

# Identifying booms and busts in house prices under heterogeneous expectations

Wilko Bolt<sup>a</sup>, Maria Demertzis<sup>a,b</sup>, Cees Diks<sup>c,d</sup>,  
Cars Hommes<sup>c,d</sup>, and Marco van der Leij<sup>a,c,d</sup>

<sup>a</sup>De Nederlandsche Bank, <sup>b</sup>European Commission, <sup>c</sup>CeNDEF - University of Amsterdam,  
<sup>d</sup>Amsterdam School of Economics and Tinbergen Institute, The Netherlands

## 1. Introduction

Aim of our paper:

- Blanchard (2014) argues that economies occasionally land in "dark corners", situations in which the economy could badly malfunction. Our approach can help to identify when housing markets may be in such dark corners.
- We apply non-linear techniques to the housing market for a number of countries. The data shows that at all times, some agents believe that prices will return to fundamentals while the rest believes that prices will continue to deviate from fundamentals.
- Policy can help the system return to the stable and uniquely defined equilibrium price path estimated.
- Our analysis provides a potential early warning tool that can support the monitoring and assessment of housing market developments.

## 2. A Housing Market Model with Heterogeneous Beliefs

Application of standard housing asset pricing model, based on imputed rents, with heterogeneous beliefs. Define excess rate of return on housing:

$$R_{t+1} = \frac{P_{t+1} + (1 + r^{rf})Q_t}{P_t} - (1 + r_t),$$

where  $\frac{P_{t+1}}{P_t}$  is capital gain,  $(1 + r^{rf})Q_t$  rent saved, and  $r_t = r_t^{rf} + \omega_t$ .

Maximizing risk adjusted returns with common beliefs about expected variances  $V_t$ , aggregation across types and market clearing yields price equation:

$$(1 + r_t + \alpha)P_t = \sum_{h=1}^H n_{h,t} E_{h,t} (P_{t+1} + (1 + r^{rf})Q_t),$$

where  $\alpha = aV \times S$ , with  $V_t = V$  and  $S = (\text{constant})$  stock of houses.

## Fundamental price

Fundamental assumed to follow geometric Brownian motion:

$$\log Q_{t+1} = \mu + \log Q_t + v_{t+1}, \quad v_t \sim N(0, \sigma_v^2).$$

Rational expectations on the first conditional moment simplifies price equation:

$$(1 + r + \alpha)P_t = E_t (P_{t+1} + (1 + r^{rf})Q_t),$$

yielding **fundamental price**:

$$P_t^* = \frac{1 + r^{rf}}{r + \alpha - g} Q_t, \quad r + \alpha > g.$$

## Heterogeneous beliefs

In **deviations** from fundamental price  $X_t = P_t/P_t^* - 1$ , price equation rewrites as:

$$X_t = \frac{1}{R} \sum_{h=1}^H n_{h,t} E_{h,t} (X_{t+1}), \quad \text{with } R = \frac{1 + r + \alpha}{1 + g}.$$

Following Boswijk, Hommes and Manzan (2007), assume two types of agents with beliefs:

$$\begin{aligned} \mathbb{E}_{1,t}(X_{t+1}) &= \phi_1 X_{t-1}, \\ \mathbb{E}_{2,t}(X_{t+1}) &= \phi_2 X_{t-1}, \end{aligned}$$

where:

- mean-reverting: fundamentalists:  $0 < \phi_1 < 1$ ,
- mean-diverting: trend extrapolators:  $\phi_2 > 1$ ,
- fractions  $n_{1,t}$  and  $n_{2,t} = 1 - n_{1,t}$  subject to (imperfect) updating based on performance.

**Evolutionary strategy switching**: agents gradually switch to better performing strategies so that 'average market sentiment' changes over time.

## Characterization of price adjustment, dynamics and estimation

Deviations from fundamentals in AR(1)-form to be estimated:

$$X_t = \frac{n_{1,t}\phi_1 + n_{2,t}\phi_2}{R + \bar{\alpha}} X_{t-1} + u_t, \quad \text{with } u_t \approx \text{white noise}.$$

Denote (time varying) **market sentiment**  $\Psi_t$ :

$$\Psi_t = \frac{n_{1,t}\phi_1 + n_{2,t}\phi_2}{R + \bar{\alpha}}.$$

Dynamics:

- Explosive market sentiment and temporary bubble state if:  $\Psi_t > 1$ ,
- Locally stable fundamental equilibrium if  $|(\phi_1 + n_{2,t}\phi_2)/(R + \bar{\alpha})| < 1$ .

Estimation in two steps:

- 1st step: calculate deviations  $X_t$  from house prices and rent indices,
- 2nd step: use deviations  $X_t$  to estimate behavioral parameters.

## 3. Data and Empirical Results

We estimate 8 countries: US, JP, UK, NL, CH, ES, SE, BE.

### Fundamental and deviations

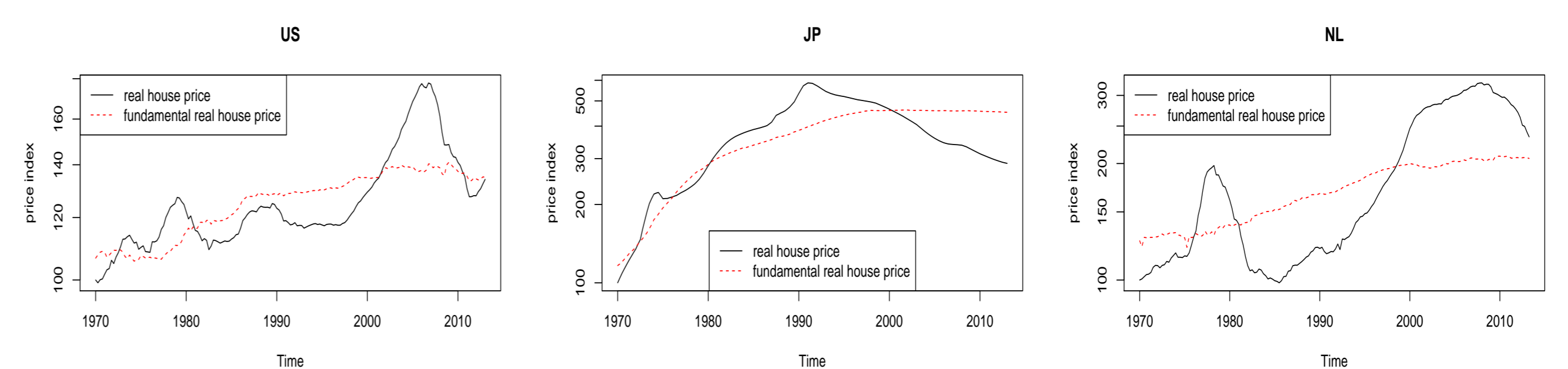


Figure 1: Real house prices (black solid lines, 1970Q1=100) and estimated fundamental real house prices (red dashed lines).

### Market sentiment and temporary bubbles

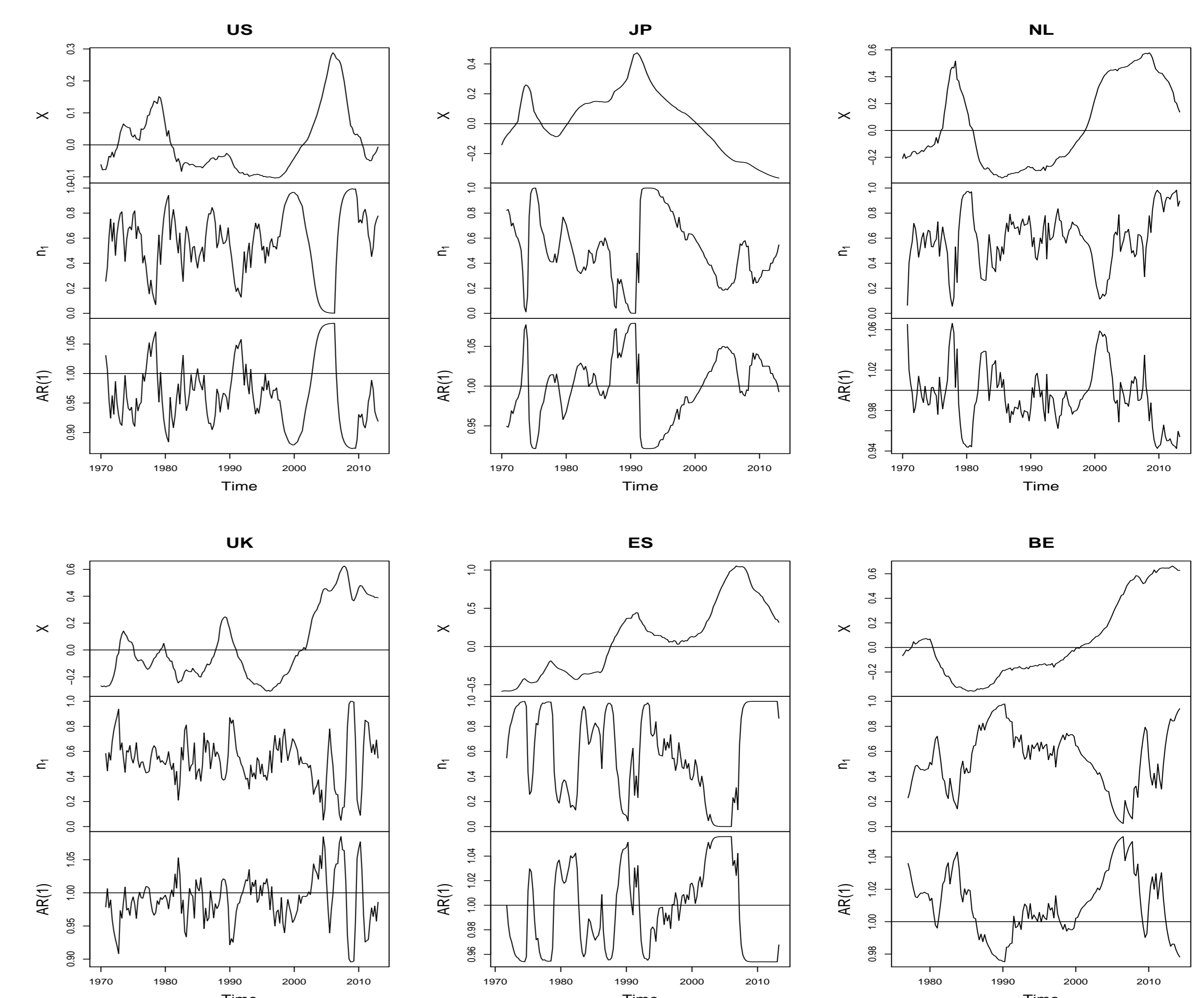
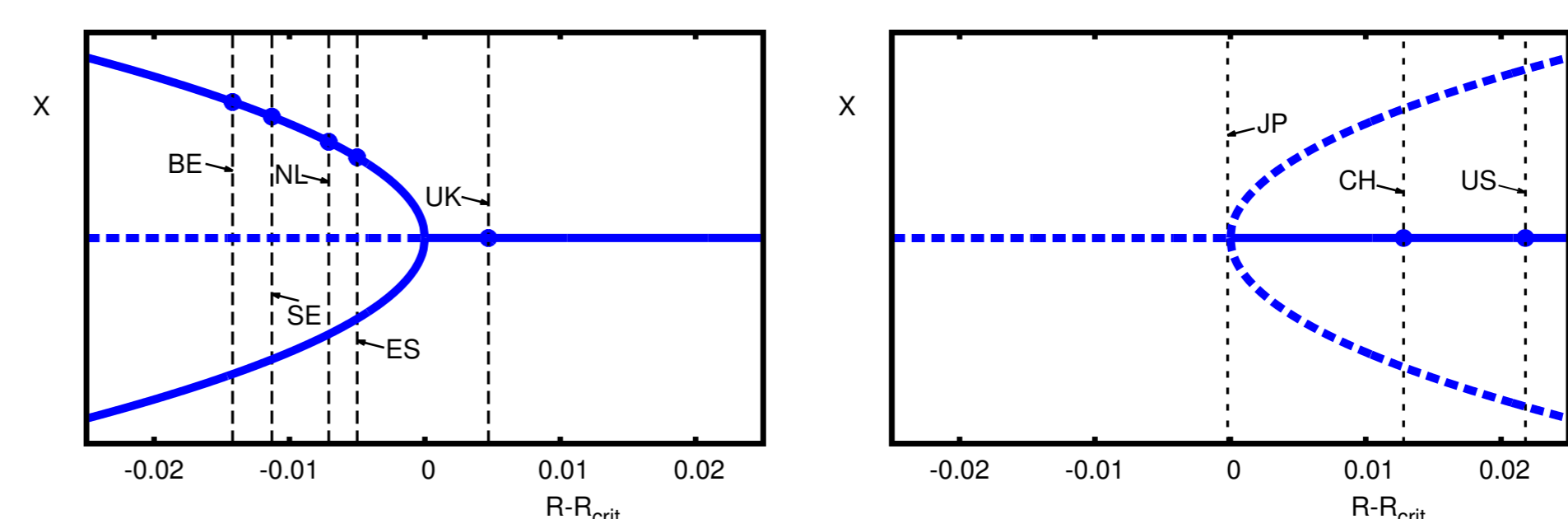


Figure 2: Price deviations  $X_t$  (top panel), estimated fractions  $n_{1,t}$  of fundamental-reverting agents (middle panel) and implied AR(1) coefficients, i.e. market sentiment (bottom panel).

## 4. Dynamics and Policy Implications



Policy implication: avoid (subcritical) pitchfork bifurcations by keeping interest rates sufficiently high, i.e. such that:

$$1 + r^{rf} + \omega = R > R_{crit} = (\phi_1 + \phi_2)/2.$$

## 5. Concluding Remarks

- Heterogeneous expectations are statistically significant in all countries.
- Two regimes captured by the data: mean-reverting vs mean-diverting beliefs.
- Resulting model qualitatively different from a RE-model (homogeneous beliefs and unique well-defined steady state).
- Prolonged periods of housing market bubbles in all countries.
- **Dark corners**: how can we use policy to stay away from points that may lead to instability?

Wilko Bolt (e-mail: w.bolt@dnb.nl)  
Research Department, De Nederlandsche Bank  
Amsterdam, The Netherlands