

## **The Price-Volume Relationships between the Existing and the Pre-Sales Housing Markets in Taiwan**

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In Taiwan, the housing market can be separated into the existing housing market and the pre-sales market. The existing market can be regarded as the stock market, and the pre-sales market the flow market. However, some unique characteristics exist in the Taiwan market. Based on these characteristics, we modified the conventional housing stock-flow model to describe the price-volume relationship between the existing and pre-sales markets. Empirical models are constructed to test the relationship. Major findings are: 1) both the pre-sales price and the existing price converge to the long-run equilibrium; however, the pre-sales price adjusts faster than the existing price, implying that the existence of the pre-sales system improves market efficiency; and 2) housing supply from the pre-sales market responds to the housing market surpluses/shortages.

### **Keywords**

Stock-flow Model, Pre-sales system, Housing Market.

## Introduction

In Taiwan, the housing market can be separated into the pre-sales and the existing housing markets. The pre-sales system also plays an important role in housing markets in other Asian countries.<sup>1</sup> In the pre-sales market, builders are allowed to sell the housing units, while still at planning stage, right after obtaining the building permits. This practice provides builders the opportunity to assess sales performance before actually committing investment funds. Besides, the down payments made by buyers provide an additional source of funding to the builders. The down payment is paid in installments according to an agreed-upon schedule between the buyer and the builder.<sup>2</sup> The buyers, on the other hand, can reduce price risk by locking-in the purchase price. Besides, paying the down payment in installments instead of a lump sum provides a form of financing to the buyer. These advantages have popularized the pre-sales system in Taiwan, and new housing units are marketed and sold predominantly through this system. In addition, the pre-sales market is in nature similar to the futures/forward markets.<sup>3</sup>

In the existing housing market in Taiwan, the buyers and sellers transact on “housing stock,” which are existing housing units. Meanwhile, in the pre-sales market, the transactions are on “housing flow,” which are new housing units still in the construction or planning stage. The price-volume relationship between the existing and pre-sales markets in Taiwan may be similar to the stock-flow relationship described by the Fisher-DiPasquale-Wheaton (FDW) Model (Fisher [1992]; DiPasquale, et al. [1992, 1994, 1996]; and Renaud, et al. [1996]). However, some special characteristics exist in the Taiwan markets. Therefore, we modified the FDW model based on those characteristics to describe the price-volume relationship between the existing and pre-sales markets. Empirical models are constructed to test the relationship. The major findings are: 1) both the existing price and the pre-sales price converge to the long-run equilibrium; however, the pre-sales price adjusts faster than the existing price, implying that the existence of a pre-sales system improves housing market efficiency, and 2) new housing supply from the pre-sales market responds to housing market surpluses/shortages.

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<sup>1</sup> For example, Hong Kong, China, and Japan. (See Wang et al. 2000)

<sup>2</sup> The total down payment is about 20% to 50% of the sales price of the housing unit. When the contract is signed, the buyer makes the first payment about 10% of the sales price. The remaining down payment is amortized into monthly payments based on the estimated total number of months for construction. The payments are made along with the progress of the construction.

<sup>3</sup> See Chang & Ward (1993) for related discussions.

The following section reviews the conventional housing stock-flow model. Section III describes the special characteristics of the housing markets in Taiwan. The empirical models are derived in Section IV, and the test results are discussed in Section V. Section VI concludes this paper. The data are described in the Appendix.

### **The Housing Stock-Flow Model**

The Fisher-DiPasquale-Wheaton (FDW) model analyzes the stock-flow relationship of housing markets. New housing supply through the flow market should adjust to eliminate the shortage/surplus in the stock market to reach the overall equilibrium. The model assumes that housing supply is fixed in the short run, and the price of housing services is determined by housing supply and demand. This price is the market rent. In turn, the market rent and the discount rate determine the price of housing stock, and the price of housing stock and construction costs jointly determine the number of housing starts (Smith [1974] and Smith, et al. [1988]).

The model is later extended to incorporate the concepts of housing consumption and investments.<sup>4</sup> The housing stock market is defined as the space market to describe the relationship between rent and housing supply and demand. The housing flow market is defined as the asset market to describe the relationship between housing supply and construction costs/investment profits.

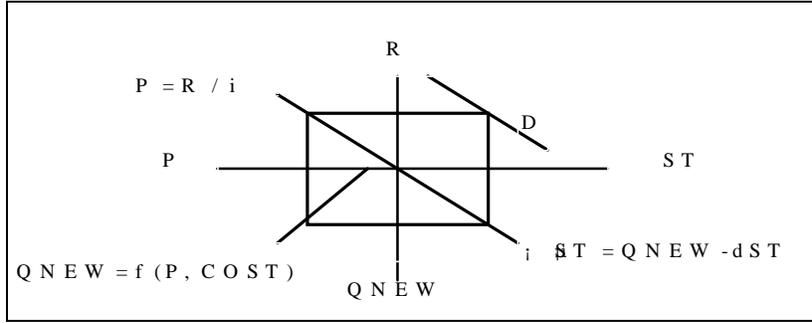
On one hand, the rent level in the stock market affects the price level in the flow market. In addition, adjustment in housing supply by the flow market serves to reduce the housing shortage/surplus in the stock market. In equilibrium, the supply should equal the shortage/surplus. When the market is not in equilibrium, housing prices, and consequently the new housing supply, would adjust via the change in market rents. This process continues until equilibrium is reached as shown in Figure 1.

However, due to incomplete information on the housing market, coupled with the construction lag, the adjustment in new housing supply may not perfectly match the shortage/surplus in the housing market. Therefore, this adjustment in response to the shortage/surplus should exhibit a continuous and dynamic process.

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<sup>4</sup> Here "housing consumption" means the consumption by the general public; whereas "housing investment" means the investment/construction by the developers/builders. These are not the same as the housing investment and consumption behaviors described by recent literature.

**Figure 1: The price-volume relationship in the FDW model**



P: Housing Price, ST: Housing Stock, COST: Construction Costs, R: Housing Rent, d: Housing Depreciation Rate, D: Housing Demand, i: Discount Rate, QNEW: New Housing Supply

Using a 1963-1990 American housing data set, DiPasquale, et al. (1994) found that the annual adjustment rate at which the housing price adjusts to the long-run equilibrium is 0.29, and the annual adjustment rate at which the housing supply converges to the long-run equilibrium is 0.02.<sup>5</sup> These results indicate that price and volume in the US market adjust to the long-run equilibrium.

### Special Characteristics of the Taiwan Housing Markets

In Taiwan, the existing housing market can be treated as the stock market, and the pre-sales market the flow market. Due to the construction lag, newly-completed housing units may not accurately represent the current housing flow in Taiwan. In the pre-sales market, housing units are already put on the market even when they are still at the planning or construction stages. Therefore, housing supply through the pre-sales system can be adjusted according to the changes in housing demand and economic outlook. Consequently, the problem arising from the construction lag may not be so acute. Pre-sales housing supply is also an investment decision for the builders. The decision takes into account the pre-sales housing price, construction and development costs, and other economic factors.

<sup>5</sup> The data of current new housing construction are used to proxy housing flow. They are not adjusted for the time lag caused by construction. The reason could be that in the U.S., houses are built in single units and mainly in wood, which take a much shorter time to complete. In contrast, in Taiwan, housing units are built in the form of a large apartment complex and predominantly in concrete.

In the FDW model, prices of new housing units are determined by discounting the rent. In the pre-sales market, housing price is not determined solely by supply and demand. The pre-sales market is in nature similar to a futures/forward market, and the pre-sales price is determined by the price of the housing stock,<sup>6</sup> carrying costs and expected future price changes, and minus a risk premium<sup>7</sup> (see Pai [1996], and Chang and Ward [1993]).<sup>8</sup>

The pre-sales market tends to react to future market conditions, and adjusts the price earlier than the existing market for at least two reasons:

In the pre-sales market, the suppliers are professional developers/builders who market the whole housing project, which typically includes a large number of housing units. Meanwhile, the suppliers in the existing market are individuals who usually just market their own homes. The developers/builders in the pre-sales market are analogous to portfolio managers in the securities market, while the individual suppliers in the existing market are analogous to individual investors. The former is generally deemed more efficient in gathering and using information than the latter for reasons such as economies of scale in information costs. Since prices reflect information, pre-sales price should adjust faster than existing price.

In the pre-sales market, housing supply can be adjusted at a lower cost. In this market, sales can be made as soon as construction permits are obtained. Therefore, if demand rises, housing supply can be increased faster than in the existing market. On the other hand, if demand drops, supply can be reduced by simply canceling the construction project. If the lower demand is due to the switch in consumer preference in product design (e.g., the size of the housing units), the builder can simply redesign the products. The lower adjustment costs also make adjustments in price easier. This also contributes to the faster price adjustment in the pre-sales market.

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<sup>6</sup> According to Pai (1996) the difference between the pre-sales price and the existing housing price depends in part on expected future economic condition.

<sup>7</sup> The risk premium in the pre-sales price reflects the uncertainty in construction quality, the completion and delivery of the house, the title of the property, etc.

<sup>8</sup> According to Pai (1996),  $PP$  is equal to  $PS(1+c(\cdot))$ , where  $PP$  is the pre-sales price,  $PS$  is the existing housing price, and  $c$  is the coefficient for carrying cost ( $A$ ). Carrying cost is a function of the existing housing price, down payment ratio, the sum of the monthly payments, interests rates, property taxes, the discount rate, time to completion and delivery of the housing unit, and title insurance fee as a percentage of the sales price. When this coefficient is greater (smaller) than zero, the pre-sales price changes at a rate higher (lower) than the existing housing price.

As a result, the pre-sales price becomes a leading indicator for the existing price. In summary, the pre-sales price affects the existing price directly due to its leading role, and indirectly through its impact on housing supply. Therefore, the change in housing price may not completely come from the change in rent resulting from changes in housing supply and demand.

Although the pre-sales and the existing markets appear to operate independently, they are in fact mutually related via a number of price-volume relationships. The equilibrium is reached when the adjustment in supply, determined by the price and construction costs in the pre-sales market, equals the shortage/surplus in the existing market. That is, when a surplus (shortage) exists, the price of existing housing falls (rises), and people anticipate a housing market downturn (upturn), which causes a decrease (increase) in the pre-sales price and a reduction (addition) of housing stock in the coming period. This process continues until the equilibrium is reached.

## Empirical Models

### *Relationship Between Housing Price and Supply*

The existing research appears to reach the consensus that demand in the existing market ( $QE_t^d$ ) is determined by the existing housing price (PS) and demand propensity, which in turn are determined by the total number of households (H) and income levels (Y); the impact of existing housing price should be negative ( $a_1 < 0$ ) and the impact of demand propensity should be positive ( $a_2, a_3 > 0$ ). When housing demand exists in both the existing and pre-sales markets, the increase in pre-sales price (PP) would result in the switch of housing demand from the pre-sales to the existing market, and vice versa. Consequently, the change in pre-sales price affects housing demand in the existing market ( $a_4 > 0$ ).

$$QE_t^d = a_0 + a_1PS_t + a_2H_t + a_3Y_t + a_4PP_t \quad (1)$$

On the other hand, short-term supply in the existing housing market depends on how many housing units enter the market for sale. Therefore, supply in the existing housing market ( $QE_t^s$ ) is affected by both the housing stock (ST) and the existing housing price (PS).<sup>9</sup> The coefficients  $b_1$  and  $b_2$  in the following equation are expected to be greater than 0.

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<sup>9</sup> In the conventional housing stock-flow model, the stock market is determined by aggregate supply and aggregate demand for housing services. Equation (2) however, focuses on the short-term supply; that is, housing units that are already “on the market” or are ready to enter the market in a very short time. In this equation, the existing price (PS) affects the propensity to sell and the housing stock (ST) proxies the potential supply scale.

$$QE_t^s = b_0 + b_1PS_t + b_2ST_t \quad (2)$$

In equilibrium,

$$QE_t^d = QE_t^s \quad (3)$$

Substituting Equations (1) and (2) for (3) yields Equation (4) below, in which the existing price is a function of the number of households, income, pre-sales price, and housing stock.

$$PS_t = (a_0 - b_0) / (b_1 - a_1) + a_2 H_t / (b_1 - a_1) + a_3 Y_t / (b_1 - a_1) + a_4 PP_t / (b_1 - a_1) - b_2 ST_t / (b_1 - a_1) \quad (4)$$

The demand in the pre-sales market ( $QP_t^d$ ) is certainly related to the pre-sales price, and is also influence by the price in the existing market.

$$QP_t^d = c_0 + c_1 PP_t + c_2 PS_t \quad (5)$$

$c_1 < 0$  and  $c_2 > 0$ .

The supply in the pre-sales market ( $QP_t^s$ ) is determined by pre-sales prices and construction costs (COST).

$$QP_t^s = d_0 + d_1 PP_t + d_2 COST_t \quad (6)$$

$d_1 > 0$  and  $d_2 < 0$ .

In equilibrium,<sup>10</sup>

$$QP_t^d = QP_t^s \quad (7)$$

Substituting Equations (5) and (6) for (7) yields Equation (8) below, where the pre-sales price is a function of existing housing price and construction costs.

$$PP_t = (c_0 - d_0) / (d_1 - c_1) + c_2 PS_t / (d_1 - c_1) - d_2 COST_t / (d_1 - c_1) \quad (8)$$

Assuming that housing stock at time  $t$  represents the equilibrium level ( $ST^*$ ), the FDW model implies that if the existing housing and pre-sales markets clear simultaneously, the difference in housing stock between times  $t$  and  $t-1$

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<sup>10</sup> The equilibrium here does not mean that the supply from the pre-sales market is completely absorbed. Part of this supply will not be sold until it becomes completed housing units.

should equal the new housing supply at time  $t$  ( $NEW_t$ ).<sup>11</sup>  $NEW_t$  is a function of the housing supply provided by the pre-sales market from current as well as previous periods under the notion of perfect expectation ( $\sum QP_i^s$ ,  $i \leq t$ ).

Therefore,  $ST_t^* - ST_{t-1} = NEW_t = Q(\sum QP_i^s)$

After rearranging,

$$ST_t^* = Q(\sum QP_i^s) + ST_{t-1} \quad (9)$$

In equilibrium, the existing housing market and the pre-sales market should clear simultaneously; that is, prices and volumes in both markets should settle at the same time. In order to empirically estimate the price-volume relationship between the pre-sales and the existing housing markets, Equations (4), (8), and (9) are transformed into econometric models (10), (11), and (12) below.

$$PS_t = \alpha_0 + \alpha_1 H_t + \alpha_2 Y_t + \alpha_3 PP_t + \alpha_4 ST_t + \varepsilon_1 \quad (10)$$

$$\alpha_0 = (a_0 - b_0) / (b_1 - a_1), \alpha_1 = a_2 / (b_1 - a_1) > 0, \alpha_2 = a_3 / (b_1 - a_1) > 0, \alpha_3 = a_4 / (b_1 - a_1) > 0, \alpha_4 = -b_2 / (b_1 - a_1) < 0$$

$$PP_t = \gamma_0 + \gamma_1 PS_t + \gamma_2 COST_t + \varepsilon_2 \quad (11)$$

$$\gamma_0 = (c_0 - d_0) / (d_1 - c_1), \gamma_1 = c_2 / (d_1 - c_1) > 0, \gamma_2 = -d_2 / (d_1 - c_1) > 0$$

$$ST_t = \delta_0 + \delta_1 QP_t^s + \delta_2 QP_{t-1}^s + \delta_3 ST_{t-1} + \varepsilon_3 \quad (12)$$

$$\delta_1 > 0, \delta_2 > 0, \delta_3 > 0$$

#### *Adjustment Rates in Housing Price and Supply*

In the FDW model, housing price and supply adjust to the long-run equilibrium, and market supply and demand clear simultaneously. In reality however, due to insufficient information, as well as the construction lag, the market mechanism may not work as perfectly as described by the model. Nevertheless, in theory at least, as long as the market mechanism is working, when the price and volume is not in equilibrium, the price and supply/demand should work to eventually close the gap. If this is true, the

<sup>11</sup> In the empirical tests, the data for the housing stock are end-of-period numbers, so the amount of housing demolition is already excluded. In addition, the housing stock is represented by the number of housing units, so depreciation would not be a problem.

annual change in housing price at time  $t$  should be equal to the equilibrium price at time  $t$  ( $P_t^*$ ) minus the price at time  $t-1$  ( $P_{t-1}$ ), multiplied by the price adjustment rate ( $\pi$ ).<sup>12</sup>

$$P_t - P_{t-1} = \pi (P_t^* - P_{t-1}).$$

After rearranging,

$$P_t = \pi P_t^* + (1-\pi) P_{t-1} \quad (13)$$

Substituting Equations (10) and (11) into (13) yields Equations (14) and (15), where  $\Phi$  and  $\Psi$  denote the adjustment rate for existing price and pre-sales price respectively.

$$PS_t = \pi_0 + \pi_1 ST_t + \pi_2 H_t + \pi_3 Y_t + \pi_4 PP_t - \Phi PS_{t-1} + \mu_1 \quad (14)$$

$$PP_t = \theta_0 + \theta_1 COST_t + \theta_2 PS_t - \Psi PP_{t-1} + \mu_2 \quad (15)$$

The change in housing supply at time  $t$  ( $\Delta ST_t$ ) is equal to the equilibrium housing stock ( $ST_t^*$ ) minus the housing stock at time  $t-1$  ( $ST_{t-1}$ ), multiplied by the supply adjustment rate ( $\eta$ ).  $\Delta ST$  is equal to  $NEW_t$ . Therefore,

$$\Delta ST_t = NEW_t = \eta (ST_t^* - ST_{t-1}) \quad (16)$$

Substituting Equation (12) into (16) yields Equation (17), where  $\Omega$  is the housing flow adjustment rate.

$$NEW_t = \eta_0 + \eta_1 QP_t^s + \eta_2 QP_{t-1}^s + \eta_3 QP_{t-2}^s - \Omega ST_{t-1} + \mu_3 \quad (17)$$

$\Omega$  reveals how fast the pre-sales housing supply adjusts to shortage/surplus. A low  $\Omega$  indicates that when there is a surplus (shortage) in the existing market, the supply in the pre-sales market decreases (increases) at a lower speed.

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<sup>12</sup> The adjustment rate tells us the magnitude at which the underlying variable (price or volume) adjusts to the equilibrium per year.

## Empirical Results

### *Price-Volume Relationship*

We used the two-stage least squares regressions to estimate the log-log form of equations (10) to (12). In this system, the pre-sales price (PP), the existing price (PS), and the housing stock (ST) are simultaneous. A dummy variable is included in the models to account for the structural change in the data.<sup>13</sup> Table 1 contains the simple statistics for the variables. The results are shown in Table 2 and are discussed as follows:

**Table 1: Simple Statistics for the Variables (1973-1999)**

	pre-sale housing price index	existing housing price index	housing stock (units)	new constructed area (m <sup>2</sup> )	construction permit areas (m <sup>2</sup> )	disposal income per month	households	construction cost index
Average	74.34	80.40	634,315	2,200,211	1,825,963	55,700	685,987	118.04
Standard deviation	35.64	34.38	181,241	1,094,370	1,477,080	27,314	169,406	35.86
Maximum	117.46	122.81	837,553	4,329,046	5,117,398	93,466	869,803	166.39
Minimum	22.54	31.82	191,003	1,000,083	438,778	9,456	142,886	37.49

The change in the existing housing price has a positive impact on pre-sales price with a coefficient of 1.38. The pre-sales price also has a positive impact on existing housing price with a coefficient of 0.64. New housing supply from the pre-sales market significantly affects housing stock with a coefficient of -0.03.

Both the income level and the number of households have a positive impact on the existing price. The coefficient for the income level is 0.09, and for the number of households 1.73. Besides, housing stock exhibits an inverse relationship with the existing housing price with a coefficient of -1.08. These results indicate that the existing housing price is indeed governed by market supply and demand

<sup>13</sup> As shown in Appendix, housing price experienced a dramatic change around 1991 and housing stock continued to rise till the same year and then leveled-off. We use the ADF model to perform stationary tests and find that the original data for NEW, ST, PS, and PP exhibit I (1). After taking the log on the variables and adding the dummy variable to account for the structural change, we find that they become I (0).

**Table 2: The Price-Volume Relationship of Pre-Sales and Existing Markets**

<i>Variables</i>	<i>Existing Price</i>	<i>Pre-sales Price</i>	<i>Housing Stock</i>
Intersection	-8.27 (-1.48)	-2.80** (-5.20)	1.89** (4.868)
Pre-sales Price (PP)	0.64** (6.82)		
Existing Price (PS)		1.38** (8.05)	
Income (Y)	0.09* (1.713)		
Households (H)	1.73* (2.30)		
Construction costs (COST)		0.24 (1.38)	
Housing stock (ST)	-1.08* (-2.548)		
ST <sub>t-1</sub>			0.91** (46.16)
Supply of pre-sales houses (QP)			-0.03* (-2.41)
QP <sub>t-1</sub>			-0.01 (-0.60)
Dummy Variable	-0.18* (-2.85)	-0.29* (-2.64)	-0.06* (-2.46)
R <sup>2</sup>	0.9579	0.9516	0.9959

\*\* Significant at 1%. \* Significant at 5%.

### The Adjustment Rates of Price and Supply

To test whether price and volume adjust to long-run equilibrium, we used two-stage regressions to estimate the simultaneous system of Equations (14), (15), and (17) in log-log form. In this system, the pre-sales price (PP) and the existing price (PS) are simultaneous. The results (see Table 3) show that the price adjustment rate in the existing market is 0.29, and in the pre-sales market 0.35.<sup>14</sup> These numbers indicate that in Taiwan, housing prices work

<sup>14</sup> According to the empirical model, the price adjustment rate in the existing housing market is equal to 1 minus the regression coefficient; that is,  $1 - 0.71 = 0.29$ . If the regression coefficient is significantly different from zero, then the adjustment rate is significantly different from 1. The t-values for the regression coefficient for the existing housing market and the pre-sales market are 5.13 and 4.17 respectively. Thus, both coefficients are statistically significant at the 99% level.

to reduce the gap between demand and supply. The higher adjustment rate for the pre-sales price indicates that it reflects market conditions faster than the existing price. The housing stock at  $t-1$  is related to the new supply from the pre-sales market with a coefficient of  $-0.36$ , indicating that new supply from the pre-sales market converges to the long-run equilibrium (see also Wang, et al., 2000).

**Table 3: The Adjustment Rates of Housing Price and Volume**

	<i>Existing Price (PS)</i>	<i>Pre-sales Price (PP)</i>	<i>Supply of New Constructed Houses (NEW)</i>
Intersection	-13.92* (-2.70)	-1.59* (-2.41)	13.71** (3.04)
Pre-sales Price (PP)	0.18* (1.73)		
PP <sub>t-1</sub>		0.65** (4.17)	
Existing Price (PS)		0.85** (3.72)	
PS <sub>t-1</sub>	0.71** (5.13)		
Housing Stock (ST <sub>t-1</sub> )	-0.10 (-0.187)		-0.36* (-1.77)
Income (Y)	0.42 (1.66)		
Households (H)	1.50* (2.32)		
Construction costs (COST)		-0.08 (-0.39)	
Supply of pre-sales houses (QP)			0.16 (1.09)
QP <sub>t-1</sub>			0.12 (0.70)
QP <sub>t-2</sub>			0.13 (0.97)
Dummy Variable	0.08 (0.70)	-0.38** (-3.09)	0.07 (0.225)
R <sup>2</sup>	0.9778	0.9538	0.7138
<b>Adjustment rate</b>	<b>0.29**</b>	<b>0.35**</b>	<b>0.36*</b>

\*\* Significant at 1%. \* Significant at 5%.

## Conclusions

The Taiwan housing market can be separated into pre-sales and existing housing markets. This paper redefines the relationship between the housing stock and flow markets based on some special market characteristics in Taiwan. Empirical models are formulated to test the price-volume relationship between the pre-sales and the existing markets. The results are: 1) the pre-sales and existing prices are mutually and positively related; 2) the existing price is governed by supply and demand; 3) both the pre-sales and existing prices converge to the long-run equilibrium; however, the pre-sales price adjusts at a faster speed, implying that the existence of the pre-sales system improves market efficiency in Taiwan; and 4) the pre-sales supply is affected by the previous housing stock, implying that pre-sales supply responds to housing surpluses/shortages.

## References

- Chang, C. O., and Hua, C. C., (1996), The Relationship between Housing Transaction Price and Volume in Taiwan, presented at the 1996 ENHR Conference in Denmark.
- Chang, C. O., (1999), Housing Information Quarterly, the Ministry of Interior Project. (in Chinese)
- Chang, C. O. and Lin, C. C., (1995), The Relationship between Real Estate Cycles and Macro Economic Cycles, National Science Council Research Project. (in Chinese)
- Chang, C. O. and Ward, C., (1993), Forward Pricing and the Housing Market: The Pre-Sales Housing in Taiwan, *Journal of Property Research*, **10**, 217-227.
- DiPasquale, D. and Wheaton, W. C., (1992), The Markets for Real Estate Assets and Space: A Conceptual Framework, *The AREUEA Journal*, **10**, 1, 181-197.
- DiPasquale, D. and Wheaton, W. C., (1994), Housing Market Dynamics and the Future of Housing Prices, *Journal of Urban Economics*, **35**, 1-22.
- DiPasquale, D. and Wheaton, W.C., (1996), *Urban Economics and Real Estate Markets*, Englewood Cliffs, NJ: Prentice Hall.

Fisher, J. D., (1992), Integrating Research on Markets for Space and Capital, *The AREUEA Journal*, **20**, 1, 161-180.

Lin, Vickey C. C., (1998), Market Efficiency Test of Pre-sales and Existing House on Taiwan Market, *Journal of Management*, **15**, .4 (in Chinese)

Muth, R. F., (1960), The Demand for Non-Farm Housing, in *The Demand for Durable Goods*, Edited by A. Harberger, Chicago: University of Chicago Press, 29-96.

Olsen, E. O., (1969), A Competitive Theory of the Housing Market, *American Economic Review*, **59**, 612-22.

Pai, C. A., (1996), Applying Forwards and Futures Pricing Theories to Study Pre-Sales Housing Price, Ph.D. Dissertation of Department of Land Economics in National Chengchi University, Taipei, Taiwan. (in Chinese)

Renaud, B. M., (1997), The 1985 to 1994 Global real Estate Cycle: An Overview, *Journal of Real Estate Literature*, **5**, 13-44.

Renaud, B. M., Pretorius, F., and Pasadilla, B. O., (1996), The Use of the Modern Real Estate Paradigm in Comparative Work: A Test for Hong Kong, presented at the 5th Annual AREUEA International Real Estate Conference.

Smith, L. B., (1974), A Note on the Price Adjustment Mechanism for Rental Housing, *American Economic Review*, **64**, 3, 478-81.

Smith, L. B., Rosen, K. T. and Fallis, G., (1988), Recent Developments in Economic Models of Housing Markets, *Journal of Economic Literature*, **26**, 29-64.

Wang, K., Zhou, Y., Chan, S. H., and Chau, K. W., (2000), Over-Confidence and Cycles in Real Estate Markets: Cases in Hong Kong and Asia, *International Real Estate Review*, **3**, 1, 93-108

### **Appendix: Data Description**

The data set contains annual housing data collected for the Taipei metropolitan area, and covers the period 1974-1999.

1. Existing housing price (PS) and pre-sales price (PP) use the same data as in Chang (1999), in which PS is calculated as the median transaction price in the existing market, and PP is the median transaction price in the pre-sales market. The advantage of this data is that it is calculated by controlling property attributes by employing the hedonic model.
2. Housing stock (ST) uses Housing Census Data in 1990 as the base number. For each year, we adjusted the base number by the total number of usage permit areas and the total number of demolished housing units to obtain the housing stock for that year.
3. Households (H) is the “Total Number of Households” from the Yearbook of Taipei.
4. Housing supply in the pre-sales market (QNEW) uses “Construction Permit Areas” from the Yearbook of Taipei.
5. Income level (Y) uses “Monthly Disposable Income per Household” from the Yearbook of Taipei.
6. Construction Cost (COST) uses “Construction Price Index” from the Yearbook of Taipei.