The effects of External shocks on Housing policy, Housing market volatility and the National Defined-Contribution Pension Scheme: Evidence from Singapore

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Abstract

In this paper we conduct an empirical study of the housing market and how its behaviour, and government policy affecting the housing market, interacts with the National Defined Contribution Pension Scheme implemented in Singapore. We empirically estimate the impact of GDP and policy change on the housing market. We then proceed to examine housing market volatility and how this relates to macroeconomic conditions. In doing this we show how exposure to housing market risk combined with the regulations affecting the country's pension scheme can leave individuals exposed to housing market change and affect the value of retirement benefits. Using data from 1990 to 2005, our findings reveal that house prices are affected by both GDP and the government's housing policy measures. The volatility pattern in the housing market is found to be different in periods with different economic conditions. In addition we find that government policies also impact upon the volatility characteristics of the housing market. However, Singapore is a small, open economy and is exposed to external shocks and/or varying degrees of financial crises. This cannot be under-estimated as there is always a risk of spill over into the housing market, leading to volatility that could potentially affect the value of the pension funds used for retirement.

Key words: *Housing markets, Central Provident Fund, conditional volatility*

1 Introduction

Singapore is a densely populated high-income city-state with a population of 4.2 million people and a land area of only 697 square kilometres. Its gross domestic product in 2007 was S$229 billion and GDP per head was US$35956. In fact, Singapore's economic development has been so rapid that the city-state has leapt from relative poverty to affluence in only a quarter of a century, since it became an independent state on August 9th 1965.

While Singapore is not a welfare state in comparison to most European countries, the large-scale government intervention in housing significantly affects the welfare of the population due to the nature and institutional features that characterise the government sector of the Singaporean economy. This extensive intervention in the housing system has played a significant role in raising saving and homeownership rates as well as contributing to economic growth and more importantly, to the development of the housing market sector. Homeownership in Singapore is now the dominant type of housing tenure covering over 90% of households. Unlike many European or North American housing markets, in Singapore, it is the behaviour of the public sector that has contributed to the substantial rise in homeownership, with the private sector playing only a relatively minor role.

In this paper we review the development of Singapore's model of welfare that places an emphasis on housing. We examine academic literature that studies the impact of policy on housing. We then proceed to examine the relationship between the housing market and the welfare system. In doing this we specifically concentrate on housing market volatility because the value of state pensions can be exposed to housing market change. The

paper is structured as follows section 2 provides a description of the development of government policies that have affected the housing market, and a review of literature examining the impact of these policies. Section 3 describes the data and the methodologies of analysis. Section 4 presents the results and section 5 summarises and concludes the paper.

2. Government regulation of the public housing market

The property market is highly imperfect. product heterogeneity, spatial fixity, limited and asymmetric information and high transaction costs[1] (including monetary and search costs) make it relatively inefficient when compared with financial stock markets. Owing to these characteristics, researchers, such as Zhu (1997), have argued that government intervention in such circumstances often makes market operations more efficient and improves resource allocation. Imperfections and thus inefficiencies in the housing market suggest a role for government policy. However the scale with which the Singaporean government has intervened is rather unusual. Their policies have often been other welfare-related goals but these have effectively increased the impact of policy on housing. Wood (2003) suggests that this feature is prevalent in other places and in relation to tax policy too. He argues that "such measures are rarely viewed as an explicit component of housing programmes." (Op. Cit, p110).

Indeed, the current shape of housing policy in Singapore is the outcome of the implementation of these non-economic goals, set by the government which began during the immediate post-war period where there was a serious housing shortage problem.

[1] See Quigley (2003) for a full discussion of transactions costs.

Through the Singapore Improvement Trust (SIT), the then town planning authority built up an estimated 20,907 units of housing between 1947 and 1959. With an aim to eradicate the seemingly increasing housing shortage problem, the Housing and Development Board (HDB) was set up as statutory board in 1960 to replace the SIT. From 1964, the Home Ownership Scheme (HOS) under the HDB was implemented to enable lower income groups to own their own homes. HDB began offering housing units to this income group, at a price lower than market valuation. In Lee (2000), the then Prime Minister, Mr Lee Kuan Yew explains the political and economic motivations for the HOS:

> My primary preoccupation was to give every citizen in the country and its future. I wanted a home-owning society. I had seen the contrast between the low-cost rental flats, badly misused and poorly maintained, and those of house-proud owners, and was convinced that if every family owned its house, the country would be more stable (pg 95)…..I had seen how voters in capital cities always tended to vote against the government of the day and was determined that our householders should become homeowners, otherwise we would not have political stability. My other important motive was to give all parents whose sons would have to do national service a stake in the Singapore their sons had to defend. If the soldier's family did not own their home, he would soon conclude he would be fighting to protect the properties of the wealthy. I believed this sense of ownership was vital for our new society which had no deep roots in a common historical experience (Lee, 2000, pp 96)

Therefore, the HOS plan was implemented and encouraged on the grounds that home ownership generated positive externalities, public spiritedness, a sense of belonging, and `good social behavior' (Low and Aw, 1997: 45). The HOS was a successful scheme and this helps generate increase of the supply of the HDB housing stock from 120,138 units in 1970 to 846,649 units in 2000, and at the same time, increase the home-ownership rate from 29 percent in 1970 to 92 percent by 2000.

The successful implementation of the HOS has relied not only on the establishment of the Housing and Development Board (HDB), which has made a significant contribution to the supply of the housing stock[2], but also by the development of the Central Provident Fund (CPF). The CPF is a form of defined contribution pension scheme. It is a savings plan

[2] The HDB is the most significant housing developer and over 85% of the population reside in HDB built residences.

enforced by the government and therefore this is also known as the "National Defined Contribution Pension Scheme", in which a certain amount or percentage of money is set aside each month by an employer and employee for the benefit of the employee[3]. There are restrictions as to when and how these funds can be withdrawn or directed, with respect to the specific schemes or policies being implemented by the government. "The CPF became an important institution for financing housing purchases from September 1968 when legislation was enacted to allow withdrawals from the fund to finance the purchase of housing sold by the HDB…"

The contribution made by both the employers and the employees, while aimed towards enhancing the savings of employees for retirement for consumption purposes, have varied in the past in response to economic conditions. They have been used by government as a policy tool, for example, "as a macro-economic stabilization instrument to … reduce wage cost" (ibid, p22). "Contribution rates are currently 20% of wages for employees and 13% for employers, up to a salary ceiling of S$5000." (ibid, p22) However, rates in the past have varied and reached a high of 25% for both employees and employers between 1984 and 1986.

As the housing stock increased over time, the problem of housing shortages became less severe. This trend resulted in the creation of a resale market in 1971, when the HDB allowed owners who had resided in their properties for at least three years to sell them on the market to buyers who met the eligibility requirements set by the HDB, for ownership.

[3] See, for example, Low and Aw (2004) for the rate contributed by the employers and employees over the past years (pg 56).

The flexibility of the use of CPF saving withdrawals for purposes of down payments, mortgage and interest payments incurred on the purchase of public-sector-built housing was further enhanced in 1981 when a similar scheme was extended to allow withdrawals for mortgage payments when purchasing private housing.

In addition to building the housing stock to ease supply shortages, the HDB also acts as a loan provider. Prior to 1993, loan financing was only up to a maximum of 80% of the 1984 HDB new flat price. From 1993, the HDB began to move its mortgage financing term closer to the market by granting financing up to 80% of the current valuation or declared resale price, whichever was lower. This has important implications for buyers who could now borrow a higher (loan-to-value) amount, and make a smaller down-payment.

In 1994, subsidies in the form of CPF housing grants for the purchase of resale HDB flats were made available. Under this scheme, the government provides a first-time applicant household with a S$30,000 grant to purchase an HDB resale flat close to parental or married childrens residence. These financial liberalization policies, together with positive macro-economic factors in the early 1990s helped fuel the asset bubble in the mid 1990s.

The timing of government policies relating to the use of CPF savings for housing finance, and the liberalization of rules on public homeownership criteria as well as housing finance, had a significant impact on private house prices. Ong and Sing (2002) studied the inter-market price discovery process of the private and public resale markets and found significant evidence that the two markets were integrated. They hypothesized that a rise in

HDB resale prices increased the affordability of private housing to HDB sellers wishing to upgrade from public to private housing.

However, there is still concern over the affordability of private housing. On May 15th, 1996, the government introduced a package of anti-speculation measures to curb real estate speculation. These included capital gains taxes on the sale of any property within three years of purchase, stamp duty on every sale and re-sale of property, limitation of housing loans to 80 percent of property value[4], as well as limiting foreigners to non-Singaporean dollar denominated housing loans. The immediate effect of these measures was to cool the property market which however entered a slump with the onset of the Asian financial crisis in 1997

In this context the anti-speculative measures seemed counter-productive and inefficient In fact, according to Lee (2000), charging a levy in the early 1990s might be a better option in cooling off the overheated housing market.

> As property prices rose, everybody wanted to make a profit on the sale of their old flat and then upgrade to a new one, the biggest they could afford. Instead of choking off demand by charging a levy to reduce their windfall profits, I agreed that we accommodate the voters by increasing the number of flats built. That aggravated the real estate bubble and makes it more painful when the currency crisis struck in 1997. Had we choked off demand earlier, in 1995, we would have been immensely better off (Lee, 2000, p 99).

The anti-speculative packages marked the first in the attempt by the government to be restrictive in their approach to handle the housing market, as this would have serious implications. The failure to foresee the Asian Financial Crisis ahead of the implementation of the package makes the government more conservative and cautious about the policies

[4] This has effect on the private residential housing markets, in which mortgage loans prior to 1996, are only allowed 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, see Sing (2001). However, the HDB housing sector is not affected as the mortgage loan granted had been up to 80% of the current valuation or the declared resale price of the flat, whichever is lower, as mentioned earlier in the paper.

subsequently it implements in the housing market. This is even more so, facing the various external economic shocks following that of the Asian Financial Crisis. Since 1997 the macroeconomic environment has been less positive than before. This was further compounded by negative shocks after 9/11 that took place in 2001. In fact, a study in 2001 estimated the unsold housing stock to be approximately 19,800 units for the private sector (Monetary Authority of Singapore, 2001). With more than 17,500 unsold new flats in early 2002, the HDB suspended its apartment registration or queuing system, diverting remaining and new applicants to its Built-To-Order programme under which flats are built only when there is sufficient demand for them.

Following the years after the Asian Financial Crisis in 1997, the few restrictive anti-speculative policies aiming at cooling the housing markets were reconsidered facing the uncertain global economic conditions, all likely to be an external shock, of a scale potentially greater than that of the Asian Financial Crisis. An example of such reconsideration is the capital gain tax which was lifted for any property sales contracted on or after 13th October 2001(see, URA (2007)). On the other hand, in November 2001, the Government further allowed developers to defer up to half of the initial 20%[5] down-payment up to the issue of Temporary Occupation Permit or any time before that. These Deferred Payment Schemes were introduced at a time when the property market was lacklustre and the economy was in recession (see, URA (2007)). However, following the recovery of the economic growth in 2007, driven by economic fundamentals including our robust economic growth and rise in wages and in view of the current buoyant property market, the Government has decided to withdraw the DPS for the sale of uncompleted

[5] It is to be noted that the government has not lifted the 80% loan-to-valuation financing limit for mortgage loans. This rule was implemented in 1996, as part of the anti-speculative package, which was a property boom period. It was however a prudential policy. The 20% of cash requirement ensures a sufficient level of owner equity in property. This lowers the risk of default, and the likely loss to the bank in case of a default and a forced sale of property. (see Tan (2002))

private residential, commercial and industrial properties with effect from 26 Oct 2007 (see, URA (2007)). It is therefore clear that the government is increasingly well aware of the economic condition and how this could affect the property market. This further increases the governmental policy intervention aiming at preventing another property crash or a potential property bubble like that of a scale prior to 1996.

During the same period in September 2002, there were also increasing concerns over the risk of over allocation of retirement savings to housing resulted in the reintroduction of the withdrawal limits[6], aiming at helping the finances of the 80% loan-to-valuation for mortgage loans. The reduction in CPF withdrawal limits are spread out over a period of 5 years as follows:

Table 4A Phasing in reductions in CPF withdrawal limits (from www.cpf.gov.sg)

CPF Withdrawal Limit	Implementation Date
150%	1st January 2003
144%	1st January 2004
138%	1st January 2005
132%	1st January 2006
126%	1st January 2007
120%	1st January 2008

[6] There was, effectively, no withdrawal limits imposed by the CPF board since 1993, though before 1993, CPF members were only allowed to withdraw 100% of the value of the properties at the time of purchase, Phang (2002).

Table 4B: The Minimum Sum Scheme (from www.cpf.gov.sg)

55th birthday On or after	Minimum Sum (in 2003 dollars)	Min Sum (after inflation)
1 July 2003	$80,000	$80,000
1 July 2004	$84,000	$84,500
1 July 2005	$88,000	$90,000
1 July 2006	$92,000	$94,600
1 July 2007	$96,000	$99,600
1 July 2008	$100,000	$106,000
1 July 2009	$104,000	} to be
1 July 2010	$108,000	} announced
1 July 2011	$112,000	}
1 July 2012	$116,000	}
1 July 2013	$120,000	}

This withdrawal limit is set based on the percentage of the property valuation and gradually reduced to 120% over 5 years, to meet the obligation for paying principle and interest over the full term. The imposition of the new withdrawal limits reduced the flexibility with which CPF funds can be used in financing mortgages. Furthermore CPF members must also keep a minimum sum in the CPF account with effect from July 2008. This means that, even before the withdrawal limit is reached, as soon as the minimum balance in the CPF account is reached, particularly before the 55th birthday, the remainder of the mortgage repayment would have to be settled by cash. The minimum balance in the CPF is to be gradually increased from $80000 in 2003, until S$120000 in 2013.

Furthermore, these amounts will be adjusted for inflation every year. Table 4B above shows the amount of the minimum balance imposed by the government in the past years, since 2003. The imposition of the withdrawal limits and the more stringent minimum CPF balance requirement reduces the flexibility of withdrawing CPF funds to finance housing mortgages.

Both the creation of the resale market by the HDB and regulations surrounding the use of CPF monies potentially strengthen the link between the macro-economy and the housing market. Hence economic shocks could be amplified through shocks more strongly affecting asset values in the housing market and this in turn feeding back into the macroeconomy. Volatility of both the housing market and the macroeconomy are therefore increased. In the next section, we discuss the research methodology used to address these issues. The findings have important implications for homeowners who used CPF withdrawal to finance mortgages, since volatility reveals the degree of exposure that these homeowners have in the housing market. This could potentially affect the value of their CPF balance at retirement

3. Data and Methodology

In this section, the impact of housing market policies on house prices is examined. We also study the impact of GDP on house prices since studies by Tu and Wong (2002) and Phang and Wong (1997) find no relationship between these variables. This is interesting and also somewhat surprising in comparison to other studies that have examined this relationship in other countries. Meen (1996) examined the interrelationship in the UK and suggests that rising income affects house prices. Meen (2003) examines the reverse

causality and considers the impact of the housing market on the macroeconomy. Muellbauer and Murphy (1997) also suggest that house price movements affect aggregate consumption patterns. Kasparova and White (2001) examine a number of countries in Europe and find evidence of GDP affecting house prices in The Netherlands, Spain, Sweden, and the UK. In addition to studying the relationships between house prices and GDP, we also assess the volatility in the housing market. This provides us with an opportunity to assess how the housing market is affected during periods covering different economic circumstances. We assess the extent to which government policy interventions in different market conditions impact on the volatility of the housing market. This is important since, as far as the volatility is concerned, this can impact on the benefits of the national defined-contribution pension scheme, and the value of individual retirement savings.

In order to study the interaction between the housing market and the macroeconomy, and housing market volatility, transaction price indices from both the private and public owner-occupied housing markets are collected from the real estate information system (REALIS) distributed by the Urban Redevelopment Authority for different (private) housing types[7]. Quarterly data are collected covering the period from 1975 quarter one to 2005 quarter four[8]. The price index of a particular property type is the weighted average of all the sub-indices of that property in the various planning areas. For the public housing sector, the HDB resale housing price index is used. This is based on the average resale price by date of registration and the weightings are based on a 12-quarter moving average trend.

[7] The property types are apartments (APT), condominiums (CON), detached houses (DET), HDB properties, semi-detached (SEM), and terraced (TER) houses.

[8] Data for HDB properties are collected from 1990 quarter one.

Public housing here refers to public-sector-built housing, and private housing includes landed and non-landed property sectors (i.e., houses versus apartments and condominiums). It is relevant to include private housing in this analysis because, since 1981, use of the CPF is also approved for financing private property purchases. These indices are not quality-controlled and according to Phang (2007), while it would be more appropriate to use hedonic price indexes for housing, they are not available. However, it is likely that the quality of housing transacted (both in the public and private sector) has been improving over time.

3.1 The effects of GDP and housing policies on housing markets

FIGURE 1 HERE

Figure 1 above shows the performance of real GDP and residential property prices over the thirty years from 1975 to 2005. GDP (indicated by the GDPRI line) clearly rises over time indicating increases in real income as the economy grows. High economic growth rates translate into approximately a six fold increase in real incomes over this period. This is much faster growth than that experienced by economies in Europe or North America over the same period. There are, however, short periods of recession, in the mid 1980s, 1998 after the Asian financial crisis, and then following the attacks of 9/11.

The figure also indicates the evolution of real house prices for different types of residential property. Prices for all property types show greater volatility than GDP, with detached houses showing the greatest amplitude of fluctuation. The early 1990s is the period when the resale market is the most active due to economic growth and policies

implemented by the government to stimulate demand for housing, such as subsidising buyers in the resale markets. The second half of the 1990s leading on to the early 2000s shows a period where external shocks to the Singaporean economy, such as the Asia financial crisis and the September 11th attacks, occur and affected the macroeconomy and housing markets adversely.

As government policy has changed in relation to the housing market and since it has had and continues to play a significant role in the housing market, we model the impact of policy on the market. The equation estimated takes the following form:

$$P^h_t = \alpha_t + \beta_1 GDP_t + \beta_{i,t} POLICY_i + \varepsilon_t \qquad (1)$$

Where the dependent variable is the log of real house prices and GDP is the log of real GDP. POLICY represents a range of policy variables, α_t is a constant and ε_t is a stochastic disturbance term with mean zero and constant variance. This model follows the form of that estimated by Tu and Wong (2002). The approach adopted here differs in that rather than use the first difference of the variable, the level of prices is used as the dependent variable. Also, the model is estimated for different housing types. Public HDB housing is analysed separately from private housing which is also subdivided into categories by property type as in figure 1 above.

The dichotomous policy variables take a value of one when new policies are implemented and allow for a time lag of at least one quarter to allow the policy to begin to have an impact. Seven policy dummies are used. The 1993 policy change effectively permitting higher loan-to-value rations, the 1994 housing grants, the anti-speculative

measures of 1996, the Asian financial crisis in 1997, reduction in housing grant in 1999, the 9/11 attacks in 2001, and finally in reduction in CPF withdrawal limits affecting the market from 2003 are included. In addition the impact of GDP is examined.

A first step before estimating (1) above is an analysis of the stationarity characteristics of the variables used. Unit root tests were uniformly performed on all used. The standard regression for this technique is

$$\Delta x_t = \alpha + \beta_1 x_{t-1} + \sum_{i=1}^{\rho-1} \delta_i \Delta x_{t-i} + \mu_t \qquad (2)$$

where the chosen value for ρ is such that μ_t will be a white noise error term. The coefficient of interest is β_1. Its *t*-statistic is compared with the critical values found in Fuller (1976). When only the lagged value of x is present, the test is referred to as a Dickey-Fuller (DF) test. When lagged difference terms are added, the resulting test is an Augmented Dickey-Fuller (ADF) test. An alternative approach to adding lagged values of the dependent variable has been suggested by Phillips (1987) and extended by Perron (1988) and Phillips and Perron (1988). They suggest adding a non-parametric correction to the *t*-test statistic. This accounts for autocorrelation that may be present. The results for the stationarity tests are presented in table 1 below

INSERT TABLE 1: Unit Root Tests

The results indicate that all variables are stationary in first differences. Next the model in (1) is estimated. These results are presented in table 2 below.

INSERT TABLE 2: Regression Model

The results presented for each property type clearly show the statistical significance of GDP in driving house prices. The variable is always highly and positively significant. This result differs from findings in earlier papers in which no impact of GDP was discovered. This may have been caused by the format of estimation used in which the change in house prices, rather than the level, was the dependent variable. In relation to policy variables (as indicated by the years in which they were enacted), the 1993 and 1994 policies that increased loan-to-value ratios and provided housing grants respectively would be expected to stimulate the market. These are found to have a positive and significant impact on house prices, although the 1993 policy is only marginally significant for condominiums. The anti-speculative policy introduced in 1996 does not seem to have cooled the market. Had it done so the variable would have been negative. Instead it is always positive and significant. The Asian financial crisis in 1997 had a statistically significant and negative impact on house prices while the reduction in housing grant in 1999 had no statistically significant impact. The impact of 9/11 is negative but only significant in the HDB and condominium housing sectors, although the HDB sector is by far the largest housing sector. Finally the impact of changes to CPF withdrawal limits coming into effect in 2003 is negative as expected and again is significant only for the HDB sector and condominiums. It is marginally insignificant for detached properties.

Using Johansen cointegration tests, each of the private housing sectors formed cointegrating relationships. It was not possible to reject the null of no cointegration for the HDB public housing sector.

3.2 The effect of the housing policies on the volatility of the housing markets

As housing policies have been found to impact the market but because results differ across housing types and across both stimulatory and restrictive policies, we examine the impact of housing policies on the volatility of each housing type. We first present the descriptive statistics of these various housing types from 1990 to 2005. We then discuss some of the distributional characteristics of the housing markets, with regards to these statistics.

TABLE 3 HERE

Table 3 lists the descriptive statistics of the housing markets quarterly returns. From the table, asymmetries in return' distributions can be observed for different housing types. The HDB market has the highest maximum return of 27%. The jump of 27% in HDB transacted prices from the first to the third quarter in 1993 follows the policy change that allowed resale public housing purchasers to obtain mortgage loans of up to 80% of the purchase price or the market value of a housing unit, whichever was lower. Before this policy revision, the value of mortgages available for resale public housing were pegged at the HDB's "posted prices," which were fixed at historical values and priced very much below transacted prices. This change in mortgage loan financing provided a significant boost to the public housing resale market, as purchasers were able to obtain much larger mortgage amounts.

Between 1990 and 2005 the lowest minimum quarterly return is –7.42% which occurs for HDB properties. During this period through which Singapore's economy

experienced external shocks of the Asian financial crisis and the impacts brought by the September 11th attacks, the public housing market did not suffer as much as private sector housing markets. distributional pattern of the public housing market exhibits significant positive skewness. Therefore, in general, one could expect the quarterly returns of the public housing market to be above the mean value of 1.8%.

The distributional return patterns of private housing sectors also exhibited varying degrees of skewness as observed in table 1. As skewness indicates the degree of concentration of the returns surrounding the mean value, this leads us to further investigate the possibility of the presence of volatility clustering underlying the data. In this case, we re-model volatility considering time-varying attributes.

As volatility will potentially have an effect on final retirement funds available to home purchasers who use the CPF, particularly those who retired between 1990 and 2005, it is therefore important to model this appropriately. Merton (1980) argues that one of the simplest ways to approximate the instantaneous volatility is to take the squared or absolute value of returns. Hence the justification for studying the correlation of squared returns in the lower part of Table 3 is to detect if there is some non-linear dependence in returns and more specifically to check if there are patterns in conditional volatility. The results show that apart from apartments and condominiums, which are not significantly correlated, all other housing sectors are correlated at the 1% significance level, revealing the possibility of a pattern of non-linear dependence. Further evidence in the Ljung-Box Q statistics at 5 lags also show that, apart from condominiums, all other housing types are significant at least at the 10% level. This is normally interpreted as evidence of the presence of ARCH-type effects in conditional volatility. When there is non-linear dependence underlying the returns

of transacted prices for each housing sector, this implies that the fluctuation of prices (and therefore returns) from one period to another follows a particular pattern, unlike the movements and fluctuations in transacted prices that tend to be random. This is to be expected since between 1990 and 2005, especially in the early 1990s, expansionary governmental policy targeted at developing the resale market, and in addition to positive economic expectations, helped to boost transacted house prices (see Tu and Wong, 2002).

In order to model non-linear dependence of distributional returns, as evidenced from the data analysis in table 1, the Generalized Autoregressive Conditional Heteroscedasticity model proposed by Engle (1982) and Bollerslev (1986) for the return data is adopted here. This adaptation builds on the basis of modelling the fluctuation of returns of housing market transacted prices, from one period to another, and then models patterns that explain volatility in a time varying framework. In short, we model the quarterly returns of the different house types as an AR(1)-GARCH(1,1)[10] process as follows:

$$r_{i,t} = a_o + a_1 r_{i,t-1} + \varepsilon_t \qquad (3)$$

$$h_{i,t} = m_i + b_i \varepsilon^2_{i,t-1} + c_i h_{i,t-1} \qquad (4)$$

where, $\varepsilon_{i,t} \left| \Omega_{t-1} \right| \sim N(0, h_{i,t})$ and $m_i, b_i, c_i \geq 0, b_i + c_i < 1$. a_o in the mean equation (3) is the constant, $r_{i,\ t}$ is the quarterly return of housing type i in quarter t. The

[10] There is no large-scale statistical simulation done to determine the best specification that fits the GARCH model. The primary concern here is to first select the auto-regression orders that fit the univariate GARCH model best. GARCH (1,1) is selected in the first instance because this is the most widely used specification for GARCH modelling. Likelihood ratio tests comparing the maximum likelihood values generated by AR(1)-GARCH(1,1) and AR(2)-GARCH(1,1) show that increasing the number of lags for the AR model does not significantly increase the maximum likelihood value. Further likelihood ratio tests were then computed to compare the likelihood values for AR(1)-GARCH(1,1) and AR(1)-GARCH(1,2). Result shows that increasing the number of lag for GARCH modelling, however, also does not significantly increase the maximum likelihood values. Result of these maximum likelihood value tests are available on request, but this serves to explain the motivation behind for using AR(1)-GARCH(1,1) to model the conditional volatility for the various housing types used for this paper.

autoregressive coefficient a_1 captures the first order autocorrelation in the quarterly returns series. $h_{i,t}$ is the conditional variance of the quarterly returns of house type i in quarter t. The coefficient b_i (commonly known as the ARCH effect) captures the tendency for the conditional variance to cluster while c_i (commonly known as the GARCH effect) captures the tendency for shocks to have a persistent influence on the conditional variance. They are more severe, the more prices (and therefore returns) fluctuate from one quarter to the next, following transactions in the market that bring about frequent changes in transacted prices arising from responses to market events that have an impact on the housing market, either in the short or long term. The value of $b_i + c_i$ implies volatility persistence, revealing the pattern of volatility moving from one period to another and continued for the entire time period from 1990Q1 to 2005Q4. Table 4 provides the results of estimating this model.

The results from table 4 give the coefficient of the various parameters described in equations (3) and (4) above. This table describes the varying degree of volatility that is present in the different housing sectors. Between 1990 and 2005, it is observed that, either the b_i or the c_i coefficients are significant at least at the 10% significance level. The combination of the two parameters then reveals the degree of volatility persistence of the underlying process. The higher the volatility persistence, the more property returns will change in the next quarter following the change in prices coming from the previous quarter.

[Figure 2]

Looking back at the table 3, what, however is important to consider is the maximum return of HDB, which was the highest at 27%, following expansionary policies implemented by the government as discussed earlier, However, following the increase of 27% in the second quarter of 1993, the public housing sector experienced only an 8% rise in the following quarter of 1993. This led to high volatility at that time and is revealed by the relatively high "peak" in Figure 2 as shown above. This higher maximum return, however, does not contribute towards stronger volatility persistence for the HDB public housing market. As the minimum return of HDB public housing market is only about –7%, which is relatively low compared to the other housing sectors, this might have dampened volatility. Therefore, graphically, the conditional volatility of HDB sector appears to be relatively mild compared to the other housing sectors. This is also revealed in table 4 in the estimates of the conditional volatility of the public sector housing market.

[Insert Table 4: Volatility Model]

From Table 4, though the volatility persistence of HDB housing market, i.e., the value of b + c, is higher than that of apartments (0.423) and condominiums (0.414), it is lower than most of the landed properties sectors, i.e., terraced, detached and semi-detached houses. It is also to be noted that the volatility persistence of condominiums, however is insignificant[11]. This appears to show that changes in the returns of transaction prices in this market are relatively more random.

[11] This is not surprising given that as revealed from table 1, condo transaction price index is not nonlinearly correlated. Furthermore, condo transaction price is also not auto-correlated at its underlying returns of 6 lags. Like the terrace and apartment housing sub-markets, the null hypothesis of normality for condo cannot be rejected. However, unlike these two housing sub-markets, there are further evidence to show that volatility clustering appears not to be significant, especially when the Ljung Box Statistics and the correlation of squared returns test also reveal further distributional characteristics of the return pattern of the condominium sub-market.

Between 1990 and 2005, the coefficient of the GARCH effect, “c” that measures the tendency for shocks to have an influence on the conditional volatility, show that such effect is the most sensitive for the terraced houses, showing it to have an impact 87.3% of the time. This is, however, different to HDB housing, which appears to be comparatively less sensitive to shocks. In fact, the shock only has an impact on the conditional volatility of the HDB market 28.6% of the time. However, the HDB market has a relatively high ARCH effect, as revealed by coefficient “a” that captures the tendency of the conditional variance to cluster, which when compared with other housing types, is relatively low at 23%. In this case, the GARCH effect is low but still slightly stronger, showing that external shocks do affect the conditional variance of the HDB market more than for the conditional variance to cluster, arising from the movement of the volatility effect from one period to another.

Even so, the volatility persistence is still relatively mild for the HDB housing sector, particularly for the period following the implementation of the anti-speculative measures in 1996. In comparison, other sectors appear to be experiencing higher conditional volatility, as seen in Figure 2. Following the anti-speculative measures, similar non-expansionary schemes were subsequently introduced. One of those schemes was the reduction of the housing grant by S$10000 in 1999. Due to the decline in the HDB resale flat market, this attracted a large number of potential buyers applying for CPF housing grants for the resale market. This increased from 500 applications per month in 1997 to 2200 per month by 1998. The reduction in grant ensured that buyers of the resale flats were genuinely those who needed to buy rather speculators. Tu and Wong (2002) have shown that this has a negative impact on the HDB housing resale prices. Results in table 2 above suggest that the impact was statistically insignificant.

For the detached houses, it is obvious that there was some volatility in the aftermath of 9/11. The other housing markets in the landed property sector, i.e., the detached, semi and the terrace houses also appear to have experienced higher conditional volatility between 1990 and 2005.

In 2003, the policy of reducing the CPF withdrawal limits for mortgages restricted the availability of liquidity to fund housing consumption. As economic conditions deteriorated with GDP growth at only 1.7% and 1.5% in 2002 and 2003 respectively, and higher unemployment this further reduced the demand for housing and resulted in slower house price growth. This subsequently led to lower volatility across all housing types. This is shown in figure 1 between the 2002 and 2005.

5 Conclusions

Many nations have enacted legislation for statutory welfare provision, even though they may not necessarily be regarded as welfare states. In the case of Singapore, however, housing welfare and intervention in the housing market has been a feature that defines the welfare system. Homeownership has been greatly enhanced by government policy that allows home buyers to withdraw from the

However, investment in housing and exposure to the risk of a decline in house prices, together with an ageing population, have caused some policy concern, especially after the housing market was hit for the first time by external shocks in 1997 following the onset of the Asian financial crisis. In this paper, we find that although GDP as revealed by our analysis has a positive impact on the housing market, the conditional volatility pattern

differs from one economic condition to another. Conditional volatility in the housing markets appeared to be affected by the housing policies. For example, the relatively more expansionary policy that was implemented in 1993 and 1994 at the time when economic conditions were good, the secondary markets. This had caused higher conditional volatility at that time

Also, during the economic slowdown following the Asia financial crisis, policy became more restrictive. The policy of restricting withdrawal limits and imposing minimum balances in the CPF appeared to have an indirect effect on the housing market. The conditional volatility appears to have dampened in recent years. In principle, this implies that, in the long run, the capital value of the housing assets should remain more stable. On the other hand, the evidence of milder volatility between 2002 and 2005 across various housing types suggests they may serve as a good "hedge" in the sense that house prices are not rising to an extent comparable to those in 1993 and 1994. Research findings from McCarthy et al. (2001) revealed that the average worker in Singapore is likely to be "asset-rich and cash-poor" with 75 percent of his retirement wealth in housing asset, provided housing values continue to rise in real terms. If the housing market were to take a downturn and remain depressed, this could substantially reduce retirement assets for Singaporean workers. This raises the problematic issue of over concentration of household assets in housing resulting in a risky under-diversified portfolio of wealth at retirement.

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Figure 1: Real Indices for House Prices and GDP 1975q1 – 2005q4

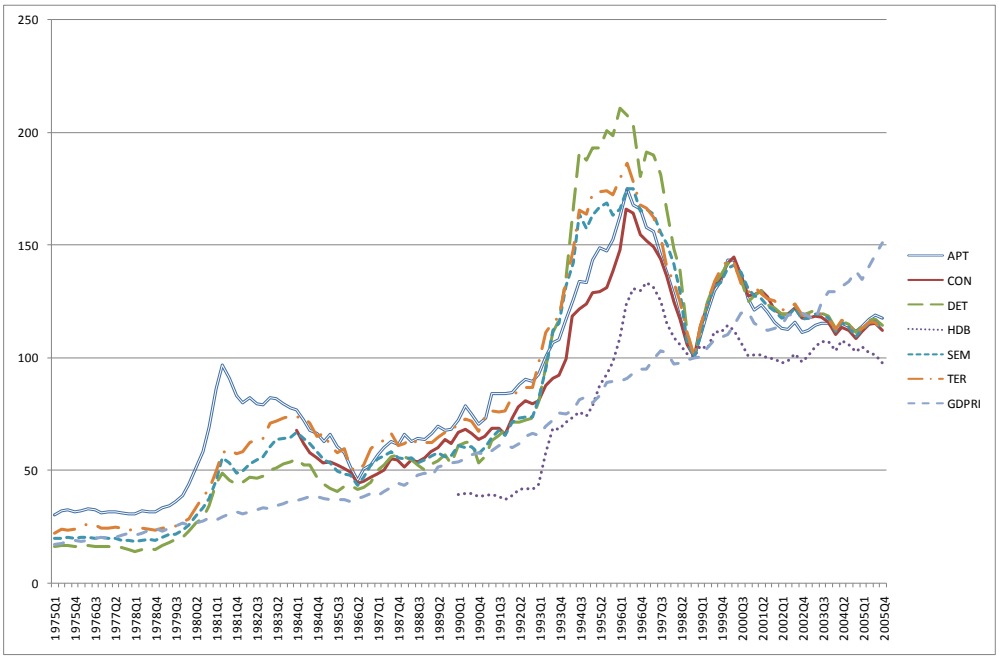

Table 1: Unit Root Tests

	ADF	PP
HDB Public Housing	-2.942**	-4.368***
Apartments	-4.029***	-6.063***
Condominiums	-4.119***	-5.930***
Terraced	-3.559***	-6.982***
Semi-detached	-3.858***	-6.329***
Detached	-3.912***	-6.469***
GDP	-4.725***	-11.279***

All variables are I(1) unless stated otherwise. ***, ** indicate significance at the 1% and 5% levels respectively.

Table 2: Regression Model

	HDB	Apartments	Condominiums	Terraced	Semi	Detached
Constant	-2.669 (-5.635)	1.603 (11.688)	0.554 (3.303)	0.746 (5.329)	0.266 (1.805)	-0.374 (-2.342)
GDP	1.574 (14.672)	0.686 (19.292)	0.922 (22.599)	0.881 (24.257)	0.977 (25.529)	1.123 (27.149)
1993	0.064 (0.924)	0.169 (2.107)	0.081 (1.732)	0.316 (3.851)	0.322 (3.725)	0.395 (4.232)
1994	0.182 (2.208)	0.353 (3.522)	0.243 (4.164)	0.489 (4.779)	0.489 (4.538)	0.663 (5.692)
1996	0.123 (2.076)	0.185 (2.499)	0.147 (3.499)	0.181 (2.397)	0.168 (2.111)	0.219 (2.558)
1997	-0.193 (-3.204)	-0.192 (-2.576)	-0.199 (-4.703)	-0.217 (-2.861)	-0.193 (-2.418)	-0.242 (-2.789)
1999	0.017 (0.184)	0.010 (0.089)	-0.016 (-0.234)	-0.003 (-0.029)	0.004 (0.029)	-0.019 (-0.151)
2001	-0.202 (-2.069)	-0.110 (-0.971)	-0.124 (-1.825)	-0.109 (-0.939)	-0.111 (-0.912)	-0.154 (-1.165)
2003	-0.357 (-4.544)	-0.034 (-0.779)	-0.309 (-6.057)	-0.054 (-1.200)	-0.048 (-1.036)	-0.083 (-1.630)
Adjusted R^2	0.824	0.819	0.904	0.879	0.889	0.902
DW	0.347	0.126	0.459	0.153	0.142	0.203

Table 3: Descriptive Statistics and Diagnostic Test

	Condominiums	Detached	HDB	Semi-Detached	Terraces	Apartment
Panel A: Summary Statistics						
Mean	1.135	1.312	1.756	1.276	1.03	1.077
Maximum	17.109	19.593	27.079	18.455	13.64	14.136
Minimum	-10.647	-22.774	-7.417	19.681	-12.133	-10.582
Standard Deviation	4.956	7.347	5.458	6.083	5.335	5.145
Skewness	0.288	-0.104	2.101	0.155	0.154	-0.152
Kurtosis	4.064	4.669	9.875	5.445	3.484	3.083
Jarque-Bera	3.844	**7.428	***170.428	***15.950	0.865	0.262
Panel B: Diagnostic Test						
Correlation of squared returns $\rho(r_t^2, r_{t-1}^2)$	0.188	***0.433	***0.375	***0.326	***0.506	0.183
Ljung-Box Statistics Q(5)	4.196	***21.056	*9.268	***15.122	***33.649	*10.128

Figure 2

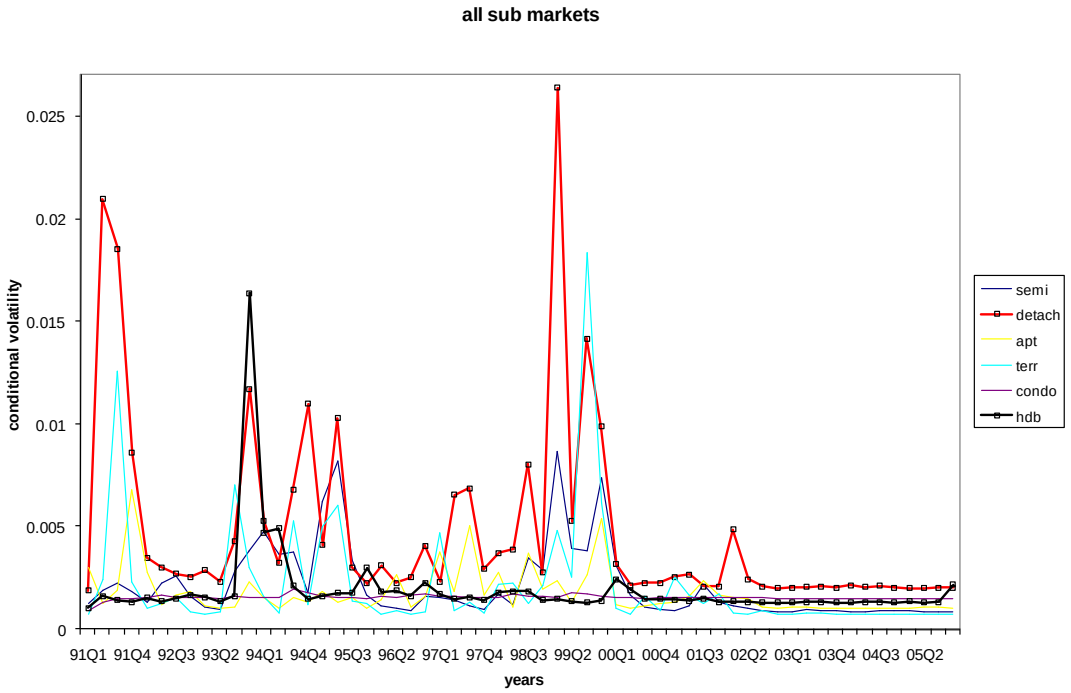

Table 4. Volatility Model

	Likelihood	a_o	a_1	m_i	b_i	c_i	$b_i + c_i$
ıdominiums	164.172	0.004	***0.62	*0.001	0.389	0.025	0.414
		[0.829]	[6.120]	[1.854]	[0.938]	[0.321]	
ached	141.786	0.005	***0.643	0.002	***0.122	***0.756	***0.878
		[0.626]	[6.502]	[1.499]	[21.145]	[3.425]	
B	161.675	0.006	***0.662	0.001	*0.226	***0.286	0.512
		[1.076]	[6.842]	[1.295]	[1.897]	[4.218]	
ıi-Detached	162.102	0.005	***0.636	***0.001	***0.32	***0.386	0.706
		[0.835]	[6.408]	[4.080]	[3.006]	[4.106]	
:aces	166.946	0.003	***0.676	***0.001	0.053	***0.873	0.926
		[0.60943]	[7.0960]	[3.384]	[0.762]	[5.393]	
ırtment	162.657	0.004	***0.553	***0.001	0.019	**0.404	0.423
		[0.710]	[5.225]	[3.929]	[0.267]	[2.236]	

Notes: t statistics are in parentheses. Likelihood is the value of log likelihood. * indicates that the null hypothesis can be rejected at the 1% level, ** at the 5% level and * at the 10% level respectively**