CHAPTER 4

Empirical Findings and Results

4.1 DF-GLS Unit Root Test

In this chapter, we discussed the results of empirical findings of the Singapore from 1990 to 2015. In table, we showed t-statistics, p value and the result of unit root test on variables we have chosen. We took the logarithm of one variable due to go along with our chosen methodology and to convert the same unit as well. Moreover, log transformation can help lessen high skewed distributions.

There are two hypotheses; null H_0 and alternative H_1. If the variable cannot reject null hypothesis, it has unit root test and if the variable rejects null hypothesis, it does not have unit-root test. We can check rather accept or reject null-hypothesis two ways. The first one is to check test statistics with critical values from 1%, 5% and 10% level. The second one is to check the p-values that must be less than at least 10% significant level to reject the null hypothesis. According to our model of cointegration, variables must be cointegrated at I (0) and I(1). So, it's necessary that our data must integrated at I(0) and I(1).

Table 4.1: DF-GLS Unit-root Tests with optimal lags

Variable	Order of Integration	Level		First Difference	
		DF-GLS tau	10% Critical value	DF-GLS tau	10% Critical value
Private HPI	I(1)	-1.811	-3.108	-3.747	-3.121
Public Resale HPI	I(0)	-3.179	-2.856		
CPI	aI(1)	-1.695	-3.084	-3.127	-3.121
ln(GDP per capita)	I(1)	-2.780	-2.856	-4.727	-3.121

Source: Calculated by author

The unit-root tests for lnGDP, Public Resale HPI and CPI are rejected at I(0)because their teststatic value is greater than 10% critical values which means we cannot reject null-hypothesis and they have unit-root at I(0). But in I(1), teststatic values of lnGDP, Public Resale HPI and CPI are greater than 10% critical values which means we can reject null-hypothesis and they do not have unit-root test at I(1).

The rest variable "Private HPI" test for unit-root is that we can reject the null hypothesis at I (0) since testststic variable is gretaer than 10% critical values, which means it, is integrated at I (0).

We can conclude that three variables- lnGDP, Public Resale HPI and CPI are stationary at level I(1). The one variable Private HPI is not stationary at I(1) but stationary at I(0).

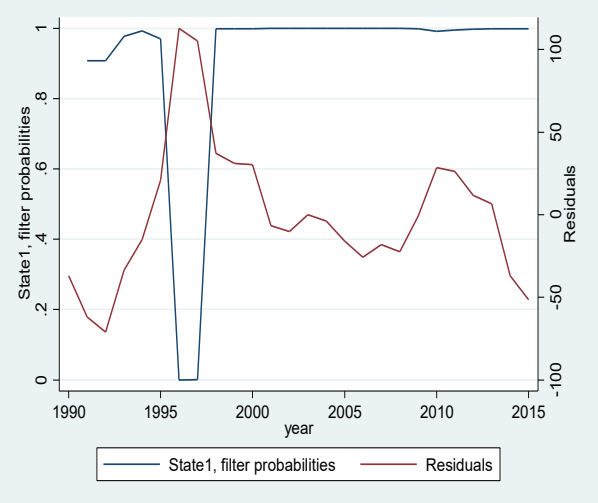
4.2 Engle-Granger (EG) intermittent cointegration (Markov Switching Model) tests

In this section, we tested intermittent cointegration to know rather which variables have intermittent in cointegration in which year. In normal Engle-granger cointegration, it can only say cointegrated or not but it can't differentiate which year are intermittent. That's why we come in thought to test this intermittent cointgration. Two price series may move together and occasionally jump apart as a result of an external shock. The random responses to shocks cause problems to the cointegration tests, which may fail to detect long-run contemporaneous relationships in price generating processes. In the Markov Switching model with time-varying stochastic shocks, price series are said to be temporary cointegrated if one or two of the states has unit-root.

Table 4.2: Intermittent cointegration test for public HPI and CPI

VARIABLES	(1) State1	(2) State2
L.ar	0.757***	1.058***
	(0.153)	(0.347)
Constant	-10.21	65.35***
	(16.87)	(24.26)
Observations	25	25

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1



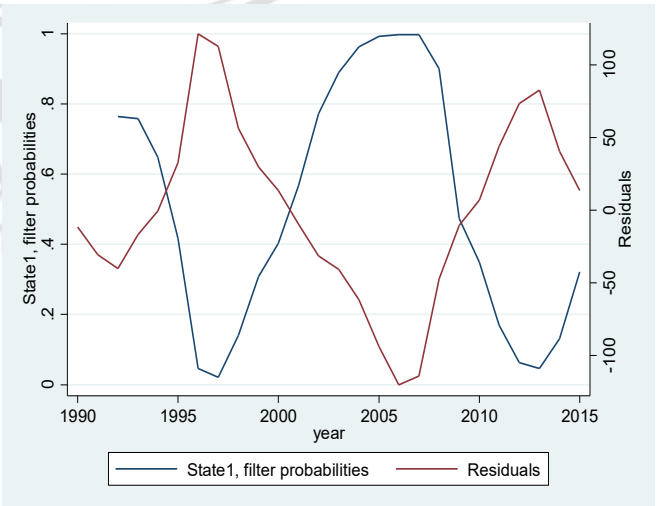
Source: Calculated by author

From the autoregressive Markov switching estimation for the residuals, State 1 estimate shows that there is no unit root but State 2 shows that there exists unit root. The Markov switching graph shows the probability of each year being in State 1. Therefore, public HPI and CPI are likely to be cointegrated in all periods except year 1996 and 1997. We would like to state that intermittent cointegration occur because of the Asia Financial crisis in 1996 and 1997.

Table 4.3: Intermittent cointegration test for public HPI and ln(GDP per capita)

VARIABLES	(1) State1	(2) State2
L.ar	0.678	0.339
	(0.424)	(0.312)
Constant	-23.64	40.64*
	(34.68)	(24.17)
Observations	24	24

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1



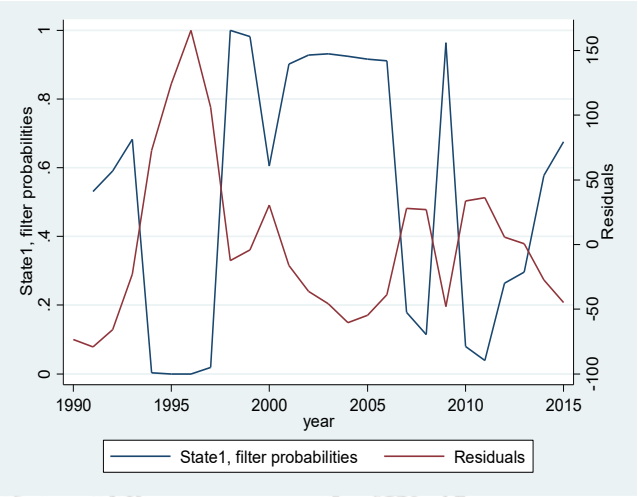
Source: Calculated by author

From the autoregressive Markov switching estimation for the residuals, both State 1 and State 2 shows that there has no unit root. Therefore, public HPI and GDP per capita are likely to be cointegrated in all periods.

Table 4.4: Intermittent cointegration test for private HPI and CPI

VARIABLES	(1) State1	(2) State2
L.ar	0.412*	0.971***
	(0.231)	(0.168)
Constant	-29.64**	45.16*
	(13.94)	(24.63)
Observations	25	25

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1



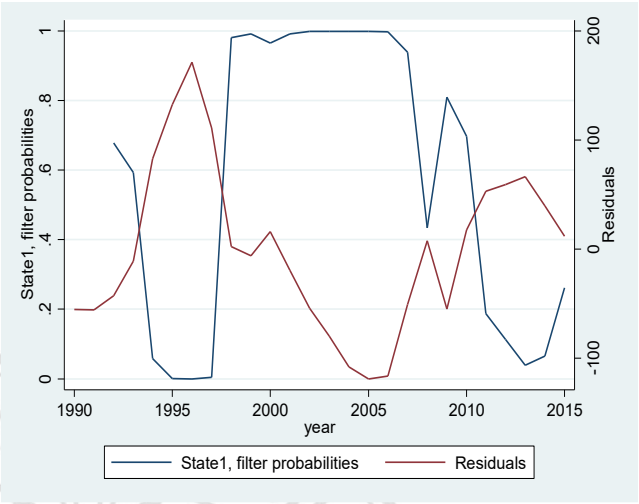
Source: Calculated by author

From the autoregressive Markov switching estimation for the residuals, both State 1 and State 2 shows that there has no unit root. Therefore, private HPI and CPI are likely to be cointegrated in all periods.

Table 4.5: Intermittent cointegration test for private HPI and ln(GDP per capita)

VARIABLES	(1) State1	(2) State2
L.ar	0.461*	0.738**
	(0.274)	(0.334)
Constant	-41.93	66.39**
	(34.57)	(33.49)
Observations	24	24

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1



Source: Calculated by author

From the autoregressive Markov switching estimation for the residuals, both State 1 and State 2 shows that there has no unit root. Therefore, private HPI and GDP per capita are likely to be cointegrated in all periods.

We can conclude from the result that all of the variables are cointegrated along the period that we studied except public HPI and CP

4.3 Results of Engle-granger two steps approach

In this section, we decided to use Engle-granger two steps approach as methodology to test the long run and short-run relationship. The study focuses on how house price is affected by other variables, the single- equation with house price and other variables may accommodate. The long-run relationship that could potentially exist between the two variables can be examined and more importantly be estimated with the estimation of a ECM model afterwards.

Table 4.6: Long-run and short-run relationships of public resale HPI with CPI and ln(GDP per capita)

	Public Resale HPI			
	CPI	CPI	ln(GDP per capita)	ln(GDP per capita)
VARIABLES	Long-run	Short-run	Long-run	Short-run
L._egresid		-0.482***		-0.312**
		(0.132)		(0.009)
LD.CPI		10.65**		
		(3.823)		
CPI	12.53***			
	(0.815)			
lnGDPpercapita			308.9***	
			(30.63)	
LD.lnGDPpercapita				231.62
				(142.42)
Constant	-654.8***	7.719	-2,981***	5.2513
	(65.07)	(4.740)	(329.2)	(9.765)
Observations	26	26	26	26
R-squared	0.908	0.569	0.809	0.40

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Calculated by author

Table 6 presents the estimation of public resale housing price and other macroeconomic variables. For the long-run relationship, the coefficients of the variables go along with our expected signs. Regarding the effect of CPI on public HPI, the estimate is 12.53. This implies that a unit increase, in the long-run CPI is associated with a 12.5-

unit increase in public HPI. In the effect of GDP per capita on public HPI, the estimate is 308.9, which implies that 1-unit increase in GDP, in the long run, is associated with a 3.08-unit increase in government HPI.

For the short-run, the effect of CPI on public resale HPI is 10.65, which means that 1 percent increase in CPI cause 10.65-unit increase in public resale HPI. In the effect of GDP on public resale HPI, the p-value is insignificant which means there is no cointegration is short-run.

The sign of the coefficient of the error term in the previous year (ε_{t-1}) is expected to be negative. This ensures that the error term in period t-1 to be corrected this year to its equilibrium level. The error correction coefficients for both regressions are significant and have the expected negative signed. The coefficients of the error term in the previous year (ε_{t-1}) were -0.483 and -0.293 for the short-run public resale HPI regressions with CPI and GDP per capita respectively. That means CPI for public resale HPI is -0.482 of the short-run adjustment coefficient of the deviation. The Public resale HPI from its long-run equilibrium level is corrected each year, and GDP for public resale HPI is -0.293 of the short-run adjustment coefficient of the deviation of the Public resale HPI from its long-run equilibrium level, corrected each year. These results ensure that the error term in period t-1 is rectified in the given year to its long-run equilibrium level.

Table 4.7: Long-run and short-run relationships of private HPI with CPI and ln(GDP per capita)

		Private HPI		
	CPI	CPI	ln(GDP per capita)	ln(GDP per capita)
VARIABLES	Long-run	Short-run	Long-run	Short-run
L._egresid		-0.4199**		-0.247**
		(0.1439)		(0.1051)
LD.CPI		12.988**		
		(6.204)		
CPI	10.44***			
	(1.180)			
lnGDPpercapita			253.1***	
			(37.10)	
LD.lnGDPpercapita				710.10***
				(183.344)
Constant	-419.8***	-0.9458	-2,312***	-22.075
	(94.21)	(12.496)	(398.8)	(12.44)
Observations	26	26	26	26
R-squared	0.765	0.419	0.660	0.260

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Calculated by author

Table 6 shows the estimation of private housing prices and other macroeconomic variables. The coefficients of the variables go along with our expected signs. Regarding the effect of private HPI on CPI, the estimate is 10.44. This implies that a 1percent increase in CPI is cause 10.44unit increase in Private HPI in the long-run. In the effect of private HPI on GDP per capita, the estimate is 253.1, which implies that 1 percent increase in GDP in the long run cause 2.53-unit increase in Private HPI.

For the short-run, the effect of CPI on public resale HPI is 12.988, which means that 1 percent increase in CPI cause 12.988unit increase in public resale HPI. The effect of GDP on public resale HPI is 710.10, which means that a 1 percent increase in GDP causes a 7.10-unit increase in public resale HPI in the short-run.

For the ECM result of CPI for private HPI is -0.4199 of the short-run coefficient of the deviation of the Private HPI from its long-run coefficient level is corrected. Due to the estimation of ECM for GDP, -0.247 of the short-run coefficient of the deviation of the Private HPI from its long-run coefficient level is corrected.

As a conclusion, both in the long run, GDP and CPI are positively effective to HPI as we forecast according to the literature review. We can conclude that public resale HPI is more sensitive in both GDP per capita and CPI compare to the private HPI in the long-run. We should not expect the changes in these variables would affect the change in house price in the short-run, but only in the long-run.

From our long-run regression results, both the public and private housing prices go up much faster than the CPI and GDP per capita, which is not very good. If there is no further intervention by the government, Singapore is likely to experience a more severe housing affordability problem in the long-run.

Homeownership affordability has always been an obvious symbol of the government's "ability to fulfil its promise to improve the living conditions of the entire nation" (Chua 1997, 139). In this study, we use two indicators of housing affordability, which are

(1) The relative prices of housing and other goods and services measured using the long-run relationship between housing price indices and the CPI and;

(2) Housing price relative to income measured using the long-run relationship between housing price index and the GDP per capita.

For the public real estate market, CPI and Public resale HPI are cointegrated in all periods except for 1996 and 1997. The long-run regression shows that a 1percent increase in CPI cause 10.44unit increase in Private HPI. For the private housing market, the long-run regression indicates that a 1 percent increase in CPI causes a 10.44unit increase in Private HPI. This shows that both housing markets went up faster than other goods and services. That means a reduction in housing affordability in both markets in the long-run.

The ability to afford property ownership depends on the household income that means the higher the household income; the more affordable is the property. For the public resale housing market, a 1 percent increase in GDP, in the long run, is associated

with a 3.08-unit increase in government HPI. For the private residential market, a 1 percent increase in GDP in the long term causes a 2.53-unit increase in Private HPI. These indicators suggest that housing prices rise faster than GDP per capita, which is not good at all.

The continuous upward trend in prices and the economic and political risks of a housing bubble and increasingly unaffordable housing urge the government to intervene.