| | 700K – 1 Mil. TWD | + |
| | Over 1 Mil. TWD | + |
| Transaction Volume | | +/- |
| Location | Inner City | + |
| | Suburbs | + |
| | Old Towns | Reference Group |
| Total Number of Households in a Community | | +/- |
| High Rise Residential Building | | +/- |
| Built by Publicly Listed Developers | | - |
| Unit Type and Square Footage | Studio | + |
| | Over 50 pings | + |
| Age | | +/- |
| Built by Government Agencies | | +/- |

## 4. Empirical Results and Discussion

The multinomial logistic regression correctly classifies about 64.2% of the outcomes. Based on the estimates, the parameters for price level categories, age, number of households over 150, built by government agencies, and minimum square footage over 50 pings are all statistically significant for both the moderate and high price dispersion groups relative to the low price dispersion group. The statistical significant level for most of them are at the 1% level, except for number of household over 150 which is statistically significant at the 5% level, and price under 400,000 TWD for the moderate price dispersion group who is significant at the 10% level. The parameters for number of transactions over 8 and built by a public developer are statistically significant at the 10% level for the moderate price dispersion group relative to the low price dispersion group, and not statistically significant for the high price dispersion group. Being located in the inner city is only statistically significant for the high price dispersion group relative to the low price dispersion group.

The price level is the main factor that affects the price dispersion. The odds ratio for the price level less than 400,000 TWD with reference to the group with a price level between 400,000 and 700,000 TWD is estimated to be 1.624 for moderate price dispersion group relative to low price dispersion group, and 5.369 for high price dispersion group relative to low price dispersion group. On the other hands, the communities with a price level over 700,000 TWD are less likely to have moderate or high price dispersion relative to the group with a price level between 400,000 and 700,000 TWD. Unlike previous studies, we find that a higher price level results in a narrower range of the price dispersion

of a community, possibly due to the price rigidity at higher price levels that was identified by Heil and Helsen (2001).

In addition to the price rigidity of higher-end communities, another factor that may have contributed to this phenomenon is related to a unique way in which the bargaining process in the Taiwan real estate market is conducted. In particular, it is a common practice for parties in a housing transaction to negotiate the price in increments of 10,000 TWD at a minimum, regardless of the base price. For instance, consider a community that is priced at 400,000 TWD per unit versus a community priced at 1 million TWD per unit. Taking 10,000 TWD as a minimum unit of price increase during the negotiation, the community with a unit price of 400,000 would have a price change of 2.5 percent whereas the community with a unit price of 1 million would only face a change of 1 percent. Furthermore, real estate agents typically charge of a fixed percentage of the transaction price as commission, instead of a flat fee. Thus real estate agents have little incentive to reduce the price of higher priced units, which results in further low price dispersion in the high-end communities.

The dummy variables for units with a minimum square footage over 50 pings and built by government agencies are statistically significant. Communities with a minimum square footage of over 50 pings are likely to have higher price dispersion than those with a minimum square footage that are under 50 pings. The odds ratios are estimated to be 1.872 for the moderate price dispersion group and 6.036 for the high price dispersion group, relative to the low price dispersion group. Communities built by government agencies are less likely to appear among the higher price dispersion groups. One possible explanation is that the communities with larger minimum square footage were often built on sites with strong positive features, such as scenic views or other unique characteristics, but such features cannot be uniformly enjoyed by all units in the community. Therefore, the prices of different units within a given community may vary widely. On the other hand, the design and construction of communities by government agencies are more homogenous than other types of communities. Consequently, the housing units in such communities have a lower price dispersion.

In terms of location, communities in the inner city are more likely to belong to the high price dispersion group, with an odds ratio of 2.109 relative to the low price dispersion group. On the one hand, it is possible that the developers of such communities in prime locations would have less incentive to offer a wide range of prices to entice prospective buyers. On the other hand, the inner city area was developed before the outer suburbs, and the inner city communities in our study sample were built over a longer span of time. Consequently, aside from some higher priced neighborhoods in the inner city of Taipei, some communities that were developed very early on are now lower price neighborhoods in the city. This could potentially explain for the high price dispersion in those communities.

Older communities are more likely to have a higher price dispersion in the neighborhoods. With every one-year increase in the age of a community, the associated odds ratio is 1.034 for both the moderate and high price dispersion groups, relative to the low price dispersion group. This is in direct contrast to the common perception that new housing units (less than five years old) are more likely to be subjected to speculation as proposed in Lee et al. (2014). Upon further examination, we find that in the five years since the transaction price registration requirement was first implemented, the real estate market in Taiwan has experienced both upward and downward pressures. Property speculations were much more likely to occur between 2008 and 2013 when the housing price continuously increased than the past five years which is more aligned with the sample period of our study. One possible explanation on why age is positively correlated with a higher price dispersion may lie in the expectation that the older housing communities could be redeveloped and as a result, the price of some of the units in those older communities may have increased. This added complexity due to price expectations may have contributed to the higher price dispersion related to age. In addition, some of the older units may have undergone major remodeling/renovations that improve their value, but such remodeling is not captured in the transaction price registration system and therefore not adjusted for in our study. That may also lead to a higher price dispersion according to our measurements.

Transaction volume is an important metric when it comes to the discussion of any real estate market. However, it only has a weak influence on price dispersion. The dummy variable that represents communities with a transaction volume above 8 in the studied period is only statistically significant at the 10% level for the moderate price dispersion group (relative to the low price dispersion group), with an associated odds ratio of 1.28, and not statistically significant for the high price dispersion group, thus implying that a higher transaction volume is not necessarily associated with price stability. In terms of the number of units in a community, the communities with over 150 households are more likely to have higher price dispersion. This could be because communities with fewer residents might find themselves short of the necessary funds for property management and maintenance which can boost property value through positive services to the residents (Chen and Lin, 2013).

The communities built by publicly listed developers generally enjoy a good reputation and post-sale services that may help to maintain property value. However, based on our study, the communities built by listed developers are less likely to belong to the moderate price dispersion group.

**Table 4 Estimation Results: Price Dispersion Groups and Housing Community Characteristics**

| Explanatory Variable | Moderate Price Dispersion | | High Price Dispersion | |
|---|---|---|---|---|
| | Parameter Estimate(B) | Odds Ratio EXP(B) | Parameter Estimate(B) | Odds Ratio EXP(B) |
| Intercept | -1.368*** | | -2.555*** | |
| Inner City | 0.193 | 1.213 | 0.746** | 2.109 |
| Suburbs | -0.286 | 0.751 | -0.547 | 0.579 |
| Transaction Volume>8 | 0.247* | 1.281 | -0.142 | 0.867 |
| Price Level: < 400K TWD | 0.485* | 1.624 | 1.681*** | 5.369 |
| Price Level: 700K – 1Mill. TWD | -0.616*** | 0.540 | -1.713*** | 0.180 |
| Price Level: > 1 Mill. TWD | -1.044*** | 0.352 | -1.623*** | 0.197 |
| Age (continuous) | 0.033*** | 1.034 | 0.034*** | 1.034 |
| Number of Households > 150 | 0.360** | 1.434 | 0.629** | 1.876 |
| High-rise residential building | -0.116 | 0.891 | -0.127 | 0.88 |
| Built by listed developers | -0.442* | 0.642 | -0.041 | 0.96 |
| Built by government agencies | -1.009*** | 0.364 | -1.178*** | 0.308 |
| Property Type：studio | 0.211 | 1.235 | 0.117 | 1.125 |
| Minimum Square Footage：> 50 pings | 0.627*** | 1.872 | 1.798*** | 6.036 |
| Correct Classification Rate | | | | 64.1% |

***Notes***: The reference group for the multinomial regressions are: communities with low price dispersion (less than 10%) that were among early developments, with a price range between 400,000 and 700,000 TWD, less than 144 resident units, not a high-rise, not built by listed developers, and not built by government agencies, with a transaction volume that does not exceed 8 during our study period.
*、**、*** represent being statistically significant at the 10%, 5% and 1% levels respectively.

In sum, the price level is the most important factor that affects price dispersion. A lower price level leads to higher price dispersion and vice versa. In terms of neighborhood characteristics, the communities built by government agencies are less likely to have high price dispersion due to the homogeneity of such planned neighborhoods, while communities with a larger number of residential units, with a larger minimum square footage and those located in the inner cities all tend to have high price dispersion.

## 5. Conclusion

Price dispersion could be driven by the search behavior of buyers or sellers, or due to product heterogeneity. It may also vary with the economic conditions. Even though the general observations on price dispersion of commodities can be extended to the housing market, the many additional challenges would need to be addressed to examine price dispersion in the housing market in particular, given that the housing market is highly heterogeneous. In spite of the housing transaction registration system used by the Taiwanese government in recent years, it is still not possible for ordinary consumers to grasp the complexity of housing price variations due to the de-identification of the registration data. In studying the price dispersion in the housing market, this paper controls for community characteristics in order to adjust for housing qualities, and determines the neighborhood characteristics that are related to the level of price dispersion.

We start by adjusting for the quality of the housing stocks at the community level to remove most of the housing stock homogeneity. Other than the omitted housing characteristics that are at levels beyond the community that we cannot control for, the remaining price dispersion could be largely attributed to the negotiation power of the parties involved in the transactions, which implies that the individual level factors are the main driver of the price dispersion in the housing market. Our data would not allow us to examine the buyer/sell behaviors that determine price dispersion. Nevertheless, we hope our work would spur further research interest in that regard.

Ultimately, we hope to better inform consumers who are facing housing choices. By telling consumers the types of communities or housing stocks that are more likely to offer a wide range of prices, we hope that consumers could take advantage of such information and have the ability to focus their search in complex and highly heterogeneous housing markets. In a general equilibrium sense, enhanced consumer searches can eventually narrow price dispersion and make the real estate market more efficient.

## References

Adams, A. F. III (1997), Search Costs and Price Dispersion in a Localized, Homogeneous Product Market: Some Empirical Evidence, *Review of Industrial Organization*, 12, 801-808.

Borenstein, S. and Rose, N.L. (1994). Competition and Price Dispersion in the U.S. Airline Industry, *Journal of Political Economy*, 102, 4, 653-683.

Bourassa, S. C., Haurin, D. R., Haurin, J. L., Hoesli, M., and Sun, J. (2009). House Price Changes and Idiosyncratic Risk: The Impact of Property Characteristics, *Real Estate Economics*, 37, 2, 259-278.

Burdett, K. and Judd, K. L. (1983). Equilibrium price dispersion, *Econometrica*, 51, 4, 955-969.

Chandra, A., Gulati, S., and Sallee, M. J. (2017). Who loses when prices are negotiated? An analysis of the new car market, *Journal of Industrial Economics*, 65, 235-274.

Chang, C. O and Farr, S. C.L. (1993). A Study of Real Estate Transaction Price, *Journal of Housing Studies*, 1, 75-97.

Chen, S. M. and Lin, P. H. (2013). A Study of the Correlation among Community Management Services, Residents' Satisfaction towards the Services and Property Values, *Journal of Architecture*, 86, 191-205.

Chen, Y. J., Chang, C. O., and Chen, S. M. (2014). A linear Structural Analysis of the Influence of a Mixture of Houses with Different Floor Area Measures in a Condominium Community on Community Management and Maintenance, *Journal of Housing Studies*, 23, 2, 77-108.

Cheung, L.H. Li, D., Sun, H. (2015). Does size matter? The dynamics of housing sizes and prices in Hong Kong, J Hous and the Built Environ ,30, 109-124.

Chiang, Y. H. (2009). A Comparison of Automated Real Estate Valuation Models and Appraisers' Appraisals-Comparable Selection, Weighting Adjustment and Valuation for the Sales Comparison Approach, *Journal of Housing Studies,* 18, 1, 39-62.

Chou, M. L. and Chang, C. O. (2005). Influential Factors of Home Buyers' Search Duration, *Management Review*, 24, 1, 133-150.

Chu, F. N. and Chang, C. O. (2013). Comparative Performance Evaluation of Condominiums in Taipei and Hong Kong, *City and Planning*, 41, 2, 199-227.

Dang, V. Q. T. and Yang, Y. (2017). Assessing market integration in ASEAN with retail price data, *Pacific Economic Review*, 22, 4, 510-532.

Deng, Y., Gabriel, A. S., Nishimura, G. K., and Zheng, D. (2012). Optimal Pricing Strategy in the Case of Price Dispersion: New Evidence from the Tokyo Housing Market, *Real Estate Economics*, 40, 234-272.

Fang, H. (2016). *How much you should pay? Learn from mistakes of others* (First print). Cite E-Printing: New Taipei City.

Harding, P. J., Knight, R. J., and Sirmans, F. C. (2003). Estimating Bargaining Effects in Hedonic Models: Evidence from the Housing Market, *Real Estate Economics*, 31, 4, 601-622.

Haurin, D. (1988). The Duration of Marketing Time of Residential Housing. *Real Estate Economics*, 16, 4, 396-410.

Heil, P. O. and Helsen, K. (2001). Toward an understanding of price wars: Their nature and how they erupt, *International Journal of Research in Marketing*, 18, 83-98.

Hsu, S. Y., Yuan, S. M., and Chang, C. O. (2011). Price Dispersion of New Housing Projects: Analysis of Price Level, Timing and Location, *City and Planning*, 38, 4, 403-426.

Hui, K. S., Cheung, A., and Pang, J. (2010). A hierarchical Bayesian approach for residential property valuation: application to Hong Kong housing market, *International Real Estate Review*, 13, 1, 1-29.

Lee, H. J., Chang, C. O., and Hua, C. C. (2006). The Relationship Between Floor Area and Unit Price Across Different Residential Types in Taipei Metropolitan Area, *Journal of Taiwan Research*, 9, 1, 63-87.

Lee, W. C., Ning, F. S., and Huang, Y. C. (2014). Research on the Bubble of Condominiums-The Case Study in Taichung City, *Journal of architecture and planning*, 15, 2/3, 155-174.

Leung, C. K. Y., Leong, Y. C. F., and Wong, S. K. (2006). Housing Price Dispersion: An Empirical Investigation, *The Journal of Real Estate Finance and Economics,* 32, 3, 357-385.

Leung, T. C. and Tsang, K. P. (2013). Anchoring and Loss Aversion in the Housing Marketing: Implication on Price Dynamics, *China Economic Review*, 24, 42-54.

Liao, C. J. and Chang, C. O. (2004). The Effect of Search Cost and Anchoring Behavior on Price Premium for Homebuyers, *Journal of Housing Studies*, 13, 2, 47-62.

Lin, C. C. (1994). Price Dispersion and Search Equilibrium: The Empirical Study in Taiwan's Housing Market, *Taiwan Economic Review*, 22, 2, 237-269.

Lin, C.C., Yang, C. S., and Chang, C. O. (1996). Housing Price Index in Taipei, *Journal of Housing Studies*, 4, 1-30.

Londerville, J. (1998). A Test of a Buying Rule for "Underpriced" Apartment Buildings, *Real Estate Economics*, 26, 3, 537-553.

McFadden, D. (1975). Londerville, J.(1998). A Test of a Buying Rule for "Underpriced" Apartment Buildings, *Real Estate Economics*, 26(3):537-553.

Peng, L. and Thibodeau, G. T. (2017). Idiosyncratic Risk of House Prices: Evidence from 26 million Home Sales, *Real Estate Economics*, 45, 2, 340-375.

Pratt, W. J., Wise, A. D., and Zeckhauser, R.(1979). Price differences in almost competitive market, *The Quarterly Journal of Economics*, 93, 2, 189-211.

Salop, S. and Stiglitz, E. J. (1982). The Theory of Sales: A simple Model of Equilibrium Price Dispersion with Identical Agents, *The American Economic Review*, 72, 5, 1121-1130.

Shen, C. H., Wang, C. A., and Lin, K. L. (2014). The Study on the Relationship between the House Price Deviations from Fundamentals and the Banking Performance: The International Evidence, *Review of Securities and Futures Markets*, 26, 4, 1-37.

Tang, B.S. and Chung, Y. Y. (2010). Space and scale: A study of development intensity and housing price in Hong Kong, *Landscape and Urban Planning*, 96, 172-182.

Tsou, S. H., Chang, C. O., and Hua, C. C. (2007). Asking Price and Discount Rate Stratgies of Real Estate Developers-An Analysis of Timing, Location, and Developer Type, *Management Review*, 26, 3, 47-69.

Wong, S. K., Chau, K. W., Yau, Y., and Cheung, C. K. A. (2011). Property price gradients: the vertical dimension, *Journal of Housing and the Built Environment*, 26, 1, 33-45.

Van Nieuwerburgh, S., Weill, P. (2010). Why has house price dispersion gone up? *The Review of Economic Studies*, 77, 4, 1567-1606.

Yiu, C. Y., Wong, S. K., and Chau, K.W. (2009). Transaction volume and price dispersion in the presale and spot real estate market, *The Journal of Real Estate Finance and Economics*, 38, 3, 241-253.