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Asymmetric Price Response to Supply: Evidence from Singapore

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Prices in the Asian residential property markets have skyrocketed over the past decade. A high rate of economic growth is one of the major reasons for the price spiral. Most Asian residential property markets are, however, concentrated and national in nature. Maintaining an artificially high price level through coordination amongst producers is not impossible and would be the natural choice of oligopolistic behavior (Scherer and Ross, 1990). This study examines price responses to changes in economic determinants in Singapore. The focus is on supply. Cointegration and error-correction techniques are employed to test if upward and downward adjustment speeds are similar. The results verify the impact of GDP growth, but also show that price response to the supply of housing units is significantly downward rigid. This is not inconsistent with the hypothesis of collusive price setting by property developers.

Keywords

Property price rigidity, Singapore, Oligopoly.

1. Introduction

Prices of Asian residential properties have skyrocketed over the last decade. Dynamic economic growth is one of the major reasons for this development. The bursting of the property price bubble in Japan, however, suggests that other factors may have contributed to high price levels.

As with all assets, the price of residential properties may not always be at equilibrium. Market frictions could cause delays in price adjustments. This is usually not a cause for concern. On the other hand, the price level may be a result of oligopolistic behavior. Industrial Organization literature has devoted copy to the issue of how the market structure can induce tacit arrangements amongst firms to maximize profits.

In the classic *Industrial Market Structure and Economic Performance*, Scherer and Ross (1990) describe the conditions that facilitate oligopolistic behavior. One such condition is when supply adjusts to demand with a time lag because of the need for setup, hiring, production and rate alterations etc. (John A. Carlson, 1973). The property market is clearly marked by a significant delay in supply meeting demand. While the lag in an average production process may take five months (Metzler, 1947) or less with computerization, the construction industry easily takes years to deliver its output.

Scherer and Ross (1990) discuss five approaches to oligopolistic coordination. In a market where supply lags behind demand, the natural alternative is through management of inventory to control prices. This form of coordination is easier in a concentrated than an atomistic market. As the authors put it "… motives for avoiding price adjustments are absent in atomistically structured and (rare) monopolistic markets. Therefore, we should expect oligopolistic industries to rely more heavily than atomistic industries upon inventory and order backlog variations in adjusting to demand fluctuations, ceteris paribus, and less heavily upon price variations. Concretely, prices should be less variable … in oligopolistic than in atomistic industries". This description is almost tailor-made for the residential property industry.

The "less variable pricing" described by the authors is not likely to be neutral in nature. It can be expected to be asymmetric for "… if the oligopoly has been successful in elevating prices above the competitive level, its members cannot be guided by the rule of expanding output until marginal cost equals marginal revenue, to do so would undermine the jointly accepted price." (Scherer and Ross, p 269). In other words, only downward price adjustments are likely to be "less variable" or rigid.

A concentrated residential property market has all the ingredients for the type of oligopolistic coordination described above[1]. Where the underlying demand is already strong due to rapid economic growth and there is a naturally limited supply of land as in the case of Singapore, the incentive for firms to coordinate their pricing to extract the maximum profits is even greater.

The effect of residential property mispricing probably has wider implications than for most other industries. Economists are concerned about equilibrium pricing as a mechanism for efficient allocation of resources (Carlton, 1989). Administered commercial bank interest rates, for instance, result in the misallocation of credit and distortion of investment decisions (Fry, 1988). Over investment in property has a more deleterious impact than other misallocations. In many land scarce economies, residential property constitutes the largest single investment for many individuals. An unsustainable high property price level has been the main element of many 'bubble' economies.

This study examines changes in Singapore private residential property prices over several decades. While price levels would eventually adjust to each new equilibrium in the long run, the short run dynamics may reveal rigidities. There is persistent public opinion that prices are kept high by the developers acting cohorts. One piece of evidence often cited is that developers would delay the release of completed units rather than reduce the price to move sales. When speculation on residential properties reached a feverish pitch at the end of 1995, the clamor for government intervention also peaked. The Singapore authorities responded by introducing a set of anti-speculation measures on May 15 1996 to cool the market. This includes a 3% transaction tax and an unprecedented capital gains tax for properties sold within three years of acquisition. Despite these measures, property prices have yet to show significant downward adjustments. There are consistent media reports of developers keeping completed units from the market even at substantial interest costs of debt to avoid adding to the surplus output. Whether property pricing is affected by collusive practices is important to policy makers. If oligopolistic behavior does exist, the need for intervention to avert economic problems is clearly justified.

2. The Singapore Property Market

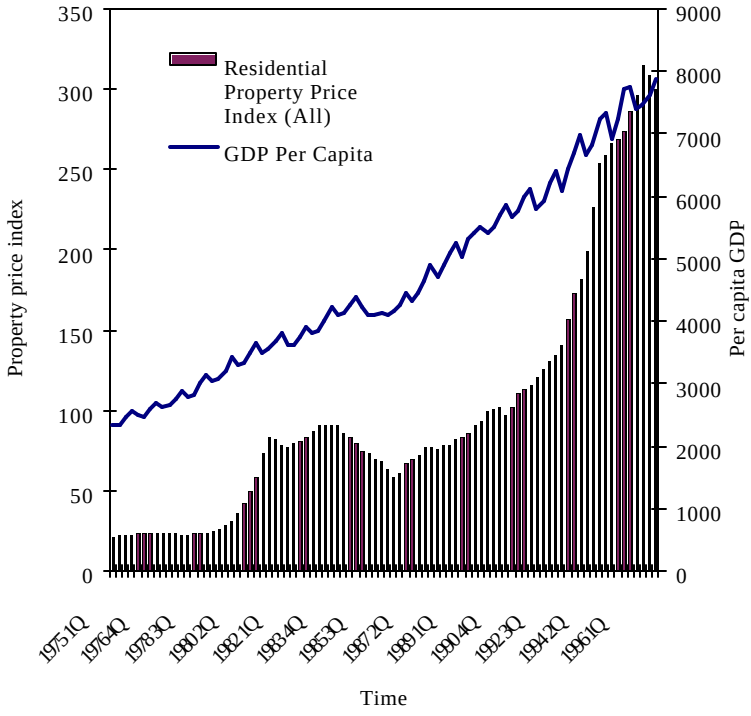
[1] Even in industries where there is little friction in the production process, like banking for instance, price rigidity has been observed (see Neumark and Sharpe, 1992 and Scholnick, 1996).

The Singapore property market has enjoyed a bull run over the last decade. The index of private residential property prices increased by almost 300% from 1988Q1 to 1996Q4. Over the same period, per capita GDP increased by less than 70%. As can be seen from Figure 1, the upward spiral in prices is especially noticeable after the Gulf War in 1991.

There is strong official encouragement for Singapore citizens to purchase their own properties for occupation. Property is the only form of investment for which an individual can use up his Central Provident Funds (CPF). The CPF is a national funded pension scheme requiring nearly equal monthly contributions of 20% of gross salary each from the employee and the employer. Until the mid-1980's, this fund could not be used for other forms of investment and could be withdrawn only upon retirement. Because the CPF paid interest rates below that of bank saving deposits, there is a strong preference for individuals to use up their contributions on residential properties[2].

2 It is common for a married couple to plan their property acquisition in such a way that the monthly installment payment for the mortgage loan exceed the combined contributions to the CPF. It is a current concern of the Singapore government that many citizens will retire with a valuable piece of property but little pension money.

Figure 1 Singapore Private Residential Property Price Index and Per Capita GDP from 1975 to 1996



More than 80% of the population reside in government-built apartments. The price of such public housing is subsidized. The remaining 20% live in private properties ranging from houses to apartments. The limited supply of private property makes them desirable. Moving from public to private housing is known as "upgrading". At the end of 1996, there were 147,000 units of private property. With rare exceptions like the measures taken on May 15 1996, the Singapore government has left market forces to determine private residential property prices.

Singapore is one of the smallest countries in the world, having a land area of less than 250 square miles. Increasing income coupled with the small portion of land set aside for private housing has induced a strong underlying demand for private residential properties. Until the mid-1990's, the private residential development industry was dominated by a handful of large firms. It is estimated that no more than six developers account for 65% to 95% of the new projects. This is partly due to the process of land sales by the government. The state is the largest landowner and regularly sells land for housing development. The high cost of each piece of land has largely acted as a barrier to entry, leaving large firms to dominate the industry.

The market structure and cursory evidence suggest that oligopolistic coordination in the Singapore residential property market is both possible and profitable. The results in this study provide some evidence that this is the case.

3. Long Run Equilibrium and Short Run Impacts

As discussed in Scherer and Ross (1990), an oligopoly would try to maintain prices above the competitive level. A testable implication of such behavior is that prices take longer to come down than to go up to a new equilibrium[3]. In this paper, we focus on the speed of change when the residential property price level is above and below its equilibrium.

The long run equilibrium price level of residential private properties is first assumed to be a function of economic determinants. Disposable income,

[3] The research design in this study is conceptually different from Case and Shiller (1989, 1990) who find evidence against random walk in residential property prices. Tests employed here do not address price increases and decreases but how price level moves toward a dynamic equilibrium. Price level may be going up all the time but yet overshoot or undershoot an equilibrium dictated by economic fundamentals. Results found by Case and Shiller are not directly comparable to the evidence shown here.

housing starts and mortgage rates are found to be good explanatory factors of the housing price level in the United Kingdom (Drake 1993).

The Singapore Department of Statistics (DOS) keeps a record of several economic series. From the DOS database, we selected a list of potential determinants of Singapore private residential property prices. Using data from 1975Q1 to 1996Q4, the list is systematically pared. Finally, the Gross Domestic Product, the property mortgage rate and the number of private property units completed in the quarter were found to be significant in the determination of property price levels.

As with most economic time series, there is the likelihood of cointegration among the variables. Engel and Granger (1987) show that when two time series are cointegrated, the OLS regression on the levels is misspecified. An error correction model is normally used to adjust for the short run relationship. The Engel and Granger approach is, however, limited to a bivariate model. Johansen (1988) develops a maximum likelihood test for the existence of cointegrating vectors in a multivariate setting.

Table 1 presents the results of the Johansen maximum likelihood test. The variables selected, per capita Gross Domestic Product (GDP), the average of 15-year residential mortgage rate (MR) and the number of private residential properties completed in the quarter (UNITS) are indeed cointegrated with the private property index level (PI). GDP, UNITS and PI are natural logarithm transformations of the original values.

The test rejects the null hypothesis of no cointegration but not the hypothesis that there is only one cointegrating vector. The existence of a unique cointegrating vector resolves the form of error correction for the short-run model. We now elaborate on the three economic explanatory variables to provide a better understanding of the hypothesis and empirical approach.

3.1 Per Capita GDP

Singapore became an independent country in 1965. At the end of 1996, there were about three million Singapore citizens with a GDP of S$80 billion. From 1975 to 1996, the DOS conducted an annual exercise to estimate the number of Singaporeans. Using these annual population estimates, we can derive the GDP per capita. From 1975Q1 to 1996Q4, the GDP per capita increased by 430% from S$5,381 to S$28,449. In a small country with limited land, we can expect rising income levels to cause an increase in property prices.

Table 1 Results of the Johansen Maximum Likelihood Test

Eigenvalue	Likelihood Ratio	5 % Critical Value	1 % Critical Value	Hypothesized no. of cointegrating equation(s)
0.6665	84.3067	47.21	54.46	None *
0.2504	22.8162	29.68	35.65	At most 1
0.0942	6.6762	15.41	20.04	At most 2
0.0201	1.1383	3.76	6.65	At most 3

* denotes rejection of the hypothesis at 1% significance level

L.R. test indicates 1 cointegrating equation(s) at 5% significance level
Normalized cointegrating coefficients. Standard deviations are in parentheses.

PI	GDP	MR.	UNITS	Constant
1.0000	-2.5815	-0.0577	-0.3139	20.072
	(0.1349)	(0.0163)	(0.0513)	

Note: Test of cointegration among private property price index (PI), Gross Domestic Product per capita (GDP), average 15-year finance company housing loan rate (MR) and the number of private property units completed UNITS.

3.2 Residential Mortgage Rate

The private residential mortgage market in Singapore is largely free from state intervention. On occasions, the bank supervisory authority may advise lending institutions to limit their exposure to the property market. The actual setting of interest rates has, however, always been left to the financial institutions themselves.

Up to the early 1980's, the main participants in the residential mortgage market were finance companies rather than the commercial banks. Finance companies in Singapore specialize in consumer loans and mortgage lending makes up a substantial portion of their portfolios.

Residential mortgage loans in Singapore range from 5 to 30 years with the intermediate maturities of 15 to 20 years being the most popular. The interest rate on the 15-year loan has been regarded as a good benchmark for the cost of residential mortgage. A record of the average interest rate on this loan set by finance companies has been maintained since 1980Q1. In a normal residential property market, the mortgage rate should be negatively related to the price level.

3.3 Number of Private Residential Units Completed

Singapore is a small country of less than 250 square miles. Land and property is relatively scarce and the government maintains strict monitoring and control over real estate development.

There are generally two types of land title for private residential properties. One is freehold which essentially means perpetual ownership. With few exceptions, only privately owned land is freehold. State owned land has a 99-year leasehold. In the 100th year, the land reverts to the state.[4] It is estimated that the state supplies three quarters of all land for new private housing.

Besides the limit on the lease, there is a significant constraint on the speed of development on 99-year leasehold land compared that of freehold land. Freehold land can be left vacant by an owner for an unlimited period. For 99-year leasehold land, there is a window of five years for the property to be completed starting from the day the land is bought from the state. Failure to comply with this regulation can result in heavy penalties.

Off all new private residential units built between 1975Q1 to 1996Q4, more than third of these were added between 1992Q1 and 1996Q4. This half-decade coincided with the rising popularity of condominiums which are increasingly built on 99-year leasehold sold by the state. In a competitive market, such a prodigious increase in output should have had a significant impact on prices. This, however, does not appear to have been the case.

No more than a handful of large developers dominate the Singapore residential property industry. This is partly a result of the state land sales process. State land is sold by tender and until recently, each plot of land is designated for entire housing projects rather than single units. Quite naturally, only large firms are able to incur the substantial investment cost of acquiring land for development. Even for relatively small plots being tendered, large developers who want to build up their land banks for the future often crowd out the smaller players with aggressive bids. This concentration in purchasing power was noticed and in 1994, the authorities tried to let small developers have a better chance at the tenders by fragmenting land for sale into smaller plots. Despite this measure, much of private residential property remains in the hands of the big firms.
A housing project can be offered for sale even before construction begins. All a developer needs is a building approval plan and a sale license which are

[4] There is a third type of title which is the 999-year lease but such title is largely considered as no different from freehold.

routinely granted in the early stages of development. Most homebuyers and investors in Singapore make their buying decisions on no more than brochures and a show unit. During the frantic years from 1993 to 1995, projects were often sold out within one day of public offer.

Unlike the five-year limit for completing a 99-year leasehold development, there is, however, no regulation on how soon an actually completed project must be offered for sale to the public. In other words, a developer with financial resources can withhold output from a slow market. There are several means of doing so. One is to simply keep the inventory. Another is to lease rather than sell the units. All these measures are aimed at not adding downward pressure to prices on the entire residential property market. Table 2 provides an indication of how far developers are prepared to go to hold prices at the expense of sales. Since the market cooling measures introduced on May 15 1996, the volume of transactions in private residential properties has fallen by half. Table 2 shows that there is a clear buildup of inventory from 1996Q1 to 1997Q1. Despite this, prices offered for the new projects have hardly changed. As a recent editorial in the business daily puts it "For 17 months after the May anti-speculation measures last year, developers have been holding themselves remarkably in check. When they competed against one another, it was in ways that did not openly affect prices …. Some called it a gentlemen's agreement. 'Tacit understanding' might perhaps be a better description …".[5]

Table 2 Proportion of Unsold Units in New Private Residential Projects

Quarter	Houses	% Unsold	Apartments	% Unsold	Total	%Unsold
1996Q1	3,281	58%	24,186	20%	27,467	24%
1996Q2	3,017	53%	26,592	22%	29,609	25%
1996Q3	3,426	61%	27,851	24%	31,277	28%
1996Q4	3,256	66%	28,922	28%	32,178	32%
1997Q1	3,682	68%	30,297	35%	33,979	39%

Note: Proportion of unsold units in new private residential projects where both the sales license and building plan approval have been granted. Apartments include flats and condominiums.
Source: Urban Redevelopment Authority of Singapore

With one third of the new supply being added in the last five years, the pricing of new projects has a significant effect on the price level of all private residential properties. It has been estimated by property analysts that 75% of

[5] Business Times October 14 1997.

all transactions are on units sold by developers and the quoted price of the most recent project is often taken as the barometer for the entire property market. Table 3 shows how transaction prices for all properties have held up and even increased despite the large oversupply of new units.

Table 3: The trend of Average Transaction Prices by type of Property and Locality (Sing$/sq ft of floor area)

	Houses		Apartments	
Month	Prime	Others	Prime	Others
Jan '96	733.17	642.52	982.70	658.99
Feb '96	728.38	633.70	994.59	677.16
Mar '96	786.04	662.27	1,009.31	692.93
Apr '96	781.70	677.55	1,064.33	758.15
May '96	816.74	705.46	1,103.55	752.20
Jun '96	868.03	653.70	1,102.92	709.16
Jul '96	747.04	660.78	1,883.28	717.93
Aug '96	777.11	648.68	1,414.51	736.04
Sep '96	950.35	632.06	1,039.53	684.56
Oct '96	764.73	612.37	1,095.84	697.77
Nov '96	1,028.22	633.68	1,450.59	706.22
Dec '96	695.93	603.32	1,306.03	742.21
Jan '97	825.39	658.49	1,177.96	666.37
Feb '97	796.18	604.09	1,124.40	680.65
Mar '97	846.49	620.94	1,259.52	677.63

Note: Average transaction price in Singapore dollars per square foot by type of property and locality. Anti-speculation measures were introduced by the Government on May 15 1996 to cool the overheated residential property market. Apartments include flats and condominiums.

The number of units completed (UNITS) would eventually translate into supply and can be expected to be negatively related to price level. As discussed in Scherer and Ross (1990), however, inventory management to delay price adjustment is the preferred alternative in an oligopoly where output lags demand. If firms in the Singapore market do coordinate, there is likelihood that the price level responds to the lagged UNITS. The lag would not be symmetric. Price levels may rise quickly when there is a shortage, but may take longer to come down, if developers are able to slow the actual supply despite an accumulating inventory[6]. Since supply and pricing has to

[6] Since how many and when to make available completed units for sale are business decisions, no reliable record is kept of the actual number of units being offered for sale.

be coordinated to be effective, significant downward price rigidity may be regarded as evidence of oligopolistic behavior among property developers.

4. Model

The long-run equilibrium price derived from the cointegrating vector allows us to examine the short-run price adjustments. The difference between the actual and the predicted price level, which is the residual in the cointegrating vector, may be considered as the prediction error. Using these residuals, we develop the error correction model to estimate the short-run dynamics for the property price index.

Residential property prices can reasonably be assumed to respond to economic factors at a lag. The effect of a change in mortgage rate, for instance, may be reflected in property price changes only after several quarters. Beside economic determinants, the price change process may also have a momentum of its own.

Modeling of the price change dynamics begins with a wide selection of potential variables and through systematic elimination, ends with a parsimonious representation. The Akaike Information Criterion is used for the eventual selection. The general model obtained with this approach is

$$\Delta PI_t = \beta_0 + \beta_1 R_{t-1} + \beta_2 \Delta PI_{t-i} + \beta_3 \Delta GDP_{t-j} + \beta_4 \Delta UNITS_{t-k} + \beta_5 \Delta MR_{t-l} + \varepsilon_t, \quad (1)$$

where Δ is the first difference, PI is the price index, R the residual from the cointegrating vector shown in Table 1 and i, j, k, l the relevant lag lengths for each factor. Since PI, GDP and UNITS are natural logarithm transformations of the raw values, the equation provides us with a measure of price elasticity with respect to the economic determinants. Seasonalities were considered but eventually eliminated.

This model assumes a symmetric adjustment in the price index. As discussed in the previous section, this need not be so. Downward revisions may be more rigid if developers have the market power to hold prices by rationing supply.

We test for this possibility of asymmetry in price adjustments by using two dummy variables D^+ and D^- that take the value

$$D^+ = 1 \quad \text{if } R_{t-1} > \mu, \qquad D^+ = 0 \quad \text{if } R_{t-1} < \mu, \quad (2)$$

and

$$D^- = 1 \quad \text{if } R_{t-1} < \mu, \qquad D^- = 0 \quad \text{if } R_{t-1} > \mu, \tag{3}$$

where μ is the mean of R. The statistic μ, which is close to zero since it is derived from a regression, captures the average deviation of the actual price level from the predicted one. It is the expected value of R and so when the price level is at equilibrium, R equals μ. When R is greater than μ, the actual price level is above the forecast equilibrium. Similarly, R less than μ means that the price level is below its equilibrium. In the error correction model, a positive residual in the previous period R_{t-1} induces a negative short-run run price adjustment and vice-versa.

Using the split residuals, we test for several possible asymmetries. The first is an analysis of the overall short-run adjustments to the long run equilibrium by using the dummy variables to separate R into two subsamples which modifies equation 1 to

$$\Delta PI_t = \beta_0 + (\beta_{1a}D^+ + \beta_{1b}D^-)R_{t-1} + \beta_2\Delta PI_{t-i} + \beta_3\Delta GDP_{t-j} + \beta_4\Delta UNITS_{t-k} + \beta_5\Delta MR_{t-l} + \varepsilon_t. \tag{4}$$

The coefficients β_{1a} and β_{1b} separately reflect short-run changes when the price level in the previous period was above and below equilibrium respectively. The relative magnitudes of the two coefficients provide an indication of how fast disequilibrium is corrected. If the absolute value of β_{1a} is larger than that of β_{1b}, a downward adjustment from above equilibrium is swifter than an upward adjustment from below equilibrium and vice-versa (Doornik and Hendry, 1994).

The dummy variables are also used to test for asymmetric adjustments to GDP where

$$\Delta PI_t = \beta_0 + \beta_1R_{t-1} + \beta_2\Delta PI_{t-i} + (\beta_{3a}D^+ + \beta_{3b}D^-)\Delta GDP_{t-j} + \beta_4\Delta UNITS_{t-k} + \beta_5\Delta MR_{t-l} + \varepsilon_t. \tag{5}$$

The coefficient β_{3a} captures how price changes in response to a change in GDP when the price level is reverting to equilibrium from above. Similarly, β_{3b} measures the response when price level was below the equilibrium. As with the coefficients for the residual R, a large absolute value in β_{3a} (or β_{3b}) is associated with less rigidity in price adjustment. The magnitudes of these two coefficients would show how changing individual incomes affect residential property prices.

The focus of this study is on the possibility of asymmetric adjustments to the variable UNITS as shown by

$$\Delta PI_t = \beta_0 + \beta_1 R_{t-1} + \beta_2 \Delta PI_{t-i} + \beta_3 \Delta GDP_{t-j} + (\beta_{4a} D^+ + \beta_{4b} D^-)\Delta UNITS_{t-k} + \beta_5 \Delta MR_{t-l} + \varepsilon_t. \quad (6)$$

The oligopolistic behavior hypothesis implies that β_{4a} and β_{4b} are different. Specifically, pricing coordination would be aimed at a slower price decrease than a price increase. Empirically, this would be evidenced by a smaller absolute value of β_{4a} than β_{4b}.

For completeness, we also test for asymmetric responses to the mortgage rate as follows:

$$\Delta PI_t = \beta_0 + \beta_1 R_{t-1} + \beta_2 \Delta PI_{t-i} + \beta_3 \Delta GDP_{t-j} + \beta_4 \Delta UNITS_{t-k} + (\beta_{5a} D^+ + \beta_{5b} D^-)\Delta MR_{t-l} + \varepsilon_t. \quad (7)$$

5. Results

The adjustment of quarterly property prices from disequilibrium is shown in Table 4. Coefficient estimates for the base model which assumes symmetric adjustment are shown in the middle column. The sign and magnitude for all the economic variables accord with intuition. The effect of per capita GDP, for instance, is positive and has the largest value. MR and UNITS have negative coefficients as expected. The lag structure is also consistent with expectations that a change in transaction prices of residential properties follow changes in the fundamentals of the property market. The contemporaneous values of the regressors are tested and found to have no explanatory power.

Consistent with the error correction process, the coefficient of R is negative which indicates that the price level revises downward when it was above equilibrium in the previous period and vice-versa. There is also a large positive coefficient for the price change at one lag. This indicates a strong momentum in property price change but this momentum does not last beyond one quarter. Among the economic factors, GDP has the largest impact but its effect shows up only after three quarters. The variable UNITS impacts on price change after two to three quarters while the effect of MR is most immediately felt.

Table 4: Results of Estimating equation (1) and (4)

Variables	Symmetric adjustment	Asymmetric adjustment
R_{t-1}	-0.06723**	
	(-3.38)	
$D^+ R_{t-1}$		-0.0459
		(-1.72)
$D^- R_{t-1}$		-0.0980**
		(-3.02)
ΔPI_{t-1}	0.6610**	0.6302**
	(8.03)	(7.33)
ΔGDP_{t-3}	0.4599**	0.4302**
	(3.85)	(3.54)
$\Delta UNITS_{t-2}$	-0.0329**	-0.0318**
	(-3.63)	(-3.50)
$\Delta UNITS_{t-3}$	-0.0259**	-0.0240**
	(-2.91)	(-2.68)
ΔMR_{t-1}	-0.0333*	-0.0280
	(-2.41)	(-1.94)
Adjusted R^2	0.57	0.58
Durbin-Watson	2.16	2.07

** Significant at 1%., * Significant at 5%.

Note: Coefficient estimates of short-run dynamics of quarterly property price index adjustment to GDP, mortgage rate MR and the number of units completed UNITS. R is the residual from the cointegrating vector. The t-values are in parentheses.

The assumption of symmetric adjustment is relaxed and the results are shown in the last column of Table 4. The variable D^+ (D^-) captures the change when price level in the previous quarter was above (below) equilibrium. It is evident that coefficient estimates for these two dummy variables are dissimilar.

The size of the D^- coefficient is more than twice that of the D^+ coefficient and the former is significant at the 1% level, while the latter not significantly different from zero. This suggests asymmetry in the price adjustment process. A larger absolute coefficient is consistent with a quicker price adjustment to the new equilibrium. D^- being larger than D^+ implies that price takes a shorter time to move up than down. This result is consistent with the

general observation of property prices in Singapore. The source of such asymmetry is now examined in detail. The results are presented in Table 5.

The response of price to GDP is asymmetric. In column 2 of Table 5, we can see that the coefficient for D^- is significantly different from zero, while that of D^+ is not. This suggests that when price level is below equilibrium, an increase in per capita GDP induces a relatively quick upward revision of property prices. A decrease in GDP, on the other hand, does not cause a fall in a price level from above equilibrium. The coefficient for the upward is almost three times that of the downward change. This is evidence that increasing individual income is a major cause of rising property prices in Singapore. Even when the country was in recession in 1985 and 1986, the decline in prices was relatively insignificant compared to the rapid recovery thereafter. The hypothesis that rising income is a key reason for the price spiral cannot be rejected.

The results for the number of units completed UNITS are probably the most interesting. As discussed earlier, this number is the output but not necessarily the actual supply for the property market. Developers have the option to withhold completed units from sale when prices are not favorable. If such a course of action is sufficiently coordinated, a price revision downwards may be delayed. The evidence is consistent with this hypothesis.

The variable UNITS is significant at two and three lags. When the assumption of symmetry is relaxed, the coefficients for the different lags are dissimilar. At two lags, the adjustment is asymmetric. D^- is significant while D^+ is not. As with GDP, the downward price adjustment to UNITS is more rigid than the upward adjustment. A lower rate of housing output causes prices to rise from below equilibrium after a lag of two quarters. A higher number of completed units, on the other hand, does not lead to a fall in the price level from above equilibrium until three quarters later. After three quarters, the effect of output is symmetrically reflected in prices.

We can reasonably interpret these results as inventory management by developers to delay a fall in prices. When the price level is above the long-run equilibrium, supply is rationed to maintain the price. This rationing can be both explicit and implicit. Developers can keep output from the market or maintain prices at above equilibrium and wait for a recovery in demand to absorb the supply. Evidence shows that developers are prepared to sacrifice sales for high prices.

Table 5: Results of Estimating Equations (5) to (7)

Variables	ΔGDP_{t-3}	$\Delta UNITS_{t-2}$	$\Delta UNITS_{t-3}$	ΔMR_{t-1}
R_{t-1}	-0.057545**	-0.066688**	-0.067161**	-0.068378**
	(-2.81)	(-3.39)	(3.35)	(-3.13)
ΔPI_{t-1}	0.669097**	0.687528**	0.657781**	0.658948**
	(8.24)	(8.24)	(7.88)	(7.79)
D^+	0.232337	-0.016338	-0.029799*	-0.035114
	(1.27)	(-1.13)	(-2.21)	(-1.82)
D^-	0.612394**	-0.042251**	-0.023346*	-0.031273
	(4.06)	(-3.84)	(-2.12)	(-1.51)
ΔGDP_{t-3}		0.491179**	0.465287**	0.460949**
		(4.09)	(3.84)	(3.81)
$\Delta UNITS_{t-2}$	-0.035102**		-0.032621**	-0.032865**
	(-3.88)		(-3.55)	(-3.58)
$\Delta UNITS_{t-3}$	-0.026175**	-0.026866**		-0.025706**
	(-2.99)	(-3.05)		(-2.85)
ΔMR_{t-1}	-0.032419*	-0.031366*	-0.032973*	
	(-2.38)	(-2.29)	(-2.37)	
Adjusted R^2	0.59	0.57	0.58	0.57
Durbin-Watson	2.17	2.16	2.11	2.11

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

Note: Coefficient estimates of short-run dynamics of quarterly property price index adjustment to GDP, mortgage rate MR and the number of units completed UNITS when price level was above and below equilibrium in the previous period. t-values are in parentheses.

Price adjustments to mo rtgage rate MR are symmetric. This provides an interesting contrast to the results obtained for GDP and UNITS. It suggests that residential property investors have a balanced sensitivity to individual financial fundamentals like mortgage costs more than economic fundamentals such as income and potential supply of property units. The symmetry in the dummy variable coefficients also show that the asymmetries found earlier are not induced by model mis-specifications.

6. Conclusion

High residential property prices in Asia may be fueled by more than strong economic growth. The conditions in a private residential property market dominated by large firms, such as that in Singapore, facilitate oliogopolistic behavior. The property market is characterized by supply meeting demand at a substantial lag. Industrial Organization theory suggests that an oligopoly would collude to control supply to maintain prices above the competitive level as the natural alternative to profit maximization. This can result in mispricing and serious misallocation of assets since residential property is often the largest single investment for most individuals.

A testable implication of the collusion hypothesis is that the price level would take longer to come down than to go up to a new equilibrium. Cursory evidence shows that residential property developers in Singapore are prepared to maintain the price level even at the expense of accumulating inventory. Using economic variables to derive a long-run equilibrium model, we examine the short-run price change dynamics of Singapore private residential property prices. We find evidence that price changes are not symmetric. Consistent with general observations, property prices takes longer to come down than to go up to a new equilibrium. A reason for this asymmetry is the effect of increasing wealth. When the price level is below equilibrium, an increase in per capita GDP induces a significant upward revision. This is not the case when price is above equilibrium. Rising income is therefore a major cause of rising property prices.

More importantly, the other source of asymmetry is how property units are supplied to the market. The evidence shows that output in the form of completed units take longer to bring down the price level when it is above equilibrium. On the other hand, a price increase due to lower supply is quicker.

In Singapore, newly completed units make up a third of the supply of private residential property. The pricing of new units affect the price level for the entire market. Despite a sharp fall in demand and clear oversupply in the past year, transaction prices have barely changed. These factors, together with the evidence on the asymmetric price response to output are not inconsistent with the hypothesis that oligopolistic behavior exists in the Singapore residential property market.

One question often asked is why would developers choose to maintain the price level at a high inventory cost. The answer is that this is strategically

optimal. The Real Estate Developers Association of Singapore has petitioned the government repeatedly to take measures to avert a crisis. The high percentage of projects unsold is cited as evidence of an impending price crash although the developers have been reluctant to reduce prices. Recommendations included the lifting of all anti-speculation measures and the curbing of land sales. The government was initially adamant in maintaining the rate of land sales and letting the market settle to its equilibrium. Shortly after the completion of this paper, the government announced first a reduction of land to be sold in 1998, and later a complete deferral of remaining land to be sold this year to next year. The window for completion of 99-year leasehold projects was extended from five to eight years with a substantial reduction of the penalty for delays. These measures lead to a cutback in the immediate and future supply, which is partly what the developers asked for in order to maintain the price level.

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