# Dynamics of the Condominium Market in Singapore

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This study examines economic and market factors that drive the demand, supply, and pricing of condominiums in Singapore using a 2-stage least squares regression methodology. This empirical study covers a sample period of 12 years from 1988 to 2000. The condominium housing demand model showed that GDP growth and the inflation rate had positive relationships with condominium demand one quarter ahead. However, demand for condominiums was negatively related to one-quarter lagged stock price change, two-quarter lagged condominium housing price change, lagged demand in the previous two quarters, and one-quarter lagged household formation. On the supply side, changes in last-quarter condominium housing stock, condominium commencement, the prime lending rate, and current and lagged-quarter labor costs would adversely affect developers' decisions to commence new condominium projects. In the condominium price model, the dummy variable used to test the effects of the government's anti-speculation policies in May 1996, which increased the supply of residential lands and restricted the loan quantum to a limit of 80% of the housing price, was significant and positive. It implied that the policies were effective in dampening condominium prices by 0.32% per quarter for two consecutive quarters in 4Q1996 and 1Q1997.

## Keywords

Condominium Housing, Market Dynamics, Condominium Housing Stocks, Condominium Commencement, Condominium Demand, Anti-Speculation Policies

## Introduction

Based on the second quarter of 2001 Urban Redevelopment Authority (URA)[1] statistics, condominium units accounted for 38% of the total available private residential stock in Singapore (Figure 1). Together with apartment units,[2] the two non-landed sectors of private residential properties constituted two-thirds of the accumulated private residential stocks in Singapore. This reflects the importance of land use intensification in land-scarce Singapore. By ownership status, non-landed properties constitute 66% of a total of 193,319 completed private residential units as of the 2nd quarter of 2001. Out of this 66%, Singaporeans owned 74.8% of a total of 95,364 completed condominium and apartment units. This phenomenon well explains the rising inspirations of Singaporeans who want to own a condominium.

**Figure 1**: **Distribution of Available Private Residential Properties (As of the end of the 2nd Quarter 2001)**
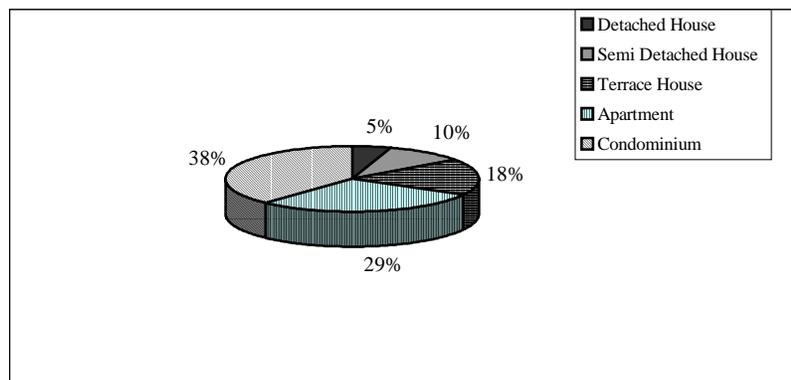


From the 3rd quarter of 1994 to the peak of the 2nd quarter in 1996, the URA condominium price index increased by 19.5% on a quarterly-compounded

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[1]    The Urban Redevelopment Authority (URA) is the national planning authority of Singapore, which is entrusted with the responsibility of planning the physical development and optimizing the scarce land resource in Singapore. The URA provides comprehensive and up-to-date data and information of the real estate market to improve the market's efficiency and transparency.

[2]    Apartments and condominiums are two property types that make-up the non-landed private residential property sector in Singapore. A condominium is a strata-titled development with a full-range of facilities provided within a minimum land area of 0.4 hectares. Apartments are also a multi-unit project built on smaller parcel of land. There is a restriction on the re-sale to foreigners of apartments in buildings with less than 6 storeys. Apartment units also include apartments above shops and privatized apartments previously under the Government Housing scheme for employees.

basis, which outpaced the quarterly-compounded growth of the average of all industries' monthly earnings of 5.92% over the same period (*source: The Central Provident Fund[3] (CPF) Board Statistics*). The divergence of the two trends has raised serious concerns on the affordability of private residential properties in Singapore (Ong, 1998 and 1999). The government took swift action on 15 May 1996 by introducing a slew of measures to cool the overheated market, and also to stamp out speculative activities (Ang, 1996; JLW Research, 1996)[4]. Besides the deliberate anti-speculation measures, the economic pressure of the 1997 Asian financial crisis has also contributed significantly to the decline in condominium prices. Condominium prices then took a downturn in the 3rd quarter of 1996, and the downward trend continued after the Asian Financial Crisis. The quarterly growth rate hit a low of -10.08% in the 3rd quarter of 1998 (Figure 2).[5] Fluctuations of economic forces clearly have an important influence on the market dynamics of Singapore's condominium market.

The 80% mortgage loan to value restriction was one of the May 1996 measures imposed by the government[6], which has been effective in moderating the sharp rise in condominium prices. The government's land sale has also been used as a policy tool to regulate the supply of new condominiums in the market. The state land sale program was stepped up to increase the supply of private housing from 6,000 units to 7-8,000 units to ease the price pressure created by strong market demand (Ang, 1996; JLW Research, 1996). In the recent economic recession in 2001, the weak market sentiment, coupled with the oversupply situation, sent the private residential market into doldrums with 18,205 uncompleted condominiums units with sale licenses remaining unsold as of the 2nd quarter 2001 (*Source: the Urban Redevelopment Authority, URA*). The land sale program has again been adopted in the off-budget measures[7] announced on 13 October 2001 (Tan,

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[3]  Central Provident Fund (CPF) is a comprehensive pension fund contributed to monthly by employees and employers to take care of the retirement, homeownership, and healthcare needs of the members. The CPF Board was set up to administer and preserve the value of the savings of its members.

[4]  The measures implemented by the government to check the sharp rise in private residential property prices included the imposition of a 80% loan-to-value limit on bank loan, levies of the capital gain tax, and seller's stamp duty for residential properties sold within three years of purchase.

[5]  The fall in condominium prices did not, however, help to cushion the market as new condominium supply continued to flood the market.

[6]  Prior to the May 1996 mortgage restriction, purchasers of private residential property were allowed to take a mortgage loan of up-to 90% of the purchase price, or valuation price, whichever is lower. The tightening of the loan-to-value ratio to 80% thus implies that purchasers will have to fork over additional equity/cash to purchase private residential property. This policy helps protect financial companies/banks against defaults. However, it will dampen the affordability of the potential private property.

[7]  The off-budget measures were a comprehensive economic package implemented to cushion the fallout of the regional economic slowdown on the Singaporean economy. Tax rebates and deferment of the government's land sale program are among the measures included

2001), but this time it aimed to tighten the supply and to shore up the sluggish property market (Sing, 2001).

**Figure 2: Historical Condominium Price and Return Trends**
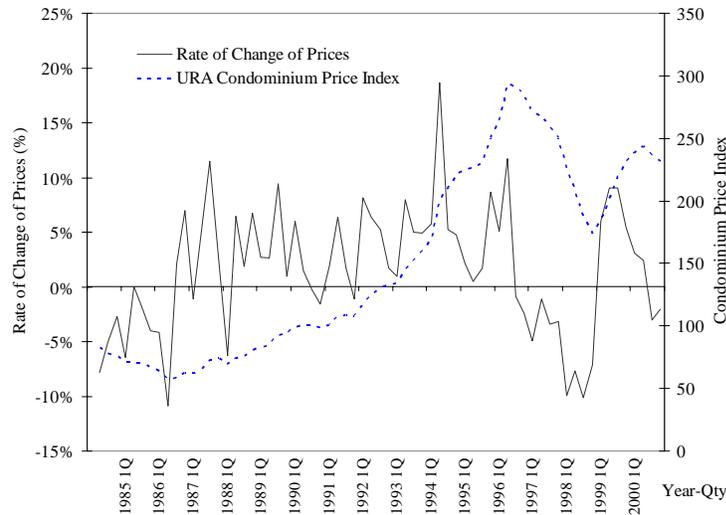


Following the announcement of the off-budget measures, the Minister for National Development of Singapore, Mr. Mah Bow Tan, who oversees the property market activities, commented that

*"...off-budget measures to stabilize the property market will not have an immediate effect, but will help boost confidence and help the real estate industry ride out the downturn.*
*The measures will not on their own help the real estate industry to recover. Ultimately, the recovery of the real estate sector will depend on the recovery of the economy as a whole."*

*The Business Times, Singapore* (Rashiwala, 2001)

Market interventions via land sales and mortgage rationing have been adopted from time to time to smooth out undesirable volatility. How significant are the measures and how long the measures will take to have an effect on the property market are important questions faced by policy makers when formulating their policies. The effectiveness of the policies is dependent on the interaction between various economic forces and property market movements. For profit-maximizing developers and investors,

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to stabilize the property market.

understanding the ups and downs of the market and the relationships between the condominium market movement and the economic cycle will enable them to respond more quickly to changing economic conditions at the investment and development planning stage.

This study thus aims to examine economic and property market forces that drive price, demand for, and supply of condominiums, and to analyze the dynamic relationships between economic variables and condominium market movements.  A two-stage least square technique is used to estimate the price, demand, and supply models for condominium based on quarterly data for the 12-year sample period from 1988 to 2000.  To better capture the dynamics of the market, two-quarter lag effects of the economic and market variables are included.  Simulation analyses are also included in this study to examine the sensitivities of the shocks on the economic and other exogenous-related factors on the condominium absorption and flow processes.

In Singapore, earlier empirical studies done by Ho and Tay (1993), Ho and Cuervo (1999), and Tu (2001) were based on aggregated data of the private residential market.  Ho and Tay (1993), who used two-stage least square methodology, did not deal with the problem of non-stationarity of time series data.  Ho and Cuervo (1999) and Tu (2001) addressed the methodological shortcomings by using cointegration technique.  There are three main motivations of this study.  First, this study focuses specifically on private condominium housing, which by available completed stocks is the largest sector of the private residential market.  Second, the effectiveness of the May 1996 anti-speculation measures, which was comprised of a program that stepped up the land sale program and a policy that restricted mortgage loans to 80% of property values, on condominium prices will be empirically tested by incorporating a time-dummy variable in the models.  Third, this study simulates the effects of exogenous shocks of variables that have significant policy implications on the condominium market dynamics.

This study is organized into seven sections.  Section 1 defines the objectives and motivations of the study, and highlights the importance of the economic factors and policy measures used to regulate the condominium market movements in Singapore.  Section 2 briefly describes the development and historical trends of the condominium market in Singapore.  Literature of housing studies, which are abundant in the UK and the US, are reviewed in Section 3.  Section 4 conceptualizes the theoretical and empirical framework for modeling the dynamics of the condominium markets.  Three models: price, demand, and supply, are empirically estimated using the quarterly economic and condominium market data of Singapore.  Section 5 defines the empirical data and uses the 2-stage least squares (2SLS) methodology to estimate the price, demand, and supply models for condominiums. Effects of stochastic shocks of selected exogenous variables on the condominium

take-up and flow processes are simulated in Section 6.  Section 7 concludes the findings.


## The Condominium Market in Singapore

The condominium was a new housing concept with self-contained and shared facilities first brought into Singapore in 1974.  The high-rise and high-density nature of condominium development constitutes a key planning strategy aimed to optimize the scarce land resources in Singapore.  This concept appeals to middle-income, young professional couples, and owning a condominium has become the aspiration of many Singaporeans (Lum, 1996; Ong 1998; Ong & Sing, 1999).

Condominium housing started off slowly in the 1970s, due to the unfamiliarity of most Singaporeans towards condominium living, and also the developer's lack of knowledge of owners' preferences in condominium facilities.  The demand and popularity of condominiums have risen in the early 1980s following a rapid growth of Singapore's economy.  The growing affluence of Singaporeans, coupled with the strong influx of multinational corporations and foreign talents, fueled the demand for condominium housing during this time.  The relaxation of the Central Provident Fund rule to allow its members to draw on their ordinary account savings via the Approved Residential Properties Scheme (ARPS) to purchase private property has also helped sustain the demand for condominiums.  The economic recession in 1985 caused a condominium market slump that was beset by both excessive supply and declining demand.  Economic forces have played a major role in the growth of this first phase of condominium housing development in Singapore (Ho and Sim, 1992).

In the second post-recession phase of condominium development in Singapore, prices rose steadily from 3Q1986 after rebounding from a trough in 2Q1986 that posted a quarter-to-quarter decline of 10.89%. Condominium prices peaked in 2Q1996 after an 11.70% jump from the previous quarter price index.  This triggered the government's anti-speculation measures, which have been effective in checking condominium prices.  The first reverse of the upward price trend occurred in 3Q1996, and the price continued to decline until it hit the trough in 4Q1998.  The price drops were aggravated by the financial crisis that hit the region in July 1997, which saw quarterly declines in prices of between 7.15% and 10.08% in 1998.  Condominium price changes were more volatile for the periods after the 2Q1996 peak with a standard deviation of 6.47%, compared to 4.82% recorded for the earlier periods from 2Q1986 to 1Q1996.

The land sale program has been an important supply-side tool for the government to regulate condominium supply and demand in Singapore. The government's land sale program was stepped up following the May 1996 measures to check the property market bubble. The effects of the increase in the land sale program were reflected in the cumulative annual commencement of condominium projects, which shot up from 5,870 units in 1995 to 10,472 units in 1996. The condominium commencement reached a peak of 16,471 units in 1997 - a threefold increase from the 1995 figure. The large number of condominium commencements between 1996 and 1997 translated into an average quarterly figure of 3,368 units, more than doubling the historical average of 1,498 units for the entire sample period.

On the demand side, the darkened line in Figure 3 shows that supply surpluses, measured by the difference between condominium commencement and demand, rose sharply since the imposition of a credit rationing rule that limits a loan to only 80% of property value in May 1996. The supply surpluses were absorbed rapidly by strong pent-up demands in the post-1997 financial crisis period. The quarterly take-up of occupied stocks between 3Q1997 and 4Q2000 averaged 1,871 units, compared to the historical average of 932 units over the period 1Q1988-4Q2000. Strong demand and a slowing down of new commencements have caused the surplus line to dip into a negative region for the periods from 4Q1998 to 3Q1999.

**Figure 3: Historical Take-up and Commencement of Condominium Housing**
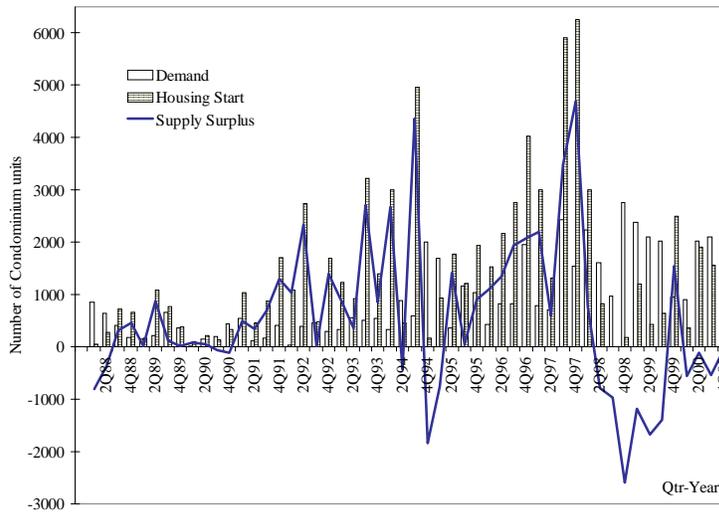
How has the 80% credit rationing policy influenced demand and housing commencement in Singapore? Stansell and Mitchell (1985) questioned the importance of credit rationing and mortgage rates on housing starts, and they found no empirical evidence for their relationships in the US from 1963 to 1980. Guttentag (1961), Burham (1972), and Meen (1990), however, found that it was the level of credit that has a significant influence on housing starts and prices in the US and UK.

On the effect of interest rates, Tan (1994) found weak uni-directional Granger causality relationships from house prices to interest rates due partly to rapid economic growth, state public housing policies, and a high savings rate in Singapore. The issues of credit rationing and the mortgage rate will be revisited in this study. The impact of the 80% mortgage restriction together with the effects of land sale increase will be collectively tested using a dummy variable that distinguishes the two quarter periods after the government's 2Q1996 anti-speculation measures.

This study will empirically estimate the dynamic models for the demand and supply of condominiums over a sample period of 1Q1988 to 4Q2000. The price variable will be instrumented using economic variables, and its predicted value will be included in the demand and supply models in a two-stage procedure. The mortgage interest rate will also be included as one of the exogenous variables in the dynamic models.

## Literature Review

The literature on modeling of housing prices is very extensive, especially in the developed housing markets in the UK and North America. Earlier empirical housing studies place more emphasis on data coherency than on theoretical underpinning of the model (Smith, 1969, Neuburger and Nichol, 1976; Mayes, 1979). The importance of building micro-foundation into modeling housing consumption and investment has been inspired by the influential papers of Davidson, Hendry, Srba, and Yeo (1978) and Hendry (1984) in the UK. In Hendry's neo-classical theory of equilibrium demand and supply functions, he derived the price of existing houses as a function of personal disposable income, rental rate, interest rate, stock of mortgage, tax rate, and number of families. Hendry's model contains a cubic excess demand term to reflect a frenzy expectation that is consistent with the "*Catastrophe Theory*". Dicks (1990) extended Hendry's model for prices of new housing in the UK. Hsieh (1990) further separated housing demand into service and investment demand in a study of Taiwan's housing market.

Topel and Rosen (1988) and Mortgomery (1996) used investment-based models[8] that are incorporated with an internal adjustment cost mechanism to analyze investment decisions of construction firms. In the Topel and Rosen (1988) model, housing starts are a function of house price and a vector of cost shifters, and land is left out from the factor of production. Wheaton and DiPasquale (1994) proposed a more complete housing starts model, which included housing prices, interest rates, land costs, construction costs, and stock of housing in the previous period.

Based on a utility maximization framework, Dougherty and Van Order (1982), and Poterba (1984) extended the user cost of capital concept to study the household choice that comprises only two goods: housing services and a composite consumption good. Using the same user cost of housing capital concept, Breedon and Joyce (1992) and Meen (1990, 1995, and 1996) examined credit-rationing effects on housing price dynamics in the UK. The user cost of housing capital concept was given a richer urban spatial framework by DiPasquale and Wheaton (1994) when stock and flow adjustment of housing are considered.[9] However, the empirical specifications of the stock-flow model do not deal with the problem of non-stationarity of data. This problem was identified and addressed by Tu (2001) using an error correction mechanism in a two-stage least squares process.

There are other studies, which do not have formal micro-foundation of housing model. They conjectured the housing market behavior in a more ad-hoc, but plausible, approach. Smith (1969) identified significant relationships and interactions of various factors that affect housing starts and prices in the Canadian housing market. The housing starts are defined as a function of the price of houses, vacancy rates, construction and land costs, cost of mortgage credit, availability of private and public mortgage credit, and seasonality, whereas housing price is a function of family disposable income, price of alternative goods, per family stock of dwelling units, and cost and availability of credit.

In Singapore, housing market studies were done mainly on the residential market as a whole using the aggregated URA transaction-based private residential property indices. Ho and Tay (1993) developed a system of six simultaneous equations for the supply of and demand for private residential properties in Singapore in a two-stage least squares process. The linear models for the completed units, the occupied units, and the price functions of

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[8]   The investment-based model is invariably based on Jorgenson's (1963) user cost of capital and Tobin's Q-ratio (1969) concepts, which attempt to optimize the utility function of investors, given the constraint in resources.

[99]   DiPasquale and Wheaton (1994) questioned issues relating to the rate of housing price adjustments to equilibrium, the future price expectation formation of consumers, and the effects of the land factor on long run housing flows, and made variations to the earlier version of stock-flow adjustment models.

the residential property market have an extremely good-fit of more than 0.99 R-squares value.  The high R-squares results may be spurious due to non-stationary of many time-series variables in the models.  Recognizing the non-stationary data problem, Ho and Cuervo (1999) and Tu (2001) incorporated an error correction term in the cointegration models to adjust for the short-term non-stationary variations.

Other studies include Ong and Sing (2002) on price discovery between private and public housing market, and Sing and Low (2001) and Chen and Sing (2000) on inflation hedging characteristics of the housing market.  There are no studies done on the economic relationships of the condominium (non-landed) properties in Singapore.  This study, therefore, fills the gap by attempting to examine the economic factors that simultaneously drive the demand, supply, and price functions of the condominium market.

## Theoretical Framework

Traditionally, the neo-classical economic theory focuses only on the demand and supply activities in the space market.  It neglects the growing role of real estate in the asset markets where real assets are included in the institutions' investment portfolio to diversify risk.  In order to have a complete picture of the key relationships between supply and demand, it is important to take into consideration the interactions between real estate space and capital markets.  Figure 4 shows a general structure for the condominium housing market in Singapore, and on which the interactions of various demand and cost shifters for the condominium models are identified.

## The Condominium Housing Market Dynamics

Government, financial institutions, firms, households, and developers are five key players in the real estate market.  The roles of government are mainly regulatory and supervisory in nature. The government ensures that the development planning and control mechanisms are properly implemented and enforced.  It also sets and manages macro-economic policies to enable efficient operations of the economic activities. There are other roles entrusted to the government, like tax collection, provision of infrastructures and facilities, the public housing program, etc.  It is assumed that there is no direct participation of government or its related companies in the real estate market.  The government's influence on the private real estate market is mainly through the management of macro-economic policies.

**Figure 4: Condominium Housing Market Structure in Singapore**
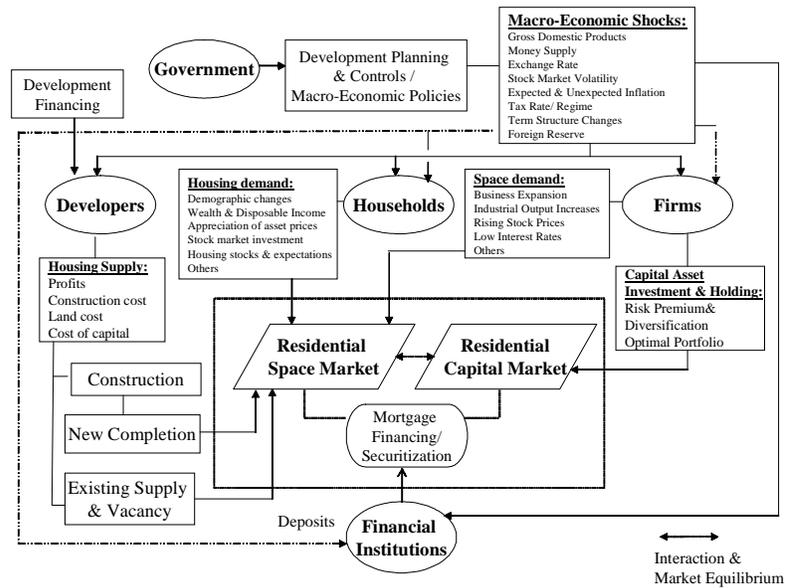
A sound economic performance, as indicated by the positive economic growth, low interest rate environment, expansionary monetary policy, bullish trends in the stock market, etc., is normally accompanied by an increase in individuals' disposable income and wealth. These will trigger a strong demand for housing either by potential upgraders or new home buyers. Prices of the new and the existing housing stocks will then be adjusted rationally to meet the new equilibrium condition. Changes in the demographic patterns such as population growth, household size and formation, migration, etc., will also affect housing demand. The user cost of housing capital is another important concept that explains the changes in housing prices and demand. It captures both the consumption and investment demand for housing by a combination of factors, which include tax rates, interest rates, expected capital gains, and depreciation of existing housing stocks.

At the firm level, the firm's revenue will be boosted by increases in outputs. The good performance of the firm will then be translated into a rise in its stock price. To sustain a strong growth of the firm's outputs, capital injection and expansion of operational space are necessary. The expansion of a firm's operations may beget new demand for housing from its expatriate staff, either through rental or ownership arrangements. For institutional investors, condominium housing can be included in their investment

portfolio if the rental yields and price appreciation are attractive. Both consumption and investment demands for condominium housing add to the demand for condominium stocks.

As a financial intermediary, banks and other financial institutions help improve the efficiency of the real estate market operation by making funds available to firms and households in the form of property mortgage loans. The originations of new mortgage loans are regulated by government's monetary policies, and the levels of new mortgage loans originated are affected by market interest rates. In the capital market, securitization of real estate offers an alternative investment avenue for institutional investors to put their funds into the real estate market. Securitization offers developers or property owners an alternative source of capital funding, and adds liquidity to the real estate market. Financial institutions play a key role in making the securitization instruments available to potential investors.

On the supply side, developers are motivated by profits when undertaking new construction projects. Due to a long lag time in the completion of a new building, developers may rely on their better accessibility to cost information to arbitrage on the short-term price variations in the market. There are also occasions when developers may misjudge the real estate cycles. However, in the long run, the space market will reach equilibrium. Excess stocks, if they exist, will be cleared at the open market price. If the real estate market is efficient, abnormal returns generated by the differences between the replacement and construction costs (inclusive of developer's profits and returns) and the market prices, if they exist, will be arbitraged away quickly by the markets. There is an important link between the space and capital markets.

## Empirical Model Specification

Many empirical housing models, some of which were reviewed in the earlier section, have been developed based mainly on the stock-flow adjustment or the classical Hendry's neo-classical frameworks. Variations among the models are mainly on the inclusion of exogenous variables and also the selection of lag orders for the variables.

Based on the literature and the condominium market dynamics reviewed in the earlier sections, several important macro-economic determinants of house prices, although not deemed exhaustive, are identified and tabulated in Table 1.

**Table 1: Condominium Housing Model Determinants**

| Demand Side Factors | Supply Side Factors |
|---|---|
| • Demographic factors (family size, number of families etc.) | • Land Cost |
| • Personal disposable income | • Construction Cost |
| • Price of housing services | • Prime Lending Rate |
| • Stock prices | • Cost of Capital |
| • Commodity prices | • Retail Price Index (Inflation) |
| • Expected appreciation of house price | • Expectation of house price changes |
| • Mortgage interest rates | • Housing completion |
| • Total outstanding mortgage | • Housing Stocks |
| • Tax rate | • |
| • Money supply | |

Due to data constraints,[10] some variables will not be included in the empirical specifications. The demand in this study refers to the new incremental occupied private condominium stocks in the primary market. The proposed demand and supply functions for condominium housing are derived as follows:

*Demand,* $HD_t = f(GDP_{t-i}, HF_{t-i}, IR_{t-i}, CPI_{t-i}, STI_{t-i}, P^*_{t-i}, HD_{t-j})$      (1)
*Supply,* $HC_t = f(BMC_{t-i}, LRC_{t-i}, PLR_{t-i}, P^*_{t-i}, HS_{t-i}, HC_{t-j})$      (2)

where, $i = [0, 1, 2]$, $j = [1, 2]$, and

| | | |
|---|---|---|
| HD | = | Demand function represented by incremental change in occupied condominium housing stocks |
| HC | = | Supply function represented by the change in the commencement of new condominium housing stocks |
| GDP | = | Gross Domestic Product |
| HF | = | Household Formation |
| IR | = | Interest Rate for Housing Loan |
| CPI | = | Consumer Price Index |
| STI | = | Stock Exchange All Share Price Index |
| $P^*$ | = | Long-term market clearing condominium price, predicted from the condominium housing price model in equation (3) |
| BMC | = | Basic Material Costs |
| LRC | = | Labour Costs |
| PLR | = | Prime Lending Rate |
| HS | = | Stocks of completed condominium housing |

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[10] Household disposal income, tax rate, and rent variables are dropped from the demand function because the time series data for these variables are unavailable or limited.

In a static equilibrium market condition, the demand for condominium housing is equal to the supply of condominium housing. That is, $HD_t = HS_t$. By rearranging the condominium demand and supply equations in (1) and (2), the market clearing price ($P^*$) can be represented as follows:

$$P^* = f(GDP_{t-i}, HF_{t-i}, IR_{t-i}, CPI_{t-i}, STI_{t-i}, P_{t-j}, BMC_{t-i}, LRC_{t-i}, PLR_{t-i}, HS_{t-I}, D96Q4) \qquad (3)$$

To empirically test the effects of the May 1996 measures, which included an 80% credit limit and a planned increase in the supply of residential lands, on condominium prices, a time dummy variable, which takes a value of –1 for the quarters 4Q1996 and 1Q1997, and 0 otherwise, is included in price model specification (3).

In a two-stage least regression estimation process, the demand, supply, and price models will be estimated as independent regression models. The first stage of the regression involves estimation of the price as a function on its lagged prices and other determinants. Then, the unstandardized predicted price is included in the demand and supply models as an instrumental variable in the second stage of the regression process. The two-stage estimation methodology was also used in Tu's (2001) housing model, which found a significant short-run error correction in the housing commencement. The error correction process was, however, not significant in the price function. She found that the short run housing price variations were explained by the user cost of housing capital, GDP, and public housing price. The user cost of capital will not be included in the empirical models in this study. Instead, the changes in interest rates and prices are explicitly modeled as exogenous variables in the proposed specifications.

## Empirical Analysis and Data

### Data Source

Unlike the aggregate landed and non-landed residential properties data used in the Ho and Cuervo (1999) and Tu (2001) studies, this study focuses only on the condominium (non-landed) housing market. Quarterly time series data for the independent and dependent variables are collected for a 12-year sample period from 1988 to 2000, and they are listed in Table 2. The data is published by various agencies in Singapore, which include the Urban Redevelopment Authority (URA), the Monetary Authority of Singapore (MAS), the Department of Statistics (DOS), the Building Control Authority (BCA), the Registrar of Marriages (ROM), and the Stock Exchange of

Singapore (SES). The data is retrieved from the DOS Time Series Retrieval and Dissemination (TREND) database.

**Table 2: List of Empirical Variables & Their Sources**

| Notation | Variable Description | Source |
|---|---|---|
| *a) Dependent Variables:* | | |
| HD | Condominium demand represented by the incremental change occupied stocks of condominium in the market | URA |
| HC | Condominium supply represented by the change in commencement of new condominium construction | URA |
| P | Condominium property price index (1990 =100) | URA |
| *b) Independent Variables:* | | |
| IR | Finance companies 15-year housing loan interest rate | MAS |
| PLR | Prime lending rate | MAS |
| LRC | Labour costs index | BCA |
| BMC | Basic material costs index (Base year 1985=100) | BCA |
| GDP | Gross domestic products at 1990 market prices | DOS |
| HS | Stocks of Completed Condominium Housing | URA |
| HF | Household formation represented by the number of marriages registered | ROM |
| STI | Singapore stock exchange all-share price index | SES |
| CPI | Consumer price index | DOS |

The economic time-series data listed above are non-stationary in level. It is, therefore, important to convert the data into stationary series by a simple first differencing process. This process will remove the unit roots inherent in the time series data, and thus eliminate spuriousness in regressions. The differencing process involves first transforming the data into logarithm forms, and then computing the first-order differenced stationary data, I(1), which is represented as $\Delta Y_t = \log Y_t - \log Y_{t-1}$, where $Y_t$ denotes a quarterly time-series variable.

***Regression Results Analysis***

Based on the empirical specifications in equations (1) to (3), the regression models for condominium housing are estimated in a general-to-specific

approach using the backward elimination criteria defined in the Statistical Package for Social Sciences (SPSS) software package. The price model is first estimated, and then the predicted prices are included in the demand and supply models in a two stage procedures. The results of the final regression models for condominium housing price, demand, and supply are summarized in Table 3.

All the exogenous variables retained in the respective models are statistically significant at the less than 10% level. The estimated adjusted $R^2$, which measures the goodness-of-fit of the models, were 0.604, 0.487, and 0.328 for the condominium housing price, demand, and supply models, respectively. The price model was the best-fit model. The Durbin-Watson statistics indicated that the models are clear of serial-correlation problems.

The price model showed that current condominium housing stock, inflation rates, and lagged stock market returns in the last two quarters have positive effects on condominium price changes. The positive condominium price change was approximately 4.66% for every 1% rise in the inflation rate, ceteris paribus. However, the condominium price changes were inversely related to the increases in the mortgage interest rate and 2-quarter lagged condominium housing stocks. A 1% increase in the mortgage rate would cause the current condominium price to decline by 0.46%, with other exogenous factors being constant. The negative condominium price and mortgage relationship is consistent with other studies done in the UK (Hendry, 1984; and Meen, 1990) and Singapore (Ho and Cuervo, 1999; Tu, 2001[11]). The positive and significant dummy variable (D96Q4) indicated that the slew of "market correction" measures introduced by the government in May 1996 has been effective in dampening the condominium housing price changes by 0.032% for two consecutive quarters in 4Q1996 and 1Q1997.

Demand for condominiums was negatively related to one-quarter lagged stock price change, two-quarter lagged condominium housing price change, lagged demand in the previous two quarters, and one-quarter lagged household formation. However, the GDP growth and inflation rate (proxy by the change in the consumer price index (CPI)) led condominium demand by one quarter.[12] Economic performance was found to drive condominium demand by 9.66% for every 1% increase in GDP growth, assuming that other factors remain unchanged.

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[11]    In Tu's (2001) study, the mortgage interest rate effect was reflected in the negative relationship between the user cost of housing capital and housing prices in Singapore. The user cost of capital is defined as the real mortgage rate minus the expected price appreciation.

[12]    The positive CPI changes and the negative household formation effects on condominium housing demand were likely to be affected by the substitution effects created by the public housing market in Singapore. However, the substitution hypothesis of the public housing will not be within the scope of this study.

**Table 3: 2SLS Multiple Regression Models for the Condominium Market in Singapore**

| Regression Models: | | Price Model (P) | Demand Model (HD) | Supply Model (HC) |
|---|---|---|---|---|
| Independent Variables | Lag Period (quarter) | Regression Coefficients | | |
| Constant | 0 | 0.001 (0.006) | -0.084 (0.071) | 0.440* (0.199) |
| Dummy variable (D96Q4) | 0 | 0.0320* (0.014) | | |
| Predicted Price | 2 | | -5.005** (2.524) | |
| Demand | 1 | | -0.559* (0.123) | |
| Demand | 2 | | -0.462* (0.119) | |
| GDP | 1 | | 9.664* (4.412) | |
| Inflation Rate (CPI) | 1 | 4.661* (1.301) | 51.456** (27.813) | |
| Stock Market Return | 1 | 0.155* (0.041) | -1.614** (0.818) | |
| Stock Market Return | 2 | 0.187* (0.039) | | |
| Condominium housing stock | 0 | 0.729** (0.416) | | |
| Condominium housing stock | 1 | | | -32.786* (14.554) |
| Condominium housing stock | 2 | -0.853* (0.342) | | |
| Mortgage Rate | 0 | -0.465* (0.139) | | |
| Household formation | 1 | | -1.528* (0.634) | |
| Housing Commencement | 1 | | | -0.480* (0.135) |
| Labour Costs | 0 | | | -12.517* (6.233) |
| Labour costs | 1 | | | -11.842** (6.594) |
| Prime Lending Rate | 1 | | | -8.091* (3.790) |
| *Regression Statistics:* | | | | |
| Adj. R-square | | 0.604 | 0.487 | 0.328 |
| Standard errors of estimate | | 0.015 | 0.297 | 0.607 |
| Durbin-Watson | | 1.896 | 1.973 | 2.145 |

* significance at 5%   ** significance at 10% level
Values in the parentheses are standard errors for the coefficients

On the supply side, new condominium supply was inversely related to last quarter condominium housing stock, and condominium housing commencement and prime lending rate were high. Similarly, developers would also reduce new condominium housing commencement, if current and lagged-quarter labor costs were high. By holding all other factors constant, a 1% increase in PLR would reduce new condominium commencement by 8.09% in a quarter ahead, while a 1% increase in current and lagged quarter labor costs would reduce new commencement of condominium housing in the current quarter by 12.52% and 11.84%, respectively.

## Simulation Analysis and Results

Based on the estimated regression models, which are rewritten in Equations (4) to (6) below, the study proceeds to simulate the effects of one standard deviation shocks of selected exogenous variables on the demand and supply of condominiums.

$$\Delta p_t = -0.001 - 0.032*D96Q4 + 4.661*\Delta cpi_{t-1} + 0.155*\Delta sti_{t-1} \\ + 0.187*\Delta sti_{t-2} + 0.729*hs_t - 0.853*hs_{t-2} - 0.465*\Delta ir_t \tag{4}$$

$$\Delta hd_t = -0.084 - 5.005*\Delta p_{t-2}^{\ *} - 0.559\Delta hd_{t-1} - 0.462\Delta hd_{t-2} + .664*\Delta gdp_{t-1} \\ + 51.456*\Delta cpi_{t-1} - 1.614*\Delta sti_{t-1} - 1.528\Delta hf_{t-1} \tag{5}$$

$$\Delta hs_t = 0.440 - 32.786*\Delta hs_{t-1} - 0.480*\Delta hc_{t-1} - 12.517*\Delta lrc_t - 11.842*\Delta lrc_{t-1} \\ - 8.091*\Delta plr_{t-1} \tag{6}$$

For Equations (4) to (6), lower case symbols are used to represent the logarithm terms of the respective variables, say $y_t = log\ Y_t$, and $\Delta y_t = y_t - y_{t-1} = log\ Y_t - log\ Y_{t-1}$, where y denotes a variable.

The average historical supply surplus, which is defined as the difference between new condominium commencement and occupied condominium stocks (i.e. [HC – DD]), was estimated at 633 units. Based on Equations (4) to (6), the expected ex-post predicted condominium supply surplus was estimatedto be 374 units, which constituted 28.56% of the predicted new supply of 1,310 units. The ex-post predicted surpluses (shortfalls) and the actual surpluses (shortfalls) are shown in Figure 5.

**Figure 5: Actual and Predicted Surpluses (Shortfalls) in Condominium Supply**
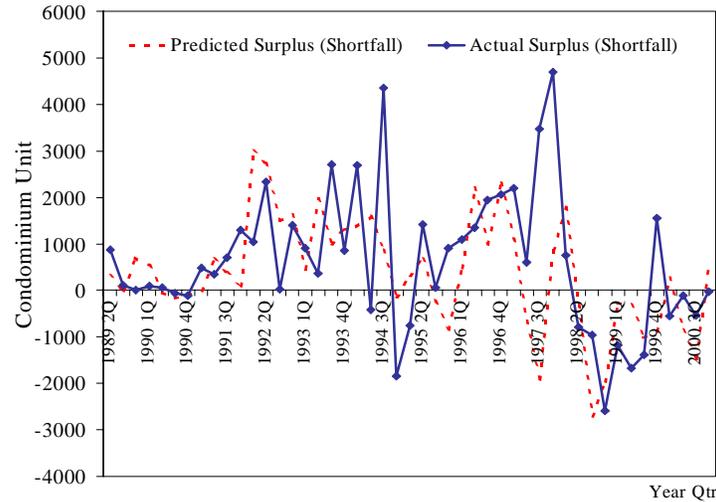


Next, the effects of one standard error shock of the dynamic multipliers, which are the coefficients of the exogenous variables in Equations (5) and (6), on the predicted demand, supply, and surplus (shortfall) of condominium stocks were examined using stochastic or Monte-Carlo simulation methodology.[13] This Monte-Carlo simulation analysis was performed by specifying a normal probability distribution for each of the exogenous variables in Equations (5) and (6). The normal distribution of each variable is defined by a mean and standard deviation, which are respectively represented by the coefficient and standard error of the variables.[14] Then, 1,000 simulation trials were performed. In each random simulation process, mean values plus an additive error term for the exogenous variables were chosen from the corresponding probability distribution of the respective variables, and the values of the predicted condominium demand, supply and surplus were computed. The frequency distribution of the predicted surplus in Figure 6 showed that the probability that the historical predicted oversupply (surplus) of condominiums would decline below 374 units was 42.10%, given one standard error shocks on the system. The results of sensitivity analysis showed that shock to one-quarter lagged condominium stocks was the most sensitive factor affecting the market clearing condition,

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[13]   The stochastic simulation methodology to test the effects of random errors associated with exogenous variables on the predictive error variance of the endogenous variables is explained in Chapter 14 of Pindyck and Rubinfeld (1998).

[14]   The values for the coefficients and standard errors of the exogenous variables are given in Table 3.

followed by the shocks on the one-quarter lagged inflation rate, GDP growth, and prime lending rate.

**Figure 6: Frequency Distribution for Predicted Condominium Housing Surplus**

## 1,000 Trials

Certainty is 42.10% from -Infinity to 374.22 Predicted Surpluses
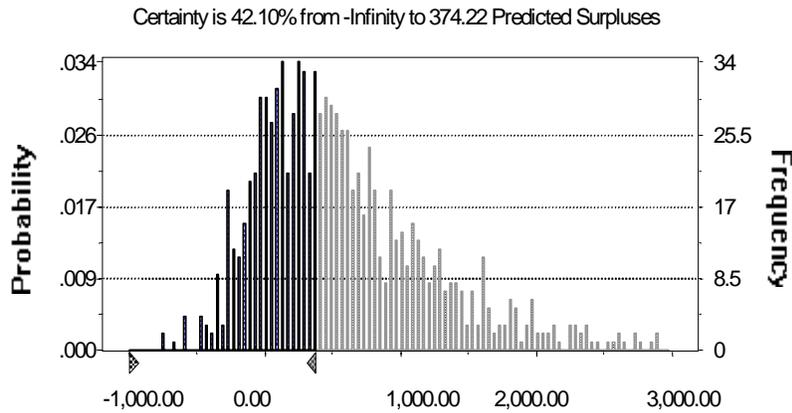


## Conclusions

Modeling economic forces and market factors that drive the condominium market in Singapore is important from the perspective of policy makers, developers, and investors. It helps to improve the judgment of the market movements, and thus ensures a more effective implementation of new condominium housing policy.

In the condominium housing price model (Equation 1), the deliberate policies taken by the government in May 1996 to increase the supply of residential lands and the rationing on loan quantum to a limit of 80% of the housing price were found to be effective in dampening condominium prices for two consecutive quarters in 4Q1996 and 1Q1997. The correction of the condominium housing price associated with the anti-speculation measures, as measured by the coefficient of the time dummy variable, was estimated at 0.32% per quarter. Increases in the current mortgage interest rate and the 2-quarter lagged condominium housing stocks were found to have negative effects on condominium housing prices. A 1% increase in the current mortgage rate would cause the current condominium price to decline by 0.46%, whereas a 1% increase in the condominium housing stocks would dampen the condominium housing prices by 0.85% two quarters ahead. The

current condominium housing stock, inflation rate, and lagged stock market returns in the last two quarters were the positive determinants for the condominium price changes.

On the demand side, developers could look to GDP growth and inflation rate (proxy by the change in the consumer price index [CPI]) as positive signals of new condominium housing demand one quarter ahead. Economic performance was found to drive condominium demand by 9.66% for every 1% increase in GDP growth, assuming that other factors remain unchanged. However, demand for condominiums was negatively related to one-quarter lagged stock price change, two-quarter lagged condominium housing price change, lagged demand in the previous two quarters, and one-quarter lagged household formation. On the supply side, changes in last quarter condominium housing stock, condominium commencement, prime lending rate, and current and lagged-quarter labor costs would adversely affect developers' decisions to commence new condominium projects. By holding all other factors constant, a 1% increase in PLR would reduce commencement of new condominium commencement by 8.09% in a quarter ahead.

The expected ex-post predicted condominium supply surplus, defined as the difference between new condominium commencement and occupied condominium stocks, was estimated at 374 units, which constituted 28.56% of the predicted new supply of 1,310 units. In the Monte-Carlo simulation, the probability that the historical predicted oversupply (surplus) of condominiums would decline below 374 units was 42.10%, given one standard error shocks on the system. The results of sensitivity analysis showed that shock to one-quarter lagged condominium stocks was the most sensitive factor affecting the market clearing condition, followed by the shocks on one-quarter lagged inflation rate, GDP growth, and the prime lending rate.

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