Can Housing Bubbles persist under Normal Credit Conditions?

Master's Thesis by Kyungeun Kim

Supervisor: Dr. Thomas Fisher

Lund University School of Economics and Finance

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Abstract

This paper analyzes house prices for a panel of 19 countries over a period of 21 years using broad categories of macroeconomic variables in order to detect possible bubble effects. The sample is divided into two sub-samples, one with normal credit conditions and one with abnormal credit conditions. “Normal” credit conditions are defined by the percentage of securitized mortgages in each country. The sub-sample with abnormal credit conditions are countries in which there are ex post confirmed housing bubbles, and the sub-sample with normal credit conditions are the countries in which we are testing for possible bubbles. The variance decompositions from Error Correction Vector Autoregressions (ECVAR) show that it is unlikely that the countries with normal credit conditions contain any significant bubble effects, from which we can generalize that it is difficult for housing bubbles to persist over long periods of time, under normal credit conditions.

Key words: Housing bubbles, Macroeconomic factors, ECVAR

1. Introduction

Due to the presence of perceived "bubbles" in the real estate market, many governments have tried to analyze the macroeconomic factors affecting real estate, and to adjust these factors through government policy in order to reduce these so-called "bubbles."

However, it is sometimes difficult to distinguish between a bubble and a booming market for which there is a very real demand. For example, due to the fact that most of the infrastructure is concentrated in a few big cities for most countries, this may create a perceived bubble effect that is in fact driven by real or residential demand.

Also, the dual nature of real estate being both a consumption good and a financial good complicates matters. There is no doubt that real estate is used as an investment device, in other words, that there is speculative demand. However, unlike other financial assets, the underlying fundamental must be "consumed", since houses must be lived in or else face devaluation, and housing services provide direct utility to tenants. This should lead to a lower degree of abstraction in the valuation of real estate compared to other financial goods (although not necessary always the case). Also, overpricing due to speculation must eventually be met with real demand in equilibrium, so these price fluctuations should be cyclical, exhibiting mean reversion. It seems therefore unlikely that bubbles, or large-scale pricing errors can persist over many years in the real estate market.

One clear exception to this was the U.S. mortgage crisis of 2008. The conditions that lead to the crisis, however, were atypical, with the collateralized debt market allowing for faulty and excessive loans to mortgage borrowers. Although this was not the sole cause of the crisis, it can definitely be seen as a necessary condition that made it possible for the crisis to occur. Homeowners borrowed with the expectation that house prices would continue to rise, in other words, they were banking on the idea that real estate was a riskless investment, and the collateralized lending conditions made this easier for them.

If we take the formal economic definition of an asset bubble, it is when prices deviate from the level that is justified by fundamentals. In the case of housing, the fundamental is the utility of residence, or dividends, as can for example be measured by rent prices (the utility of living cannot directly be measured in the case of owner-occupied homes). In the case of a housing bubble, prices would reflect more on future expected returns than on the discounted value of these dividends. We can conclude that when the "investment" or financial aspect of real estate dominates the consumption good aspect, the market becomes a bubble.

In this paper, several countries in which there are perceived bubbles will be examined. These countries will be divided into a sample with normal credit conditions and a sample with “abnormal” credit conditions. An Error Correction Vector Autoregressive (ECVAR) model will be used to capture the endogenous interactions of the housing sector with the macroeconomy. Then, through variance decompositions, we will look at which factors contribute most to house price variations, from which we can deduce whether in fact these markets contain bubbles or are driven by real demand. We may then be able to generalize whether housing bubbles can persist over many years, under normal credit conditions.

Although VARs have been used to model house prices for individual countries in the past (Apergis 2003, Brooks & Tsolacos 1999, Iacoviello 2000), this is the first time, to the author’s knowledge, that VARs have been used to model house prices for a large panel of countries. The methodology for detecting bubbles used in this paper is, as well, original and not found in previous literature, to the author’s knowledge. Traditional methods for detecting bubbles such as the user cost model will be discussed in the Literature Review section, as well as the flaws of each of these previous methods.

The tricky aspect about a bubble as far as empirical research is concerned, is that its existence cannot be proven in a strict sense, until the bubble actually bursts. Therefore, no methodology is exact, and the methodology used in this paper is, as well, only a diagnostic test based on macroeconomic indicators, and in no way confirms or disconfirms the existence of bubbles in the hypothesized countries.

2. Review of the Literature

Much research has been done on real estate valuation and the factors affecting real estate, but largely the literature can be divided into pre- and post-U.S. mortgage crisis. Before the crisis, the literature has largely focused on valuation methods. In their 1994 paper, Born & Pyhrr discuss the cyclicality of the factors affecting real estate. They claim that traditional valuation models overestimate prices during economic expansion and underestimate them during contraction, due to the assumption of trends as opposed to economic cycles. According to their study, the most important single variable affecting value is the "rent rate catch-up cycle", which can be defined as the time required for rent rates to reach equilibrium conditions, in which market supply equals market demand.

Housing as related to macroeconomic variables has been an area of extensive research, both before and after the crisis. In their paper, Davis & Van Nieuwerburgh (2015) discuss the interplay of housing, finance and macroeconomics. They find that there is a great deal of heterogeneity in house prices, both on the metropolitan and national level, as well as in owner occupied vs. rented homes. They also find that household economic activity is closely linked with the housing market. More specifically, housing wealth tends to increase household consumption, and there is also a high correlation between house price growth and income growth. They claim that because investment in housing is much more leveraged than investments in other financial assets, real estate is much more sensitive to monetary policy. This is confirmed by the empirical findings of Iacoviello (2000). Piazzesi & Schneider (2016) also study the relationship between housing and macroeconomics. They find that housing expenditure as a fraction of total consumption is relatively constant over time and that changes in house prices experience a reversal in sign approximately every 5 years.

Empirical research on the area has made use of Vector Autoregressions (VARs) to model the interaction between housing and the macroeconomy. Apergis (2003) examined the effect of macroeconomic variables on new houses sold in Greece. He argues that since many of the macroeconomic variables are influenced by supply and demand shocks in the housing sector, they will be endogenous. Therefore, he uses a VAR to account for these effects. He finds that deregulation of the monetary sector leads to higher house prices, and that housing mortgage rate has the highest explanatory power over variation in real house prices. Through impulse response functions, he determines that positive shocks to housing mortgage rate decrease house prices.

Brooks & Tsolacos (1999) also use a VAR to investigate the impact of macroeconomic and financial variables on a U.K. real estate return series. They find that none of the macroeconomic or financial variables used in existing research have a significant explanatory power over property prices in the U.K., except for the lagged values of the real estate return series themselves. They attribute this to the potential peculiarity of the particular data set that is used. The fact that real estate returns themselves are highly autocorrelated is explained by the fact that information is incorporated slowly into the real estate market, therefore current returns have predictive power over future returns.

Adams & Füss (2010) examine the macroeconomic determinants of housing based on a panel of 15 countries over 30 years. They consider the possibility that house prices may exhibit a feedback reaction to the macroeconomy, and run a Panel Dynamic Ordinary Least Squares regression, which takes into account serial correlation and endogeneity of regressors. They find that several countries show a similar long-run response to macroeconomic changes, and that the speed of adjustment to equilibrium after a shock is slower than previously suggested. As predicted, they find an increase in economic activity leads to an increase in house prices, and an increase in construction costs likewise had a positive effect, due to the reduction in supply. They find that a higher long-term interest rate decreases the value of real estate, as other fixed-income investments such as bonds become relatively more attractive.

After the 2008 crisis, there has been more research that look specifically into the nature of housing bubbles. Glaeser & Nathanson (2014) examine various models for predicting housing bubbles. They claim that one key aspect of housing is that the difficulty of arbitrage allows prices to deviate from fundamentals much more so than other assets. According to them, internally driven bubbles are defined by significant positive serial correlation in price growth, in which price growth itself is the factor driving more growth. In comparing rational vs. semi-rational models, they find that rational bubbles are possible only when default risk is underpriced. Pertaining to the U.S. housing boom of the 2000s, Piazzesi & Schneider (2016) find that the securitization of mortgages decreased the incentive for banks to screen borrowers, and along with the tendency of young homeowners with bad credit scores to extract more equity from their homes, this increased both the supply and demand for mortgages, leading to an overall increase in the amount of mortgage debt.

Maher (2019) uses several different methods to detect housing bubbles in Sweden during the period 1986-2016. The first of these methods is ratio analysis, where price-to-income ratios or price-to-rent ratios are used to determine deviations from fundamentals. In the case of owner-occupied homes, the user cost or imputed rent is compared to actual rents. He finds that the user cost model, is, however, extremely sensitive to assumptions about expected capital gains. Next, he uses a Vector Error Correction Model (VECM) to determine the long run equilibrium relationship between house prices and macroeconomic factors, and deviations from this relationship. He finds that adjustment back to equilibrium can take decades, even longer than proposed in Adams & Füss (2010). One flaw in this equilibrium relationship method is that it is sensitive to the particular set of variables used, i.e. if the variables don't fully explain house prices, adjustment back to equilibrium will be very weak, even in the absence of a bubble. Lastly, he uses a right-tailed alternative of the unit root test to find periods with explosive autoregressive coefficients in house prices. A combination of these methods leads to the conclusion that the Swedish housing market has been overvalued since the mid-2000s.

Mayer (2011) looks into possible causes and explanations of housing bubbles around the world over the past 25 years. According to him, there are generally three methods of examining deviations from fundamentals: the user cost of capital model, construction costs, and affordability metrics as measured by macroeconomic factors such as household income. He finds that declining interest rates and an increase in subprime lending were common factors among countries with housing booms during the most recent cycle, but they have limited ability in explaining the full extent of house price volatility. He concludes by saying that there is still no consensus about what caused the most recent crisis or how to diagnose housing bubbles in the future.

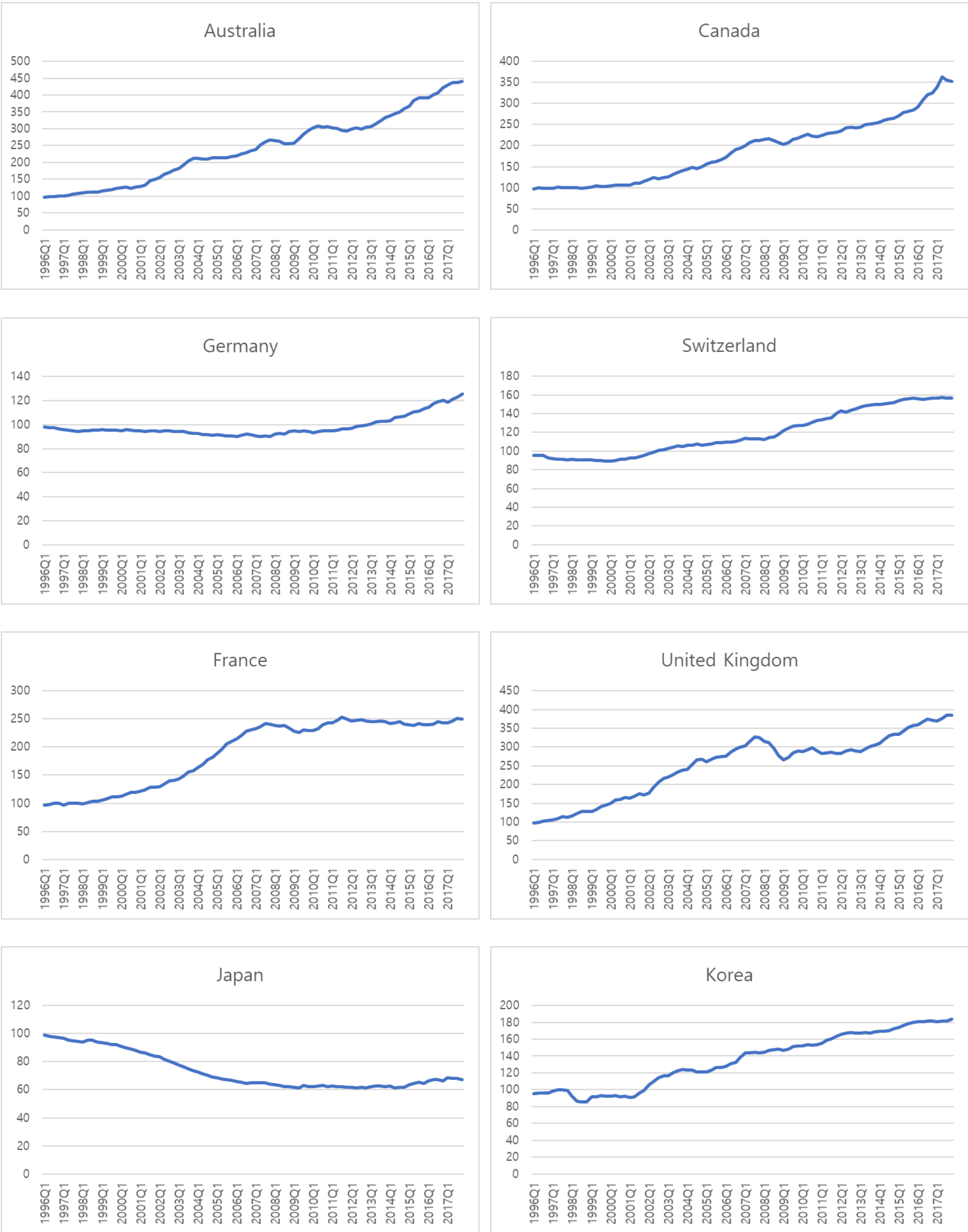
3. Data and Methodology

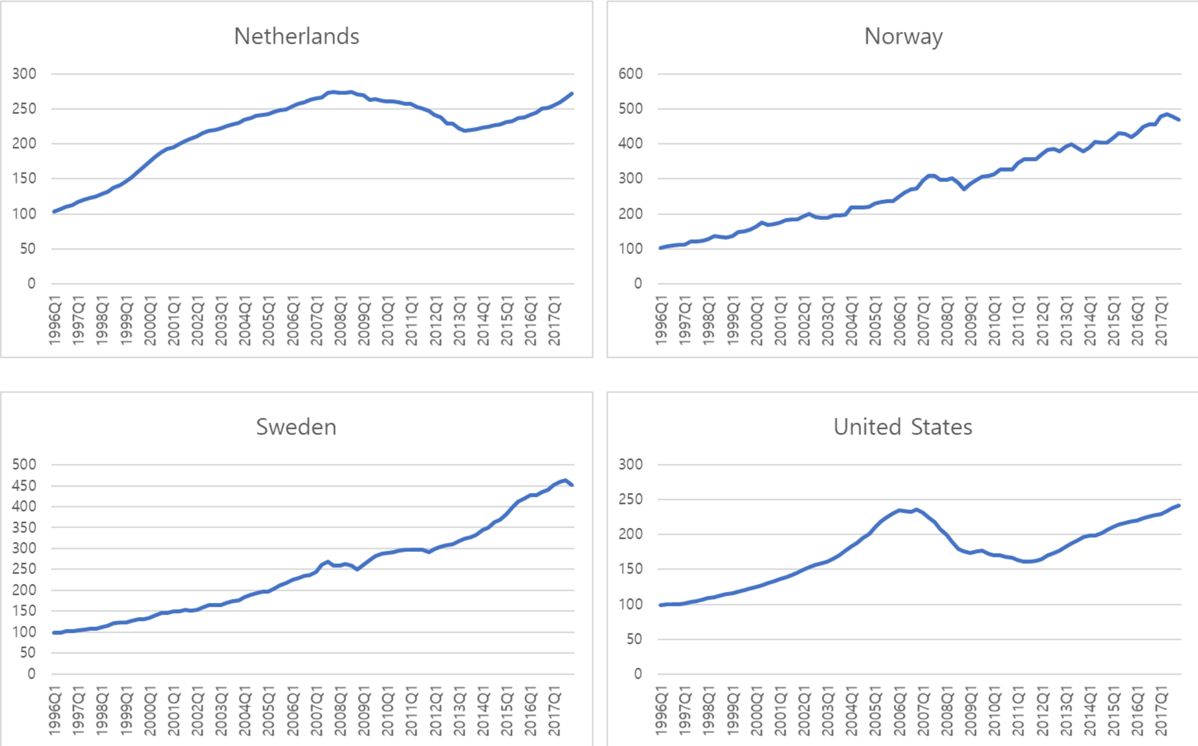
For the left-hand side variable, real residential house prices for 19 developed countries were used, taken at a quarterly frequency, from Q1 1996 to Q4 2017. The period was chosen based on the availability of all the corresponding macro data. Nominal house prices, taken from the Bank for International Settlements, were deflated using the CPI for each country, which was provided by the OECD. In order to analyze our "bubble" hypothesis, we can first take a look at the levels of the house prices of the countries in which there are perceived bubbles in the year 2018, according to financial websites.[1] While housing bubbles mostly center around cities, and there is a great deal of heterogeneity between cities, due to the availability of data, we will have to assume that these bubble effects (if present) dominate the portfolio of house prices on a national level. Indeed, given the level of urbanization in developed countries, this seems to be a fair assumption. The house price graphs for these 12 countries are shown in Figure 1.

[1] *The World's Biggest Real Estate Bubbles in 2018.* Visual Capitalist.
UBS Global Real Estate Bubble Index. UBS.

Figure 1

Real house prices for 12 countries in which there are perceived bubbles, according to financial websites, 2018. House prices are normalized so that the 1995 values are equal to 100.



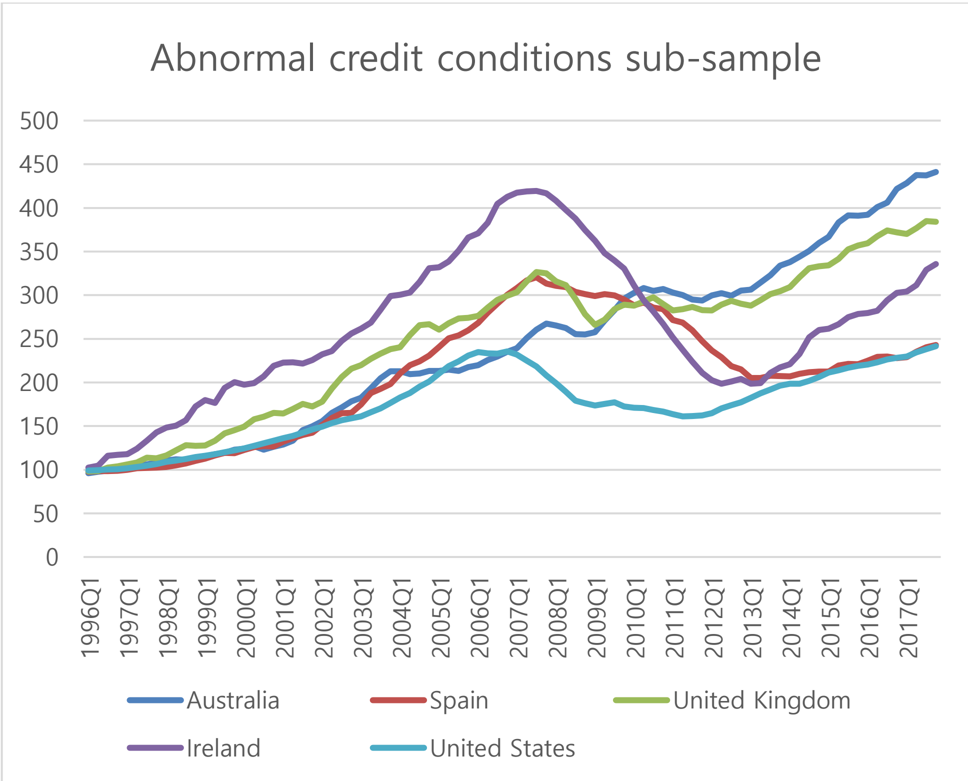


In order to select our "bubble" sub-sample for analysis, we can first screen for countries in which house prices increased consistently during the 1996-2017 period. Surprisingly, the house prices for Germany have been relatively stable during this 21 year stretch, and the house prices in Japan have even gone down steadily. We can conclude that the bubble effects in these countries (if present) do not dominate the portfolio of house prices on a national level. Therefore, these two countries are excluded from the bubble sub-sample.

It is also important to define "normal" credit conditions. Although there are many aspects to mortgage credit, such as Loan-to-Value ratio, or the interest rates themselves, the aspect that is most relevant and comparable in predicting bubbles ex post for the sample period is the securitization of mortgages. Since securitization of mortgages was arguably the main catalyst for the U.S. crisis from a financial perspective, the percentage of securitized mortgages will be used as a criterion for screening countries for normal credit conditions. According to Cardarelli et al. (2008), the countries with the highest percentage of securitized mortgages as of 2008 are, along with the U.S., Australia, U.K., Ireland, and Spain in our sample. Incidentally, these were all countries that went through a similar crash during the U.S. financial crisis. Therefore, these countries can be interpreted as cases in which there was a clear housing bubble "crash," of varying magnitudes as can be seen in Figure 2. In a separate regression, we will look at these "abnormal" credit condition countries for the purpose of comparison.

Figure 2

Real house prices of countries with the highest rate of securitized mortgages as of 2008.



So, with the U.S., Spain, Ireland, Australia and the U.K. being further excluded, we will look at Canada, Switzerland, France, Korea, Netherlands, Norway, and Sweden, for our bubble sub-sample with normal credit conditions.

In these countries, we can see that there have been small fluctuations or disturbances in the otherwise steady increase of house prices, which can be seen as "mini" booms and busts. However, none are nearly as significant as the 2007-2009 crash for the abnormal credit conditions countries. This small fluctuation around 2007-2009 can also be found in several countries in which the markets are correlated with the US market.

A summary of the countries contained in each sample are presented in Table 1.

Table 1

Summary of the countries contained in each sample.

Sample	Full Sample	Abnormal Credit Conditions Sub-sample	Normal Credit Conditions Sub-sample
Countries	Australia, Belgium, Canada, Switzerland, Germany, Denmark, Spain, Finland, France, United Kingdom, Ireland, Italy, Japan, Korea, Netherlands, Norway, New Zealand, Sweden, United States	Australia, Spain, United Kingdom, Ireland, United States	Canada, Switzerland, France, Korea, Netherlands, Norway, Sweden

Since the effect of specific macroeconomic variables is well established in the literature, i.e. interest rates are negatively correlated with house prices, employment and consumption are positively correlated with house prices, etc., we will instead use broad categories of macro variables to detect possible bubble effects. The variables were divided into two broad categories: Economic Activity and Monetary factors. In their paper about macroeconomic factors affecting international housing markets, Adams & Füss (2010) define "Economic Activity" as the first principal component of the matrix consisting of real money supply, real consumption, real industrial production, real GDP, and employment. In this paper, a similar method is used for the variables Economic Activity and Monetary factors, where Economic Activity is the first principal component of a matrix containing real GDP, real money supply, and real consumption; and Monetary factors are the first principal component of the matrix containing real long-term interest rate and real mortgage interest rate. All variables were transformed to their natural logarithms, to insure comparability of variable influences.

Table 2

Descriptions of the macroeconomic variables used to regress house prices.

Variable group	Economic Activity			Monetary factors	
Variables	Real GDP	Real money supply	Real consumption	Long-term interest rate	Mortgage interest rate
Source	Thomson Reuters Datastream	OECD Data	Thomson Reuters Datastream	OECD Data	Thomson Reuters Datastream

Variance decompositions from the ECVAR will tell us which of the factors contribute most to the variance of house prices. In interpreting the results, Economic Activity will reflect the "real" demand for houses, since it relates to the purchasing power of the economy as a whole, and Monetary factors will reflect the "investment" demand, since interest rates are likely to mostly affect the decision making of speculative buyers. We expect Monetary factors to dominate the Economic Activity factor for the case of confirmed bubbles. For the case of countries with normal credit conditions, the Monetary factor will dominate the Economic Activity factor if bubbles exist, and the opposite will be true if they don't exist.

The reason rent prices were not used to reflect residential demand is that there is a great deal of heterogeneity between rented homes and owner-occupied homes, and therefore rent prices do not accurately reflect the market as a whole. Although demographic variables were also initially considered, most demographic variables were not available at quarterly frequencies, and population, the only demographic variable available at a quarterly frequency, has been shown to have an insignificant impact on house prices in the literature.

4. Empirical Analysis

4.1 Full Sample

We first conduct a preliminary analysis on the full sample of 19 countries, including countries which have no perceived bubble effects. Before proceeding with the ECVAR model, we can first check our three variables, Real House Prices (RHP), Economic Activity (EA), and Monetary factors (Monetary) for unit roots. We use a summary of several different panel unit root test methods, namely: Levin, Lin & Chu, Im, Pesaran and Shin (IPS), ADF-Fisher and the PP-Fisher tests. The Levin, Lin & Chu method assumes a common unit root process for the cross-section units, whereas the other three methods assume different individual unit roots. The results of these tests are shown in Appendix A.

We get that all four variables have unit roots in levels, with the test statistics indicating individual unit roots for each cross-section. After running unit root tests on first differences, we get that all variables are stationary. Therefore, RHP, EA, and Monetary are all integrated of order 1. We will next consider these three variables for cointegration testing.

There are several methods for testing cointegration in panel data, but we will use the Kao Cointegration Test because the assumptions are relatively simple and easy to interpret. The Kao test assumes cross-section specific intercepts (individual fixed effects) and homogeneous first-stage regression coefficients. In the bivariate form it would look like:

$$y_{it} = \alpha_i + \beta x_{it} + \varepsilon_{it} \tag{1}$$

Where α_i is heterogeneous and β is homogeneous across cross-sections (Kao 1999). Then the residuals from this equation are tested for unit roots:

$$\varepsilon_{it} = \rho \varepsilon_{it-1} + v_{it} \tag{2}$$

Despite the possibly restrictive assumption of homogeneous coefficients, we still get that the three variables, RHP, EA, and Monetary are cointegrated.

Next, we run an ECVAR for our full sample with RHP, EA, and Monetary as endogenous variables. An ECVAR combines the levels and first differences of variables in order to capture both the long-term as well as the short-term relationships between variables (Brooks 2014). The residuals from the cointegrating equation of the variables' levels are used along with the first differenced terms of the variables. An ECVAR with g variables in matrix form would look like:

$$\underset{g\times 1}{\Delta y_t} = \underset{g\times g}{\Gamma_1}\underset{g\times 1}{\Delta y_{t-1}} + \underset{g\times g}{\Gamma_2}\underset{g\times 1}{\Delta y_{t-2}} + \cdots + \underset{g\times g}{\Gamma_k}\underset{g\times 1}{\Delta y_{t-k}} + \underset{g\times 1}{\Pi \hat{u}_{t-1}} + \underset{g\times 1}{v_t} \tag{3}$$

Where $\hat{u}_{t-1}$ are the residuals from the cointegrating equation. The cointegrating equation included an individual intercept and a time trend for each cross-section. Lag length was selected based on Lag Exclusion Wald Tests. The tests suggested a 2-lag ECVAR. The results are shown in Appendix D.

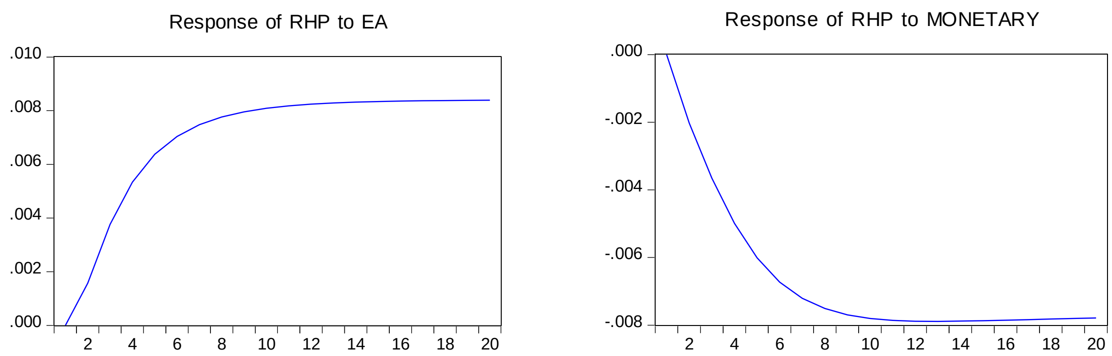
It is difficult to directly interpret the coefficients from an ECVAR, since all variables are endogenous. But we can see that the signs of the coefficients are in line with economic theory, where its own lag values have a positive effect, lags of EA also have a positive effect, and the first lag of Monetary is negatively correlated with RHP. The second lag for Monetary has a mildly positive coefficient. This could be due to short-term cyclicality of investment demand. The coefficient for the residuals from the cointegrating equation, also known as the error correction term, can be interpreted as the speed of adjustment back to the equilibrium state, or the proportion of last period's deviation from equilibrium that is corrected for (Brooks 2014). The small negative value of this coefficient indicates some adjustment to equilibrium is present, although not nearly as high as previous literature suggests. This could be due to the particular set of cointegrating variables that were used, i.e. there exists a different set of variables that more fully explain equilibrium house prices.

In order to see we which variables have significant effects on the other variables, we can perform Granger Causality tests on this regression. We get that all three variables have a significant causal effect on each other at the 5% level, except for RHP on Monetary. The results are shown in Appendix C. "Causality" in this case is defined as lead-lag correlation between two variables.

Due to the ambiguity of interpreting the coefficients of a VAR, we can look at the impulse responses to a one standard deviation shock to each of the macro variables to see the sign and magnitude of the effects of each variable.

Figure 3

Impulse responses to RHP from a Cholesky one standard deviation shock to EA and Monetary for the full sample.



We can see from Figure 3 that the EA variable has a shock that reaches 0.008 by period 10 (2.5 years) and persists through the horizon, and the Monetary variable has a shock that reaches -0.008 by period 12 (3 years) and persists through the horizon. We can note that the magnitude of the shocks from each variable are almost identical, but with opposite signs. The signs of the responses are in line with economic theory.

In order to see the degree of importance of each of the variables in influencing RHP, we can conduct variance decompositions. The effect of a one standard deviation innovation to each variable is calculated up to 20 periods, or five years, and the proportion of total variance explained by each variable is shown in each column of Table 3.

Table 3

Variance Decomposition of RHP for the full sample. The highlighted value is where the variance contribution of EA overtakes that of Monetary.

Period	Standard Error	RHP	EA	MONETARY
1	0.017728	89.93959	0.921288	9.139126
2	0.031969	91.70204	1.931524	6.366438
3	0.044995	91.87230	3.222989	4.904709
4	0.056925	91.74862	4.288111	3.963273
5	0.067933	91.58717	5.092988	3.319841
6	0.078131	91.44354	5.688658	2.867801
7	0.087612	91.32423	6.133271	2.542496
8	0.096459	91.22552	6.471419	2.303056
9	0.104749	91.14285	6.734068	2.123083
10	0.112549	91.07256	6.942243	1.985201
11	0.119919	91.01196	7.110304	1.877733
12	0.126912	90.95911	7.248226	1.792663
13	0.133572	90.91255	7.363079	1.724372
14	0.139937	90.87119	7.459970	1.668844
15	0.146039	90.83418	7.542661	1.623161
16	0.151905	90.80087	7.613966	1.585168
17	0.157560	90.77073	7.676026	1.553249
18	0.163024	90.74333	7.730489	1.526181
19	0.168314	90.71833	7.778646	1.503023
20	0.173445	90.69544	7.821514	1.483047
Cholesky Ordering: EA MONETARY RHP				

Since the ordering of the variables is important for a variance decomposition, we show the variance decomposition for the ordering that is most theoretically sound, where shocks to EA lead to shocks to Monetary, and then to shocks in RHP. The results show that as is typical for a VAR, shocks to its own value explain most of the variance for RHP. However, between EA and Monetary, Monetary contributes to more of the variance initially, but EA overtakes Monetary in the long run. Different Cholesky orderings show similar results, where the variance contribution of EA exceeds that of Monetary in the long run. We can therefore conclude that Monetary factors have a stronger short-term effect, and Economic Activity has a stronger long-term effect on house prices for the full sample. This is consistent with the findings of Apergis (2003).

4.2 Abnormal credit conditions sub-sample

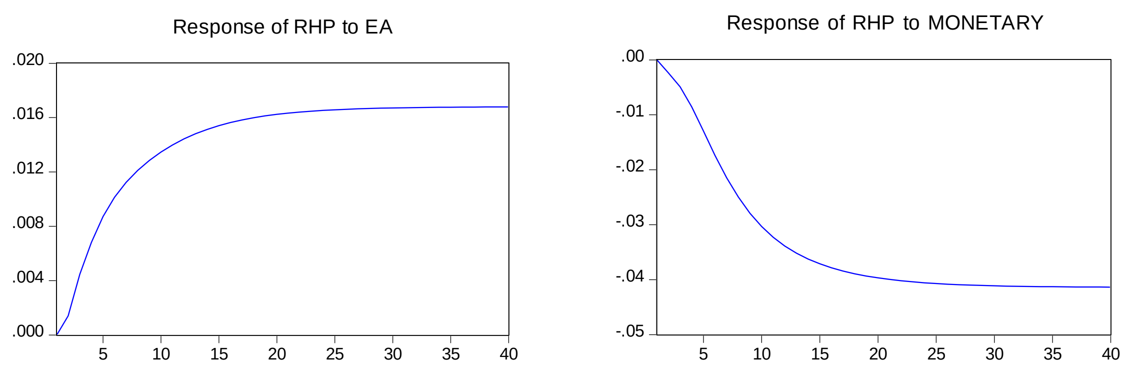
In order for hypothesis testing, we must first look at the case of "abnormal" credit conditions, to see if, in fact, in the case of ex post confirmed bubbles, the EA variable dominates the Monetary variable. We repeat all the steps leading up to the ECVAR regression, and only show the regression results. Again, the Lag exclusion tests suggested a 2-lag ECVAR. Results are shown in Appendix D.

One thing to note in this regression is that the coefficient for the EC term is larger in absolute value than for the full sample, indicating a greater adjustment to equilibrium. This makes sense because the bubble effects allowed house prices to deviate further from equilibrium values, necessitating a higher degree of mean reversion as the bubbles crashed.

Again, due to the ambiguity of interpreting the signs of the coefficients, we take a look at impulse responses for EA and Monetary on RHP. We look at a 40 period horizon this time because it takes longer for the impulse responses to reach a steady state. From Figure 4 we see that a shock to EA has a gradually increasing response that reaches 0.016 by the 20 period (5 years) horizon and then stays constant, and a shock to Monetary has a response that gradually reaches -0.04 by the 40 period (10 years) horizon. The effect of a shock to Monetary is approximately 2.5 times the effect of a shock to EA in terms of magnitude. Clearly, interest rates have a stronger lasting impact on house prices.

Figure 4

Impulse responses to RHP from a Cholesky one standard deviation shock to EA and Monetary for the abnormal credit conditions sub-sample.



This time we look at 30 periods for the variance decomposition, since the variance contribution of Monetary starts to exceed that of EA at around 18 periods, or 4.5 years. We can note that this period of 4.5 years is similar to the run-up to the most recent bubble. From Table 4 we can also see that the Monetary variable also has a stronger influence initially, before being overtaken by EA at period 3. In the medium term, the EA variable contributes to more of the variance, but then the Monetary variable dominates in the long run. Different Cholesky orderings provided similar results. We can therefore conclude that in the case of confirmed bubbles under abnormal credit conditions, the financial aspect dominates the consumption good aspect in the long run.

Table 4

Variance Decomposition of RHP for the abnormal credit conditions sub-sample. The highlighted values are where the variance contribution of either EA or Monetary exceeds that of the other.

Period	Standard Error	RHP	EA	MONETARY
1	0.019333	92.56340	0.941570	6.495025
2	0.035578	94.17471	1.731643	4.093646
3	0.050600	94.02416	3.277591	2.698244
4	0.064448	93.62048	4.674214	1.705306
5	0.077730	92.88313	5.847923	1.268949
6	0.090749	91.85696	6.733447	1.409597
7	0.103656	90.64035	7.378526	1.981120
8	0.116460	89.36310	7.840203	2.796697
9	0.129115	88.12041	8.173673	3.705916
10	0.141564	86.96768	8.419715	4.612606
11	0.153754	85.92787	8.606625	5.465509
12	0.165650	85.00432	8.752918	6.242762
13	0.177230	84.19015	8.870588	6.939258
14	0.188484	83.47426	8.967414	7.558329
15	0.199411	82.84452	9.048553	8.106928
16	0.210017	82.28941	9.117523	8.593068
17	0.220310	81.79860	9.176812	9.024584
18	0.230304	81.36315	9.228243	9.408609
19	0.240009	80.97539	9.273197	9.751414
20	0.249442	80.62884	9.312747	10.05842
21	0.258614	80.31799	9.347746	10.33426
22	0.267540	80.03821	9.378882	10.58291
23	0.276232	79.78553	9.406717	10.80776
24	0.284704	79.55658	9.431715	11.01171
25	0.292968	79.34849	9.454260	11.19725
26	0.301034	79.15879	9.474674	11.36653
27	0.308914	78.98536	9.493230	11.52141
28	0.316618	78.82636	9.510155	11.66348
29	0.324155	78.68021	9.525645	11.79415
30	0.331533	78.54551	9.539866	11.91462

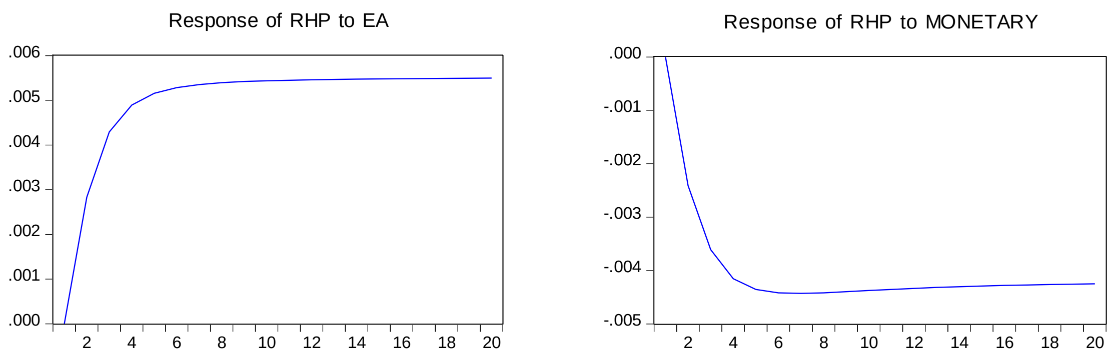
Cholesky Ordering: EA MONETARY RHP

4.3 Normal credit conditions sub-sample

For the normal credit conditions sub-sample, again we only show the regression results. Again, the Lag exclusion tests suggested a 2-lag ECVAR, and results are shown in Appendix D.
This time, we get that the coefficients for the endogenous variables all have alternating signs for the coefficients including its own lags. Figure 5 shows the impulse responses for this sub-sample.

Figure 5

Impulse responses to RHP from a Cholesky one standard deviation shock to EA and Monetary for the normal credit conditions sub-sample.



We can see that a shock to EA has about a 0.005 magnitude response that persists until the 20 period (5 years) horizon, and a shock to Monetary has a -0.004 shock that persists as well.

From the variance decomposition in Table 5 we see that in the case of the normal credit conditions sub-sample, EA dominates Monetary in the long run, that is, after the 3rd period. We can therefore conclude that the real demand is more influential than the investment demand, for the normal credit conditions sub-sample.

We must consider the possibility that short-term price deviations may exist within this sample period for some countries. But with reference to the "abnormal" sub-sample, any large-scale bubble with a run-up of at least 5 to 6 years would have made its effects known according to this methodology.

Table 5

Variance Decomposition of RHP for the normal credit conditions sub-sample. The highlighted value is where the variance contribution of EA overtakes that of Monetary.

Period	Standard Error	RHP	EA	MONETARY
1	0.018373	88.26569	2.168182	9.566127
2	0.031513	88.76682	5.030773	6.202410
3	0.041611	88.49097	6.730540	4.778489
4	0.049853	88.21478	7.784347	4.000874
5	0.056983	87.99287	8.475503	3.531626
6	0.063363	87.81989	8.952561	3.227550
7	0.069188	87.68210	9.298462	3.019435
8	0.074575	87.56969	9.559444	2.870863
9	0.079608	87.47602	9.762809	2.761170
10	0.084348	87.39653	9.925552	2.677916
11	0.088840	87.32805	10.05871	2.613237
12	0.093118	87.26831	10.16972	2.561972
13	0.097212	87.21566	10.26372	2.520625
14	0.101141	87.16886	10.34438	2.486763
15	0.104926	87.12698	10.41437	2.458649
16	0.108580	87.08927	10.47571	2.435023
17	0.112116	87.05514	10.52991	2.414950
18	0.115545	87.02412	10.57815	2.397723
19	0.118876	86.99582	10.62137	2.382805
20	0.122116	86.96991	10.66031	2.369778
Cholesky Ordering: EA MONETARY RHP				

5. Conclusion

The word "bubble" gets thrown around too often today, even when it is not necessarily applicable. This is especially true of the housing market. The objective of this paper was to diagnose a panel of countries for possible housing bubbles, given normal credit conditions. In order to do so, we first analyzed a full sample of 19 countries and then two sub-samples, one with normal credit conditions and one with abnormal credit conditions. Through variance decompositions, we saw that its own lags explain most of the variance in house prices for all three samples. This is hardly surprising, since high autocorrelation is a trait of housing markets in general (Shiller 2007, Maher 2019, Arestis & González 2013).

For the full sample, the Economic Activity (EA) variable had a more significant influence on house prices than the Monetary factors (Monetary) variable in the long run. Next, for the sub-sample of countries with abnormal credit conditions, in which there were ex post confirmed bubbles, we found that the Monetary variable dominates in the long run, albeit being less influential in the medium term (3 to 18 quarters). This period of 18 quarters or 4.5 years is very similar to the run-up to the Great Housing Bubble, which would reflect the fact that it took approximately this long for the investment demand for housing to exceed the residential demand. Finally, for the sub-sample with normal credit conditions, we found that the EA variable dominated the Monetary variable in the long run, despite having perceived "bubble" effects.

For all the samples, the Monetary variable was more influential than the EA variable in the very short-term (1 to 2 periods). This is most likely because Economic Activity takes time to propagate its way into various sectors, whereas Monetary factors have an immediate influence on market participants' decision making. In the special case of confirmed bubbles, we can deduce that the decision making of homebuyers based on credit conditions had a snowballing effect, in which house purchases based on expected future house prices lead to more purchases based on expected future prices.

In comparing the two sub-samples, it is difficult to conclude that the countries with normal credit conditions contain any significant bubble effects. This is because in the case of confirmed bubbles, as hypothesized, the financial aspect, represented by the Monetary variable, dominates the consumption good aspect, represented by the EA variable, in the long term.

This is a very general conclusion and has no policy implications of its own, other than perhaps that governments should not jump to bubble conclusions too quickly. However, based on the criteria used in this paper, individual countries may also be examined, for potential policy implications. Also, although normal credit conditions were defined by the percentage of securitized mortgages for this particular sample period, different criteria may be used for future periods, especially those that do not contain the effects of the U.S. financial crisis. For example, if some new financial innovation or monetary policy allows house prices to deviate from fundamentals, this should be taken into account.

Lastly, future research can incorporate demographic and fiscal variables, such as urbanization, home ownership and tax policies, which are generally only available in annual frequencies. Including these variables in annual regressions would provide a more complete view of the house price mechanism.

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Appendix

A.

Summary of unit root tests for the levels and first differences of all three variables.

Panel unit root test: Summary
Series: EA
Sample: 1996Q1 2017Q4
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 5

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-5.75085	0.0000	19	1626
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	1.21858	0.8885	19	1626
ADF - Fisher Chi-square	30.4695	0.8025	19	1626
PP - Fisher Chi-square	31.5253	0.7617	19	1653

Panel unit root test: Summary
Series: RHP
Sample: 1996Q1 2017Q4
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 9

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-5.14201	0.0000	19	1592
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	0.82942	0.7966	19	1592
ADF - Fisher Chi-square	50.1130	0.0903	19	1592
PP - Fisher Chi-square	76.4959	0.0002	19	1653

Panel unit root test: Summary
Series: MONETARY
Sample: 1996Q1 2017Q4
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 4

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-2.42529	0.0076	19	1628
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-0.23833	0.4058	19	1628
ADF - Fisher Chi-square	36.1900	0.5534	19	1628
PP - Fisher Chi-square	40.2245	0.3720	19	1653

Panel unit root test: Summary
Series: D(EA)
Sample: 1996Q1 2017Q4
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 4

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-15.1312	0.0000	19	1614
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-15.8851	0.0000	19	1614
ADF - Fisher Chi-square	336.500	0.0000	19	1614
PP - Fisher Chi-square	430.031	0.0000	19	1634

Panel unit root test: Summary
Series: D(RHP)
Sample: 1996Q1 2017Q4
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 8

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-8.89255	0.0000	19	1588
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-11.3740	0.0000	19	1588
ADF - Fisher Chi-square	241.241	0.0000	19	1588
PP - Fisher Chi-square	409.279	0.0000	19	1634

Panel unit root test: Summary
Series: D(MONETARY)
Sample: 1996Q1 2017Q4
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 1

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-31.6566	0.0000	19	1630
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-28.8162	0.0000	19	1630
ADF - Fisher Chi-square	596.249	0.0000	19	1630
PP - Fisher Chi-square	586.402	0.0000	19	1634

B.

Kao Cointegration Test for Monetary, RHP, and EA.

Kao Residual Cointegration Test
Series: MONETARY RHP EA
Sample: 1996Q1 2017Q4
Included observations: 1672
Null Hypothesis: No cointegration
Trend assumption: No deterministic trend
Automatic lag length selection based on SIC with a max lag of 11

	t-Statistic	Prob.
ADF	-7.788968	0.0000

Residual variance	1.68E-05
HAC variance	2.43E-05

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RESID)
Method: Least Squares
Date: 04/17/19 Time: 10:48
Sample (adjusted): 1996Q3 2017Q4
Included observations: 1634 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESID(-1)	-0.093721	0.008000	-11.71567	0.0000
D(RESID(-1))	0.401492	0.022144	18.13107	0.0000

R-squared	0.200157	Mean dependent var	-0.000199
Adjusted R-squared	0.199667	S.D. dependent var	0.004101
S.E. of regression	0.003668	Akaike info criterion	-8.376876
Sum squared resid	0.021963	Schwarz criterion	-8.370268
Log likelihood	6845.908	Hannan-Quinn criter.	-8.374425
Durbin-Watson stat	1.945753		

C.

Granger Causality tests for RHP, EA, and Monetary.

VEC Granger Causality/Block Exogeneity Wald Tests
Sample: 1996Q1 2017Q4
Included observations: 1615

Dependent variable: D(RHP)

Excluded	Chi-sq	df	Prob.
D(EA)	24.92637	2	0.0000
D(MONETARY)	12.74070	2	0.0017
All	42.14102	4	0.0000

Dependent variable: D(EA)

Excluded	Chi-sq	df	Prob.
D(RHP)	70.36912	2	0.0000
D(MONETARY)	9.623529	2	0.0081
All	72.23068	4	0.0000

Dependent variable: D(MONETARY)

Excluded	Chi-sq	df	Prob.
D(RHP)	3.429863	2	0.1800
D(EA)	8.591151	2	0.0136
All	9.874165	4	0.0426

D.

*ECVAR regression results for the full sample and two sub-samples, with ΔRHP as the dependent variable. T-statistics are shown in brackets. * denotes significance at the 5% level and ** denotes significance at the 1% level.*

Variable	Full Sample	"Abnormal" Sub-sample	"Normal" Sub-sample
Constant	0.001670* [2.21791]	0.000646 [0.35436]	0.004773** [3.28560]
ΔRHP(-1)	0.522759** [20.0273]	0.573215** [11.7697]	0.400400** [9.17480]
ΔRHP(-2)	0.005898 [0.22446]	-0.012605 [-0.25491]	-0.093689* [-2.13759]
ΔEA(-1)	0.121618** [3.50227]	0.111082 [1.54215]	0.258184** [3.77481]
ΔEA(-2)	0.068473* [1.98822]	0.156375* [2.17513]	-0.061973 [-0.91283]
ΔMonetary(-1)	-0.208479** [-3.55519]	-0.033155 [-0.29098]	-0.249973* [-2.55408]
ΔMonetary(-2)	0.016705 [0.28196]	0.163512 [1.39422]	0.024329 [0.24616]
EC(-1)	-0.001094** [-2.91409]	-0.009352** [-5.02374]	-0.000952 [-1.52941]