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The Relationship Between Rents and Prices of Owner-Occupied Housing in Taiwan

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Abstract

This article analyzes the changes of equilibrium rent and equilibrium price of owner-occupied housing in Taiwan, and also computes the rent multiplier and its trend in the past ten years in Taiwan to show how the housing consumption and housing investment change. A hedonic rent equation and a hedonic housing price equation are built first. Then, we apply the "Housing Survey Report" data from 1979 to 1989, and employ ordinary-least squares method to estimate the two equations. Using estimated coefficients of the two equations, we compute the market rents for owner-occupied housing and the market prices for rental housing. Finally, the rent multipliers are calculated from the market rents and market prices. The article finds that (1) changes of housing prices in Taipei lead to price changes in Kaoshung, and the latter leads Taiwan province; (2) changes of rent are much smaller than the changes of housing price; and (3) housing prices in Taiwan increased drastically. We also find: (1) at the peak of the housing market cycle, the rent multiplier is extremely high; (2) the rent multiplier drops in the year after the peak year because the rent catches up; (3) the rent multiplier in Taipei is greater than that of Kaoshung, and the multiplier in Kaoshung is greater than that of Taiwan province; and (4) overall, the rent multiplier in Taiwan is much greater than that of the United States.

Key words: Owner-occupied housing, hedonic equation, rent multiplier

Since February 1987, the housing prices in Taiwan have increased dramatically, especially in the two largest cities, Taipei and Kaoshung. The increase is the greatest in 40 years. In 1981, the average price for a new dwelling in Taipei costs its buyer two years' salary. But in 1989, a resident in Taipei had to work ten years to buy a new house. The average transaction price for housing units at Taipei in 1989 was about NT $4.5 million, about seven years' salary for an average worker. The sharp increase of housing prices in Taiwan since 1987 also affects the income distribution in that the rocket-high housing prices and the larger wealth discrepancy between the rich and poor make the society more unstable.

The main purpose of this article is to analyze the changes of equilibrium housing prices and equilibrium rents, and thus to distinguish consumption and investment. In addition, we compute the rent multiplier, that is, the ratio of housing value to its monthly rent. By analyzing changes in the rent multiplier, we can separate the changes of consumption need and investment need over the past ten years in Taiwan.

1. Methodology and structure

It takes a long time for a household to accumulate enough money to buy a house. Before one can afford to buy a house, one has to rent one; therefore, the rental market is popular.

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Since both owning and renting provide housing services, they are substitutible. Households are potential demanders for both types of housing units, so the owner-occupied housing market and the rental market are closely related.

Not much literature exists that discusses housing demand in Taiwan: some examples are, Yuan (1980), Wu (1981), Lee (1984), Tseng and associates (1985), Deng (1985), and L.C. Chen (1988). There is no literature analyzing owner-occupied housing and rental housing. C.C. Chen (1988) has discussed the relationship of rental price and buying price for land, not for dwelling units. Since there is high substitutibility among rental housing and owner-occupied housing, one gets biased estimates if one market is studied without considering the other.

This article analyzes how the equilibrium prices change for both markets in Taiwan. Since our data come from the same housing market, the substitution between the two types of housing is implicit. Here we estimate a housing price equation and rental equation, and then compute estimated market price and market rent for the dwelling units in our data set. Housing rent is usually close to market rent since housing rent adjusts often. But housing rent may be lower than the market rent because of the adjustment lag and because of the discount rate existing among tenant and landlord.[1] This article applies hedonic rent equations to estimate the market rent to avoid the error from using actual rent data.

In the U.S. housing market, the average housing price for single houses is roughly 100 times as high as its monthly rent; in other words, the rent multiplier is 100. For apartment units, the average rent multiplier is about 70. The two figures come from actual transaction price and actual rent. Applying data from Green Bay, Wisconsin, and South Bend, Indiana, Lin (1989b) estimated price and rent equations and then computed market prices and market rents. Lin finds that the 1 percent-rule holds only in Green Bay. In South Bend, the multiplier is much lower. The discrepancy is due to different market situations. Green Bay is a growing city with an increasing population, and so its housing market is tight and its housing value increases. On the other hand, South Bend is losing people, and so it has a higher vacancy rate, a looser housing market, and its housing values go down gradually. In this case, households in Green Bay are willing to invest in real estate both for consumption and for capital gain, while people in South Bend do not want to invest in houses. It turns out that, though the two cities have similar rents but different house prices, the rent multiplier in Green Bay is much higher than that in South Bend.

The situation in Taiwan is similar. Both population and per capita income have grown fast in the past, though they are slowing down lately, so the long-term demand for housing is strong. Moreover, home ownership is a goal for everybody, and so is investing in real estate in Taiwan. Since housing prices are expected to increase in the long run, the rent multiplier is higher than in the United States. Furthermore, since the future price in Taipei is expected to be better than in Kaoshung, and the latter is better than in Taiwan province, we expect the rent multiplier in Taipei to be higher than in Kaoshung, and Kaoshung in turn to be higher than in Taiwan province.

This research applies both reduced form and ordinary least-squares methods to estimate market rents and market prices. The data set is a housing survey collected since 1979. This annual survey is included with the "Labor Survey Report" in Taiwan, so we have housing attributes as house year, floor space, and so on, along with household characteristics such as household age, family size, and so on.

In the second section, we explain the change and trend of the housing market in Taiwan from 1980 to 1989. In the third section, which is the main body of this research, we apply hedonic equations to estimate market price and market rent, and to calculate the rent multiplier and analyze its changes. Our conclusion is given in the last section.

2. Trend of housing prices and rents in Taiwan

2.1. Data description

Since 1979, Directorate General of Budget, Accounting and Statistics (DG-BAS), Executive Yuan in Taiwan has conducted the "Housing Condition Survey in Taiwan" as a supplement of a survey for the "Human Resource Condition Survey in Taiwan." There are about 12,000 sample points with about 70 variables in each sample; 80 percent are owner-occupied housing and 20 percent are rental housing. It is the most complete housing data set in Taiwan. There are several categories in the survey: (1) housing characteristics, including house age, type of structure, housing type, main purpose for the dwelling unit, floor space, number of rooms, number of kitchens, number of bathrooms, type of fuel, and so on; (2) neighborhood condition, including the distance to public facilities, such as school, post office, park, market, and hospital, and so on; (3) type of ownership, including built by the owner, bought, rented, or government owned; (4) user cost, including year of purchase, total price, down payment, mortgage, source of finance, monthly rent, security payment for renters, and so on; (5) future plan, whether the tenant plans to change his or her living condition, how to change it, and what is his or her ideal living condition.

Since a house is not portable, location plays a crucial role in determining housing price. For the same reason, housing market conditions may differ among cities. Therefore, in this article we separate the market in Taiwan into three parts: Taipei city, Kaoshung city, and Taiwan province.

2.2. Basic properties in the housing market in Taiwan

Table 1 shows that the ownership ratio in Taiwan increased from 75.5 percent to 80.1 percent from 1980 to 1989. Private rental dwelling units decreased from 13.3 percent to 11.5 percent. Public- and company-owned rental houses remained about 10 percent. The ownership ratio in Taiwan is higher than that in most Western countries. On the other hand, the ownership ratio in the cities is lower, which is the same as other countries. In table 2, the ownership ratio in Taipei is between 59.2 percent and 70.2 percent, Kaoshung 57.4 percent and 73.5 percent, Taiwan province 78.7 percent and 83.3 percent.

From 1981 to 1989, the average housing transaction price went up from NT $418,000 to NT $1120,000, increasing about 168 percent. The average monthly rent went up, too, from NT $2,180 to NT $4,690, increasing 115 percent from 1979 to 1989.[2] Floor space increased and owner-occupied dwelling units have larger floor space than rental units. There is about a three-year discrepancy on the average construction year. It shows that house owners want higher living quality. The other possibility is that housing age has a more significant effect on housing price than on rental price, so it is better to rent an old unit.

Table 1. Basic properties of the housing market in Taiwan.

	Ownership Ratio (%)			Ave. Price (NT$ 10000)		Ave. Floor-Space (Pin)		Year of Construction (Year)[d]	
	Owner-Occupied	Rental	Other[a]	Owner-Occupied[b]	Rental[c]	Owner-Occupied	Rental	Owner-Occupied	Rental
1979	75.5	13.3	11.1	—	0.2180	24.31	19.42	1965.98	1964.68
1980	77.7	13.4	8.9	—	0.2470	25.14	20.10	1958.45	1966.58
1981	75.9	13.5	10.5	418	0.2920	26.39	20.62	1971.78	1966.90
1982	75.4	13.3	11.3	524	0.3460	27.06	21.14	1971.43	1967.35
1983	74.9	13.6	11.6	614	0.3440	30.71	24.62	1971.72	1967.49
1984	76.4	13.2	10.4	654	0.3500	31.28	24.35	1972.39	1967.74
1985	77.3	12.5	10.2	692	0.3660	31.41	24.99	1973.30	1969.10
1986	78.9	11.1	10.0	743	0.3760	32.39	25.48	1975.30	1969.80
1987	79.4	11.5	9.1	933	0.3810	32.80	25.52	1976.53	1971.50
1988	79.6	12.0	8.4	1003	0.4040	33.19	25.05	1974.50	1971.40
1989	80.1	11.5	8.5	1120	0.4690	34.26	26.22	1975.30	1972.30

[a]Including private-companies-owned and government-owned houses.
[b]The average price here is computed from actual purchase prices.
[c]Average monthly rent.
[d]1974.50 means June 1974.
Source: Housing Condition Survey, 1980–1990, Department of Budgeting, Account and Statistics, Executive Yuan, Taiwan.

Table 2. Ownership ratio in Taiwan.

	Taipei			Kaoshung			Taiwan Province		
	Owner-Occupied	Rental	Other[a]	Owner-Occupied	Rental	Other	Owner-Occupied	Rental	Other
1979	63.4	21.1	15.5	57.4	23.0	19.6	79.4	11.0	9.6
1980	63.3	24.8	11.9	67.4	25.9	6.7	81.2	10.2	8.6
1981	59.2	22.2	18.5	66.2	22.4	11.5	79.9	11.1	9.0
1982	59.6	24.0	16.4	63.3	20.7	16.0	79.7	10.5	9.8
1983	60.5	23.3	16.2	63.2	20.2	16.6	78.7	11.1	10.2
1984	64.2	22.0	13.8	64.4	20.5	15.0	79.9	10.8	9.3
1985	63.3	21.5	15.2	62.6	21.2	16.2	81.2	10.1	8.7
1986	67.2	18.6	14.2	67.0	17.1	15.9	82.0	9.2	8.8
1987	70.2	18.7	11.0	67.2	16.6	16.2	82.3	9.6	8.0
1988	68.8	20.4	10.9	73.5	16.6	9.9	82.0	10.1	7.8
1989	66.7	20.0	13.3	70.3	15.9	13.8	83.3	9.6	7.1

Notes: Same as note a, table 1. Units are in percents.
Source: See table 1.

Since rental housing is smaller and older, living quality for renters is lower and prices of rental housing are lower. So we have to keep in mind that the rent multiplier will be upward biased if one computes it using actual housing price for owner-occupied housing and actual rent for rental housing.

2.3. The trend of housing prices

Table 3 shows the average price for one-year-old housing.[3] The average price in Taipei increased from NT $754,000 in 1981 to NT $7.12 million in 1989, up about 845 percent. The average price in Kaoshung went from NT $1.22 million to 2.43 million, up 100 percent. (In fact, the housing price in Kaoshung in 1981 is just at the top of a cycle. If we compare the price in 1982, NT $862,000, to the price in 1989, 2.43 million, the price increases about 181 percent.) The price in Taiwan province goes from NT $693,000 to 1.65 million, up 138 percent. One of the reasons for sharp increases in housing prices is higher demand; the other reason is that average housing size is larger. Thus, it is appropriate to compute the housing price per "pin" (around 36 square feet). Table 3 also shows that average prices per square pin are higher, too. The average price goes up from NT $33,000, NT $53,000, and NT $22,000 to NT $150,000, NT $62,000, and NT $37,000 for Taipei, Kaoshung, and Taiwan province, respectively. Table 4 shows the prices for two-year-old dwelling units. The average prices are higher but at a less rapidly increasing rate.

Table 3. Average transaction price of one-year-old owner-occupied dwelling units in Taiwan[a].

	Taipei		Kaoshung		Taiwan Province	
	Total Price	Price Per Pin	Total Price	Price Per Pin	Total Price	Price Per Pin
1979	—	—	—	—	—	—
1980	—	—	—	—	—	—
1981	754	32.8	1219	52.7	693	21.6
	—	—	—	—	—	—
1982	1541	55.5	863	28.5	770	24.5
	(104%)[b]	(69%)	(-29%)	(-46%)	(12%)	(13%)
1983	1634	39.1	1307	15.2	907	24.2
	(6%)	(-30%)	(52%)	(72%)	(16%)	(-1%)
1984	1471	48.2	1183	35.0	830	21.9
	(-10%)	(23%)	(-10%)	(28%)	(8%)	(10%)
1985	1461	49.9	805	21.3	1121	28.3
	(-1%)	(3%)	(-32%)	(-39%)	(35%)	(29%)
1986	1874	61.8	1123	32.4	1024	22.2
	(28%)	(24%)	(40%)	(52%)	(9%)	(22%)
1987	2526	72.3	1088	32.7	997	26.5
	(35%)	(17%)	(-3%)	(1%)	(3%)	(19%)
1988	3036	82.4	2307	53.6	1263	31.2
	(20%)	(14%)	(112%)	(64%)	(27%)	(18%)
1989	7118	149.5	2420	62.1	1649	37.1
	(134%)	(79%)	(5%)	(16%)	(31%)	(19%)

[a]Since it takes 18 months to 24 months to complete a dwelling unit, the price for one-year-old house is different from the pre-sale price in that year.

[b]The growth rate is based on previous year.

Note: Unit: NT $1000.

Source: See table 1.

Table 4. Average transaction price of two-year-old owner-occupied dwelling units in Taiwan.

	Taipei		Kaoshung		Taiwan Province	
	Total Price	Price Per Pin	Total Price	Price Per Pin	Total Price	Price Per Pin
1979	—	—	—	—	—	—
1980	—	—	—	—	—	—
1981	877	34.6	1042	39.8	641	21.2
	—	—	—	—	—	—
1982	1163	41.8	940	30.1	747	23.7
	(33%)[a]	(21%)	(-10%)	(-24%)	(16%)	(12%)
1983	1868	52.7	1427	43.5	870	24.4
	(61%)	(26%)	(52%)	(45%)	(16%)	(3%)
1984	1731	56.9	1340	40.2	889	24.4
	(-7%)	(8%)	(-6%)	(-8%)	(2%)	(0%)
1985	1350	49.2	1289	36.8	1019	25.8
	(-22%)	(-14%)	(-4%)	(-8%)	(15%)	(6%)
1986	1851	59.6	1245	37.2	1055	24.7
	(37%)	(21%)	(-3%)	(1%)	(4%)	(-4%)
1987	2073	66.1	1164	35.5	1093	27.7
	(12%)	(11%)	(-7%)	(5%)	(4%)	(12%)
1988	2179	67.3	1436	42.4	1167	30.8
	(5%)	(2%)	(23%)	(19%)	(7%)	(11%)
1989	4260	106.5	2637	62.1	1662	38.1
	(96%)	(58%)	(84%)	(46%)	(42%)	(24%)

[a]The growth rate is based on previous year.
Note: Unit: NT $1000.
Source: See table 1.

For both one-year-old and two-year-old housing units, the housing price in Taiwan went up drastically with a large cycle since 1979. There are two peaks, 1979 to 1981 and 1987 to 1989. It means that a business cycle in housing market in Taiwan is about six to seven years. In the cycle, we find that Taipei has a higher growth rate while Kaoshung has a larger cycle. And it also shows that the cycle starts at Taipei, then it affects Kaoshung, and then Taiwan province.

Taipei is the largest city in Taiwan. Higher per capita income with a high population growth rate make housing prices in Taipei grow fast in the long run. When a housing business starts, people invest in housing at Taipei first, then the investors go to Kaoshung and Taiwan province and bring up housing prices there. This phenomenon demonstrates people's speculative behavior in Taiwan.

Finally, another reason that prices go up so fast when the cycle starts is that the housing constructors provide larger lot size dwelling units. In table 5, when the price is in the peak of the cycle at 1982 and 1983, the average floor space for new houses in Taipei gets bigger from 27.76 pin to 41.75 pin. In Kaoshung and Taiwan province the space goes up from 26.73 pin and 31.81 pin to 33.75 pin to 37.55 pin, respectively. The same thing happens at another peak in 1988 and 1989. When the housing price goes up, the constructors build larger houses to make more profits. In the meantime the total price for a single dwelling unit increases more. It turns out that the public forms an expectation that the age for high housing prices is coming. Therefore, it is more difficult for the high price to drop when recession comes.

Table 5. Average floor space of owner-occupied dwelling units in Taiwan.

	Taipei			Kaoshung			Taiwan Province		
	One-Year-Old	Two-Year-Old	Total	One-Year-Old	Two-Year-Old	Total	One-Year-Old	Two-Year-Old	Total
1979	24.45	28.57	26.32	30.80	24.40	22.59	26.63	27.13	24.10
1980	32.36	31.63	27.01	27.25	26.00	22.82	29.71	29.00	25.04
1981	22.94	29.33	26.86	23.11	26.19	27.49	32.07	30.24	26.24
1982	27.76	27.82	27.27	30.25	31.19	28.52	31.81	31.57	26.91
1983	41.75	35.42	29.89	26.73	32.78	29.90	37.55	35.65	30.90
1984	30.53	30.40	29.78	33.75	33.31	33.82	37.83	36.47	31.31
1985	29.25	27.44	29.49	37.83	35.06	31.13	39.58	39.45	31.70
1986	30.32	30.98	29.76	34.67	33.59	30.67	46.04	42.64	32.94
1987	34.94	31.34	31.03	33.18	32.83	30.52	37.61	39.44	33.32
1988	36.86	32.36	30.24	43.00	33.85	32.79	40.49	37.92	33.69
1989	47.56	40.00	31.24	39.00	42.45	33.47	44.32	43.62	34.78

Note: Unit: Pin.
Source: See table 1.

2.4. The trend of rent

Renting a house is a pure consumption decision. Without investment and speculative behavior, the change of rent is much smaller than in the owner-occupied market. Table 6 shows that the average rent in Taipei went up from NT $3080 to NT $6290 from 1979 to 1989, and it went up from NT $2310 to NT $1820 to NT $4100 and NT $4210 in Kaochung and Taiwan province. The percentage increases in Taipei, Kaoshung, and Taiwan province were 105 percent, 77 percent, and 131 percent, which is much smaller than the percentage increase in housing price of 845 percent, 99 percent, and 181 percent. If we count the rent per pin, the percentage of increase of rent is also smaller from 1979 to 1989, that is 77 percent, 11 percent, and 65 percent compared to 356 percent, 18 percent, and 118 percent. Table 7 shows the average space for rental housing in Taiwan.

When the rent increases, there is also a business cycle in the rental market with a much smaller magnitude. The two peaks are in 1979 to 1982 and 1987 to 1989. Generally speaking, besides a smaller amplitude, there is a one-year time lag compared with owner-occupied housing. One reason is that rental contract is usually counted by year, and there is an adjustment lag. On the other hand, since the rental behavior is simply for consumption, not for investment and speculation, the rental price reacts more slowly.

Moreover, the business cycle in Taipei and Taiwan province is similar, but a little different from Kaoshung. In Kaoshung, the growth rate for rent is smaller but the amplitude is larger. Kaoshung is a growing city, and the speed of population increase is between Taipei and Taiwan province. So the consumption demand for housing service increases less than in Taipei. On the other hand, there is much more open space that can be used to construct new houses in Kaoshung. So whenever the housing price goes up, constructors start to build many new dwelling units, but they take one to two years to finish. So the price keeps going up. When the new buildings are done, there is excess supply, and the price and rent go down. Obviously, there are a larger supply elasticity and larger speculation in Kaoshung, which cause the housing market to fluctuate there.

Table 6. Average monthly rent in Taiwan.

	Taipei		Kaoshung		Taiwan Province	
	Total Rent	Rent Per Pin	Total Rent	Rent Per Pin	Total Rent	Rent Per Pin
1979	3080	140	2310	138	1820	96
	—	—	—	—	—	—
1980	3330	152	2370	130	2120	108
	(8%)[a]	(9%)	(3%)	(-6%)	(16%)	(13%)
1981	4000	187	3020	150	2490	122
	(20%)	(23%)	(31%)	(15%)	(17%)	(13%)
1982	4620	211	3910	201	2920	138
	(16%)	(13%)	(29%)	(34%)	(17%)	(13%)
1983	4710	189	3250	133	2950	120
	(2%)	(-10%)	(-17%)	(-34%)	(1%)	(-13%)
1984	5030	206	3310	117	2950	125
	(7%)	(9%)	(2%)	(-12%)	(1%)	(4%)
1985	4930	202	3740	135	3170	129
	(-2%)	(-2%)	(13%)	(15%)	(7%)	(3%)
1986	5330	211	3590	136	3250	128
	(8%)	(4%)	(-4%)	(1%)	(3%)	(-1%)
1987	5340	201	3500	141	3320	131
	(2%)	(-5%)	(-3%)	(4%)	(2%)	(2%)
1988	5600	232	3880	145	3520	140
	(5%)	(15%)	(11%)	(3%)	(6%)	(7%)
1989	6290	248	4100	153	4210	158
	(12%)	(7%)	(6%)	(6%)	(20%)	(13%)

[a]The growth rate is based on previous year.
Note: Unit: NT $.
Source: See table 1.

Table 7. Average floor space of rental dwelling units in Taiwan.[a]

	Taipei		Kaoshung		Taiwan Province	
	Two-Year-Old	Total	Two-Year-Old	Total	Two-Year-Old	Total
1979	23.80	22.00	27.00	16.72	21.34	18.89
1980	26.83	21.85	29.80	18.20	22.46	19.72
1981	16.50	21.37	25.50	20.17	23.24	20.40
1982	23.36	21.92	20.50	19.41	24.61	21.14
1983	31.69	24.89	13.50	24.36	27.12	24.55
1984	29.42	24.44	40.00	28.23	28.95	23.57
1985	27.14	24.46	50.00	27.77	30.45	24.57
1986	26.83	25.29	100.00	26.44	24.36	25.35
1987	33.00	26.51	23.80	24.79	27.71	25.29
1988	26.05	24.15	27.05	26.75	27.51	25.08
1989	33.00	25.36	22.60	26.82	32.71	26.58

[a]Since the sample size for one-year rental dwelling units is too small, the statistic does not mean much and is neglected.
[b]The sample size for Kaoshung in 1983, 1984, 1985, and 1986 are also small, so those figures are not reasonable.
Note: Unit: Pin.
Source: See table 1.

The price elasticity of housing demand is small. Polinsky (1977) concluded that the average price elasticity of rental housing unit is about -0.75 and the income elasticity is between 0.8 to 1.0. More importantly, both figures are stable. Wu (1981) finds that the income elasticity of housing demand in Taiwan is near 0.8.[4] Taking rental behavior as an index for housing consumption, we can use the change in rental market as the change in the demand for housing. Furthermore, we may capitalize the rent and get the corresponding housing price. So, if what we care about is only the consumption demand, then the related rent multiplier should be stable. If the rent multiplier fluctuates sharply, it shows that there is a severe change in investment and speculation demand. How the rent multiplier changes in Taiwan will be discussed in the next section.

3. Trend of rent multiplier in Taiwan

3.1. Hedonic price equation and hedonic rent equation

This article applies hedonic theory to estimate equilibrium market price according to the housing characteristics embedded in each dwelling unit such as floor space, age of house, location, construction material, and so on. To estimate market value we also have to consider depreciation and inflation factors. We also apply hedonic theory to estimate market rent, considering housing attributes, rent adjustment lag, and rent discount. Then we compute rent multiplier by estimated market price and estimated market rent. In this case the estimated rent multiplier will correctly reflect the changes in the equilibrium of rental market and owner-occupied market. If one uses the actual rent and actual transaction price to compute rent multiplier, he or she may get a seriously biased result for neglecting certain important factors such as rent adjustment lag and rent discount.

According to the hedonic theory (for example, Rosen (1974), Ellickson (1981), and Lin (1990)), we assume that the housing price is composed of housing attributes and assume that the price function has Cobb–Douglas form. Then the housing price for dwelling unit i is determined by the following equation:

$$H_i = \alpha_0 T_1^{\alpha_1} T_2^{\alpha_2} Z_1^{\beta_1} \ldots Z_n^{\beta_n} \tag{1}$$

Where H_i is the market price of dwelling i, T_1 is age of house, T_2 is duration of owning the house, $Z_1, \ldots, Z_n$ are housing attributes affecting housing price. α_1 shows the effect of housing age on housing price, that is, depreciation effect, and α_2 represents the effect of length of owning on housing price, that is, capital gain. Finally, $\beta_1, \ldots, \beta_n$ are the marginal contributions to housing price for each housing attribute, that is, shadow price. For estimation purpose, we take the logarithm in both sides of the above equation and put an error term, ϵ_i, which represents the error of measurement. Then we may rewrite equation (1) as

$$lnH_i = ln\alpha_0 + \alpha_1 lnT_1 + \alpha_2 lnT_2 + \beta_1 lnZ_1 + \ldots + \beta_n lnZ_n + \epsilon_i. \tag{2}$$

Though we have put two time variables here, T_1 and T_2, and we do have data on those two variables, these two variables usually highly correlate. So it is difficult to separate

them in the regression, that is, there is a serious multicollinearity problem. And we may get a downward biased estimation of housing price if we put both variables in the regression equation. In order to avoid this problem, we take T_1 as the only variable to represent the depreciation effect.

To deal with the capital gain, we reshuffle the data set. The dwelling units that have the same transaction year are combined from 1979 to the 1989 data set. One merit of this method is that those transaction prices will show the actual market condition in different years. So in that case we do not have to put T_2 into our price equation. The other benefit is that the number of observations becomes larger.

The same method is applied in estimating the rent equation. The rent equation is written as

$$lnR_i = ln\gamma_0 + \gamma_1 lnT_1 + \theta_1 lnZ_1 + \ldots + \theta_m lnZ_m + \eta_i, \tag{3}$$

where R_i is market rent for dwelling i, $Z_1, \ldots, Z_m$ are housing attributes, and η_i is an error term. Since consumption is the only purpose for renting a house, different from owning a house, housing attributes will have different effects on rent. In addition, what a renter cares about is the age of the house and he or she does not care when the landlord bought the house, so T_2 is not in the equation.[5]

In traditional literature, the rent multiplier is computed by the actual transaction price and actual rent: for example, Shelton (1968). There are a few problems. First, the transaction price is not equal to the market price at the date of data collection, so there is a serious bias on housing price. Second, the actual rent does not equal the market rent either, since there is an adjustment lag on rent. The other problem is that, as Lin (1988a) points out, when one stays in a place for a long time he may get a rent discount by having a good relationship with his landlord. So the result will also be biased if we use actual rent to estimate rent multiplier.

In this article, we apply the estimated market rent and estimated market price to compute the rent multiplier. But the market rent and market price are not in our data set, so we have to compute them first. We utilize the ordinary least-squares method to estimate the price equation and the rent equation as equation (2) and equation (3). Since the data set is composed of annual data for ten years, we have a great opportunity to test whether our model is stable since there is a lack of such analysis in Taiwan.

3.2. Explanation of variables

We apply the hedonic equations to estimate market prices for owner-occupied and market rents for rental dwelling units in our data set. Since there are no price data for rental housing units in the data set, we have to use the estimated price equation of owner-occupied housing units to estimate market prices for rental housing units. And then we use estimated market prices and estimated market rents to compute rent multipliers.

By the hedonic theory, the price or rent of a dwelling unit is determined by the sum of value of all characteristics embedded in each dwelling unit. So we get some housing attributes available from our data set, the Housing Survey Report, including: PIN, HAGE, MATALD, HFUND, HTYPED, KITCHD, BATHD, RESTD, FUELD, and ENVIRD. The variables are defines as follows:

PIN: lot size, measured by pin (about 36 square feet).
HAGE: housing age.
MATALD: materials of housing construction, a dummy variable. If dwelling unit is made of cement, then MATALD = 1; if it is of brick, stone, or wood, then MATALD = 0.
HFUND: main function of the dwelling unit, a dummy variable. If it is for pure household consumption, the HFUND = 0; if the dwelling unit is for some business or other purpose, such as an office or warehouse, then HFUND = 1.[6]
HTYPED1: housing type one, a dummy variable. If it is a five-floor apartment, then HTYPED1 = 0; otherwise HTYPED1 = 1.
HTYPED2: housing type two, a dummy variable. If it is a five-floor apartment or a tall building, then HTYPED2 = 0; otherwise HTYPED2 = 1.
HTYPED3: housing type three, a dummy variable. If it is a five-floor apartment, a tall building, or a duplex, then HTYPED3 = 0; otherwise HTYPED3 = 1.[7]
KITCHD: number of kitchens, a dummy variable. If there are two or more kitchens in the unit, then KITCHD = 1; otherwise KITCHD = 0.
BATHD: number of bathrooms, a dummy variable. If there are two or more bathrooms in the unit, then BATHD = 1; otherwise BATHD = 0.
RESTD: number of restrooms, a dummy variable. If there are two or more restrooms in the unit, then RESTD = 1; otherwise RESTD = 0.
FUELD: type of fuel in the unit, a dummy variable. If gas is the main fuel, then FUELD = 1; otherwise FUELD = 0.
ENVIRD: satisfaction of neighborhood, a dummy variable. If the tenant is satisfied, then ENVIRD = 1; otherwise ENVIRD = 0.[8]
PRICE: transaction price of the housing unit.
RENT: current monthly rent payment.

We assume that both the price and rent equations are log-linear. All the explanatory variables are taken in logarithmic value, except for dummy variables (where the variables ended with a D), such as house price (PRICE), rent (RENT), lot size (PIN), and house age (HAGE). In this setting, the coefficient of PIN means the elasticity of price on the lot size.[9] The coefficient of HAGE represents total housing depreciation, that is, house depreciation rate times housing age.[10]

In estimating price and rent equations, we apply the same variables, because when we compute the rent multiplier we have to comute the market value for rental house using the estimated price equation. Generally, rent is high when the price of a house is high, so the contribution for a certain housing attribute on price and rent has the same direction. But the importance may be different. Basically, a houseowner cares about environment, lot size, and so on, if he/she lives there. On the contrary, if an owner buys a house for investment and speculative purposes, he/she cares more about housing age, building material, and so on. Since renting a house is for consumption only, a renter pays more attention to lot size and environment, but less to house age and housing material. The usage of a dwelling unit also has significant effect on housing price and rent. The rent of a building for business usage will be much higher than the same building used for household consumption purpose. We will discuss those points later on.

3.3. Estimation of price equation

To avoid multicollinearity and estimation error among age of house and time of purchase, we reconstruct the data set from 1979 to 1989, that is, we combine the data with same purchase year. In our new data set, we may omit purchasing time since the transaction year is the same. In other words, we can neglect the price difference (i.e., capital gain) between time of purchase and time of survey. The capital gain has already been counted on the marginal contribution of each housing attribute. In this case, the coefficient of housing age represents purely the depreciation rate.

Applying the ordinary least-squares method to our reconstructed data set and using the estimated equations (2) and (3), we estimate price equations and rent equations for every year from 1979 to 1989. The results are listed in table 8 through table 17, and the average coefficients are in table 18.[11]

Lot size is one of the main factors affecting housing price. This situation is especially significant for the Taiwan market since lots of brokers list the housing price by PIN. In our estimated regression of 1979 to 1982 the coefficients for PIN are positive and significant, somewhere between 0.2 to 0.3. But the coefficients are much larger after 1982, between 0.6 to 0.9. The variation is especially large in Kaoshung: for example, 0.0999 in 1979 and 1.5838 in 1988. This phenomenon is consistent with a large price fluctuation in Kaoshung. In fact, not only does the total price vary in Kaoshung but the price per pin changes rapidly. Table 18 shows that the elasticity of lot size on housing price is 0.6134 at Taipei, 0.7715 at Kaoshung, and 0.5968 in Taiwan province.

The coefficients of HAGE represent the total depreciation. The older house should have a lower value, so we expect the coefficients to be negative. In our estimation of 1979 to 1988, most coefficients are negative and significantly different from zero, but with a few positive numbers. In addition, the coefficients are different among cities. Since the depreciation rate should be the same as long as they have the same construction materials, we have to figure out why the depreciation rates are different among cities. In table 18, the total depreciation rates are 0.0011, −0.0544, and −0.0256 for Taipei, Kaoshung, and Taiwan province, respectively, which shows that Kaoshung has the highest depreciation, while there is no depreciation at all in Taipei.

Construction material (MATALD) is defined as a dummy variable. We find that the buildings made of cement have a much higher value than the building made of bricks or wood. The situation is also most vivid at Kaoshung, which shows that people in Kaoshung are more sensitive about materials. The other possible reason is that there are lots of new buildings in Kaoshung, with much higher value than old buildings. Since most buildings in Taipei are made of cement, the difference is trivial. The average coefficients of MATALD are 0.0211, 0.1882, and 0.1068 for Taipei, Kaoshung, and Taiwan province, respectively.

The coefficient of HFUN is large, and it means that the housing value is very high for houses with functions other than pure consumption. The situation is similar to Taipei, Kaoshung, and Taiwan province. But since most business-usage dwelling units are located on the first floor, the high value could be simply owing to its good location.

The coefficient of HTYPED1 represents the discrepancy between five-floor apartments and other buildings. The estimated positive coefficients show that five-floor apartments have lower values than others. HTYPED2 has a negative coefficient and show that the average

Table 8. Price equation and rent equation, 1979.

Dep. Var.: PRICE				Dep. Var: RENT		
	Owner-Occupied Housing			Rental Housing		
Indep. Var.	Taipei	Kaoshung	Taiwan†	Taipei	Kaoshung	Taiwan
CONST	3.4702	4.0667	3.3014	7.2529	6.2735	7.2005
	(30.228)*	(24.850)*	(68.449)*	(53.636)*	(18.697)*	(104.418)*
PIN	0.2017	0.0999	0.2373	0.0872	0.0812	0.0656
	(6.058)*	(2.378)*	(18.615)*	(4.481)*	(3.006)*	(5.884)*
HAGE	0.0166	-0.2610	-0.0934	-0.1030	0.0591	-0.0723
	(0.495)	(5.379)*	(6.706)*	(3.878)*	(1.484)	(5.414)*
MATALD	0.0950	0.3943	0.0938	0.1323	0.3406	0.0753
	(2.398)*	(6.489)*	(3.978)*	(1.982)*	(4.803)*	(2.056)*
HFUND	0.1777	0.2053	0.1258	0.1719	0.3986	0.1952
	(5.649)*	(5.275)*	(9.474)*	(6.058)*	(6.963)*	(11.557)*
KITCHD	0.0739	0.1892	0.1310	0.0628	0.1771	0.0388
	(0.476)	(1.533)	(2.563)*	(0.478)	(0.579)	(0.858)
HTYPED1	0.3346	0.3239	0.2149	-0.0049	-0.0892	-0.4486
	(6.493)*	(2.176)*	(2.235)*	(0.032)	(0.695)	(1.114)
HTYPED2	-0.4751	-0.2944	-0.3259	0.0291	—	0.1616
	(5.681)*	(1.964)*	(3.357)*	(0.176)		(0.403)
HTYPED3	0.2098	-0.0596	-0.1832	0.1017	0.0405	-0.1169
	(2.301)*	(0.764)	(9.272)*	(1.156)	(0.349)	(3.773)*
BATHD	0.1116	0.2639	0.2451	0.1395	0.0939	0.0639
	(1.597)	(3.448)*	(10.280)*	(1.127)	(0.711)	(1.369)
RESTD	0.2556	0.1748	0.3255	0.1216	0.1084	0.1845
	(3.942)*	(2.380)*	(16.022)*	(1.329)	(1.119)	(4.581)*
FUELD	0.1329	-0.1835	0.0977	0.2366	—	0.0905
	(3.364)*	(1.237)	(4.815)*	(3.788)*		(2.066)*
ENVIRD	-0.0083	0.0175	0.0135	-0.0294	-0.1894	-0.0082
	(0.223)	(0.347)	(0.822)	(0.664)	(3.224)*	(0.337)
Adj. R^2	0.3442	0.3148	0.2916	0.2851	0.4409	0.3371
F-value	36.344*	21.788*	185.872*	16.087*	17.085*	51.689*
Number of observations	808	543	5390	454	204	1196

†Taiwan province does not include Taipei and Kaoshung.
‡The absolute t-value is in the parenthesis.
*The coefficient is significant under 95 percent level.
'The coefficient is significant under 90 percent level.
Source: This study.

price for five-floor apartments and tall buildings is higher than for duplexes and single houses. HTYPED3 has a negative coefficient and shows that the average price for five-floor apartments, tall buildings, and duplex units has a lower value than single houses. We conclude that five-floor apartments are the cheapest, the duplexes are the next less expensive, single houses have the second highest value, while the tall buildings are the most expensive. The only exception comes from HYTPED3 at Taipei, where the average coefficient for HTYPED3 is positive. The positive coefficient of HTYPED3 shows that

Table 9. Price equation and rent equation, 1980.

Dep. Var.: PRICE				Dep. Var: RENT		
	Owner-Occupied Housing			Rental Housing		
Indep. Var.	Taipei	Kaoshung	Taiwan†	Taipei	Kaoshung	Taiwan
CONST	3.3923	3.6757	3.3107	7.5598	7.0507	7.4402
	(21.497)*	(18.401)*	(58.699)*	(65.436)*	(37.267)*	(106.413)*
PIN	0.2950	0.1184	0.2558	0.0944	0.0363	0.0584
	(7.100)*	(2.178)*	(16.666)*	(5.551)*	(1.364)	(4.819)*
HAGE	0.0106	0.0229	-0.0638	-0.0657	0.0524	-0.0691
	(0.269)	(0.454)	(4.824)*	(2.060)*	(1.306)	(4.448)*
MATALD	0.0775	0.0850	0.0689	-0.0095	-0.0620	0.1046
	(1.598)	(1.235)	(2.581)*	(0.186)	(0.647)	(1.789)!
HFUND	0.0908	0.1309	0.1887	0.0984	0.2602	0.1684
	(2.613)*	(2.278)*	(11.704)*	(4.126)*	(5.585)*	(9.141)*
KITCHD	—	0.1345	-0.0233	-0.1634	0.2069	-0.0.439
		(0.694)	(0.455)	(1.250)	(1.825)!	(0.798)
HTYPED1	0.1717	0.3888	0.3717	-0.3378	-0.3046	0.1464
	(2.991)*	(2.182)*	(3.278)*	(2.550)*	(0.915)	(0.783)
HTYPED2	-0.6623	-0.4172	-0.5701	0.1724	-0.1149	-0.4821
	(6.244)*	(2.264)*	(4.979)*	(1.200)	(0.348)	(2.627)*
HTYPED3	0.4909	-0.0226	-0.1660	-0.0615	-0.2270	-0.1561
	(4.107)*	(0.214)	(6.908)*	(0.728)	(1.700)!	(4.757)*
BATHD	0.1027	0.0735	0.1889	0.2143	-0.0046	0.0437
	(1.166)	(0.722)	(6.952)*	(1.339)	(0.027)	(0.781)
RESTD	0.2591	0.4428	0.3231	0.2016	0.2933	0.2823
	(3.075)*	(4.162)*	(13.101)*	(1.637)	(1.964)!	(6.763)*
FUELD	0.2254	-0.0364	0.1478	0.1755	—	0.0690
	(5.069)*	(0.193)	(5.822)*	(3.523)*		(1.452)
ENVIRD	-0.0051	0.0456	-0.0205	-0.0516	-0.0657	-0.0808
	(0.118)	(0.715)	(1.027)	(1.189)	(1.124)	(3.160)*
Adj. R^2	0.3764	0.2820	0.2912	0.2845	0.2994	0.3397
F-value	33.699*	10.787*	133.294*	17.599*	11.025*	51.381*
Number of observations	596	299	3864	501	258	1175

†Taiwan province does not include Taipei and Kaoshung.
‡The absolute t-value is in the parenthesis.
*The coefficient is significant under 95 percent level.
!The coefficient is significant under 90 percent level.
Source: See table 8.

the single houses in Taipei are the most valuable. The reason is simply that most of the single houses in Taipei were built a long time ago and with very large lot size, and so they have a very high price.

About the housing construction, the kitchen (KITCH), bathroom (BATH), and restroom (REST) all should have positive signs according to our definitions. In table 8 through table 17 we find that most coefficients of BATH and REST are positive, and it shows that they have positive contributions on housing price. But KITCH has more negative signs than positive. In table 18, the average coefficient of KITCH at Taipei is barely larger than zero,

Table 10. Price equation and rent equation, 1981.

Dep. Var.: PRICE				Dep. Var: RENT		
	Owner-Occupied Housing			Rental Housing		
Indep. Var.	Taipei	Kaoshung	Taiwan†	Taipei	Kaoshung	Taiwan
CONST	3.8174	2.9688	3.2992	7.7329	7.5277	7.7345
	(19.776)*	(8.854)*	(47.144)*	(48.961)*	(34.181)*	(99.824)*
PIN	0.2095	0.3872	0.3133	0.0877	0.0774	0.0781
	(3.681)*	(5.439)*	(16.555)*	(4.360)*	(2.414)*	(6.126)*
HAGE	0.0532	-0.0162	-0.1080	-0.0023	-0.0634	-0.0913
	(0.957)	(0.118)	(6.710)*	(0.048)	(0.966)	(4.183)*
MATALD	0.0946	0.2087	0.2510	-0.0109	-0.2779	0.2087
	(1.605)	(2.080)*	(8.177)*	(0.187)	(2.802)*	(2.883)*
HFUND	-0.0040	0.0911	0.1828	0.1761	0.2534	0.1866
	(0.110)	(1.249)	(9.641)*	(5.932)*	(3.586)*	(10.034)*
KITCHD	0.4321	-0.2280	0.2029	-0.3064	0.3283	-0.1809
	(2.139)*	(1.681)!	(2.891)*	(0.657)	(1.514)	(1.326)
HTYPED1	0.2340	0.0247	0.2222	0.1239	0.4249	-0.3506
	(3.007)*	(0.132)	(1.976)*	(0.816)	(1.247)	(1.766)!
HTYPED2	-0.1763	0.1084	-0.4475	-0.3586	-0.5768	-0.0371
	(1.636)	(0.551)	(3.892)*	(2.031)*	(1.767)!	(0.189)
HTYPED3	0.2557	-0.0518	-0.2129	-0.3450	-0.2180	-0.2918
	(2.000)*	(0.344)	(7.777)*	(3.161)*	(1.877)!	(8.106)*
BATHD	0.1278	0.2188	0.1619	-0.3504	-0.2786	0.2054
	(1.022)	(1.915)!	(5.235)*	(1.272)	(1.371)	(1.763)!
RESTD	0.2596	0.2709	0.2833	0.1205	0.5095	0.2716
	(2.151)*	(2.351)*	(10.414)*	(0.675)	(3.418)*	(3.815)*
FUELD	0.1869	0.3915	0.1573	0.2194	-0.2950	0.1083
	(3.314)*	(1.626)	(5.065)*	(3.852)*	(2.146)*	(2.729)*
ENVIRD	-0.0134	0.0177	-0.0201	-0.0267	-0.0257	-0.0625
	(0.256)	(0.215)	(0.922)	(0.519)	(0.349)	(2.182)*
Adj. R^2	0.4448	0.3877	0.3650	0.2527	0.2749	0.3097
F-value	21.626*	11.344*	126.043*	14.727*	8.679*	50.084*
Number of observations	309	196	2611	487	243	1313

†Taiwan province does not include Taipei and Kaoshung.
‡The absolute t-value is in the parenthesis.
*The coefficient is significant under 95 percent level.
!The coefficient is significant under 90 percent level.
Source: See table 8.

while Kaoshung and Taiwan province have negative signs, though the magnitude is much smaller than the coefficients of BATH and REST. One reason is that most housing units have only one kitchen, while there may be two or more bathrooms and restrooms for a large house. So the correlation of BATH and REST with housing value is larger than KITCH.

A dwelling unit of which gas is the main fuel should have higher value. Table 18 shows that the average coefficients for FUELD are 0.1492 and 0.1538 for Taipei and Taiwan province, but the coefficient in Kaoshung is near zero—0.0413. The insignificant coefficient at Kaoshung is because there are hardly dwelling units there using gas as the main fuel.

Table 11. Price equation and rent equation, 1982.

Dep. Var.: PRICE				Dep. Var: RENT		
	Owner-Occupied Housing			Rental Housing		
Indep. Var.	Taipei	Kaoshung	Taiwan†	Taipei	Kaoshung	Taiwan
CONST	2.7316	1.3700	2.1287	7.8520	8.2680	7.9798
	(12.005)*	(3.953)*	(22.943)*	(59.452)*	(32.219)*	(91.891)*
PIN	0.6134	0.9587	0.6342	0.0779	0.1112	0.0948
	(9.348)*	(10.894)*	(25.998)*	(3.871)*	(3.420)*	(6.945)*
HAGE	0.0070	-0.1929	-0.0365	-0.1090	-0.1140	-0.1527
	(0.216)	(3.076)*	(2.140)*	(3.001)*	(1.609)	(6.268)*
MATALD	-0.0366	0.1504	0.0860	0.2562	-0.1168	-0.0756
	(0.774)	(1.903)!	(3.450)*	(4.295)*	(1.191)	(1.300)
HFUND	0.0756	0.2523	0.1638	0.2356	0.2232	0.2410
	(2.820)*	(2.973)*	(10.692)*	(8.092)*	(3.613)*	(10.913)*
KITCHD	—	0.3830	-0.1679	—	0.0936	-0.1360
		(2.581)*	(2.652)*		(0.341)	(0.974)
HTYPED1	0.1165	0.5402	0.3499	-0.0083	-0.5594	0.3463
	(2.813)*	(4.035)*	(5.207)*	(0.081)	(1.983)*	(0.960)
HTYPED2	-0.2882	-0.7382	-0.6120	-0.0810	0.1563	-0.6982
	(3.306)*	(4.813)*	(8.810)*	(0.702)	(0.570)	(1.938)!
HTYPED3	0.0855	-0.3405	-0.2108	-0.3238	-0.1362	-0.2993
	(0.625)	(1.647)	(9.140)*	(2.488)*	(0.981)	(7.363)*
BATHD	0.1677	-0.1926	0.1461	0.0524	0.2317	0.0830
	(2.600)*	(1.977)*	(6.142)*	(0.268)	(0.874)	(0.789)
RESTD	0.0983	0.4341	0.1501	0.3246	-0.0357	0.1640
	(1.551)	(4.233)*	(6.606)*	(2.032)*	(0.218)	(2.547)*
FUELD	0.1963	0.2237	0.2333	0.2121	—	0.1136
	(4.769)*	(0.870)	(9.617)*	(3.652)*		(2.941)*
ENVIRD	0.0640	0.0014	0.0936	-0.0591	-0.2249	-0.0104
	(1.864)!	(0.021)	(5.488)*	(1.270)	(2.711)*	(0.347)
Adj. R^2	0.4818	0.5290	0.4442	0.2803	0.2014	0.3161
F-value	37.933*	24.026*	191.938*	21.221*	6.481*	50.543*
Number of observations	437	246	2867	571	239	1286

†Taiwan province does not include Taipei and Kaoshung.
‡The absolute t-value is in the parenthesis.
*The coefficient is significant under 95 percent level.
!The coefficient is significant under 90 percent level.
Source: See table 8.

By our definition ENVIRD should have a negative sign. But the coefficients for ENVIRD from table 8 through table 17 are insignificant with minus and plus signs. The coefficients are 0.0120, −0.0385, and 0.0260 for Taipei, Kaoshung, and Taiwan province. It shows that people in Taiwan are not very sensitive to their living environment. Though sometimes people protest about air pollution made by firms in their neighborhood, most of the time people also pay a high price for a house with a high noise pollution in the downtown area.

Overall, our estimates from table 8 through table 17 are good. Most coefficients are the same as we expected. The adjusted R^2s are between 0.3 and 0.7, which are not too bad

Table 12. Price equation and rent equation, 1983.

Dep. Var.: PRICE				Dep. Var: RENT		
	Owner-Occupied Housing			Rental Housing		
Indep. Var.	Taipei	Kaoshung	Taiwan†	Taipei	Kaoshung	Taiwan
CONST	1.8544	0.5975	1.8097	7.9381	7.3739	7.5967
	(8.814)*	(2.296)*	(20.511)*	(43.593)*	(21.033)*	(62.957)*
PIN	0.8075	1.1752	0.6973	0.1486	0.1946	0.1847
	(14.665)*	(13.881)*	(30.372)*	(3.714)*	(2.567)*	(6.644)*
HAGE	-0.0705	-0.0124	0.0890	-0.1034	-0.0633	-0.1001
	(2.481)*	(0.255)	(5.315)*	(2.775)*	(0.885)	(4.022)*
MATALD	-0.1105	0.1099	0.1280	0.0598	0.0219	-0.0682
	(2.597)*	(1.935)!	(5.752)*	(1.188)	(0.224)	(1.242)
HFUND	0.3502	0.0210	0.1661	0.1742	0.1909	0.1981
	(8.418)*	(0.329)	(11.334)*	(6.158)*	(4.456)*	(9.594)*
KITCHD	-0.3605	0.3521	-0.0333	-0.0035	-0.0695	-0.2138
	(2.376)*	(2.420)*	(0.609)	(0.021)	(0.248)	(1.798)!
HTYPED1	0.1559	0.1586	0.1513	0.0530	-0.2283	0.2659
	(3.782)*	(1.877)!	(2.467)*	(0.676)	(1.012)	(1.027)
HTYPED2	-0.3468	-0.1529	-0.5191	-0.2830	0.0628	-0.6082
	(4.223)*	(1.722)!	(8.172)*	(2.957)*	(0.293)	(2.346)*
HTYPED3	-0.4933	-1.3855	-0.2089	-0.1856	-0.4028	-0.3841
	(3.649)*	(6.402)*	(9.658)*	(1.953)!	(3.009)*	(9.670)*
BATHD	0.1496	-0.0117	0.1363	0.0068	0.3189	0.0713
	(2.520)*	(0.184)	(5.824)*	(0.049)	(1.935)!	(0.819)
RESTD	0.0981	0.0624	0.1985	0.1952	-0.0789	0.0656
	(1.655)!	(0.976)	(8.969)*	(1.587)	(0.737)	(1.199)
FUELD	0.1212	0.0735	0.1279	0.1619	-0.2645	0.1132
	(3.153)*	(0.254)	(5.532)*	(3.564)*	(1.244)	(2.941)*
ENVIRD	0.0244	0.0600	-0.0030	0.0625	-0.0842	0.0106
	(0.767)	(1.259)	(0.186)	(1.523)	(0.963)	(0.365)
Adj. R^2	0.5810	0.5254	0.4514	0.2927	0.2554	0.2963
F-value	62.580*	31.717*	218.302*	20.796*	7.574*	49.989*
Number of observations	533	333	3169	574	230	1396

†Taiwan province does not include Taipei and Kaoshung.
‡The absolute t-value is in the parenthesis.
*The coefficient is significant under 95 percent level.
!The coefficient is significant under 90 percent level.
Source: See table 8.

for a cross-sectional data set. All F-values are significant, too. The reliable estimates strengthen our confidence in using them to estimate the market values for rental housing.

3.4. Estimation of rent equation

Since there is no capital gain or loss for renters, the effect of housing age on rent simply reflects people's attitude for new buildings or old buildings. In estimating rent equations,

Table 13. Price equation and rent equation, 1984.

Dep. Var.: PRICE				Dep. Var: RENT		
	Owner-Occupied Housing			Rental Housing		
Indep. Var.	Taipei	Kaoshung	Taiwan†	Taipei	Kaoshung	Taiwan
CONST	2.5719	0.4351	2.0302	7.6717	7.5560	7.6241
	(11.020)*	(1.796)!	(20.726)*	(36.782)*	(20.116)*	(62.404)*
PIN	0.7515	1.1789	0.6906	0.2776	0.2308	0.1921
	(11.355)*	(17.710)*	(26.109)*	(6.140)*	(3.350)*	(6.976)*
HAGE	-0.1159	0.0492	-0.0394	-0.1308	-0.1046	-0.1219
	(4.635)*	(1.265)	(2.235)*	(2.903)*	(1.251)	(4.819)*
MATALD	-0.0737	0.1020	0.0993	-0.0309	0.0515	-0.1719
	(1.826)!	(2.020)*	(3.795)*	(0.534)	(0.575)	(3.049)*
HFUND	0.1236	-0.0322	0.1803	0.2002	0.2165	0.2406
	(4.051)*	(0.710)	(10.539)*	(6.792)*	(4.232)*	(11.569)*
KITCHD	-0.3692	0.2008	0.0689	0.3666	0.0022	0.1679
	(2.422)*	(1.700)!	(1.016)	(1.056)	(0.012)	(1.226)
HTYPED1	0.1511	0.2264	0.2076	0.0678	-0.2687	0.0387
	(4.192)*	(2.904)*	(3.024)*	(0.876)	(1.822)!	(0.208)
HTYPED2	0.0713	-0.3042	-0.4584	-0.3504	0.0021	-0.4668
	(0.957)	(3.329)*	(6.527)*	(3.475)*	(0.016)	(2.515)*
HTYPED3	0.3834	-0.2814	-0.2103	-0.1484	-0.5684	-0.3033
	(1.997)*	(2.987)*	(7.848)*	(1.439)	(5.438)*	(7.645)*
BATHD	0.1762	-0.2185	0.1216	0.2004	-0.1170	-0.0433
	(4.041)*	(2.399)*	(4.397)*	(1.299)	(0.690)	(0.496)
RESTD	-0.0095	0.4835	0.1350	-0.1303	-0.0448	0.1497
	(0.212)	(4.975)*	(5.048)*	(0.938)	(0.436)	(2.580)*
FUELD	0.1016	—	0.1433	0.1893	—	0.1182
	(3.021)*		(5.523)*	(3.843)*		(3.208)*
ENVIRD	0.0156	0.1382	0.0390	-0.0008	-0.0982	0.0534
	(0.563)	(3.338)*	(2.022)*	(0.016)	(1.313)	(1.806)!
Adj. R^2	0.4723	0.6706	0.4193	0.3336	0.3193	0.3341
F-value	45.822*	57.812*	149.677*	23.731*	11.873*	60.044*
Number of observations	601	307	2471	545	255	1412

†Taiwan province does not include Taipei and Kaoshung.
‡The absolute t-value is in the parenthesis.
*The coefficient is significant under 95 percent level.
!The coefficient is significant under 90 percent level.
Source: See table 8.

we apply the original survey data, and we do not reconstruct the data set as we do in estimating price equations, since there is no multicollinearity problem between purchase time and survey time. In addition, we use exactly the same explanatory variables in estimating rent equations because we have to compare rents and estimated market values later on. We also apply the ordinary least-squares method and log-linear form and estimate the rent equation for three different areas—Taipei, Kaoshung, and Taiwan province. The estimated results are shown in table 8 through table 17. The average coefficients are in table 18.

Table 14. Price equation and rent equation, 1985.

Dep. Var.: PRICE				Dep. Var: RENT		
	Owner-Occupied Housing			Rental Housing		
Indep. Var.	Taipei	Kaoshung	Taiwan†	Taipei	Kaoshung	Taiwan
CONST	2.0994	1.0736	2.0392	7.5958	6.9184	7.1968
	(10.635)*	(2.528)*	(18.457)*	(33.190)*	(22.936)*	(60.740)*
PIN	0.8359	0.8956	0.6742	0.2500	0.3021	0.2574
	(14.096)*	(7.462)*	(22.938)*	(5.177)*	(4.651)*	(9.726)*
HAGE	-0.0152	0.0247	-0.0147	-0.0327	0.0446	-0.0346
	(0.836)	(0.488)	(0.859)	(0.677)	(0.713)	(1.451)
MATALD	-0.0222	0.1716	0.1401	-0.1065	-0.0851	0.0071
	(0.671)	(2.515)*	(4.468)*	(1.723)!	(1.112)	(0.139)
HFUND	0.0689	0.3050	0.1544	0.0854	0.1273	0.2637
	(3.662)*	(3.839)*	(8.941)*	(2.677)*	(2.862)*	(12.988)*
KITCHD	-0.1822	-0.8892	-0.0215	0.0251	-0.1123	-0.4571
	(1.779)!	(2.506)*	(0.281)	(0.086)	(0.832)	(3.843)*
HTYPED1	0.2401	-0.3096	0.2002	0.1751	0.2188	0.1219
	(7.975)*	(2.780)*	(2.794)*	(2.493)*	(1.921)!	(0.971)
HTYPED2	-0.3418	-0.2998	-0.4468	-0.4566	-0.3925	-0.5998
	(5.048)*	(2.668)*	(5.923)*	(4.476)*	(3.617)*	(4.698)*
HTYPED3	—	-0.1694	-0.2937	-0.1111	-0.1918	-0.3178
	—	(1.078)	(9.571)*	(0.981)	(1.534)	(7.891)*
BATHD	0.0585	0.1191	0.1885	0.0817	-0.1071	0.1271
	(1.691)!	(1.267)	(5.923)*	(0.644)	(0.832)	(1.906)!
RESTD	0.1171	0.0531	0.1603	0.1201	0.0792	0.1138
	(3.296)*	(0.501)	(5.118)*	(1.074)	(0.732)	(2.306)*
FUELD	0.1095	—	0.1859	0.1214	—	0.1791
	(4.086)*		(5.909)*	(2.359)*		(4.964)*
ENVIRD	0.0155	0.1232	0.0445	0.0556	0.1018	-0.0094
	(0.650)	(2.029)*	(2.007)*	(1.196)	(1.384)	(0.322)
Adj. R^2	0.6241	0.4756	0.4160	0.2485	0.1610	0.3857
F-value	88.702*	19.555*	141.011*	15.057*	5.989*	71.802*
Number of observations	581	225	2359	510	286	1353

†Taiwan province does not include Taipei and Kaoshung.
‡The absolute t-value is in the parenthesis.
*The coefficient is significant under 95 percent level.
!The coefficient is significant under 90 percent level.
Source: See table 8.

Generally, the rent is high for a high-value house. All the factors that affect housing value also affect rent. What is different is that housing price is determined both on housing consumption demand and investment and speculative demand, while rent is determined only by housing consumption. So a housing attribute affecting housing consumption influences both housing price and rent, but a housing attribute affecting mainly investment and speculative demand influences housing price more and rent less.

To save space, we only discuss the average coefficients in table 18 here and concentrate on comparing the difference of the coefficients on rent equations and price equations. In

Table 15. Price equation and rent equation, 1986.

Dep. Var.: PRICE				Dep. Var: RENT		
	Owner-Occupied Housing			Rental Housing		
Indep. Var.	Taipei	Kaoshung	Taiwan†	Taipei	Kaoshung	Taiwan
CONST	2.2517	1.9093	1.4207	7.2171	7.6263	7.1818
	(10.799)*	(8.335)*	(14.102)*	(30.673)*	(26.713)*	(57.840)*
PIN	0.8315	0.7255	0.8278	0.3350	0.1894	0.2650
	(13.829)*	(10.532)*	(29.169)*	(6.298)*	(2.934)*	(9.526)*
HAGE	-0.1180	0.1379	0.0035	-0.0068	0.1130	-0.0024
	(5.055)*	(4.049)*	(0.279)	(0.145)	(1.968)!	(0.096)
MATALD	-0.0685	0.1017	0.1056	-0.0985	-0.0111	0.0397
	(1.268)	(1.351)	(3.896)*	(1.366)	(0.125)	(0.728)
HFUND	0.2457	0.1753	0.2318	0.1439	0.2268	0.1704
	(6.918)*	(3.437)*	(11.660)*	(4.308)*	(4.760)*	(8.127)*
KITCHD	-0.1490	-0.3478	-0.3273	0.1177	-0.2349	-0.1654
	(0.563)	(1.358)	(4.980)*	(0.351)	(1.227)	(1.350)
HTYPED1	0.0867	-0.3811	0.1476	0.1739	0.1153	0.1411
	(1.728)!	(5.175)*	(1.855)!	(2.402)*	(0.705)	(1.236)
HTYPED2	-0.6351	0.3191	-0.3992	-0.3806	-0.3002	-0.5562
	(6.236)*	(3.546)*	(4.850)*	(3.533)*	(1.790)!	(4.783)*
HTYPED3	-0.5159	-0.2395	-0.2765	-0.1686	-0.7120	-0.3657
	(2.981)*	(1.965)!	(9.874)*	(1.264)	(6.746)*	(8.558)*
BATHD	0.1641	0.2193	0.1922	-0.0648	0.2734	0.0952
	(2.745)*	(3.611)*	(6.661)*	(0.508)	(2.360)*	(1.347)
RESTD	0.0921	0.0033	0.1516	0.1164	0.0688	0.1700
	(1.466)	(0.045)	(5.316)*	(0.997)	(0.790)	(3.360)*
FUELD	0.0598	-0.1466	0.1560	0.2003	-0.0429	0.1791
	(1.297)	(1.226)	(5.535)*	(3.981)*	(0.281)	(2.012)*
ENVIRD	-0.0877	-0.0882	0.0490	0.1469	0.0096	0.0364
	(2.466)*	(1.769)!	(2.425)*	(2.797)*	(0.133)	(1.146)
Adj. R^2	0.6050	0.6421	0.5175	0.2577	0.4115	0.3306
F-value	59.080*	8.530*	95.752*	12.806*	4.693*	52.521*
Number of observations	455	251	2179	408	235	1252

†Taiwan province does not include Taipei and Kaoshung.
‡The absolute t-value is in the parenthesis.
*The coefficient is significant under 95 percent level.
!The coefficient is significant under 90 percent level.
Source: See table 8.

table 18 we find that the signs of coefficients on rent equation are almost the same as on price equations. In other words, almost all housing attributes have the same effects on rent and on price. There are few variables with different signs on rent equations and price equations, and the differences are small.

Lot size, PIN, has positive effects both in the rent equation and the price equation, but the magnitudes are quite different. The elasticity of lot size on housing value is between 0.60 to 0.77, but is 0.17 to 0.18 on rent. It shows that home buyers are more sensitive to lot size than renters. One reason is that homeowners have higher income so they have higher

Table 16. Price equation and rent equation, 1987.

Dep. Var.: PRICE				Dep. Var: RENT		
	Owner-Occupied Housing			Rental Housing		
Indep. Var.	Taipei	Kaoshung	Taiwan†	Taipei	Kaoshung	Taiwan
CONST	2.0544	2.3609	1.7632	7.9381	7.3136	7.3696
	(3.310)*	(5.451)*	(9.426)*	(30.493)*	(26.796)*	(55.659)*
PIN	0.7497	0.5917	0.7590	0.2135	0.2814	0.2321
	(3.977)*	(4.741)*	(14.059)*	(3.130)*	(4.405)*	(7.531)*
HAGE	0.1569	-0.0423	-0.0020	-0.0990	-0.0875	-0.0781
	(3.707)*	(0.807)	(0.094)	(2.195)	(1.719)!	(3.095)*
MATALD	0.0290	0.2329	0.0324	-0.0283	-0.0694	0.1575
	(0.298)	(1.643)	(0.591)	(0.464)	(0.724)	(3.070)*
HFUND	0.2121	0.2962	0.1652	0.0939	0.1441	0.1498
	(2.184)*	(2.563)*	(5.534)*	(2.689)*	(3.081)*	(7.469)*
KITCHD	0.6679	-0.0180	-0.1489	-0.6604	-0.3440	-0.2261
	(1.825)!	(0.072)	(1.288)	(2.776)*	(1.855)!	(1.947)!
HTYPED1	0.3291	0.2385	0.4118	-0.0276	0.5484	0.1648
	(2.989)*	(1.453)	(3.307)*	(0.273)	(2.385)*	(1.293)
HTYPED2	-0.5657	0.1542	-0.5355	-0.1500	-0.6752	-0.3673
	(2.822)*	(0.865)	(4.111)*	(1.203)	(3.003)*	(2.749)*
HTYPED3	0.9657	-0.1462	-0.2503	-0.0580	-0.6048	-0.3204
	(2.944)*	(0.529)	(4.777)*	(0.540)	(6.584)*	(7.569)*
BATHD	-0.0748	0.2080	0.1765	0.0766	0.0890	0.0727
	(0.715)	(1.179)	(3.363)*	(0.538)	(0.791)	(1.086)
RESTD	0.2524	-0.0480	0.1507	0.0350	0.1634	0.0410
	(2.339)*	(0.269)	(2.660)*	(0.274)	(1.604)	(0.844)
FUELD	0.0697	-0.4642	0.1542	0.1271	—	0.1937
	(0.747)	(1.004)	(3.039)*	(2.245)*		(4.531)*
ENVIRD	-0.0488	-0.1035	0.0475	-0.0731	0.1137	0.0250
	(0.639)	(1.003)	(1.218)	(0.964)	(0.806)	(0.607)
Adj. R^2	0.5791	0.5875	0.4741	0.1604	0.4633	0.2850
F-value	12.807*	10.376*	50.956*	8.260*	19.599*	44.784*
Number of observations	103	79	665	456	237	1318

†Taiwan province does not include Taipei and Kaoshung.
‡The absolute t-value is in the parenthesis.
*The coefficient is significant under 95 percent level.
!The coefficient is significant under 90 percent level.
Source: See table 8.

demand for lot size. Furthermore, home buyers pay more attention to housing quality than renters while renters want only an appropriate quality, so the housing age should have larger effect on price than on rent. To our surprise, the depreciation rates on owner-occupied housing are smaller and even have a positive effect. In the rent equations the coefficients of HAGE are negatively significant; they are −0.0776, −0.0628, and −0.0841 for Taipei, Kaoshung, and Taiwan province. Since the depreciation cannot be positive, we believe that there is estimation bias on our price equations. One possibility is that there still exists a capital gain on owner-occupied houses though we have already rearranged the data set.

Table 17. Price equation and rent equation, 1988.

Dep. Var.: PRICE				Dep. Var: RENT		
	Owner-Occupied Housing			Rental Housing		
Indep. Var.	Taipei	Kaoshung	Taiwan†	Taipei	Kaoshung	Taiwan
CONST	1.5163	-0.1268	1.7154	8.0572	7.9088	7.5283
	(1.788)!	(0.073)	(6.147)*	(36.190)*	(27.501)*	(59.522)*
PIN	0.8384	1.5838	0.8789	0.2393	0.1794	0.2216
	(3.731)*	(2.423)*	(10.858)*	(4.895)*	(2.641)*	(7.710)*
HAGE	0.0863	-0.2559	0.0093	-0.1229	-0.2381	-0.1184
	(0.804)	(1.751)!	(0.315)	(2.327)*	(3.649)*	(4.567)*
MATALD	0.0052	0.3250	0.0624	-0.0375	-0.1606	0.2298
	(0.024)	(0.557)	(0.732)	(0.674)	(1.624)	(5.550)*
HFUND	0.6488	0.1806	0.0556	0.1091	0.2615	0.1643
	(4.010)*	(0.487)*	(1.021)	(3.803)*	(4.461)*	(9.676)*
KITCHD	—	—	-0.2245	-0.4959	0.0703	-0.1605
			(1.277)	(1.015)	(0.446)	(1.330)
HTYPED1	0.4214	0.3751	0.0738	0.0348	0.0672	-0.0667
	(2.243)*	(0.615)	(0.448)	(0.387)	(0.435)	(0.490)
HTYPED2	0.4537	—	-0.3642	-0.2761	-0.1807	-0.1390
	(1.303)		(2.013)*	(2.449)*	(1.073)	(0.993)
HTYPED3	—	-0.9239	-0.2518	-0.2144	-0.3877	-0.3208
		(1.427)	(3.110)*	(1.771)!	(3.123)*	(7.769)*
BATHD	0.5572	-0.6116	0.1698	0.0619	0.0951	0.1462
	(1.572)	(0.893)	(1.678)!	(0.437)	(0.753)	(2.381)*
RESTD	-0.3338	0.4741	0.0399	-0.0234	0.1343	-0.0010
	(0.892)	(0.891)	(0.418)	(0.181)	(1.165)	(0.023)
FUELD	0.4001	-0.1881	0.1350	-0.0495	-0.0855	0.2003
	(1.763)!	(0.170)	(1.765)!	(1.038)	(0.593)	(5.131)*
ENVIRD	-0.1032	-0.5971	0.0162	-0.0088	0.3244	0.0670
	(0.639)	(1.639)	(0.259)	(0.175)	(2.260)*	(1.839)!
Adj. R^2	0.7192	0.6157	0.4652	0.1895	0.3830	0.3354
F-value	10.732*	3.564*	21.295*	10.605*	13.103*	61.278*
Number of observations	38	16	280	493	234	1433

†Taiwan province does not include Taipei and Kaoshung.
‡The absolute t-value is in the parenthesis.
*The coefficient is significant under 95 percent level.
!The coefficient is significant under 90 percent level.
Source: See table 8.

Construction material (MATALD) has a positive sign in both equations, but is larger in the price equation. On the one hand, homeowners pay more attention to materials. On the other hand, a house with better material is easy to resell. The coefficient of HFUN shows that there is an equal effect of HFUN on price and rent, and it means that there is not much difference of investment demand on housing usage.

KITCH has an unclear effect on rent just like its effect on price. BATH has a positive effect on rent with smaller coefficients for price. It means that renters have less demand for number of bathrooms, and it also shows that home buyers prefer houses with multiple

in Taipei is extremely high; for example, it reached 801 in 1988, although it dropped to 562 one year later.

Assume Mr. A buys a house with NT $5 million and assume a 40 percent down payment and 60 percent mortgage, which is typical in Taiwan. In 1990, the time deposit rate was 9 percent and mortgage rate was 12 percent, so the average interest rate cost was 10.8 percent for Mr. A. Assume the dwelling unit stays for 50 years and assume a linear depreciation, so the depreciation rate is 2 percent per year.[12] The property tax rate in Taiwan is between 1.5 percent to 2 percent. But the appraisal value is usually much lower than the market value. So the actual property tax rate is usually around 0.5 percent. The vacancy rate for rental houses is about 0.5 percent. Finally, most rental houses are rented out by individuals, not by rental companies, so the management cost is trivial. Adding up all the above costs, the annual opportunity cost is estimated 13.8 percent.

Now assume the above dwelling unit is located in Taipei; Mr. A can rent it out at a monthly rent of NT $10,000 using a 500 rent multiplier. Then the annual rent is NT $10,000, which is 2.4 percent of the market value. Obviously, Mr. A has to believe that the price of the house will increase more than 11.4 percent per year (i.e., capital gain is more than 11.4 percent) for it to be worthwhile for him to purchase the dwelling unit. If the unit is located in Kaoshung, Mr. A can rent for a price of NT $12,500, and the annual rent revenue is 3 percent of the market value. In this case, the growth rate for the housing price has to be higher than 10.8 percent per year for Mr. A to have a net gain. If the unit is located in Taiwan province, where the rent multiplier is 250, then Mr. A can rent it out for NT $20,000 per month, 4.8 percent annually of the market value. So the growth rate of housing value has to be higher than 9.0 percent per year for Mr. A to have a net gain. According to table 3 and comparing the average price per pin in 1989 and 1982, we find that the annual growth rate is 15.20 percent, 11.76 percent, and 6.11 percent for Taipei, Kaoshung, and Taiwan, respectively.[13] So, if the dwelling unit is located in Taipei or Kaoshung, Mr. A will have a net gain, but he faces a net loss if the dwelling unit is in Taiwan province. In other words, if we consider capital gain, even the rent multiplier in Taipei as high as 500, and 400 in Kaoshung, is still too low.

The increase in rent multiplier is either because of low rent or because of the high price of the house. Here we analyze the ratio of rent (and price) to the average household income in Taiwan to see if housing expense has changed. Table 20 shows that the monthly rent payment keeps a stable percentage of household income in Taipei, around 13 percent, with a slowly decreasing rate. It means that income elasticity of rent expenditure is less than unit, and that housing is a necessity commodity, which is consistent with the estimated housing income elasticity around 0.8 to 1.0; for example, Polinsky (1977) and Wu (1981). On the contrary, the ratio of average housing price to monthly income increases fast. For instance, the ratio of annual income to the average price for a one-year-old housing unit goes up from 24.19 to 128.58 in 9 years, that is, 1981 to 1989. In other words, Taipei citizens could buy a house with two years' salary in 1981, but they had to save their salaries for ten years to buy a house in 1989.

If we use a two-year-old dwelling unit as an example, people in Taipei still had to pay six years of their salaries to own a house in 1989. The above situation shows that the income elasticity of housing demand for owning is much higher than the income elasticity of housing demand for renting. Kaoshung and Taiwan province have similar results, while the ratio is a little smaller; see table 21 and table 22.

Table 20. Household burden of housing expense, Taipei.

	Average Monthly Household Income (NT $)	Average One-Year Housing Price / Average Monthly Household Income	Average Two-Year Housing Price / Average Monthly Household Income	Monthly Rent / Average Monthly Household Income
1979	20566	—	—	0.1498
1980	25471	—	—	0.1307
1981	29908	25.19	29.32	0.1337
1982	33738	45.66	34.47	0.1369
1983	36550	44.70	51.12	0.1289
1984	36835	39.92	47.00	0.1366
1985	38459	37.98	35.11	0.1282
1986	37998	49.32	48.72	0.1403
1987	43186	58.48	48.00	0.1237
1988	45031	67.41	48.38	0.1244
1989	55359	128.58	76.95	0.1136

Source: See table 1.

Table 21. Household burden of housing expense, Kaoshung.

	Average Monthly Household Income (NT $)	Average One-Year Housing Price / Average Monthly Household Income	Average Two-Year Housing Price / Average Monthly Household Income	Monthly Rent / Average Monthly Household Income
1979	—	—	—	—
1980	20290	—	—	0.0969
1981	24447	49.86	42.61	0.1135
1982	26602	32.42	35.34	0.1470
1983	28197	46.36	50.62	0.1153
1984	28863	40.97	46.43	0.1147
1985	31363	25.67	41.09	0.1192
1986	33888	33.15	36.87	0.1059
1987	38443	28.31	30.28	0.0910
1988	41206	55.99	34.84	0.0942
1989	49132	49.26	53.68	0.0834

Source: See table 1.

A mild increase of rent shows that the consumption housing demand changed slowly in 1988 and 1989. On the contrary, the average prices of dwelling units were so high that most salary-income families could not afford them. So we may conclude that a large part of increasing of price was generated by investment and speculative demand for housing in 1988 and 1989. On the other hand, we find that the fluctuation of the rent multiplier was very similar to price changes. So we may also conclude that a large part of change of the rent multiplier is caused by increasing investment and speculative demand.

Table 18. Average regression coefficients for price equation and rent equation, 1979–1988.

Dep. Var.: PRICE				Dep. Var.: RENT		
	Owner-Occupied Housing			Rental Housing		
Indep. Var.	Taipei	Kaoshung	Taiwan	Taipei	Kaoshung	Taiwan
CONST	2.5760	1.8331	2.2818	7.6816	7.3817	7.4852
PIN	0.6134	0.7715	0.5968	0.1811	0.1684	0.1650
HAGE	0.0011	-0.0544	-0.0256	-0.0776	-0.0628	-0.0841
MATALD	0.0211	0.1882	0.1068	0.0148	0.0187	0.0507
HFUND	0.1976	0.1604	0.1613	0.1489	0.1980	0.1978
KITCHD	0.0549	-0.1099	-0.1055	-0.1174	0.0118	-0.1377
HTYPED1	0.2241	0.1586	0.2351	0.0250	-0.0076	0.0359
HTYPED2	-0.2966	-0.1806	-0.4679	-0.1972	-0.2248	-0.3719
HTYPED3	0.1727	-0.3620	-0.2265	-0.1515	-0.3408	-0.2876
BATHD	0.1541	-0.0285	0.1701	0.0418	0.0809	0.0865
RESTD	0.1089	0.2348	0.2048	0.1081	0.1355	0.1442
FUELD	0.1492	-0.0413	0.1538	0.1594	-0.1720	0.1261
ENVIRD	0.0120	-0.0385	0.0260	0.0069	-0.0139	0.0021

Source: See table 8.

bathrooms, especially for speculative buyers, since they are easier to resell. REST has the same effect for similar reasons. ENVIRD has the same effect on rent and on price, while the coefficient on rent is much smaller. Since the homeowners do not care much about the living environment as we mentioned before, the renters do not care about it, either.

Most coefficients in rent equations in table 8 through table 18 are the same as our expectation. Though the adjusted R^2s are smaller, between 0.16 and 0.46, the coefficients in the rent equations always have the same signs as in the price equations and F-values are significant, and so we may conclude that our estimates are reliable.

3.5. Estimation of the rent multiplier

Applying the above estimated price equations, we calculate the housing price for each rental unit by timing housing attributes with corresponding coefficients in estimated price equations. Employing the same method, we compute estimated market rent for each rental unit to avoid some nonmarket disturbances, such as rent discount. Then we divide estimated house price by estimated monthly rent and get the rent multiplier. The average rent multipliers from 1979 to 1989 are listed in table 19.

There are a few findings in table 19. First, the rent multiplier is extremely large at the peak of a housing market business cycle. For instance, at the peak years of 1979 to 1981 the multipliers in Taipei, Kaoshung, and Taiwan province are all around 300. This phenomenon states that the rent cycle is smaller than the price cycle. Since there is only a consumption motive in the rental market while there are both consumption and investment demands in the owner-occupied market, and the investment demand is strong at the peak of the cycle, so housing price increases much faster than housing rent and thus the rent multiplier goes up sharply. Second, though the rent multiplier is high at the peak of the

Table 19. Rent multiplier.

	Taipei	Kaoshung	Taiwan Province
1979	388.43	368.68	312.64
1980	304.98	342.28	256.92
1981	306.71	276.31	230.05
1982	237.08	105.63	168.33
1983	257.59	263.07	257.14
1984	320.89	332.56	242.62
1985	283.52	295.18	239.95
1986	246.99	390.30	237.24
1987	435.87	435.24	267.35
1988	801.49	393.64	267.72
1989	561.99	389.56	216.70

Source: See table 8.

cycle, it drops the next year: for instance, 1979 to 1980 and 1988 to 1989, since rent adjustment has time lag by the rent contract. So when the housing price goes up and the rent catches up a little one year later, then the rent multiplier drops.

Third, roughly speaking, Taipei has the highest rent multiplier, Kaoshung is the next, and Taiwan province the last. Since rent in Taipei is higher than in Kaoshung and Taiwan, why is the rent multiplier still higher in Taipei? The reason is simple. The population growth rate in Taipei is faster than in Kaoshung, and the latter is again higher than in Taiwan province, and the average income is in the same order. So the housing market in Taipei is expected to grow in the long run. In addition to strong housing consumption demand, investment and speculation demand in Taipei are also higher than in other areas. In fact, the average growth rate of house price in Taipei is greater than other area in Taiwan in the past few years. Many homeowners in Taipei are willing to rent their houses out at a low rate which may only cover the owners' overhead costs as taxes, maintenance fees, and so on. The reason for the owners to rent out their houses at a low rent is that they expect a huge capital gain when they sell their units a few years later. This phenomenon is exactly the same as Lin (1989b). He finds that the rent multiplier in Green Bay is much higher, because population grows fast, the housing market is tight, and housing prices are high. On the contrary, South Bend is losing its people, the housing market is sluggish, house prices decrease, and so the rent multiplier is smaller.

Fourth, the average rent multiplier in Taiwan is much higher than in the United States. In the United States, the value of a dwelling is roughly 100 times its monthly rent, in other words, the rent multiplier is about 100. Also, the rent multiplier for apartments is around 70. The multiplier also varies among cities. For instance, Lin (1989b) computes that the rent multiplier at Green Bay is exactly 100, while it is only 60 at South Bend. If we take a few large cities with tight housing markets in the United States, such as New York, Boston, San Francisco, and Los Angeles, the rent multiplier does not exceed 200, since the rent will be too low to cover the overhead costs for the owners. But the rent multiplier in Taiwan is always higher than 200. Only once was the multiplier smaller than 200, that is, 1971 at Kaoshung and Taiwan province. Roughly speaking, the rent multiplier in Taiwan province is around 250. The figure in Kaoshung increased to 400 after the peak in 1987. The multiplier

Table 22. Household burden of housing expense, Taiwan Province.

	Average Monthly Household Income (NT $)	Average One-Year Housing Price / Average Monthly Household Income	Average Two-Year Housing Price / Average Monthly Household Income	Monthly Rent / Average Monthly Household Income
1979	15274	—	—	0.1192
1980	18591	—	—	0.1140
1981	21801	31.79	29.42	0.1142
1982	23580	33.06	31.68	0.1238
1983	25758	35.21	33.76	0.1145
1984	26631	31.17	33.38	0.1108
1985	28894	38.79	35.27	0.1097
1986	29915	34.23	35.27	0.1086
1987	31951	31.21	34.22	0.1039
1988	34402	36.72	33.91	0.1023
1989	40729	40.47	40.81	0.1034

Source: See table 1.

4. Conclusion

The properties of expensiveness, durability, and indivisibility of a dwelling unit make it the most important single investment item for most households. It is sophisticated to analyze the change of housing price since the housing demand is composed of consumption and investment decisions. The housing price has increased drastically in the past few years in Taiwan. The price is so high that most individuals in a salary class cannot afford to buy.

One property of the housing market is its high rental ratio. To rent a house is a simple consumption behavior, which is different from purchasing a dwelling unit. So, to distinguish consumption demand and investment demand, this article has analyzed the change of rent and housing price since the form reflects a pure change of consumption demand while the latter reflects both consumption and investment demand.

We first build a hedonic rent equation and a hedonic price equation for empirical study. Then applying Housing Survey Report data from 1979 to 1989 and applying the ordinary least-squares method, we estimate rent equation and price equation. To avoid multicollinearity for housing age and the time of purchase, we estimate price equation using a data set of dwelling units with same year of transaction. Then we use estimated coefficients in price equation and housing characteristics to estimate the market price of rental housing units. The same method is applied to estimate the market rent for rental housing units, too. Finally, the rent multiplier is computed by using estimated market price and estimated market rent.

About the housing market in Taiwan from 1979 to 1989, we have the following main findings. First, the change of price in Taipei leads that in Kaoshung, while the latter leads Taiwan province. Second, the owner-occupied ratio in Taiwan is near 80 percent, which is higher than most Western countries. In the meantime, rental houses are smaller, older, and lower in quality. Third, the amplitude of changes of rent is much smaller than that of price, and it is also smaller than the growth rate of per capita gross national product (GNP). Finally,

housing price increases very fast. In 1981, citizens in Taipei could buy a house with only two years' salary. But by 1989, people in Taipei had to save for ten years to purchase a house.

In regard to estimated rent multiplier, we also have a few findings. First, the rent multiplier is the largest at the peak of the business cycle of the housing market. Second, the rent multiplier drops at the next of the peak of the business cycle. It shows that the rent adjustment has a one-year lag. Third, the rent multiplier in Taipei is larger than Kaoshung, and in turn larger than Taiwan province. One main reason is simply because the growth rate of housing prices in Taipei is greater. Fourth, with the same reason as above, the rent multiplier in Taiwan is much higher than in the United States. Since the average rent in Taiwan grows at a stable rate, we conclude that the fluctuation of the rent multiplier is mainly caused by the drastic change of housing price, which shows that the investment and speculation demand for housing is very unstable in Taiwan.

Finally, we point out a few directions for further research. First, it is worthwhile to collect more detailed data to estimate user costs for homeowners, without considering capital gain, so that we may estimate a "reasonable" rent multiplier in Taiwan. Second, there are a few important factors neglected in this study in determining housing price and rent, such as neighborhood characteristics and location. Third, to estimate market price, one has to consider buyers' willingness to pay. We therefore need to have homeowners' characteristics, such as income, age, schooling, and so on. Fourth, since we have cross-sectional data for ten years, we can apply pooling estimation to get more insight into the housing market in Taiwan.

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Notes

1. When one rents a place for long, he or she usually builds a good relation with the landlord and so he or she can pay a lower rent, that is, get a rent discount. This case happens often; see Lin (1988a).
2. For regression analysis this research had to delete a few observations, so the figures here will be a little different from the official report of the Housing Survey Report.
3. Since there is a pre-sale system in Taiwan, the price of a one-year-old house was determined about one to two years ago and the price will be different from the pre-sale house in that year. For example, in Taipei the average price for pre-sale dwelling unit was about NT $200,000 per pin (about 36 square feet) in 1989. But in table 3, the average price for a one-year-old dwelling unit was only about NT $150,000, which was about the pre-sale price in Taipei in 1987 and 1988.
4. Since there are no income data in our data set, the author cannot estimate the income elasticity of housing demand in Taiwan.
5. In fact, the age of the house has a larger effect on housing price than on rent, so we expect that α_1 will be larger than γ_1.
6. In fact, it is usually difficult to distinguish the business district and pure-family district in Taiwan. It is very common to see business-using units and family-using units located in the same building. For instance, the unit on the first floor is a retail store, the unit on the second floor is an office for a lawyer, and the units above the second floor are for families. So, whenever a dwelling unit has some purposes other than pure household consumption, then it is very likely that the dwelling unit is located on the first floor. Unfortunately, because we lack relevant data, we cannot test our guess.

7. The reason to put three dummy variables for housing types is to test the differences among different types. For example, the coefficient of HTYPED1 tells the price difference between a five-floor apartment and all other types of dwelling units.
8. If there is no flood, no pollution, or no noise, then it is defined as safisfied.
9. This coefficient is also a shadow price of lot size.
10. For example, if we consider the effect of depreciation on housing value, the price equation can be written as:

$$PRICE = MARKET\ VALUE \times e^{-bt}$$

where b is depreciation rate in continuous time, t is housing age, and MARKET VALUE represents the market value for a new house, Taking logarithmic value in both sides, we get

$$\log(PRICE) = (MARKET\ VALUE) - bt$$

then,

$$-b = \frac{\partial log(PRICE)}{\partial t} = \frac{\partial PRICE}{\partial t}\frac{1}{PRICE}.$$

In our setting let β be the coefficient of HAGE, then

$$\beta = \frac{\partial log(PRICE)}{\partial log(t)} = \frac{\partial PRICE}{\partial t}\frac{t}{PRICE} = -bt.$$

11. Since the number of observations for 1989 is too small and there is a negative degree of freedom, we neglect the result. When we estimate the market housing price in 1989, we apply the estimated price equation in 1988 instead.
12. The average depreciation rate in the United States is about 1 percent.
13. For instance, the average price per pin in Taipei is NT $55,500, and NT $149,500 in 1989, so the annual growth rate is 15.20 percent.

References

Chen, C.C. "A Comparative Analysis of Land Price and Land Rental Price." Unpublished Thesis, Graduate School of Land Economics, National Chengchi University, Taipei, 1988. (In Chinese)

Chen, L.C. "A Discussion on Housing Demand." *Quarterly Journal of Land Finance in Taiwan* 23(3) (1986), Taipei. (In Chinese)

Deng, C.M. "A Study of Housing Demand in Taiwan." Unpublished Thesis, Graduate School of Urban Planning, National Chung-Shin University, Taipai, 1985. (In Chinese)

Ellickson, B. "An Alternative Test of the Hedonic Theory of Housing Market." *Journal of Urban Economics* 9 (1981), 56–79.

Lee, W.L. "A Study on Housing Demand and Supply in Taipei." *Journal of City Bank of Taipei* 12(3) (1984). (In Chinese)

Lin, C.C. "Housing Demand and Residential Mobility: A Stochastic Process Model." Unpublished dissertation, Department of Economics, U.C.L.A., Los Angeles, 1988a.

Lin, C.C. "A Stochastic Process Model of Housing Demand and Residential Mobility." *Annual Conference Proceedings of Chinese Economic Association*, 1988b, pp. 265–317, Taipei. (In Chinese)

Lin, C.C. "Housing Market and Housing Policy in the United States." *Journal of American Studies*, Research Center of International Relationship, National Chengchi University, Taipei (1989a). (In Chinese)

Lin, C.C. "An Empirical Study of the Relationship of Rent and Housing Price in the United States." *Journal of National Chengchi University* 60 (1989b), 137–153, National Chengchi University, Taipei. (In Chinese)

Lin, C.C. "A Reversed Nested Multinomial Logit Model of Housing Demand and Tenure Choice." *Economic Paper* 18(1) (1990), 137–158, Academia Senica, Taipei. (In Chinese)

Polinsky, A.M. "The Demand for Housing: A Study in Specification and Grouping." *Econometrics* 42 (1977), 447–461.

Polinsky, A.M., and Smith, L.B. "The Price-Adjustment Process for Rental Housing at the Natural Vacancy Rate." *American Economic Review* 73 (1983), 779–786.

Rosen, S. "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition." *Journal of Political Economics* 82 (1974), 34–55.

Shelton, J.P. "The Cost of Renting Versus Owning a House." *Land Economics* 44 (1968), 59–72.

Tseng, K.S. et al. "A Study on the Relationship of Location and Price for a Building in Taipei." *City and Planning* (1985), Taipei. (In Chinese)

Wu, S.T. "Income Elasticity of Housing Demand: An Empirical Study of Taipei." *Economic Study* 23 (1981), National Chung-Shing University, Taipei. (In Chinese)

Yuan, C.L. "An Analysis of Housing Demand in Taipei." *Quarterly Journal of Land Finance in Taiwan* 28(4) (1980), Taipei. (In Chinese)