Housing and Credit Cycles

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Motivation

- The study of housing prices has become more important in understanding financial market stability. We also observed increasing use of monetary policies.

Contributions

1. **Relationship between housing prices and household credit**
    - Apply Unobserved Component Model (Morley 2007) to extract information about trends and cycles.

    $\Rightarrow$ Focus on the dynamics between transitory cycle components.

2. **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.

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)
- 2 countries: US & GB
- Time frame: 1990:Q1 - 2019:Q3

Main 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:***

$$\tau_{yt} = \tau_{yt-1} + \eta_{yt}, \qquad \eta_{yt} \sim iidN(0, \sigma^2_{\eta y}) \tag{3}$$

$$\tau_{ht} = \tau_{ht-1} + \eta_{ht}, \qquad \eta_{ht} \sim iidN(0, \sigma^2_{\eta h}) \tag{4}$$

Methodology: UC Model

- ***Cycles:***

$$c_{yt} = \phi_y^1 c_{yt-1} + \phi_y^2 c_{yt-2} + \phi_y^{x1} c_{ht-1} + \phi_y^{x2} c_{ht-1} + \varepsilon_{yt}, \quad \varepsilon_{yt} \sim iidN(0, \sigma_{\varepsilon y}^2) \quad (5)$$

$$c_{ht} = \phi_h^1 c_{ht-1} + \phi_h^2 c_{ht-2} + \phi_h^{x1} c_{yt-1} + \phi_h^{x2} c_{yt-1} + \varepsilon_{ht}, \quad \varepsilon_{ht} \sim iidN(0, \sigma_{\varepsilon h}^2) \quad (6)$$

Methodology: UC Model

State Space Representation

Transition equation:

$$\beta_t = F\beta_{t-1} + \tilde{v}_t \tag{7}$$

Where the transitory components are:

$$\begin{bmatrix} \tau_{yt} \\ c_{yt} \\ c_{yt-1} \\ \tau_{ht} \\ c_{ht} \\ c_{ht-1} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & \phi_y^1 & \phi_y^2 & 0 & \phi_y^{x1} & \phi_y^{x2} \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & \phi_h^{x1} & \phi_h^{x2} & 0 & \phi_h^1 & \phi_h^2 \\ 0 & 0 & 0 & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} \tau_{yt-1} \\ c_{yt-1} \\ c_{yt-2} \\ \tau_{ht-1} \\ c_{ht-1} \\ c_{ht-2} \end{bmatrix} + \begin{bmatrix} \eta_{yt} \\ \varepsilon_{yt} \\ 0 \\ \eta_{ht} \\ \varepsilon_{ht} \\ 0 \end{bmatrix} \tag{8}$$

Regression results

Methodology UC Model

The covariance matrix for $\tilde{v}_t$, denoted Q, is:

$$Q = \begin{bmatrix} \sigma^2_{\eta y} & 0 & 0 & \sigma_{\eta y \eta h} & 0 & 0 \\ 0 & \sigma^2_{\varepsilon y} & 0 & 0 & \sigma_{\varepsilon y \varepsilon h} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ \sigma_{\eta y \eta h} & 0 & 0 & \sigma^2_{\eta h} & 0 & 0 \\ 0 & \sigma_{\varepsilon y \varepsilon h} & 0 & 0 & \sigma^2_{\varepsilon h} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \tag{9}$$

Regression results

Methodology: UC Model

Constraint estimation

- Conventional VAR models constrain parameters using a transformation function so that they lie in feasible region.
- I ran into problems of setting up a working prior.

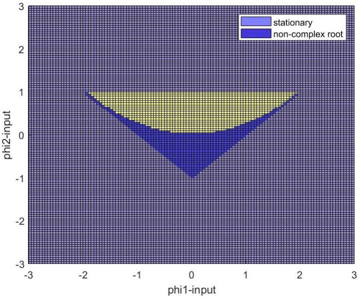
- **What I do:** Add a penalty term on magnitude of cycles in the log-likelihood function:

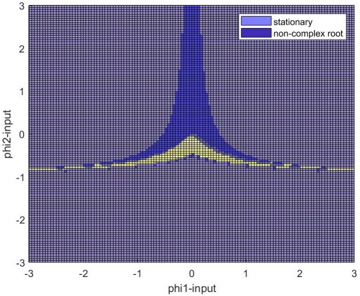
$$l(\theta) = -\frac{1}{2}\sum_{t=1}^{T} ln[(2\pi)^2|f_{t|t-1}|] - \frac{1}{2}\sum_{t=1}^{T}\eta'_{t|t-1}f^{-1}_{t|t-1}\eta_{t|t-1}$$
$$-0.003 * \sum_{t=1}^{T}(c^2_{yt} + c^2_{ht})$$

Methodology: UC Model

Stationary Region AR(2) series

- Visualize using isStable() function in Matlab





Key Results Regression Table: United States

Parameters	VAR(2)		VAR(2) 1st-cross-lag		VAR(2) 2-cross-lags	
	Estimate	Std. Error	Estimate	Std. Error	Estimate	Std. Error
ϕ_y^1	1.5217	0.3236	1.8903	0.0363	1.8866	0.0003
ϕ_y^2	-0.5922	0.2828	-0.7732	0.0217	-0.8942	0.0032
ϕ_y^{x1}			-0.0127	0.0012	0.0428	0.0005
ϕ_y^{x2}					-0.0403	0.0009
ϕ_h^1	1.8040	0.0394	1.4655	0.0646	1.8647	0.0387
ϕ_h^2	-0.8210	0.0393	-0.7369	0.0478	-0.8980	0.0391
ϕ_h^{x1}			2.5769	1.6420	0.0897	0.1145
ϕ_h^{x2}					-0.0320	0.1136
σ_{ny}	0.9681	0.0646	0.9758	0.0667	0.8590	0.0554
σ_{ey}	0.1366	0.0739	0.0004	0.0087	0.0306	0.0167
σ_{nh}	0.9643	0.1072	1.2720	0.1280	1.1356	0.1060
σ_{eh}	0.4711	0.0790	0.2960	0.1616	0.3638	0.0775
σ_{eyeh}	-0.9994	0.0302	-0.8812	0.3118	-1	5.1900×10^{-7}
σ_{nynh}	0.4642	0.0944				
Log-likelihood value	-369.9163		-384.7974		-363.3991	

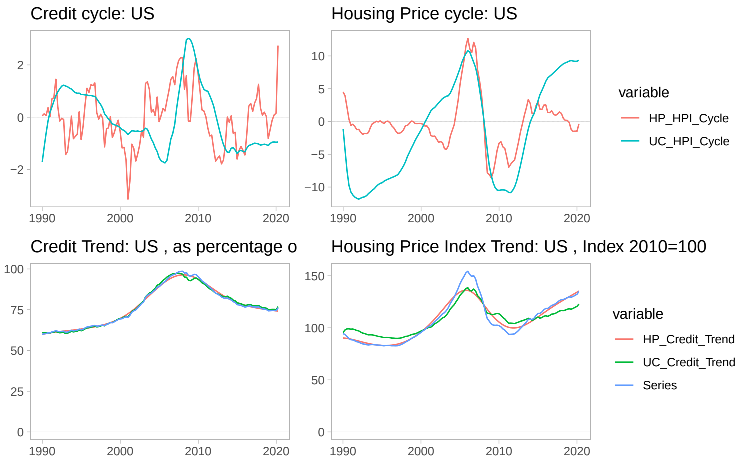
StateSpace

Key Results Regression Table: Great Britain

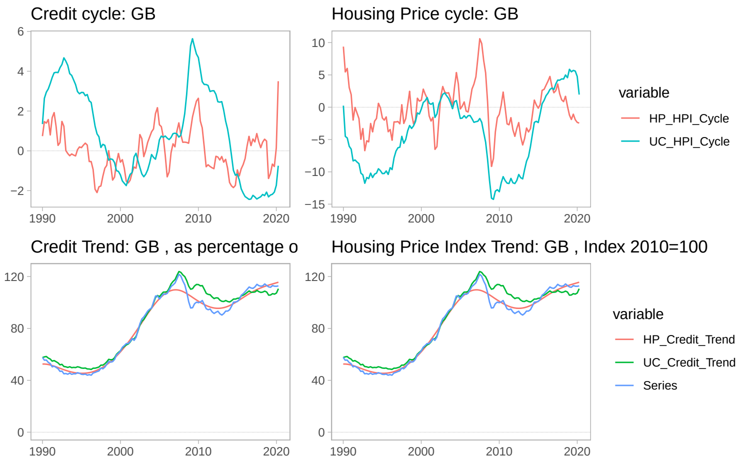
Parameters	VAR(2)		VAR(2) 1st-cross-lag		VAR(2) 2-cross-lags	
	Estimate	Std. Error	Estimate	Std. Error	Estimate	Std. Error
ϕ_y^1	1.2542	0.1910	1.2572	0.0608	1.1506	0.1764
ϕ_y^2	-0.2631	0.2052	-0.1698	0.0949	-0.2922	0.1860
ϕ_y^{x1}			-0.0323	0.0120	-9.2500×10^{-5}	0.0406
ϕ_y^{x2}					0.0013	0.0499
ϕ_h^1	1.6249	0.1069	0.6803	0.1111	0.3790	0.1344
ϕ_h^2	-0.7357	0.1164	-0.0581	0.1194	-0.5132	0.1730
ϕ_h^{x1}			1.0953	0.6445	1.0422	0.9597
ϕ_h^{x2}					-0.2495	1.4444
σ_{ny}	0.8608	0.0821	1.1443	0.1162	0.7399	0.0402
σ_{ey}	0.2894	0.1205	0.1927	0.0763	0.4752	0.1062
σ_{nh}	2.3401	0.1723	2.1626	0.1875	1.4238	0.0591
σ_{eh}	0.7506	0.2205	1.8984	0.3425	2.0796	0.4701
σ_{eyeh}	0.9571	0.2528	0.5021	0.1633	0.4853	0.1539
σ_{nynh}	0.5919	0.0720				
Log-likelihood value	-410.0147		-448.3113		-512.4697	

▸ StateSpace

Key Results Regression Graphs: United States



Key Results Regression Graphs: Great Britain



Conclusions

1. **Dynamics of temporary components in housing and credit**
   - Evidence showing that past movement of a cycle has predictive power over the other cycle
   - Extracting temporary and permanent components information gave insights on the dynamics of the two series