Credit and House Prices Cycles

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Chapter 1: Credit and House Prices Cycles

Introduction

Motivation

- The study of housing prices and excessive credit has become more important in understanding financial market stability
- We also observed increasing use of monetary policies, significant growth in macro balance sheet size, including real estate values and total credit lending to household
- We study the dynamic relationship between housing prices and household credit in this paper

Contribution

1. Relationship between housing prices and household credit

- Apply Unobserved Component Model (Clark 1987) to extract information about trends and cycles

  $\Rightarrow$ Jointly examine the two variables and their interaction both in the long-run and short-run

- Specify cycles to be VAR process (cross-cycle) rather than univariate AR process

  $\Rightarrow$ Test if past movement of one cycle has predictive power over another cycle

Contribution

2. Technical contribution to the optimization process:

- Novel numerical optimization / parameters constraint method to ensure the cyclical components are in feasible stationary region

3. Overcome "curse of dimensionality" using Bayesian method:

- Common problem in estimating complex unobserved component state space model
- We use random walk Metropolis-Hasting method to estimate posterior distribution of parameters of interest

Literature Review

1. Dynamics of credit changes:

- Kiyotaki & Moore (1997), Myerson (2012), Guerrieri & Uhlig (2016), Boissay et al (2016).

2. Dynamics of house prices changes:

- Hong & Stein (1999), Glaeser et al (2008) (2017), Kishor, Kumari, & Song (2015)

Literature Review

3. House price cycles generates credit cycles:

- Bernanke & Gertler (1989), Bernanke et al (1999); Kiyotaki & Moore (1997) "
- Empirical Evidence: Fitzpatrick and McQuinn (2007), Berlinghieri (2010), Gimeno and Martinez-Carrascal (2010), Anundsen and Jansen (2013), for evidence from Ireland, USA, Spain and Norway, respectively

4. Credit cycles genereates house price cycles:

- Agnello & Schuknecht (2011), Kermani (2012), Justiniano et al (2019), Schularick et al (2012) (2016)

$\Rightarrow$ However, the debate on which cycle causes changes on the other is still open

Data

Bank of International Settlement (BIS)

- Household Credit to GDP: Total Credit to non-financial sector (household)
- House Price Index: Residential property prices: selected series (real value). Index $= 100$ at full sample average for each country

- 2 countries: US & UK
- Time frame: 1990:Q1 - 2021:Q3

Model

Unobserved Component Model

$$100 * ln\frac{Credit}{GDP} = y_t = \tau_{yt} + c_{yt} \tag{1}$$

$$100 * lnHPI = h_t = \tau_{ht} + c_{ht} \tag{2}$$

- Trends: τ_{yt} & τ_{ht}

$$\tau_{yt} = \mu_{yt-1} + \tau_{yt-1} + \eta_{yt}, \qquad \eta_{yt} \sim iidN(0, \sigma_{\eta y}^2)$$

$$\mu_{yt} = \mu_{yt-1} + \eta_{\mu yt}, \qquad \eta_{\mu yt} \sim iidN(0, 0.01)$$

$$\tau_{ht} = \mu_{ht-1} + \tau_{ht-1} + \eta_{ht}, \qquad \eta_{ht} \sim iidN(0, \sigma_{\eta h}^2)$$

$$\mu_{ht} = \mu_{ht-1} + \eta_{\mu ht}, \qquad \eta_{\mu ht} \sim iidN(0, 0.01)$$

Model

Unobserved Component Model

- Cycles: c_{yt} & c_{ht}

$$c_{yt} = \phi_y^1 c_{yt-1} + \phi_y^2 c_{yt-2} + \phi_y^{x1} c_{ht-1} + \phi_y^{x2} c_{ht-1} + \varepsilon_{yt} \qquad (3)$$

$$\varepsilon_{yt} \sim iidN(0, \sigma_{\varepsilon y}^2) \qquad (4)$$

$$c_{ht} = \phi_h^1 c_{ht-1} + \phi_h^2 c_{ht-2} + \phi_h^{x1} c_{yt-1} + \phi_h^{x2} c_{yt-1} + \varepsilon_{ht} \qquad (5)$$

$$\varepsilon_{ht} \sim iidN(0, \sigma_{\varepsilon h}^2) \qquad (6)$$

Model

Covariance Matrix

$$Q = \begin{bmatrix} \sigma_{\eta y}^2 & 0 & 0 & \sigma_{\eta y \eta h} & 0 & 0 & 0 & 0 \\ 0 & \sigma_{\varepsilon y}^2 & 0 & 0 & \sigma_{\varepsilon y \varepsilon h} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ \sigma_{\eta y \eta h} & 0 & 0 & \sigma_{\eta h}^2 & 0 & 0 & 0 & 0 \\ 0 & \sigma_{\varepsilon y \varepsilon h} & 0 & 0 & \sigma_{\varepsilon h}^2 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0.01 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0.01 \end{bmatrix} \tag{7}$$

Model

Optimization process

- Kalman filter with adjusted Likelihood function:

$$l(\theta) = -0.5 \sum_{t=1}^{T} ln[(2\pi)^2 |f_{t|t-1}|] - 0.5 \sum_{t=1}^{T} \eta'_{t|t-1} f_{t|t-1}^{-1} \eta_{t|t-1}$$
$$-w1 \sum_{t=1}^{T} (c_{yt}^2) - w2 \sum_{t=1}^{T} (c_{ht}^2)$$

Empirical Results

VAR(2) - 1 Cross-lag Model Estimate - UK and US

Description	Para.	UK VAR2 1-cross lag		US VAR2 1-cross lag	
		Median	[10%, 90%]	Median	[10%, 90%]
Credit to household 1st AR parameter	ϕ_y^1	1.4238	[1.3585, 1.4892]	1.2074	[1.1374, 1.2785]
Credit to household 2nd AR parameter	ϕ_y^2	-0.4698	[-0.5305, -0.4090]	-0.2483	[-0.3152, -0.1825]
Credit to household 1st cross cycle AR parameter	$\phi_y^{\times 1}$	**0.0238**	**[0.0154, 0.0319]**	**0.0318**	**[0.0228, 0.0407]**
Credit to household 2nd cross cycle AR parameter	$\phi_y^{\times 2}$				
Housing Price Index 1st AR parameter	ϕ_h^1	1.3173	[1.2647, 1.3701]	1.8038	[1.7700, 1.8363]
Housing Price Index 2nd AR parameter	ϕ_h^2	-0.3315	[-0.3885, -0.2746]	-0.8261	[-0.8605, -0.7903]
Housing Price Index 1st cross cycle AR parameter	$\phi_h^{\times 1}$	**-0.0173**	**[-0.0464, 0.0062]**	**0.0104**	**[0.0007, 0.0204]**
Housing Price Index 2nd cross cycle AR parameter	$\phi_h^{\times 2}$				
S.D. of permanent shocks to Credit to household	σ_{ny}	0.2714	[0.2150, 0.3155]	0.2954	[0.2312, 0.3414]
S.D. of transitory shocks to Credit to household	σ_{ey}	0.8021	[0.7699, 0.8376]	0.8631	[0.8287, 0.9012]
S.D. of permanent shocks to Housing Price Index	σ_{nh}	0.0789	[0.0742, 0.0845]	0.1390	[0.1222, 0.1618]
S.D. of transitory shocks to Housing Price Index	σ_{eh}	1.2242	[1.1886, 1.2613]	0.8988	[0.8641, 0.9355]
Correlation: Permanent credit to household/Permanent HPI	ρ_{nynh}	0.0189	[-0.3049, 0.3393]	0.0082	[-0.3117, 0.3226]
Correlation: Transitory credit to household/Transitory HPI	ρ_{eyeh}	0.2536	[0.1713, 0.3337]	0.1537	[0.0399, 0.2619]
Log-likelihood value	llv	578.6200	[576.1600, 582.1500]	204.9400	[202.4200, 208.4500]

Note:
UK - US Bayesian method random walk Metropolis-Hasting posterior distribution estimates

VAR(2) - 1 Cross-lag Model Estimate Summary

- The sum of AR parameters of the cyclical components in all three models is smaller, although close to one

- The standard deviation of the shocks in the cycles σ_{ei} is much higher than the standard deviation of the shocks to the trend σ_{ni} of both credit and housing prices

- Variations in the housing price cyclical components σ_{eh} of the UK are bigger than in the US

- The correlation of the shocks to the cyclical components among the two variables ρ_{eyeh} suggests that cyclical variation among housing price and household credit is strongly positively correlated

Cross-country Comparison of Causal Coefficients

Country	ϕ_y^{x1} HPI on Credit		ϕ_h^{x1} Credit on HPI	
	Median	[10%, 90%]	Median	[10%, 90%]
Australia	0.0157	[-0.0093, 0.0412]	0.0521	[0.0014, 0.1060]
Belgium	0.0279	[0.0013, 0.0559]	-0.0656	[-0.0980, -0.0339]
Canada	0.0191	[0.0032, 0.0332]	-0.0152	[-0.0343, 0.0025]
Finland	0.0080	[0.0017, 0.0156]	0.0085	[0.0021, 0.0156]
France	0.0298	[0.0185, 0.0411]	-0.0643	[-0.1098, -0.0241]
Germany	0.0728	[0.0500, 0.0917]	-0.0061	[-0.0282, 0.0052]
Hong Kong	-0.0031	[-0.0079, 0.0019]	-0.0629	[-0.0836, -0.0453]
Italy	0.1001	[0.0895, 0.1063]	-0.0027	[-0.0072, 0.0014]
Japan	-0.0088	[-0.0326, 0.0174]	0.1659	[0.1202, 0.2173]
Netherlands	0.0058	[-0.0039, 0.0166]	-0.0043	[-0.0156, 0.0070]
New Zealand	0.0078	[-0.0035, 0.0199]	-0.0139	[-0.0249, -0.0036]
Norway	0.0109	[0.0097, 0.0116]	0.0059	[0.0047, 0.0066]
South Korea	0.0106	[-0.0033, 0.0308]	0.0027	[-0.0251, 0.0369]
Spain	0.0144	[0.0003, 0.0331]	0.0051	[-0.0023, 0.0146]
Sweden	0.0159	[0.0071, 0.0252]	0.0400	[0.0218, 0.0617]
United Kingdom	0.0238	[0.0154, 0.0319]	-0.0173	[-0.0464, 0.0062]
United States	0.0318	[0.0228, 0.0407]	0.0104	[0.0007, 0.0204]

Cross-country Comparison of Causal Coefficients Summary

- In 11 out of 17 countries, the HPI on Credit causal coefficient ϕ_y^{x1} are positive and significant. All 11 countries are in North America and Europe.

- Only 6 countries have positive and significant Credit on HPI causal coefficient ϕ_y^{x1}. Three of which have smaller magnitudes than their ϕ_y^{x1} counterpart
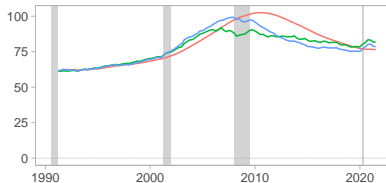
$\rightarrow$ Overall, we found evidence that past transitory shocks to house price credit will cause a positive deviation in future transitory household credit. However, the effect in the opposite direction is much smaller and sometimes insignificant

Unobserved Component Graphs: United States
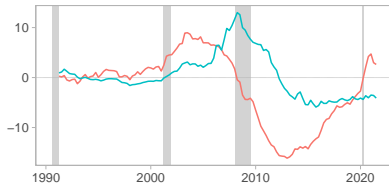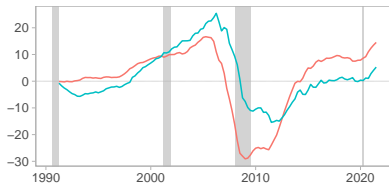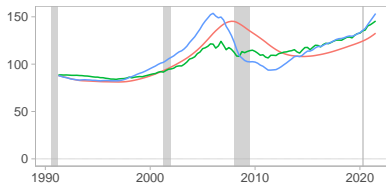
Unobserved Component Graphs: United Kingdom
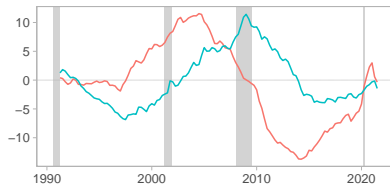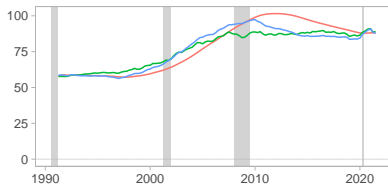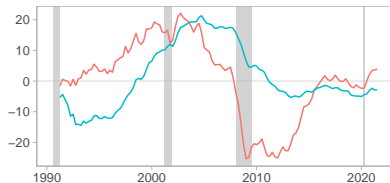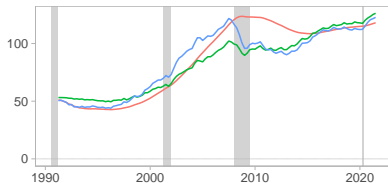
Conclusion

- Extracting temporary and permanent components information gave insights on the dynamics of the two series housing and credit in both short-run and long-run
- Evidence showing that past movement of a cycle (HPI) has predictive power over the other cycle (credit)

Thank You

I look forward to your questions and comments