The Cyclical Association of Residential Price and Consumption

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A growing body of research has investigated the association of residential price and aggregate consumption. However, there are inconsistencies pertaining to the role of residential price (and wealth) in explaining consumption. This paper develops a theoretical framework to investigate private consumption changes that are brought about by the residential price effect, which in turn is envisaged to comprise the income effect, substitution effect and expectation effect along with the residential price cycle. A frequency domain-based model in the form of the cross-spectra analysis is consistent with such a theoretical framework, and helps to validate it, because of its model-free characteristics that avoid the problem of model misspecification and parameter-estimation errors. In the Singapore context, the results show that the residential price affects consumption significantly, depending on the time scale and frequency without a consistent sign. The expectation effect, operating through the capital-gain effect, is important in explaining the residential price-consumption relationship and contributes more during the expansion period than the recession period. Thus, the results of Lettau and Ludvigson (2004), that find consumption to be a function of the trend components in wealth and income and to be dominated by permanent shocks, cannot be generalized to the Singapore context.

Keywords: Residential price, consumption, expectation effect, residential price asymmetry and cross-spectra analysis.
1. Introduction

The large changes in asset prices in the past two decades seem to affect an economy substantially. Economic researchers and monetary policymakers pay increasing attention to the association of residential price and consumption. For example, Alan Greenspan (2001) reiterates that “And thus far this year, consumer spending has indeed risen further, presumably assisted in part by a continued rapid growth in the market value of homes”.

However, the explanation for the association remains ambiguous from different theoretical perspectives and empirical results. According to the life-cycle theory on consumption, consumers’ expenditure depends on human capital and the value of tangible and financial assets (Deaton, 1992). Residential real estate, as one of the most important non-financial assets in the households’ portfolios, affects households’ consumption through housing wealth. However, alternative explanations exist, like the collateral enhancement and the balance sheet effect, which assumes that households face binding credit restrictions, and that credit instruments allow the withdrawal of housing equity for consumption. The empirical results on the residential price-consumption issue are also inconsistent, such as the variation in non-financial wealth that has no effect on aggregated consumption (Elliott, 1980). The marginal propensity to consume from housing wealth is approximately 6% (Skinner, 1993). There is a statistically significant and quite large effect of the housing wealth on household consumption (Case et al, 2001). Nevertheless, the wealth effect is ambiguous and becomes more important over time (Ludwig and Slok, 2002).

As a result, the private residential market in Singapore is investigated to deepen the residential price-consumption issue, owing to its significant impact on the economy as well as its large and frequent boom-bust cycles. This market accounts for 52% of the total gross housing wealth while the ratio of the gross private residential wealth to GDP is about 1.48 in Singapore (Phang, 2001). As shown in Figure 1, the boom period between 1980 and 1984 occurred as a result of rapid real GDP growth and the CPF regulation, which has allowed the Central Provident Fund (CPF) savings, a form of social security, to be used to pay the private housing mortgages. Another boom period between 1987 and 1996 was deflated by the government’s real estate anti-speculation policy of 1996 and exacerbated by the Asian currency (and economic) crisis in 1997. The issue of the residential price-consumption linkages has been extensively studied in Singapore (Abeyesinghe and Keen, 2004; Phang, 2002, 2004; Edelsteina and Lum, 2004). Owing to the different sample periods and econometric models, their inconsistent results are not comparable.

Lettau and Ludvigson. (2004) make an important breakthrough through the VECM (vector error-correction mechanism) cointegration model. They propose a permanent-transitory variance decomposition framework to separate the trend and cycle effect in asset values on consumption. Using US data, they conclude that consumption responds differently to temporary changes in wealth than to permanent changes. Although transitory variation in asset wealth is quantitatively large and highly persistent, the transitory shocks in wealth are found to be unrelated to aggregate consumer spending, contemporaneously and at any future date. The wealth in their study is the sum of the human capital and nonhuman (asset) wealth, which are tradable under a representative agent economy. Chen (2006) applies the same framework to Swedish data in order to differentiate the wealth component effects on
consumption. The permanent changes in housing wealth are found to have long-run effects on consumption, not so for the transitory changes.

Nonetheless, both the Chen as well as the Lettau and Ludvigson studies are based on the life-cycle permanent income consumption theory, under a general equilibrium framework from the macro perspective. The distinguishing feature of this paper is to develop a unique theoretical framework, focusing on the individual’s optimization behavior, to explain the association of residential price with consumption. This framework also captures the dual characteristics of the residential real estate as both a consumption good and an investment asset. The impact of residential price on consumption comprises three effects, namely, the income effect, the substitution effect and the expectation effect. The expectation effect focuses on the consumers’ formation of expectations on residential prices. Meanwhile and in order to take into account of the asymmetry in residential price, according to Guirguis et al. (2006), our theoretical framework investigates the residential price effect on consumption from a cyclical perspective. The frequency domain method of the cross-spectral analysis is deployed to identify the existence and strength of the association between residential price and consumption in Singapore case. The statistical results are consistent with our theoretical explanation, i.e. that the expectations effect plays an important role in explaining the residential price-consumption association. In addition, the residential price affects consumption significantly depending on the time scale and frequency without a consistent sign. Owing to the inherent model-free charlatanistic of cross-spectral analysis, our results avoid the error from the model misspecification and are independent of the causal effect of residential price on consumption.

The paper is organized as follows: Section 2 briefly reviews the related literature on the association of residential price and consumption; Section 3 develops a unique theoretical framework; Section 4 introduces the econometric model and data treatment; Section 5 reports and analyzes the empirical results while Section 6 concludes the study, provides policy suggestions and further research.

2. Related literature review

The correlation between household wealth and aggregate consumption is a deep-rooted issue in classical economics. It has motivated many empirical studies.

2.1. Economics on the housing-consumption linkage

The earliest description on the linkage is developed by John Maynard Keynes (1936) in a consumption function to express consumer spending. The total consumption is the sum of autonomous consumption and induced consumption as

\[ C = a + MPC \times Y \]  

(1)

Where MPC is the marginal propensity to consume; Y is disposable income (income after taxes and transfer payments). The Keynesian consumption function is also known as the absolute income hypothesis, as it only bases consumption on current income ignoring potential future income. Criticism of this assumption leads to the development of Milton Friedman's permanent income hypothesis (PIH) and Franco Modigliani's life cycle hypothesis (LCH). PIH states that consumers’ decisions on their

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1 The statistic linkage is found not dependent on particular theoretical foundation in the study of Chen (2006).
consumption patterns are determined by their longer-term income expectations. The key determinant of consumption is an individual’s real wealth, not his current real disposable income. Hence, consumers try to smooth out consumer spending based on their estimates of permanent income. LCH assumes that individuals consume a constant percentage of the present value of their life income. Including wealth in the consumption function is proposed by Ando and Moligiani (1963) as derived in Deaton (1992). Ando and Moligiani (1963) visualized consumption optimization program as:

\[ C_t = c_Y Y_t + c_A A_t + c_H H_t \]  

(2)

This function today acts as a standard starting point of the explanation about the wealth effect on the consumer spending. The wealth affecting consumption comprises human wealth, net financial wealth and tangible wealth. The weights on them are MPCs, respectively. These MPCs could plausibly vary, given their varying liquidity and the possibility of liquidity constraints on households in general. Owing to this point, different housing wealth effects on consumption are debated.

2.1.1. Housing wealth effect

A basic mechanism from changes in housing price (wealth) to changes in consumption is the imagined wealth effect. When housing prices rise, individuals will feel their wealth rise and find themselves with more assets than they need. Then, they will increase their consumption in order to return their assets to their equilibrium ratio to income. This channel of consumption rises due to psychological joys, satisfaction or optimistic future perspective is consistent with the household’s “mental accounts” framework developed in Thaler (1990) as well as Shefrin and Thaler (1988). Empirically, Skinner (1996) found a positive relationship between housing capital gains and consumption.

However, the imagined wealth effect is controversial concerning difficulties in using gains from housing equity. For example, in the Singapore case, Phang (2004) found no evidence about the private housing price effect on consumption and attributed it to the institutional obstacles to extract housing equity gains. In the Engelhardt (1996) study using US micro data, homeowners’ consumption is found to react to capital losses in housing instead of to capital gains in housing. He explained it as a result of obstacles of liquidating housing capital gains or suspicion on the degree of permanency of increase in housing prices. In addition, the intergenerational bequest motive and regarding house as the most standing symbol of social status make the housing asset as so called “an end in itself” (Case etc., 2001).

Interestingly, and taking into account expected inheritance including housing wealth, the parental housing value or net wealth is found to have a positive influence on the consumption of the adult children (Hrung, 2004; 2002). Thus, there are two kinds of the wealth effects of housing: realized wealth effect and unrealized wealth effect, named by Ludwig and Slok (2002). The realized wealth effect happens when households spend more after cashing in their housing capital gains. The unrealized wealth effect occurs when households spend more today on the belief that they “are” richer than before.

2.1.2. Housing collateralized effect
Another mechanism of housing affecting consumption in its role as collateral is the “credit channel”. People owning their houses with equity can more easily pledge to repay loans, hence overcoming commitment problems in credit markets and expanding one’s consumption credit loans. This is the “relaxation of borrowing constraints effect” exploited by Lustig and Van Nieuwerburgh (2004) and the “liquidity constraint effect” denoted by Ludwig and Slok (2002). Iacoviello (2004) develops a dynamic general equilibrium model in which housing (collateral) values affect debt capacity and consumption possibilities for a fraction of households and then derives an aggregate consumption Euler equation. The robust results support housing prices as a driving force of consumption fluctuations. Several studies develop the idea that in the presence of collateralized loans, borrowing constraints distort the intratemporal allocation of resources even between durables and non-durables (See, for example, Chah et al., 1995; Alessie et al., 1997).

If financial innovation and liberalization over the past decade have made borrowing against home equity easier and cheaper, the “credit channel” of housing effect on consumption should be in the transition to be stronger than before by directly relieving borrowing constraints. This hypothesis still needs formal econometric evidence (Chen, 2006).

2.1.3. The renter’s response

Renters, as part of potential homebuyers, react to increases in housing prices. It is also a channel through which housing price affects consumption. In Chen (2006), many economists argue that housing equity is regarded as a precautionary buffer against economic adversity, and increases in house price may induce ‘forced savings’ of renters and dampen their consumption. Ludwig and Slok (2002) name this as the budget constraint effect. See also Skinner (1989, 1993). The housing price rises benefits people that aim to trade down but harms those people who have not yet entered the market or who aim to trade up (Masnick et al., 2005). In the aggregate, if gainers and losers balance out assuming that the net migration and foreign demand for housing are insignificant, then the wealth effect of house price rises on consumption is argued to be zero, i.e. housing price changes can redistribute wealth rather than increase it in the aggregate. It is considered as the “Ricardian equivalence result” (Skinner, 1989).

However, an alternative explanation is well reviewed in Chen (2006), “During periods of soaring house prices, renters or those wishing to ‘trade up’ may expedite their home purchase plan in order to avoid the costs of more expensive houses in the next period. See discussions of the self-fulfilling and self-amplifying prophecies of housing price dynamics in Stein (1995) and Shiller (2004). There are empirical evidences that increases in house prices may induce renters to reduce rather than to increase their savings. See evidences from Japan in Yoshikawa and Ohtake (1989) and from Canada in Engelhardt (1994). Hence the literature has not reached any conclusive prediction regarding the renters’ possible reactions”.

2.2. Interest rate-housing wealth effect

There is a major alternative theory based on the Euler equation to LCH on consumption. This theory seeks to aggregate the optimal intertemporal consumption decision of a representative consumer characterized by rational expectations (Hall, 1978). Consumption is suggested to be a random walk
with a discount factor such as the real interest rate being the only relevant driving variable. Hence, interest rate is regarded as some potential factor on the housing price and consumption linkage. According to Dombrecht and Wouters (1997), the transmission channels of interest rate reductions to household consumption and housing investment are classified as follows: firstly, interest rate reductions that cause portfolio reallocations from financial assets towards real assets like housing; secondly, the portfolio reallocation induces upward pressure on bond, share and real estate prices, all tending to increase the market value of household wealth and hence consumption expenditures. This is donated as the “indirect effect” in HM Treasury (2003). Third, interest rate declines imply the reductions in income from wealth and may therefore exert negative income effects. This is called the “direct effect” in HM Treasury (2003).

2.3. Households’ behavior effect

Further investigation of the housing price-consumption issue will touch behavioral finance by identifying the household’s mortgage refinancing behavior effect on consumption. The impact of capital gains on spending may well be a function of whether or not the gain is realized. In principle, unrealized gains can be borrowed against, through home mortgage refinancing. Consumers should distribute anticipated changes in wealth over time and the marginal propensity to consume out of all wealth, whatever its form, should be the same small number, just over the real interest rate (Paiella, 2007). In practice though, the households’ behavior is not so correctly timed as to follow the nominal interest rate. This effect still awaits more empirical study.

2.4. Causality between the housing price and consumption

Although there is a clearly observed co-movement pattern between housing price (wealth) and consumption worldwide, some economists suspect this pattern to be a statistical artifact without causality. For example, as Paiella (2007) argues, the MPC out of the wealth estimated by traditional macroeconomic analysis conveys no information about the household behavior, and consequently, about the timing as well as the nature of the “wealth effects” that changes in asset prices might have; that changes in some unidentified economic factor may produce changes in both price and consumption. Hence, in Paiella (2007), the causality is called the “direct channel” that operates directly through the budget constraint. However, she gets the empirical evidence that the wealth effects2 in Italy appear to be small and are unlikely to be direct. According to Aoki et al., (2004), housing prices are correlated with the volume of housing transactions; and transactions seem to be correlated with consumption as people buy goods that are complimentary to housing like furniture, carpets and major appliances. In addition, housing prices may affect the economy directly instead of by affecting consumption because such is the case for the United Kingdom, where housing prices enter directly into the retail price index via housing depreciation that in turn depends on the level of housing prices.

However, some studies show evidence on the causality transmission mechanism between wealth and consumption. For example, Iacoviello (2004) focuses on the housing collateral effect through affecting debt capacity and obtains robust results supporting housing prices as a driving force of consumption fluctuations. In Lyhagen (2001), the hypothesis that changes in wealth deliver a direct effect on the

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2 Also taking into account of the stock market wealth effect on consumption
movement of consumption is supported when attitudes towards future income are controlled. See also Brodin and Nymoen (1992).

Summarizing the above section, we can reach the conclusion that the sign and magnitude of the housing effect on consumption depends on lots of different channels. Some effects from these different channels are consistent, while some are competing. As Chen (2006) argues that for a given economy, it is not feasible to determine \textit{a priori} the relationship between housing and consumption, nor the strength of this relationship; it must be empirically investigated. Hence, the association of the housing price and consumption can be regarded as an empirical result derived from some consistent economic theory for a certain economy and within a certain period.

3. The theoretical model

Following the two–period model presented by Dusansky and Koç (2006) as well as Dusansky and Wilson (1993), we develop a theoretical framework to explain the association of consumption and residential price under intertemporal uncertainty. In period one, the consumer works while earning income and choosing an optimal amount of owner-occupied residential services. In period two, the consumer retires and consumes the rental residential services. The formation of expectation on uncertain future prices is crucial, i.e., the links between the current residential prices and expectations of future prices are of importance to the perceptions of potential capital gains and the implications for the effect of changes in the current residential prices on consumption.

The two-period assumption is feasible and supported by the empirical results in Lehnert (2004), i.e. that the consumption of the age quintile on the verge of retirement is responsive to housing wealth. Meanwhile, households with the highest sensitivity to housing wealth gains (aged 52-62 years) are precisely those preparing to retire and the likeliest to “downsize” their house.

Specifically, we assume that a working householder chooses consumption goods and residential service, supposing that he just purchases owner-occupied residential real estate during his pre-retirement period. Then, he, as a non-working retiree, chooses consumption goods and rental residential real estate. The owner-occupied residential real estate is sold at the beginning of period two and the sales proceeds are devoted to consumption and rental residential real estate. This two-period model is expressed as:

\[
U = U(x_1, h_1^o, x_2, h_2^r) \tag{3}
\]

\[
\sum_{i=1}^{n} p_{i1}x_{i1} + p_{o1}h_{1i}^o = Y \tag{4}
\]

\[
\sum_{i=1}^{n} p_{i2}x_{i2} + p_{r2}h_{2i}^r = S + p_{o2}h_{1i}^o \tag{5}
\]

In equation (3), \(x_1, x_2\) represent the vectors of regular consumption goods in the respective periods; \(h_1^o, h_2^r\) depicts units of owner-occupied and rental residential services in the respective periods.

Equation (4) and (5) describes the budget constraint in the respective periods. \(p_{i1}\) and \(p_{o1}\) represent the
prices of the consumption goods and owner-occupied residential real estate, respectively. \( Y \) is certain earned income or wealth in period 1. The owner-occupied residential real estate serves both as a consumption good and as an investment asset for the intertemporal transfer of wealth by carrying residential stock into the subsequent retirement period. \( p_{r2} \) is the price of a standardized unit of rental residential services in period 2; \( S \) is fixed exogenous income. In period two, hence, the budget is constrained by \( S \) augmented by the proceeds from the sale of the residential stock.

\[
\phi(x_1, h_1, p_2) \tag{6}
\]

\[
V_i(x_i, h_i^o, p_i) = \int_{p_2} U[\phi(x_i, h_i^o, \cdot)]dF(\cdot | p_i) \tag{7}
\]

With regard to any particular action in period 1 \((x_1, h_1^o)\), lots of different consumption programs in the two periods can be envisioned depending on the price system that prevails in period 2. Among all these consumption patterns, one would be interested in only feasible and optimal ones denoted by formula (6) that not only satisfy the period 2 budget constraint but also are consistent with utility maximization.

In order to make choices of the consumption program in period 1, the consumer must develop some expectations on the equilibrium price system prevailing in the subsequent period 2. R. Dusansky and Ç. Koç (2006) assume that the expectations about future values are based on present ones. Accordingly, the consumer forecast for period 2 prices are depicted by the conditional subjective probability distribution \( F(p_2 | p_1) \). Hence, the expected utility can be defined as equation (7). \( V_i(\cdot) \) is the von Neumann–Morgenstern expected utility function of the action \((x_i, h_i^o)\). Following the economic assumption, the consumer here pursues the maximized expected utility. So, the optimization problem becomes maximizing (7) subject to (4). Usually, the first order conditions can be solved for the demand functions for consumption goods and owner-occupied residential real estate, respectively. The latter is shown in Equation (8) by Slutsky equation:

\[
\frac{\partial h_i^o}{\partial p_{r_o}} = -h_i^o \frac{\partial h_i^o}{\partial Y} + \lambda \frac{D_{n_{o1+n_{o1}}} }{D} - \left[ \sum_{j} \psi_{n_{j,1+n_{j,1}}} (\frac{D_{j_{n_{j,1+n_{j,1}}} } }{D} + V_{w_{o,n_{j,1}}} (\frac{D_{n_{o1+n_{o1}}} }{D}) \right] \tag{8}
\]

where \( D \) is the determinant of the Jacobian of the first order conditions. The expression in equation (8) consists of the weighted income effect and the substitution effect, together with additional terms. The additional terms describe the effect of a changing owner-occupied residential price on the expected utility function, operating through the marginal utilities of all consumption goods and residential services. As a result, the sign of the right hand in equation (8) is ambiguous and the Slutsky-Hicks properties do not hold. Moreover, Dusansky and Koc (2006) also obtained the empirical evidence that the housing demand is upward sloping. This implies that the housing role as an asset with its potential for capital gain dominates its role as consumption good.

Hence, the expectation effect is necessary to taken into account in explaining the impact from residential price changes on consumption. Moreover, the asymmetry exists in real house price as Guirguis et al., (2006) has found that the residential price appears to exhibit some price rigidity, reacting more readily to positively lagged changes than to the negative lagged changes in prices. Homeowners may be reacting to negative market changes by temporarily holding off from listing or
releasing for sale the existing housing stock. Alternatively, buyers and sellers may simply be adjusting to market conditions, with both sides trying to account for past and future predicted price movements. Their analysis demonstrates that it is necessary to incorporate or consider the asymmetry in some study to avoid model misspecification.

In addition, common sense prevails and people tend to easily expect more to gain but be always reluctant to lose. This is described by Duffy et al., (2007) as a loss-averse investor whose aim is to invest in a static, single-period portfolio that maximizes his expected return at a trading time scale while safeguarding, with high probability, the return from falling below an acceptable level. In this setting, an investor is defined by the trading time scale, the threshold that determines the unacceptable loss and a specified bound on the probability that such a loss occurs. Empirically, loss aversion is an important phenomenon in the metropolitan housing markets in the United States and household mobility is significantly influenced by nominal loss aversion (Engelhardt, 2003). Theoretically, “…loss aversion is a departure from expected-utility theory that provides a direct explanation for modest scale risk aversion”, Rabin (2000b) argues.

Here, our aim in this paper is not to investigate the different risk attitudes or the different loss probabilities along with the trading time scale but instead, we try to differentiate the expectation effects in two different cycle periods, i.e. the expansion and recession periods. No matter that cycles in wealth are driven by house prices and could have contributed to the cyclical nature of overall demand in the past 30 years or explained through the credit market as Aoki (2004) proposes, it is necessary to investigate the relationship between residential price and consumption from a cyclical perspective taking into account the asymmetry in residential price.

From the foregoing discussion, the expectation effect during recession is smaller than that during expansion, as it is operating through the capital gain effect. Consequently, during the recession period, and if the expectation effect is smaller than the sum of the income effect and the substitution effect, then the residential price impacts consumption negatively. During the expansion period, the expectation effect is larger. If it is large enough to cover the sum of the income effect and the substitution effect, then the residential price impacts consumption positively. Hence, the relationship between residential price and consumption shows negative and positive alternately owing to the alternate recession and expansion along the residential price cycle.

4. Methodology – the cross-spectral density model

This paper seeks to investigate how consumption is affected by changes in current residential price from a cyclical perspective. In an attempt to estimate such a relationship, the univariate spectral and cross-spectra density models are deployed. Spectral analysis, as an unconventional ramification in time series econometrics, is purely a mathematical model on a process that generates the underlying series. This inherent model-free characteristic avoids the problem of model misspecification and parameter-estimation errors. Moreover, standard regression models will assume the same model for each cycle-duration. The subtle relationships may therefore be discerned (Rosenthal, 1986). The cross-spectral density model provides a solution to these problems. Our study in this paper, hence, complements effectively the inconsistent empirical results of the housing price-wealth-consumption
Cycles of different duration can be distinguished and the subtle relationships between residential prices and consumption at different cycle periods can also be estimated via the univariate spectral and cross-spectra density models. Spectral analysis is essentially a modification of the Fourier analysis in order to enable a fit for stochastic rather than for deterministic functions of time. Given a (possible complex-valued) function $h(m)$ of an integer variable $m$, the integer Fourier-transform of $h(m)$ is defined as:

$$f(\omega) = \frac{1}{2\pi} \sum_{m=-\infty}^{\infty} h(m)e^{i\omega m}, -\pi \leq \omega \leq \pi,$$  \hspace{1cm} (9)$$

Here, $f(\omega)$ is only defined in the interval $[-\pi, \pi]$, and to make $f(\omega)$ exist, a sufficient condition is $\sum_{m}[h(m)] < \infty$, then, an inversion formula can be obtained as:

$$h(m) = \int_{-\pi}^{\pi} f(\omega)e^{-i\omega m} d\omega, m = 0, \pm 1, \pm 2, \ldots$$  \hspace{1cm} (10)$$

The function $h(m)$ in the equation (10) is also often referred to as the inverse Fourier transform of $f(\omega)$. Both are commonly called a Fourier transform pair. In time-series analysis, the Fourier transform of the absolutely assumable autocovariance function is called spectral density function, which is often also shortened to spectrum. The spectrum is a continuous function in $[-\pi, \pi]$ for a purely indeterministic discrete stationary process. Hence, the spectrum of an indeterministic process with absolutely assumable autocovariance sequence $\lambda(k)$ can be defined as:

$$f(\omega) = \frac{1}{2\pi} \sum_{k=-\infty}^{\infty} \lambda(k) \cos \omega k = \frac{1}{2\pi} [\lambda(0) + 2\sum_{k=1}^{\infty} \lambda(k) \cos \omega k]$$  \hspace{1cm} (11)$$

The spectrum and the autocovariance function are equivalent ways in explaining a stationary stochastic process. They are complementary to each other in the application. The spectrum defines the relative “power” of each frequency component, i.e. its contribution to the total variance of the whole process. For a purely indeterministic discrete stationary process, the total area under the spectrum curve is equivalent to the total variance, and a peak in a particular frequency range indicates the presence of a strong cyclical component.

Spectral approach split time series into a set of mutually uncorrelated components, each one corresponding to a cycle of a different frequency, from which the periodogram can be portrayed. It shows an estimate of the amount of variance of the series accounted for by each frequency band cycles. The frequencies are measured in terms of cycles per time period and the important bands of frequencies can be seen via examining a spectrum.

Cross-spectral analysis, essentially, performs a number of regressions between the same frequency cycles in a pair of time series. It can also provide direct estimates of the lead-lag relationships between series components, which may be fractions of observation period units and differ for different cycles. In some sense, co-spectral analysis can be considered as the equivalent to the correlation analysis in frequency domain. The definition of the cross spectrum is obtained by substituting the cross covariance function for the autocovariance function. Cross-spectral representation of the relationship between two time-series is summarized at each frequency by six key statistics. Suppose two time-series $x_1(j)$ and $x_2(j)$ with the crosscovariance $\gamma_{12}(J) = \gamma_{21}(-J)$, then, the cross spectrum is,
\[
\hat{S}_{12}(k) = \Delta t \sum_{J=1}^{N-1} \hat{\omega}(J) \hat{y}_{12}(J) e^{-i2\pi kJ/N} = \hat{C}_{12}(k) - i \hat{Q}_{12}(k) \tag{12}
\]

The crosscovariance is not an even function, thus, the real part \(\hat{C}_{12}(k)\) is the cospectrum and the imaginary part \(\hat{Q}_{12}(k)\) is the quadrature spectrum. The Squared coherency, coherence-squared function, or coherence spectrum estimates between two time series, and measures the amount that one series can be predicted from the other at different frequencies from which whether two time series share common cycles can be indicated, as well as the strength of the contemporaneous relationships. Following the above equation, the coherency similar as the correlation coefficient can be expressed as,

\[
\hat{K}_{12}(k) = \frac{\hat{S}_{12}(k)}{\sqrt{\hat{S}_{11}(k) \hat{S}_{22}(k)}} = \frac{\hat{C}_{12}(k)^2 + \hat{Q}_{12}(k)^2}{\sqrt{\hat{S}_{11}(k) \hat{S}_{22}(k)}} \tag{13}
\]

The Cross-amplitude can present a further confirmation by being interpreted as a measure of co-variance between the respective frequency components in the series. The Phase or phase difference provides the amount by which the frequency cycle of one series is leading the other and interprets the period of time delays between the two series. Moreover, specific cycle frequencies appearing to share strong correlations between the two series can also be revealed. The way to get phase is only up to adding or subtracting an integer number of cycles of the given frequency, and the only way maybe offset this ambiguity is considering the phase diagram as a whole. The phase spectrum can indicate the lead-lag linkages between two time series. Usually, phase is expressed in frequency terms as degrees or radians as,

\[
\hat{\Phi}_{12}(k) = \tan^{-1}\left(\frac{\hat{Q}_{12}(k)}{\hat{C}_{12}(k)}\right) \tag{14}
\]

The number of leads can be obtained from \(\hat{\Phi}_{12}(k) > 0\) or lags from \(\hat{\Phi}_{12}(k) < 0\) when \(x_1(k)\) and \(x_2(k)\) in sampling intervals at frequency \(v_k\) is given by standardized phase \(2\pi v_k^{-1}\hat{\Phi}_{12}(k)\).

The Gain can be regarded as analogous to the absolute value of the regression coefficient for each decomposed frequency cycle pair, i.e. gain explains how one amplitude is translated into the amplitude of the other, as

\[
\hat{G}_{12}(k) = \frac{\hat{S}_{22}(k)}{\hat{S}_{11}(k)} \tag{15}
\]

Here, \(\hat{G}_{12}(k)\) indicates the extent to which the spectrum of \(x_1(k)\) has been modified to approximate the corresponding frequency component of \(x_2(k)\).

5. Data and empirical results

5.1. Data and treatment

Two time series, residential price and consumption, are required in this study. The quarterly data
covering the period from Q1 1980 to Q2 2005 is collected from the SingStat Time Series (STS), the Singapore Department of Statistics’ web-based time series retrieval system. For the residential price, we select the private residential price index maintained by the Urban Redevelopment Authority (URA), the physical planning authority of Singapore. The private residential properties refer to the ones built by individuals or private developers on either private or state-tendered land. The reasons for focusing on the private sector comprise: firstly, that the private residential market operates in a laissez-faire economic system within which the residential prices are mainly determined by a function of the demand and supply in the market (Sing, Tsai and Chen, 2004); and hence, the interest in this sector stems from the fact that it is subject to the full rigor of market forces in sharp contrast to the public sector where state-administered social pricing prevails through subsidies and loans. Secondly, that the so-called “upgrading” phenomenon in Singapore makes the private residential assets more popular owing to the exclusive lifestyle of the condominiums themselves (Koh and Ling, 1996; Tu, 2003). These reasons enhance the impact of the private residential market sectors on the national economy.

As for consumption, we select the private consumption expenditure from the Department of Statistics (DOS) Database, under the Ministry of Trade and Industry. Singapore’s statistical data on private consumption expenditures are not broken down into spending on consumer durables and non-durable goods and services; hence, we model aggregate expenditures without differentiating between these two important categories. Another drawback of using total consumption is that it includes expenditures on housing services in the form of imputed rents on owner-occupied dwellings. (Abeyesinghe and Keen, 2004). The original data is plotted in Figure 1.

**Figure 1. Plots of the Original Series**

![Residential Price Index](image1)

![Consumption Expenditure](image2)

**Figure 2. Plots of the Series Detrended by HP Filter**

![Residential Price Index](image3)

![Consumption Expenditure](image4)

To facilitate the spectral analysis, all the time series should be stationary. In practice, however, most
economic time series exhibit a clear tendency to grow over time, characterized as “trending”. It essentially produces a higher order of power at the lowest frequencies and leads to spill-over that distorts the spectrum at higher frequencies, when smoothing the periodogram. To overcome the time-trend problem usually found in economic time series, various trend-removal procedures have been developed like the linear regression, polynomial regression or the alternative filter way including the Hodrick-Prescott (HP) filter and first differencing. In this paper, the (HP) filter is selected to detrend the series before proceeding with the spectra density analysis. The cyclical components of two series are extracted from the original data set as plotted in Figure 2.

<table>
<thead>
<tr>
<th>Table 1. ADF and PP Unit Root Tests for the Detrended Series</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>-------------------------------</td>
</tr>
<tr>
<td>Lagged difference=4</td>
</tr>
<tr>
<td>residential price</td>
</tr>
<tr>
<td>consumption</td>
</tr>
</tbody>
</table>

The next analytical method is the stationarity test for the cyclical components of all the time-series under the PP test and the ADF test. The results are presented in Table 1 and it shows that the null hypothesis of a unit root in each of the detrended series can be rejected at even the 1% level. It indicates that these time series are stationary after being detrended by the HP filter.

The seasonality tends to produce strong peaks in the spectrum at the seasonal frequency and its harmonics. All the time series should hence be free from seasonal fluctuations before applying the spectra analysis. We use the moving average method to conduct the seasonal adjustments for these cyclical components. The final results are plotted in Figure 3.

Figure 3. Cyclical Components of the Seasonally Adjusted Series

In order to investigate the cyclical relationships among the variables rather than to define some data as percentage changes and others in absolute market value, the above seasonally adjusted series are normalized by the conventional method: subtracting each observation from the series’ mean and then

---

3 Both the original residential price and consumption series are stationary by KPSS test at 5% level and 1% level, respectively, which avoid the artificial cycles (Park, 1996). As for the HP filter, we make a choice $\lambda = 1600$ based on Canova’s (1998) study.
dividing it by the series’ standard deviation to take into account the differences in volatility. The result is shown in Figure 4.

**Figure 4. Normalized the Cyclical Components of the Seasonally Adjusted Series**

5.2. Empirical results and analysis

The spectral periodogram and spectra density of two series are plotted in Figure 5. The spectral decomposition information extracted from the spectral estimates is reported in Table 2. From Figure 5 and Table 2, both the residential price and consumption present a dominant cycle and several weak cycle(s) each. Specifically, Table 2 provides the smoothed periodogram values at main peaks for two time series. The periodogram of each series shows one high spike and several other smaller jagged spikes. The focus is on those key frequency bands providing useful information about the cycles for each series rather than to present all frequencies.

**Table 2. Spectral Decomposition-smoothed Periodogram Values at Major Cycle and Minor Cycle Points**

<table>
<thead>
<tr>
<th></th>
<th>Residential Price</th>
<th>Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Duration</strong></td>
<td><strong>Smoothed Periodogram value</strong></td>
<td><strong>Duration</strong></td>
</tr>
<tr>
<td>Major cycle</td>
<td>17.00 0.124369</td>
<td>17.00 0.098916</td>
</tr>
<tr>
<td>Minor cycle(s)</td>
<td>6.80 0.024149</td>
<td>7.29 0.035082</td>
</tr>
<tr>
<td></td>
<td>4.08 0.002151</td>
<td>3.92 0.020798</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.04 0.010634</td>
</tr>
</tbody>
</table>

In terms of the residential price cycle, the high peak happens at approximately 17 quarters (more than 4 years) and corresponds to a major cycle. The variation at this frequency band is 12.44%. It means that
approximately 12.44% of the variation in price return can be accounted for by the long-run cyclical behavior. Similarly, the other two minor cycles are identified to be at 6.80 quarters and 4.08 quarters respectively. The variances accounted by the cycles of these frequency bands are 2.41% and 0.21% respectively. Concerning consumption, the major cycle is the also 17 quarters with a variation of the frequency band at 9.89% that accounts for the cycle. Three minor cycles are 7.29, 3.92 and 2.04 quarters, respectively. Most of the variances that account for the respective cycles of consumption are higher than the ones for residential price, which implies that consumption has more regular cycles relative to the residential price. The variances that account for the peak of the residential price is higher than that for consumption, which means that in the long run, stronger cycles appear and they exist for the residential price, compared with consumption.

**Figure 5. Periodogram and Spectra Density of the Two Series**

In order to consolidate the cross-spectral calculations and to ensure that their results are meaningful, the correlation between the series is first estimated. The coefficient is .539(**). Residential price is thus significantly correlated with consumption. It is reasonable and consistent with the foregoing theoretical analysis. To further examine the similarity and co-dependence between residential price and consumption, the coherence is a principal indicator measuring the strength of the relationship between the two cyclical components of the two processes at different periods. Together with the gain,

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4 ** Correlation is significant at the 0.01 level (2-tailed).
5 The theoretical model omits the housing loan and truncation cost, etc.
cross-amplitude and phase value, we report the results of five\textsuperscript{6} key statistics for this pair of time series in Table 3 and Figure 6.

Figure 6. Cross-amplitude, Coherency, Phase Spectrum & Gain of the Two Series during the Total Sample Period

\begin{itemize}
  \item Cross Amplitude of ResidentialPriceIndex and ConsumptionExpenditure by Period
  \begin{figure}
    \centering
    \includegraphics[width=\textwidth]{cross-amplitude.png}
    \caption{Cross Amplitude of ResidentialPriceIndex and ConsumptionExpenditure by Period}
  \end{figure}
  \item Coherency of ResidentialPriceIndex and ConsumptionExpenditure by Period
  \begin{figure}
    \centering
    \includegraphics[width=\textwidth]{coherency.png}
    \caption{Coherency of ResidentialPriceIndex and ConsumptionExpenditure by Period}
  \end{figure}
\end{itemize}

\textsuperscript{6} Report two Gain statistics.
Phase Spectrum of Residential Price Index and Consumption Expenditure by Period

Window: Tukey-Hamming (5)

Gain of Residential Price Index and Consumption Expenditure

Gain of
- Consumption Expenditure from Residential Price Index
- Residential Price Index from Consumption Expenditure

Window: Tukey-Hamming (5)
<table>
<thead>
<tr>
<th>Fourier Frequency</th>
<th>Fourier Period*</th>
<th>Amplitude</th>
<th>Phase</th>
<th>Gain</th>
<th>Gain**</th>
<th>Coherency</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0098</td>
<td>102.0408</td>
<td>2.58877</td>
<td>-2.25173</td>
<td>0.20926</td>
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<td>-0.44514</td>
<td>0.49462</td>
<td>1.87124</td>
<td>0.92556</td>
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<tr>
<td>0.03922</td>
<td>25.4972</td>
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</tr>
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<td>0.04902</td>
<td>20.39984</td>
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<td>0.35003</td>
<td>0.60135</td>
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<td></td>
</tr>
<tr>
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<td>17.00102</td>
<td>385.4587</td>
<td>0.33512</td>
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<td>1.07092</td>
<td></td>
</tr>
<tr>
<td>0.07843</td>
<td>12.75022</td>
<td>359.2693</td>
<td>0.48845</td>
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<td>1.11192</td>
<td></td>
</tr>
<tr>
<td>0.08824</td>
<td>11.33273</td>
<td>282.7213</td>
<td>0.37345</td>
<td>0.65228</td>
<td>1.15718</td>
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</tr>
<tr>
<td>0.09804</td>
<td>10.19992</td>
<td>230.2845</td>
<td>0.1209</td>
<td>0.57302</td>
<td>1.31017</td>
<td></td>
</tr>
<tr>
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<td>-0.07819</td>
<td>0.48308</td>
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<td>48.20782</td>
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<td>0.28103</td>
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<td>0.12745</td>
<td>7.846214</td>
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<td>-1.6157</td>
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<td>4.38437</td>
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<td>2.42417</td>
<td>-1.95592</td>
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<td>1.42913</td>
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<td>-2.5731</td>
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<td>-2.59246</td>
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<td>1.55755</td>
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<td>0.90504</td>
<td>1.11111</td>
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<td>1.90376</td>
<td>0.48402</td>
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<td>1.01955</td>
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<td>0.19894</td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Cross-spectral Statistics of the Two Series during the Total Sample Period
Referring to the amplitude and coherency, it is clear that the cyclical relationship between residential price and consumption is strong at around 17 quarters. Both the coherence and amplitude are almost highest at the frequency band of 0.05882 (period: 17 quarters) with the low phase value. It is not surprising that the two series show the same major cycles 17 quarters. According to the rule of thumb, Granger and Hatamura (1964) ascribes the relationships between two cycles as strong if most coherences are above 0.5 and some are above 0.8, moderate if most coherences range from 0.3 to 0.6, and low otherwise. Coherency values in Table 3 provide evidence that the cyclical relationship between residential price and consumption is strong in the long run and weak in the short run. In addition, the coherence values are more than 69% at the band of 17 quarters. It implies that, if low frequencies are interpreted as indicating long-run relationships, at least 69% of variation in the relationship between the residential price and consumption is accounted by the long run cycles.

With regard to the phase spectrum in Figure 6, it shows that the phase values are distributed within both the positive and negative areas alternatively before the low frequency band of 25.5 quarters (approximately 6 years). It implies that the lead or lag relationship between residential price and consumption appear alternately within approximately 6 years. Beyond 6 years, the phase values constantly show negative signs, which implies that the residential price slightly lags consumption. Moreover, within the high frequency bands, for e.g. from band 2 to band 9.273, then high phase values will mean that strong lead and lag relationships appear alternately. However, the low phase values suggest that almost contemporaneous movements occur between them especially so around the long cycle interval. More detailed alternate lead-lag relationships are summarized in Table 4.

Table 4. The Alternate Lead-lag Relationships

<table>
<thead>
<tr>
<th>Fourier Period Intervals</th>
<th>Phase Values</th>
<th>Lead-lag Relationship</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 to 2.684203</td>
<td>positive</td>
<td>lead</td>
</tr>
<tr>
<td>2.75672 to 9.272997</td>
<td>negative</td>
<td>lag</td>
</tr>
<tr>
<td>10.19992 to 25.4972</td>
<td>positive</td>
<td>lead</td>
</tr>
<tr>
<td>More than 25.4972</td>
<td>negative</td>
<td>lag</td>
</tr>
</tbody>
</table>

The coherency spectrum, in the present case, indicates whether the residential price shares the common cycles with consumption, and the corresponding strength of the contemporaneous relationship. High coherency values fall away as frequency increases and that the associated bands show stronger and alternate negative and positive phase values. Thus, if low frequencies from 9.272997 to 102.0408 quarters are interpreted as indicating mid and long run with relatively high coherency, then, in the mid and long run, the residential price and consumption are each closely linked and they show clear alternate lead and lag relationships. If high frequencies from 2 to 8.499788 quarters are interpreted as indicating short run, then, in the short run, there is a weak evidence for cyclical relationships between
the two series and also for clear alternate lead-lag relationships. Due to the different strength of the contemporaneous relationships in the short, mid and long run that are accompanied by different lead-lag relationships, both the residential price and consumption perform pro- and counter-cyclically as shown in Figure 4 - for e.g. the counter-cyclical relationship in the marked parts. If residential price and consumption are pro-cyclical with high coherency values, the implication is that the residential price and consumption positively affect each other. Otherwise, oppositely, if residential price and consumption are counter-cyclical with high coherency values, and the implication is that the residential price and consumption negatively affect each other.

Hence, our finding is that the residential price does not affect consumption significantly in the short run. However, it significantly affects consumption in the mid and long run, alternately positively and negatively. From the cyclical perspective, the above results and the analysis from the frequency perspective are supported in Figure 4. It is approximately seen that consumption leads residential price before 1995 Q4 with shorter durations and less co-movement. However from 1996 Q1 to 2001 Q4, residential price leads consumption with longer durations and more co-movement.

Table 5. Granger Causality test of Residential Price and Consumption (Lags: 2)

<table>
<thead>
<tr>
<th>Null Hypothesis</th>
<th>F-Statistic</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential price does not Granger Cause consumption</td>
<td>5.83830</td>
<td>0.00406</td>
</tr>
<tr>
<td>Consumption does not Granger Cause Residential price</td>
<td>2.85108</td>
<td>0.06274</td>
</tr>
</tbody>
</table>

Further results of Granger Causality Tests in Table 5 imply that the direct Granger causality cannot be established between residential price and consumption. Hence, there are some underlying factors for the interactions like wealth in the literature. According to Paiella (2007), if wealth is not causal to consumption, then a change in assets market will be interpreted as a symptom of a future change in consumer spending rather than a cause. Further, the implications of a sharp correction in asset prices might differ depending on whether a price change causes revisions in the expectations of future economic conditions. Hence, the “expectation effect” in our theoretical model is necessary and makes the theoretical explanation well enough to capture the association between residential price and consumption.

To investigate the importance of the capital gain effect from residential price on consumption, we select a typical period from 1996 Q1 to 2001 Q4 as shown in Figure 7 to conduct the cross-spectral analysis, because in the Singapore private residential market, property purchasing for consumption and investment had turned into speculative buying owing to strong economic growth, increased purchasing power and a strong sustained “upgrading” demand for residential property, deemed to be comparatively superior as an investing instrument to other asset classes. From 1986 to 1996, the private residential price index rose by about 440%. About two-thirds of this gain was in the early 1990s up to 1996. Over 1992 to 2002, 58% of the 3-million population changed homes. Among private homeowners, it was almost 70%. This created an upward spiral of property prices that was exacerbated by speculative elements (Daniel, 2006).

The results are reported in Table 6 and Figure 7. The amplitude and coherency are consistent with the results from the total sample by disturbing small values in short run and large values in mid and long
Moreover, as expected from our theoretical model, the percentage of the high coherency values is more than that of the results from the total sample. It provides the evidence that the capital gain effect is important in explaining the impact from residential price on consumption. In addition, the phase still shows positive and negative signs alternately. However, the values are smaller than the ones from the total sample. It also means that residential price and consumption have strong contemporaneous relationships with slight leads or lags during this period. The gain values in Table 6 are larger than the ones of corresponding frequency bands in Table 3 marked in green. It means that changes in residential price in the typical period have more amplitude on consumption than during the total sample period.

According to the gain**, the changes in consumption in the typical period have also more amplitude on residential price than during total sample period. Hence, the capital gain effect is important in explaining the impact from residential price on consumption, especially for the then speculative residential market.

Figure 7. A Typical Period from 1996 Q1 to 2001 Q4

Table 6. Cross-spectral Statistics of the Two Series during the Period from 1996 Q1 to 2001 Q4

<table>
<thead>
<tr>
<th>Fourier Frequency</th>
<th>Fourier Period*</th>
<th>Amplitude</th>
<th>Phase</th>
<th>Gain</th>
<th>Gain**</th>
<th>Coherency</th>
</tr>
</thead>
<tbody>
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<td>0</td>
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<td>765.1448</td>
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<td>0.67688</td>
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<td>45.94082</td>
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<td>0.43636</td>
<td>0.91754</td>
<td>0.40307</td>
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<td>1.00857</td>
<td>0.21189</td>
<td>0.21371</td>
</tr>
<tr>
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<td>2.8565</td>
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<td>0.05823</td>
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<tr>
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<td>3.14159</td>
<td>0.72427</td>
<td>0.16789</td>
<td>0.1216</td>
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</tbody>
</table>

* (Quarters), **Gain from consumption expenditure to residential price index.
In order to investigate the ambiguous sign of the capital gain effect of residential price on consumption, we select the typical periods from 1998 Q4 to 2001 Q4 as the expansion period and from 1996 Q1 to 1998 Q4 as the recession period in Figure 7. The results of the cross-spectral analysis for expansion and recession periods are reported in Figure 9, Table 7 and Figure 10, Table 8, respectively. The coherency of expansion is smaller than the one for recession while that for expansion is relatively larger. It implies that in the recession period, the residential price and consumption have more
contemporaneous cyclical movements and that consumers are more sensitive to the residential market recession than to expansion. However, the gain from expansion is larger than the one from recession. These findings are consistent with our hypothesis based on the theoretical model. The expectation effect operating through the capital gain effect during the expansion period is larger than the one during the recession period. Hence, the residential price affects consumption positively or negatively in different frequencies with alternate expansion and recession along the residential price cycle.

Table 8. Cross-spectral Statistics of the Two Series during the Period from 1996 Q1 to 1998 Q4 (recession period)

<table>
<thead>
<tr>
<th>Fourier Frequency</th>
<th>Fourier Period*</th>
<th>Amplitude</th>
<th>Phase</th>
<th>Gain</th>
<th>Gain**</th>
<th>Coherency</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
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<td>0</td>
<td>0.59435</td>
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<tr>
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<td>0.59029</td>
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<td>0.78624</td>
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<tr>
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<tr>
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<td>0.43395</td>
</tr>
</tbody>
</table>

* (Quarters)
**Gain from consumption expenditure to residential price index.

Figure 9. Cross-amplitude, Coherency, Phase & Gain of the Two Series from 1998 Q4 to 2001 Q4 (expansion period)
Figure 10. Cross-amplitude, Coherency, Phase & Gain of the Two Series 1996 Q1 to 1998 Q4 (recession period)

6. Conclusion

Residential property (real estate), as a major component of wealth for households, are prone to cyclical fluctuation, and it is therefore important to understand in-depth the fluctuations of residential price that affect households’ consumption decisions. A unique theoretical framework is developed in this paper to explain the consumption expenditure changes brought about by changes in residential price. The framework focuses on the wealth effect taking into account the dual characteristics of residential real estate in terms of it being a consumption good and an investment asset. Different from the Slutsky equation as it appears in standard microeconomic theory, the impact of residential price changes on consumption contains the income and substitution effects together with the additional terms defined as “expectation effect” (R. Dusansky, etc., 1993; R. Dusansky, Ç. Koç, 2006). This expectation effect operates through the capital gain effect.

Considering that the capital gain effect from the residential real estate is different and asymmetric along with the residential price cyclical dynamics, we investigate the association of residential price and consumption from a cyclical perspective through the spectral and cross-spectral density models. First, from the total sample period, the spectral analysis shows that both residential price and consumption have a major cycle at approximately 17 quarters (more than 4 years) with the variations of 12.44% and 9.89% respectively. Compared with consumption, the residential price performs cyclically
and stronger in the long run with less minor cycles. According to the cross-spectral analysis and where low frequencies from 9.272997 to 102.0408 quarters indicate the mid and long run with relatively high coherency, then in the mid and long run the residential price and consumption are closely linked and that they show clear alternate lead and lag relationships. High frequencies from 2 to 8.499788 quarters indicate the short run, and there is therefore weak evidence for cyclical relationships between the two series and for clear alternate lead-lag relationships. Furthermore, the direct Granger causality cannot be established between residential price and consumption.

Secondly, the results from the period between 1996 Q1 and 2001 Q4 that reflected Singapore’s speculative residential market, do provide clear evidence that the expectation effect operating throughout the capital gain effect is important in explaining the residential price effect on consumption along the residential price cycles. Thirdly, the results from the expansion period from 1998 Q4 to 2001 Q4 and the recession period from 1996 Q1 to 1998 Q4, suggest that the expectation effect is larger during expansion period than the recession period. It can be concluded that residential price affects consumption significantly, depending on the time scale and frequency without a consistent sign. Consequently, no single number or “marginal propensity”, as mentioned before, can accurately describe the response of consumption to residential price from the cyclical perspective.

The policy suggestions are provided as follows: we need not worry about the cyclical variance of residential price in the short run of approximately 2 to 8.5 quarters, as it is a weakly cyclical co-movement with consumption. However, the cyclical variance of residential price in the mid and long run is approximately 9 to 102 quarters and deserves our attention, as it is closely linked with consumption. The different gain values imply different MPCs within the different time scale and frequency, which make them accurate enough to diagnose an overheating or bubble-like residential market. Finally, due attention should be accorded to take into account the varying magnitudes of the residential price effect during the expansion relative to the recession.

Our results from a cyclical perspective are inconsistent with those by Lettau and Ludvigson (2004) as well as by Chen (2006). There are three possible reasons for the inconsistency: first, Singapore’s statistical data on private consumption expenditures models aggregate expenditure without differentiating consumer durables, non-durable goods and services; and total consumption includes expenditures on housing services in the form of imputed rents on owner-occupied dwellings so that an increase in house prices will cause consumption to rise independently of any wealth effect (Abeyasinghe and Keen, 2004). Secondly, the empirical characteristics of the residential price-consumption issue highlight different channels through which the residential price affects consumption. Some effects from these different channels are consistent while some are competing. Which effect(s) is dominating or what is the integrated effect is an empirical issue, depending on the different dataset within the different time span for the different area. In addition, the coefficients in the VECM are constant for each lag, i.e. it is assumed that they adjust back to equilibrium at a constant pace. However, the generalized autoregressive conditional heteroskedasticity (GARCH) model widely used in financial market studies relaxes this assumption of constant error variance. It is also applies to analyzing house price volatilities (for e.g. in Cho and Megbolugbe, 1997; Guirguis and Vogel, 2006). Finally, another reason lies in a theoretical explanation. Macroeconomic estimation, as argued by Andrew and Meen (2003), needs to be complemented by careful microeconomic analysis. In our paper, the housing
price-consumption issue is explained by individual expectation effects in the pursuit of optimization, following persistent residential price cycles.

Further study can be undertaken to establish and estimate the income effect, the substitution effect and the expectation effect as well as to calculate the different MPCs utilizing more micro data. We can also extend the foregoing theoretical model taking into account the time trend. Finally, as Rabin and Thaler (2001) argue, the loss aversion and the tendency to isolate each risky choice must both be key components of a good descriptive theory of risk attitudes. It will be a meaningful contribution to investigate the different risk attitudes or the different loss probabilities along with the trading time scale towards different cycle periods, in order to quantify the expectation effect.

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