CHAPTER 2

Theoretical Foundation and Literature Review

2.1 Theory

This study examines the relationships between housing price and other macroeconomic variables. The theoretical framework follows Iacoviello and Neri (2010), based on the dynamic stochastic general equilibrium (DSGE) model of the U.S. economy with two sectors—housing and nonhousing sectors. Balance in the DSGE model is based on household behaviours on the demand side and firms' behaviours on the supply side.

(A) Households

There are two types on the demand side: patient (lenders) and impatient (borrowers). Patient households work, consume and accumulate housing: they own the capital and lend to the supply funds to firms and impatient households as well. For impatient households, they work, consume and accumulate housing: because they need to finance the down payment on their homes but are up against their housing collateral constraint in equilibrium. Households maximizes

$$E_0 \sum_{T=0}^{\infty} (\beta G_c)^t z_t \left(\tau_c \ln(c_t - \varepsilon c_{t-t}) + j_t \ln h_t - \frac{\tau_t}{1+\eta}\left(n_{c,t}^{1+\xi} + n_{h,t}^{1+\xi}\right)^{\frac{1+\eta}{1+\xi}}\right) \quad (1)$$

$$E_0 \sum_{T=0}^{\infty} (\beta' G_c)^t z_t \left(\tau_c' \ln(c_t' - \varepsilon' c_{t-1}') + j_t \ln h_t' - \frac{\tau_t}{1+\eta'}\left((n_{c,t}')^{1+\xi'} + n_{h,t}'\right)^{\frac{1+\eta'}{1+\xi'}}\right) \quad (2)$$

where c, h, n_c, n_h are consumption, housing, hours in the consumption sector and hours in the housing sector. The discount factors are β and β'. The terms z_t and τ_t capture shocks to intertemporal preferences and to labor supply. The equation with prime is impatient household, and the other is a patient household.

j_t are housing preference shocks. There are at least two possible interpretations of this shock. One interpretation is that the shock captures, in a reduced form way, cyclical variations in the availability of resources needed to purchase housing relative to other goods or other social and institutional changes that shift preferences towards housing. Another interpretation is that fluctuations in j_t, could proxy for random changes in the fact or mix required to produce home services from a given housing stock. The shocks are following:

$$lnz_t = \rho_z lnz_{t-1} + u_{z,t}; ln\tau_t = \rho_\tau ln\tau_{t-1} + u_{\tau,t}; lnj_t = (1-\rho_j)lnj + \rho_j lnj_{t-1} + u_{j,t} \quad (3)$$

where $u_{z,t}, u_{\tau,t}$ and $u_{j,t}$are independent and identically distributed with variances. $\boldsymbol{\varepsilon}$ measures habits in consumption, and $G_c$is the growth rate of consumption in the balanced growth path.

According to Davis and Heathcote (2005) and Fisher (2007), consumption and housing reconcile the trend in the relative housing prices, and the stable nominal share of expenditures on household investment goods go along better with the log-log speciation. By Michael Horvath (2000), this speciation follows disutility of labour and allows for less than perfect labour mobility across sectors.

Patient households accumulate capital and houses and make loans to impatient households. They rent capital to firms, choose the capital utilisation rate and sell the remaining un-depreciated capital. Moreover, there is a joint production of consumption and business investment goods. Patient households maximise their utility subject to:

$$c_t + \frac{k_{c,t}}{A_{k,t}} + k_{h,t} + k_{b,t} + q_t h_t + p_{l,t} l_t - b_t = \frac{w_{c,t}\eta_{c,t}}{X_{w\,c,t}} + \frac{w_{h,t}\eta_{h,t}}{X_{w\,c,t}} + \left(R_{c,t} z_{c,t} + \frac{1-\delta_{kc}}{A_{k,t}}\right) k_{c,t-1} + (R_{h,t} z_{h,t} + 1 - \delta_{kh}) k_{h,t-1} + p_{b,t} k_{b,t} - \frac{R_{t-1} b_{t-1}}{\pi_t} + (p_{l,t} + R_{l,t}) l_{t-1} + q_t(1-\delta_h) h_{t-1} + D_i v_t - \phi_t - \frac{a(z_{c,t}) k_{c,t-1}}{A_{k,t}} - a(z_{h,t}) k_{h,t-1} \quad (4)$$

Patient agents choose consumption c_t; capital in the consumption sector $k_{c,t}$, capital $k_{h,t}$and intermediate inputs $k_{b,t}$(priced at $p_{b,t}$) in the housing sector, housing h_t

(priced at q_t); land l_t (priced at $p_{l,t}$),hours $n_{c,t}$ and $n_{h,t}$; capital utilization rates $z_{c,t}$and $z_{h,t}$,and borrowing b_t (loans if is b_t negative) to maximize utility.

From the perspective of impatient households, they do not own and accumulate capital, land and good firms. Their shares' only come from labour unions. Also, to calculate the impatient households' maximum borrowing rate, the expected value of their home multiplies with the loan-to-value(LTV) ratio.

$$c_t' + q_t h_t' - b_t' = \frac{w_{c,t}' n_{c,t}'}{X_{w\,h,t}'} + \frac{w_{h,t}' n_{h,t}'}{X_{w\,h,t}'} + q_t(1-\delta_h)h_{t-1}' - \frac{R_{t-1} b_{t-1}'}{\pi_t} + D_i v_t' \qquad (5)$$

$$b_t' \leq mE_t\left(\frac{q_t+1 h_t' \pi_t+1}{R_t}\right) \qquad (6)$$

The assumption β'<β implies that for small shocks the constraint holds with equality near the steady state. When is β' lower than β, impatient agents decumulate wealth quickly enough to some lower bound and, for small shocks, the lower bound is binding. Patient agents own and accumulate all the capital. Impatient agents only accumulate housing and borrow the maximum possible amount against it. According to the equilibrium, changes in housing values can affect borrowing and spending constraints. If the effect is grater, the lager the m is. It measures the liquidity of housing.

(B) Technology

Both the housing sector and non-housing sector use capital and labour to produce goods from the supply side. New homes require labour, land and capital.

Normally, firms produce goods by using and hiring labour, land and capital. The non-housing sector produces goods by using labour and capital.

$$\max \frac{Y_T}{X_t} + q_t IH_t - \left(\sum_{i=c,h} w_{i,t} n_{i,t} + \sum_{i=c,h} w_{i.t}' n_{i,t}' + \sum_{i=c,h} R_{i.t} z_{i,t} k_{i,t-1} + R_{l,t} l_{t-1} + p_{b,t}\, k_{b,t}\right) \qquad (7)$$

where X_t is the markup of final goods over wholesale goods.

$$Y_t = \left(A_{c,t}\left(n_{c,t}^{\alpha} n_{c,t}'^{1-\alpha}\right)\right)^{1-\mu_c} (z_{c,t} k_{c,t-1})^{\mu_c} \qquad (8)$$

The housing sector produces goods by utilising land, labour and capital, intermediate input$k_{b,t}$

$$IH_t = (A_{h,t}(n_h^{\alpha} n_{h,t}'^{1-\alpha}))^{1-\mu_h-\mu_b-\mu_1} \quad (z_{h,t}k_{h,t-1})^{\mu_h} \quad k_{b,t}^{\mu_b} l_{t-1}^{\mu_l} \tag{9}$$

where $A_{c,t}$ and $A_{h,t}$ measure productivity in the non-housing and housing sector, respectively. α measures the labor incomes share of unconstrained households.

Due to the Cobb-Douglas function, hours of the two households includes in two-production functions. This assumption states that two groups of labour skills are complementary which allows obtaining closed-form solutions for the steady condition of the model.

(C) Nominal Rigidities and Monetary Policy

The experts indicated that the housing has flexible prices. The first reason is that housing is expensive compared to the other goods and so if menu costs have important fixed components; there is a big chance to negotiate on the price of housing. Secondly, most homes are pricey on their first time sold. (Robert Barsky, Christopher House and Miles S. Kimball (2007))

$$ln\pi_t - l_\pi \, ln\pi_{t-1} = \beta G_C(E_t ln\pi_{t+1} - ln\pi_t) - \varepsilon_\pi \ln(X_t/X) + u_{p,t} \tag{10}$$

where l_π is index prices to the previous period inflation rate with an elasticity

$$\varepsilon_\pi = \frac{(1-\theta_\pi)(1-\beta G_C \theta_\pi)}{\theta_\pi}$$

They assume that the central bank sets the interest rate, which may respond to inflation and GDP growth

$$R_t = R_{t-1}^{rR} \pi_t^{(1-rR)r_\pi} (DP \; / \; {}_cDP_{\;t-1})^{(1-r_R)r_Y} \overline{rr} - r_R \frac{u_{R,t}}{S_t} \tag{11}$$

where $\overline{rr}$ is the steady-state real interest rate. $u_{R,t}$ is an i.i.d. monetary shock with variance; $S_t$is a stochastic process with high persistence capturing long-lasting deviations of inflation from its steady-state level.

(D) Equilibrium

The goods market produced the equilibrium conditions Consumption, business investment and intermediate inputs. When it comes to the housing market, it produces new homesIH_t.

$$C_t + IK_{c,t}/A_{k,t} + IK_{h,t} + k_{b,t} = Y_t - \phi_t \quad (12)$$

$$H_t - (1 - \delta_h)H_{t-1} = IH_t \quad (13)$$

where $IK_{c,t}$ and $IK_{h,t}$ are two components of business investment.

(E) Trend and growth rate

Productivity in the consumption, nonresidential and housing sector are allowed to have heterogeneous trends. These processes are following:

$$lnA_{c,t} = t\ ln(1 + \gamma_{AC}) + lnZ_{c,t}; lnZ_{c,t} = \rho_{AC} lnZ_{c,t-1} + u_{C,t} \quad (14)$$

$$lnA_{h,t} = t\ ln(1 + \gamma_{AH}) + lnZ_{h,t};\ lnZ_{h,t}\rho_{AH} lnZ_{h,t-1} + u_{h,t} \quad (15)$$

$$lnA_{k,t} = tln(1 + \gamma_{AK}) + lnZ_{k,t};\ lnZ_{k,t} = \rho_{AK} lnZ_{k,t-1} + u_{K,t} \quad (16)$$

$\gamma_{AC}, \gamma_{AH}, \gamma_{AK}$ are the net growth rates of technology in each sector. Since preferences and production functions have a Cobb-Douglas form, a balance growth path exists in the variables, these are as follow

$$G_C = G_{IK_h} = G_{qXIH} = 1 + \gamma_{AC} + \frac{\mu_c}{1-\mu_c}\gamma_{AK} \quad (17)$$

$$G_{IK_c} = 1 + \gamma_{AC} + \frac{1}{1-\mu_c}\gamma_{AK} \quad (18)$$

$$G_{IH} = 1 + (\mu_h + \mu_b)\gamma_{AC} + \frac{\mu_C(\mu_h+\mu_b)}{1-\mu_C}\gamma_{AK} + (1 - \mu_h - \mu_l - \mu_b)\gamma_{AH} \quad (19)$$

$$G_q = 1 + (1 - \mu_h - \mu_b)\gamma_{AC} + \frac{\mu_C(1-\mu_h-\mu_b)}{1-\mu_C}\gamma_{AK} - (1 - \mu_h - \mu_l - \mu_b)\gamma_{AH} \quad (20)$$

$IK_{h,t}, IK_{c,t}/A_{k,t}$ *and* $q_t IH_t$ are all equal to G_C; the trend growth rate of real consumption. Second, we consider that business investment normally grows faster than consumption if $\gamma_{AK} > 0$. Third, the difference between productivity growth and consumption and the housing sector offsets the trend growth rate in real housing prices. This occurs from the rates of technology in consumption and housing sector and to the presence of land in the production function for new homes.

2.2 Literature Review

Real Estate is a popular area to research. Many researchers did research in advance about the relationship between housing price and other macroeconomic variables in specific countries. We explained and compared each result of different authors from different area of study in this section. We surprisingly noted that different countries have

different perspective on housing affordability and of course different impacts on economic, political and social affairs as well.

The experts **Tien-Foo Sing, I-Chun Tsai,Ming-Chi Chen(2006**) examined Price dynamics in public and private housing markets in Singapore(2006). They used the public housing price and private housing price as dependent variables and GDP growth, stock market return, prime lending rate, and unexpected inflation rate as independent variables from 1990 to 2006. In private housing, they categorized into condominium, apartment, semi-detached house and terrace house and HDB resale flat in public housing. According to the result, the stock market coefficients are positive and significant to the price of condominium, terrace and semi-detached housing markets. Prime lending rates were found to have significant dampening effects on public resale flats and all private landed houses. Unexpected inflation has positive effects on detached house prices, and GDP growth dampens price changes in terrace houses. The public housing resale prices and private housing prices has stochastic permanent breaks. The relative prices drift apart occasionally, but mean-revert to a long-run fundamental equilibrium. Household mobility creates co-movements of prices in public and private housing submarkets in the long run.

Tilak Abeysinghe & Jiaying Gu(2016) estimated fundamental and affordable housing price trends: a study based on Singapore .They used Housing Price as dependent variables and Income, housing stock, population size, CPF, user cost of housing as independent variables from According to the result, 1%increase in per capita in housing stock is likely to have a much bigger effect on HDB housing prices compared to private housing. Short-run fluctuations in population affect private housing price inflation and not HDB.

Shanmuga Pillaiyan(2015) examined Macroeconomic Drivers of House Prices in Malaysia. He used HPI as dependent variable and GDP, CPI, Stock Market, Number of housing loan approved, Money supply, Bank lending rate from 2000 to 2010. Due to the results, Malaysian house prices were found to have a strong long-term relationship with inflation, Stock Market, Money Supply and number of residential loans approved. There is a real danger that the house prices are in a bubble, as GDP was not identified as a driver of long-term house prices. This could indicate that house prices have in the last fifteen years deviated from economic fundamentals. Investors should be cautious when making

new investments the Malaysian housing market.

Theodore Panagiotidis and Panagiotis Printzis (2015) examined Macroeconomic Determinants Of The Housing Market in Greece. In that study, HPI as independent variable and CPI, Industrial Production Index (IP), Volume of Retail trade, Loan Interest Rate, Annual Growth Rate of Mortgage, Money Supply growth rate (M1), Unemployment as independent variables from 1997 to 2013. In the long run, mortgages and the retail trade contribute to housing prices. Retail trademarks is the most important variable in the long run. In the short run mortgages, CPI and retail contribute HPI. In conclusion, mortgage loans and retail trade are the ones which cause the most of the variation of housing price.

Lei Feng, Wei Lu, Weiyan Hu, Kun Liu (2010) investigated macroeconomic Factors and Housing Market Cycle both on the national level and using data from four typical cities from China which include Beijing, Shanghai, Guangzhou and Chongqing. In the long run, there is a stable relationship between macroeconomic factors and price of real estate. In the long run, GDP, income and investment to housing price is greater compare to the average construction cost and housing stock. Among all of them, Beijing and Shanghai have greater fluctuations in their house prices compared to Guangzhou and Chongqing.

Andrews Dan (2010) studied Real House Prices in OECD Countries: The Role of Demand Shocks, Structural and Policy Factors. The dependent variable is Housing price and independent variables are Interest rates, disposable income and CPI. The housing prices rise in proportion with the household income and with declines in the unemployment and real interest rates. Countries with a significant tax relief on mortgage debt financing cost show a tendency for demand shocks.

Katrin Assenmacher-Wesche (2009) studies the responses of residential property and equity prices, inflation and economic activity to monetary policy shocks in 17 countries in the period 1986-2007. He used single-country VARs and panel VARs to compare the results of countries. The effect of monetary policy on property prices is only about three times as large as its impact on GDP. Short-term interest rates depresses real GDP by about 0.125%, and real residential property prices by about three times as much,

or 0.375%, after one or two years.

Nicholas Apergis(2003) examined Housing Prices and Macroeconomic Factors: Prospects within the European Monetary Union using independent variable as HPI and dependent variables as CPI, Employment and Mortgage Interest rate from 1981 to 1999. The housing mortgage rate is the most effective variable to the real housing price and the inflation is the second most explanatory variable. Moreover, a positive shock in housing loan rate decrease real housing price and increase the housing demand, while a positive shock in inflation and employment increases real housing prices and decrease housing demand.

Nicholas Apergis and Anthony Rezitis (2000) investigated the Housing Prices and Macroeconomic Factors in Greece: Prospects within the EMU using housing price as dependent variable and consumer prices, housing loan rates, inflation, employment, and money supply, as independent variables 1981-1999.According to the result, they found that all those independent variables respond to housing price (dependent variable). A positive shock in housing mortgage rate decrease housing price and a positive shock in consumer prices, employment, and money supply increases housing prices. Among all those variables, Housing mortgage rate is the most effective variable to the housing price and second is employment.

Baffoe-Bonnie (1998) investigated The Dynamic Impact of Macroeconomic Aggregates on Housing Prices and Stock of Houses: A National and Regional Analysis using the variables- Housing price, Stock of houses, housing stock, prices, interest rates, CPI, employment and money supply. According to the result, employment growth rate and interest rate are the most sensitive variables to the housing price.

Table 2.1: Literature Review

TITLE	AUTHORS	VARIABLES	METHODOLOGY	RESULTS
Price dynamics in public and private housing markets in Singapore (2006)	**Tien-Foo Sing, I-Chun Tsai, Ming-Chi Chen**	Dependent-Public Housing Price and Private Housing Price Independent-Stock market coefficient, GDP, Prime lending rate, Unexpected Inflation	VECM	Stock market coefficient (+) GDP (+) Prime lending rate (+) Unexpected Inflation (+)
Fundamental and affordable housing price trends: a study based on Singapore (2016).	**Tilak Abeysinghe & Jiaying Gu**	Dependent-Housing Price Independent-Income, housing stock, population size,	VECM	Income (+) Housing stock (-) Population size (+)
Macroeconomic Drivers of House Prices in Malaysia (2015)	**Shanmugam Pillaiyan**	Dependent-HPI Independent-GDP, CPI, Stock Market, Number of housing loan approved, Money supply, Bank lending rate	Johnhansan Cointegration, VECM	GDP (+) CPI (-) Bank lending rate (+) Number of housing loans approved (+) Stock Market (+) Money Supply (+)

Table 2.1: Literature Review (Cont;)

TITLE	AUTHORS	VARAIABLES	METHODOLOGY	RESULTS
Macroeconomic Determinants Of The Housing Market in Greece (2015)	**Theodore Panagiotidis and Panagiotis Printzis**	Dependent-HPI Independent-CPI, Volume of Retail trade, Loan Interest Rate, Annual Growth Rate of Mortgage, Money Supply growth rate (M1), Unemployment	VECM	CPI (+) Volume of Retail trade (+) Loan Interest Rate (-) Annual Growth Rate of Mortgage (+) Money Supply growth rate (M1)(+) Unemployment (-)
Real House Prices in OECD Countries: The Role of Demand Shocks, Structural and Policy Factors (2010)	**Andrews Dan**	Dependent-housing prices Independent-Interest rates, disposable income, CPI, for 29 OECD countries 1980-2005	VECM (Vector Error Correction Model)	Interest rates (-) Disposable income (+) CPI (+)

Table 2.1: Literature Review (Cont;)

TITLE	AUTHORS	VARAIABLES	METHODOLOGY	RESULTS
Macroeconomic Factors and Housing Market Cycle both on the national level and using data from four typical cities from China which include Beijing, Shanghai, Guangzhou and Chongqing(2010)	**Lei Feng, Wei Lu, Weiyan Hu, Kun Liu**	Dependent-HPI Independent-GDP, Urban Population, Disposable income, Fixed Asset Investment, CPI, Loans of financial institution, Housing stock, Cost of construction completed residential units	VECM	GDP (+) Urban Population (+) Disposable income (+) Fixed Asset Investment (+) CPI (+) Loans of financial institution (-) Housing stock (-) Cost of construction completed residential units (+)
Financial Structure and the Impact of Monetary Policy on Asset Prices (2008)	**Assenmacher - Wesche and Gerlach**	Dependent-GDP, Asset Prices Independent-interest rates	VAR	Interest-rate-GDP (-) Interest-rate-Asset Prices (-)

Table 2.1: Literature Review (Cont;)

TITLE	AUTHORS	VARAIABLES	METHODOLOGY	RESULTS
Housing Prices and Macroeconomic Factors: Prospects within the European Monetary Union (2003)	**Nicholas Apergis**	Dependent-HPI Independent-CPI, Employment, Mortgage Interest Rate	ECVAR	CPI (+) Employment (+) Mortgage Interest Rate (-)
House price dynamics and their reaction to macroeconomic changes (2003)	**Ogonna Nneji, Chris Brooks, Charles Ward**	Dependent – residential property market prices Independent-inflation, disposable income growth, the short rate and the term structure of interest rates	Markov Switching Model	Inflation (+) Disposable income growth (+) The short interest rate (-) The term structure of interest rates (-)
Housing Prices and Macroeconomic Factors in Greece: Prospects within the EMU (2000)	**Nicholas Apergis and Anthony Rezitis**	Dependent-Housing Price Independent-housing loan rates, inflation, employment, and money supply	ECVAR	Housing loan rates (-) Inflation (+) Employment (+) Money supply (+)

Table 2.1: Literature Review (Cont;)

TITLE	AUTHORS	VARAIABLES	METHODOLOGY	RESULTS
The Dynamic Impact of Macroeconomic Aggregates on Housing Prices: A National and Regional Analysis (1998)	**Baffoe-Bonnie**	Dependent-Housing price, Stock of houses Independent-housing stock, prices, interest rates, CPI, employment, money supply	VAR	Interest rates (-) CPI (+) Employment (+) Money supply (+)

From all the literatures on housing prices, many researchers use different methodology, which are suitable with their variables available, and time frame. In this study, we applied Engle-Granger two-step approach for time-series data of Singapore's housing price, GDP and CPI for testing the cointegration of long-run and short-run. In addition, we estimated if there was intermittent cointegration between variables by using Markov-switching model. The following literature reviews are that we replied on for choosing the methodology. For exceptional, we used Engle-granger instead of Johansen cointegration test because we don't have sufficient amount of data to run Johnhansen cointegration.

Tien-Foo Sing, I-Chun Tsai,Ming-Chi Chen (2006) examined the time-series data of Singapore(1990-2006) by using VECM. The variables used in that are public housing price, private housing price as dependent variables and GDP growth, stock market return, prime lending rate, and unexpected inflation rate as independent variables. They firstly used STOPBREAK process to test if there was temporary cointegration between variables. After that, they used VECM to test if there was long-run and short-run cointegration.

Shanmuga Pillaiyan (2015) examined Macroeconomic Drivers of House Prices in Malaysia. He used HPI as dependent variable and GDP, CPI, Number of housing, money supply, and Consumer sentiment index from 2000 to 2010. Firstly, he tested unit-root test. Consumer sentiment index is integrated at level (0) and the rest are integrated at level (1). He used Johnhanson cointegration for long-run cointegration and VECM to test short-run and long-run cointegration.

Theodore Panagiotidis and Panagiotis Printzis (2015) investigated macroeconomic determinants of the Greece's housing market. They used the quarterly data from 1997-2013 as housing price is dependent variable and Consumer Price Index, Industrial Production Index, volume of Retail trade, loan interest rate, annual growth rate of mortgages ,money supply growth rate M1 and the Unemployment rate. They firstly tested the unit-root test with Phillips-Perron test and Structural break. All the variables are integrated at I(1). To decide the lag order, they used AIC. To estimate the long-run and short-run relationship, they used Johansen cointegration and VECM. At conclusion, they tested the variance decomposition (Cholesky decomposition) to examine the response of a variable aftershocks to the other variables.

Nicholas Apergis(2003) studied House price dynamics and their reaction to macroeconomic changes using property price as dependent variable and inflation, disposable income growth, the short rate and the term structure of interest rates as independent variables from 1960Q1 to 2011Q3. They employ a three-state Markov switching nonlinear econometric model to examine the relationship between the residential real estate market and key macroeconomic variables in the US. There are normally three regimes in housing market that are steady-state, boom and crash regimes. They found that macroeconomic fundamentals seem not to be affective at all to the real estate market in housing bust situation. Our goal is to find the estimated probabilities of switching from one regime to another. They found out that probability of moving housing boom from housing bust is 5%, but 98% chance of remaining within steady-state if the housing market was previously in the steady-state. They find there is a statistically significant and positive relationship between increases in the term spread and the probability of being in the housing crash regime, thus implying that a reduction in the spread between long and short-term interest rates reduces the probability of being in the

crash regime. Interest rates and money supply cannot, however, be used to instigate a switch away from a housing bust.