Analysis of Real Estate Bubbles in Eight Residential Markets

Testing for econometric regime shifts and concordance indicators using fundamental based methods

Robert Kuert
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Research focus
Research focus

US housing prices, real

Research questions

- How can we identify a housing price bubble with fundamentals?
- Which (out of eight) countries show such regimes?
Relevance
Systemic Risk

- Housing stores
- Private wealth
- Mortgage debt

Price corrections have impacts on…

- Defaults
- Creditor liquidity
- The wider economy (spill-overs)
Relevance in Switzerland

  
  [...] has resulted in imbalances on the mortgage and residential real estate markets.

- Mortgage debt at over 1’000 bio. CHF
- Vacancy rates in residential investment properties at high levels

- **Swiss Bankers Association (March 2019)**

  [...] considering [more] amandments to self-regulation
Previous work focused on Error Correction Models

- Review of various econometric papers on housing prices in different countries

- Works of Anundsen (2013) found bubble regime for the US

- Not yet used for other countries

- Error Correction Models & Cointegration
  Assuming that prices adjust to a long term equilibrium with fundamentals
Previous work focused on Error Correction Models

Prices and User cost are cointegrated
Methodology

Approaches
- Price to Rent
- Price to Income

Specifications
- 1. ECM Single Equation
- 2. Cointegration Vector Error Correction

Data
- Eight economies

Bubble indication
- Concordance of indicators
Results for the US

- Concordant bubble regime between 2002 and 2009
Signals in Canada and New Zealand
Japan - a difficult case - and Switzerland
## Thesis methodology is more conservative than literature

Indications of a bubble regime

<table>
<thead>
<tr>
<th>Country</th>
<th>Literature</th>
<th>Thesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>France</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Germany</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Netherlands</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>New Zealand</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Switzerland</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>United Kingdom</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>

(Independent of period)
Takeaway

- Don’t buy a home in Canada or New Zealand

- Switzerland’s owner occupied sector seems (or seemed) safe

- Data has higher impact than model specifications
  You can not compensate data deficiencies with better model specifications.
Review

- **Prof. Dr. Maximilian von Ehrlich**
  University of Bern

- Research fellow at the Center for Regional Economic Development (CRED)
Panel discussion
Contact information and credits

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Appendix
## A0 Data Description and temporal properties

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Dimension</th>
<th>Deflation</th>
<th>Main Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>PH</td>
<td>Property Price Index</td>
<td>Index</td>
<td>by CPI2</td>
<td>BIS</td>
</tr>
<tr>
<td>Pop</td>
<td>Population</td>
<td>[Total residents]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R</td>
<td>Real housing rent</td>
<td>Index</td>
<td>by CPI2</td>
<td>OECD</td>
</tr>
<tr>
<td>Y</td>
<td>Per capita disposable income</td>
<td>[national currency/resident]</td>
<td>by CPI2 and Pop</td>
<td>AMECO</td>
</tr>
<tr>
<td>H</td>
<td>Per capita Housing stock</td>
<td>[national currency/resident]</td>
<td>by PJ and Pop</td>
<td>Oxford Economics</td>
</tr>
<tr>
<td>CPI1</td>
<td>CPI Less shelter</td>
<td>Index</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CPI2</td>
<td>CPI All items</td>
<td>Index</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UC</td>
<td>User Cost</td>
<td>(1-(\tau_y))(1+(\tau_p)) - (\pi + \delta)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Notes:
- **No seasonal adjustment**
- **User cost** is constructed out of the following rates collected per country and if necessary, aggregated: depreciation, property tax, income tax, mortgage interest, and inflation. Deflators are the consumer price index (CPI), once without housing components (CPI1), for deflating PH, R and Y, once measured for all items in order to account for the inflation in the user cost (CPI2).
- Additionally, the value of the housing stock is deflated by an appropriate metric, depending on the measure used for the stock (PJ).
A1  Single Equation Methodology Price-to-Rent

\[ \Delta p_{h,t} = \mu + \alpha_{ph} (p_h - \gamma_{r}r - \gamma_{UC}UC)_{t-1} \]

\[ + \sum_{i=1}^{p} \rho_{ph,i} \Delta p_{h,t-i} + \sum_{i=0}^{p} \rho_{r,i} \Delta r_{t-i} + \sum_{i=0}^{p} \rho_{UC,i} \Delta UC_{t-i} + \sum_{l=1}^{3} \lambda_{d,l}d_{l} + \epsilon_{t} \]

H₀: \( \alpha_{ph} = 0 \)  
(indicating no cointegration)

Hₐ: \( \alpha_{ph} \neq 0 \)  
(indicating cointegration)

whereas \( p_h - \gamma_{r}r - \gamma_{UC}UC \) is called the error correction term. Furthermore, lagged differences with up to \( p \) lags as well as seasonal dummies, \( d_{l} \), are introduced for the quarters \( l = 1, 2, 3 \) while the 4\textsuperscript{th} quarter seasonal effect is captured by \( \mu \). Note that the error correction term accounts for
A2 VECM & CVAR Methodology Price-to-Rent

\[ \Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-1} + \Phi D_t + \varepsilon_t \]

Here, \( y_t \) is a \( k \times 1 \) vector of the endogenous variables, \( \Phi \) being a \( k \times d \) matrix of coefficients and \( D_t \) is a vector of \( d \) constants, including centered seasonal dummies and the intercept. Since there are several possible deterministic trends, they are included in \( \Pi \). Now \( \Pi y_{t-1} \) is the error correction term and the error is given by \( \varepsilon_t \sim \mathcal{N}(\mu=0, \sigma=\Omega) \), with \( \Omega \) being diagonal. In detail \( \Pi \) and \( \Gamma_i \) are defined as follows.
A3  Log Periodic Power Law Fit (independent of fundamentals)

\[ ph_t = A + B(t_c - t)^m + C(t_c - t)^m \cos[\omega \ln(t_c - t) - \phi] \]  \[ 18 \]

where $\omega$ is the log frequency and $\phi$ is a phase constant. Hence the bubble indicator is a detected faster-than-exponential growth of $PH_s$ (in levels) possibly extended by log periodic oscillations\(^\text{10}\).
A4 Concordance Indicator

\[ I_K = \frac{1}{T} \left[ \sum_{t=1}^{T} S_{x,t} S_{y,t} + \sum_{t=1}^{T} (1 - S_{x,t})(1 - S_{y,t}) \right] \quad \forall K \]

\[ i_S = \begin{cases} 
1 & \text{Total concordance or } \rho_S = 1 \\
(0,1) & \text{No concordance or } \rho_S = -1 \\
0 & \text{No concordance or } \rho_S = 1 
\end{cases} \]

The set \( K \) can either consist of the countries, whereas \( x \) and \( y \) would correspond to the approaches, or \( K \) denotes the approaches and \( x \) and \( y \) are the countries respectively. In this study, both cases are of interest. The concordance indicator \( I_K \) first calculated for all possible combi-
## A5 Results Cross-Country Concordance

<table>
<thead>
<tr>
<th></th>
<th>CAN</th>
<th>CH</th>
<th>FRA</th>
<th>GER</th>
<th>JAP</th>
<th>NL</th>
<th>NZ</th>
<th>UK</th>
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<tr>
<td>CAN</td>
<td>1.00</td>
<td>0.36</td>
<td>0.50</td>
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<td>0.68</td>
<td>0.52</td>
<td>0.59</td>
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<td>0.71</td>
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<td>0.77</td>
<td>1.00</td>
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<td>0.62</td>
<td>0.69</td>
<td>0.76</td>
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<tr>
<td>GER</td>
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<td>0.69</td>
<td>0.71</td>
<td>0.80</td>
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<td>JAP</td>
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<td>0.69</td>
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<tr>
<td>NL</td>
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<td>1.00</td>
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<tr>
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<td>0.66</td>
<td>0.75</td>
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### A6 Results Cross-Model Concordance (only Canada)

Table 14 Concordance matrix for Canada

<table>
<thead>
<tr>
<th></th>
<th>cvar invd noT</th>
<th>cvar invd</th>
<th>cvar ptor noT</th>
<th>cvar ptor</th>
<th>sing ptor</th>
<th>sing invd</th>
<th>LPPLs</th>
<th>PL</th>
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<tbody>
<tr>
<td>cvar invd noT</td>
<td>1.00</td>
<td>0.56</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>0.83</td>
<td>0.67</td>
<td>0.67</td>
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<tr>
<td>cvar invd</td>
<td>0.56</td>
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<td>0.56</td>
<td>0.56</td>
<td>0.56</td>
<td>0.39</td>
<td>0.44</td>
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<tr>
<td>cvar ptor noT</td>
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<td>1.00</td>
<td>1.00</td>
<td>0.83</td>
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<td>0.67</td>
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<tr>
<td>cvar ptor</td>
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<td>0.56</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>0.83</td>
<td>0.67</td>
<td>0.67</td>
</tr>
<tr>
<td>sing ptor</td>
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<td>1.00</td>
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<td>1.00</td>
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<td>0.67</td>
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<tr>
<td>sing invd</td>
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<td>0.83</td>
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<td>0.72</td>
<td>0.83</td>
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<tr>
<td>LPPLs</td>
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<td>0.67</td>
<td>0.72</td>
<td>1.00</td>
<td>0.89</td>
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<tr>
<td>PL</td>
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<td>0.67</td>
<td>0.67</td>
<td>0.67</td>
<td>0.83</td>
<td>0.89</td>
<td>1.00</td>
</tr>
</tbody>
</table>

This table reports the concordance indices (see [21]), a measure of coincidence for bubble cycles, specification wise for the recursive estimations of Canada. CVAR refers to equation [12] for ptor and [15], for invdem, whereas sing represents the single equation specification. [7] and [11] respectively. noT indicates, that no Trend is included in the equation specification. PL represents the power law fit after [18] and LPPLs is log periodic power law fit following [19]. A 0 indicates no synchronization, a 1.00 represents synchronization over the total overlapping sample.