

# **A State Space Approach to Extracting the Signal from Uncertain Data**

**October 2007**



## Aim of presentation

- Model in paper is widely used across Bank of England Monetary Analysis area
- Many practical implementation issues
- Aim to outline some of these questions and investigate sensitivity of results



# Structure

- Motivation

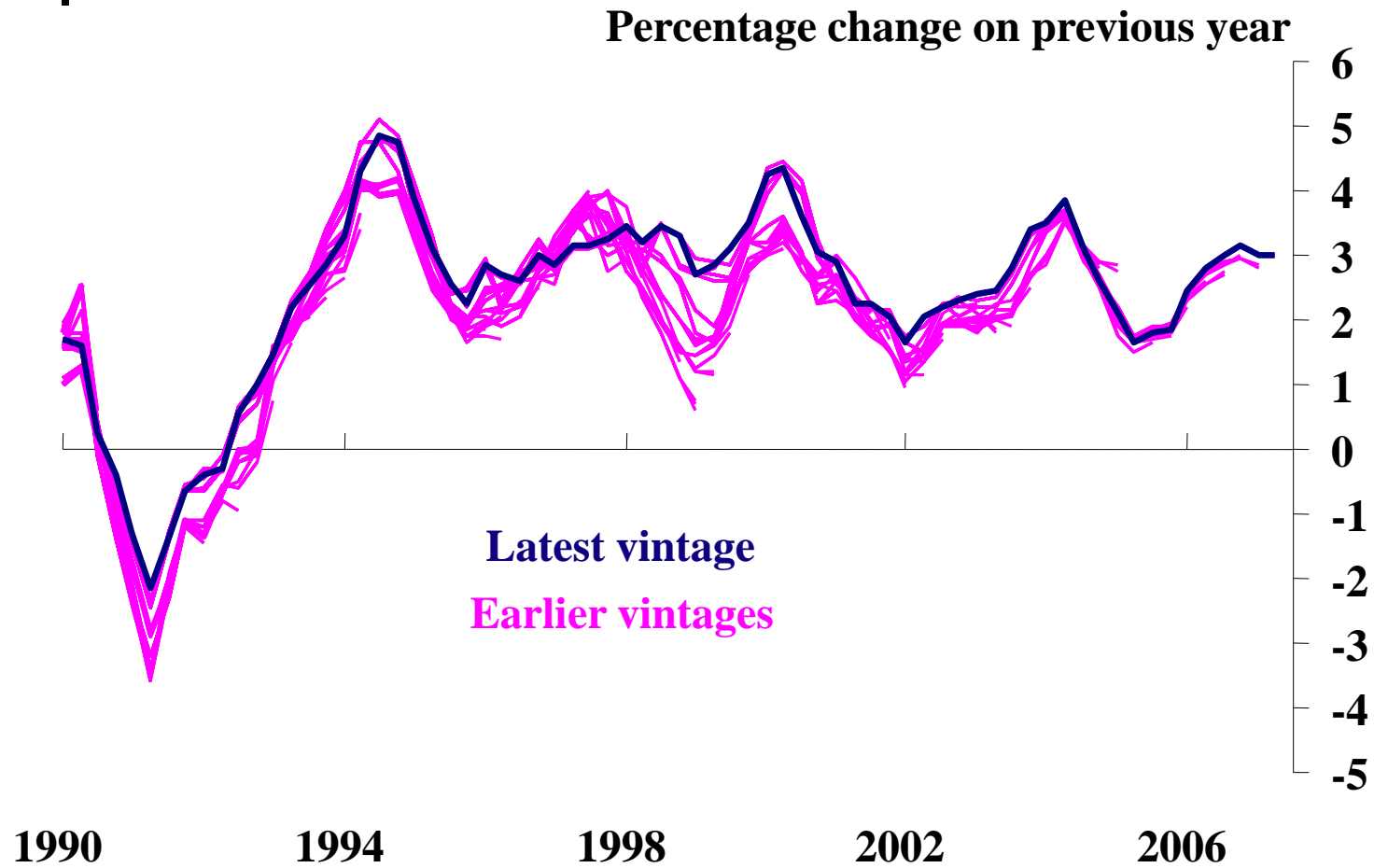
- Model

- What drives the results?

  - Example: UK Business Investment

# Motivation

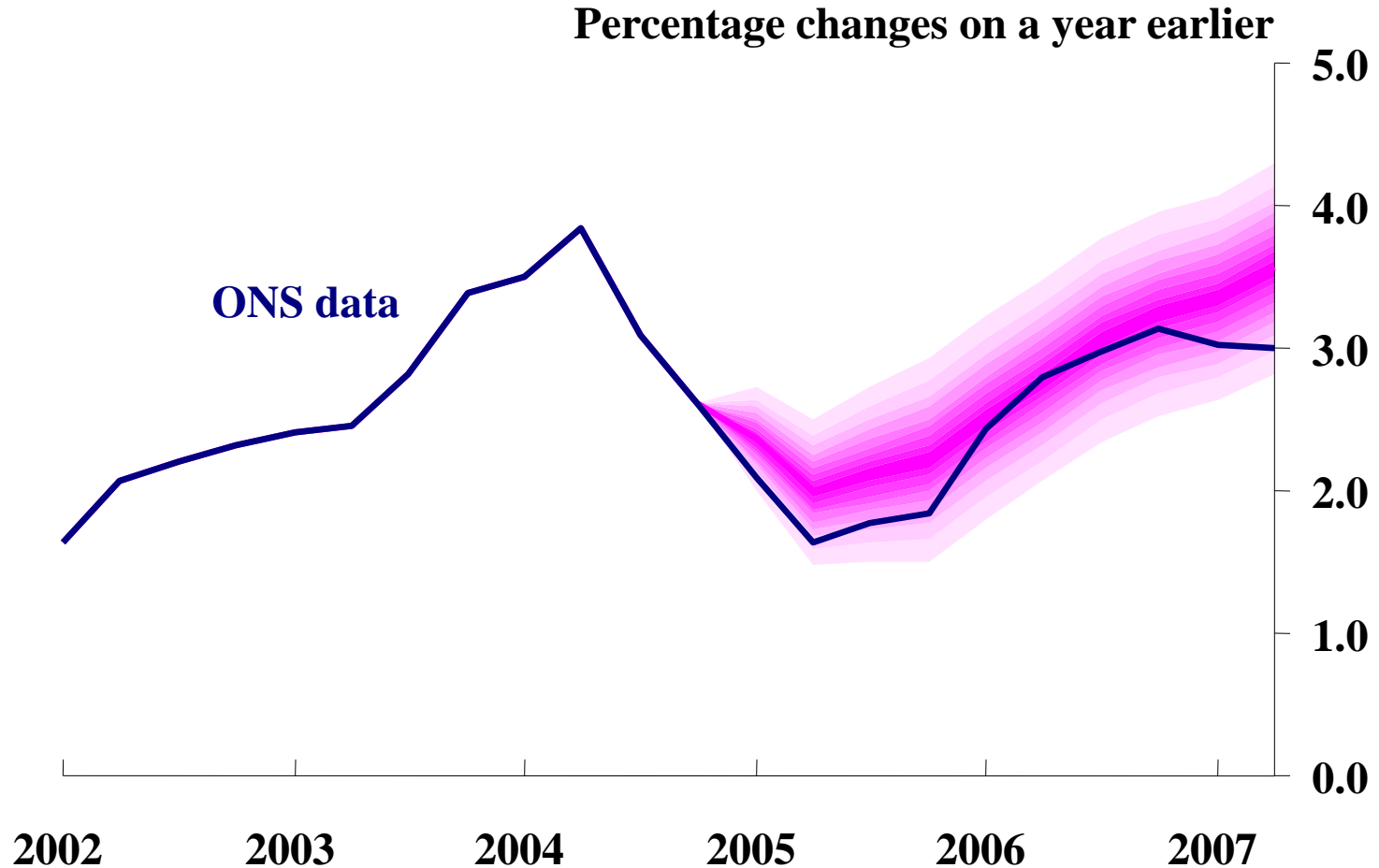
## *Revisions to GDP*



- UK revisions often substantive, often some years after first release – symptom of uncertainty

# Motivation

## GDP backcast *Inflation Report* August 2007



- BoE published alternative estimates of past GDP growth

# Model equations (1)

- Measurement equation for official data, estimated over revisions history

**Bias in measurement**

$$\tilde{y}_t^{t+n} \Rightarrow \tilde{c}^n + y_t + \tilde{v}_t^{t+n}$$

**Serial correlation in measurement errors**

$$B(L)\tilde{\eta}_t^{t+n} = \tilde{\varepsilon}_t^{t+n}$$

**Error variance decays with maturity**

$$\tilde{\varepsilon}_t^{t+n} \sim N(0, \sigma_{\tilde{\varepsilon}^n}^2)$$

$$E(\tilde{\varepsilon}_t^{t+n} \eta_t) \neq 0$$

**Correlation with economic shocks**



## Model equations (2)

- Measurement equation for official data, estimated over revisions history

- Measurement equation for alternative indicators

$$y_t^i = c^i + Z^i y_t + v_t^i \quad v_t^i \sim N(0, \sigma_{v^i}^2)$$

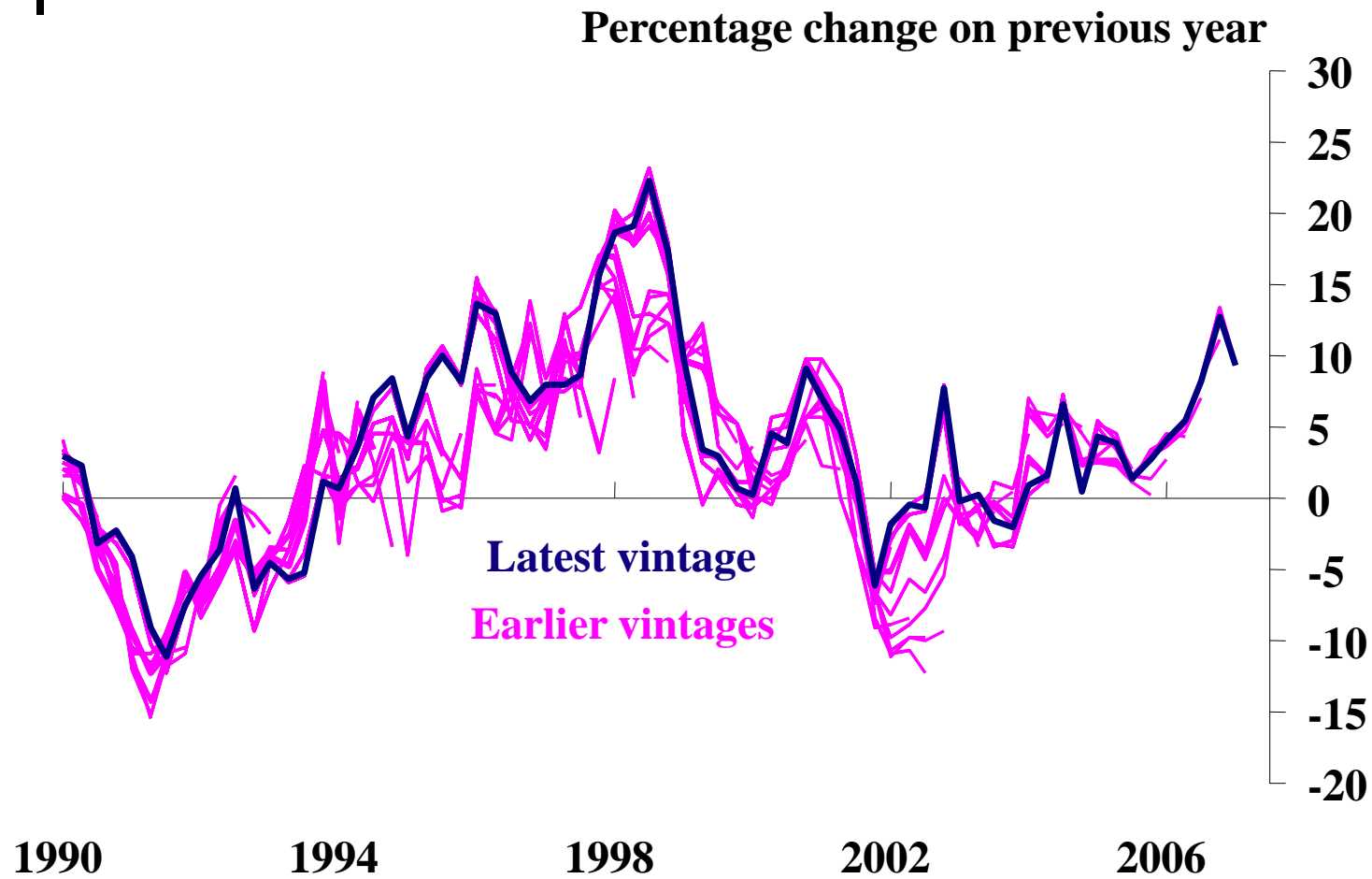
- Simple transition law drives prior

$$A(L)(y_t - \mu) = \eta_t \quad \eta_t \sim N(0, \sigma_\eta^2)$$

- Output = estimate of true state

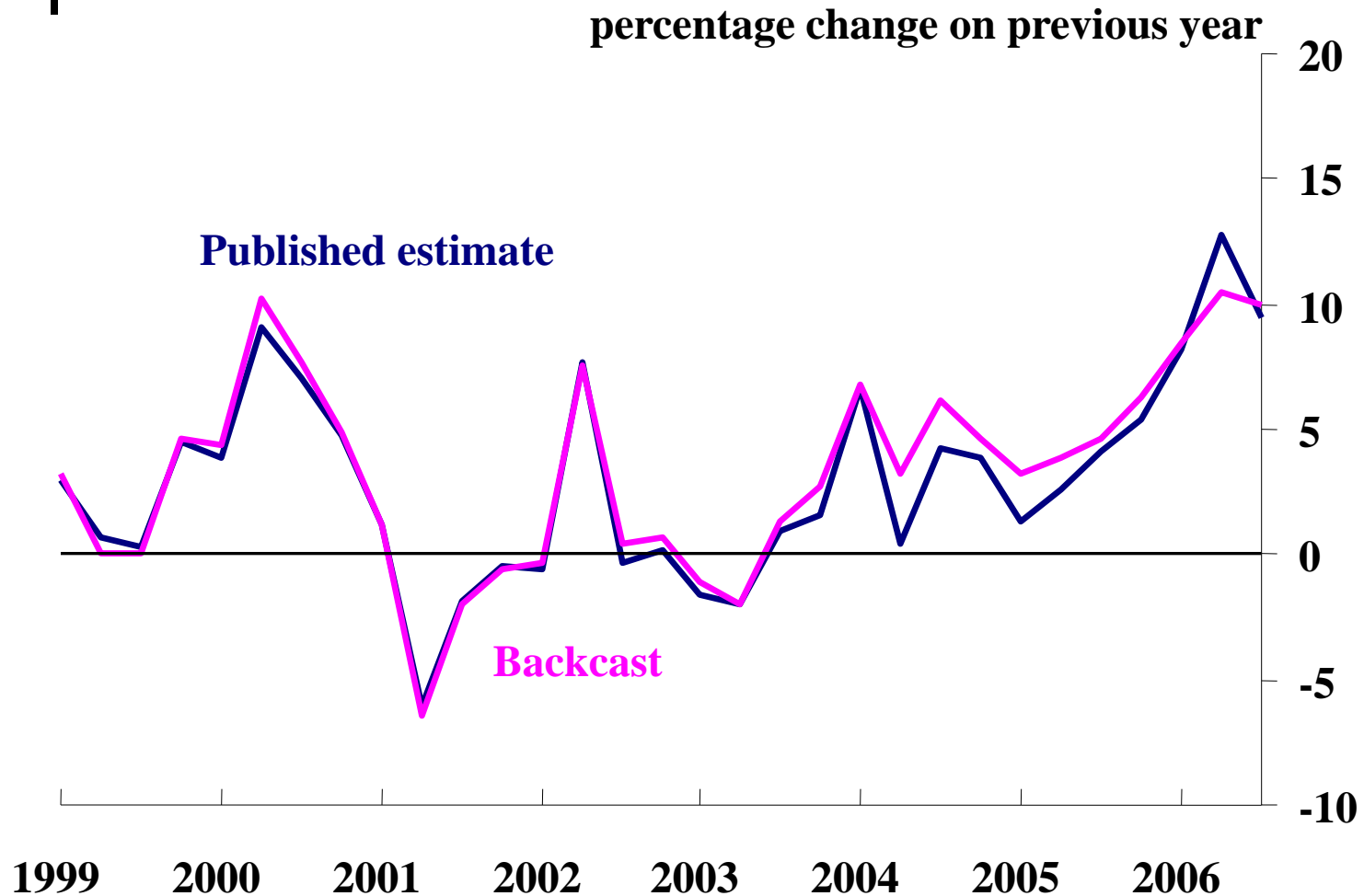
$\approx$  weighted average of current measures  
and dynamics

# Revisions to business investment



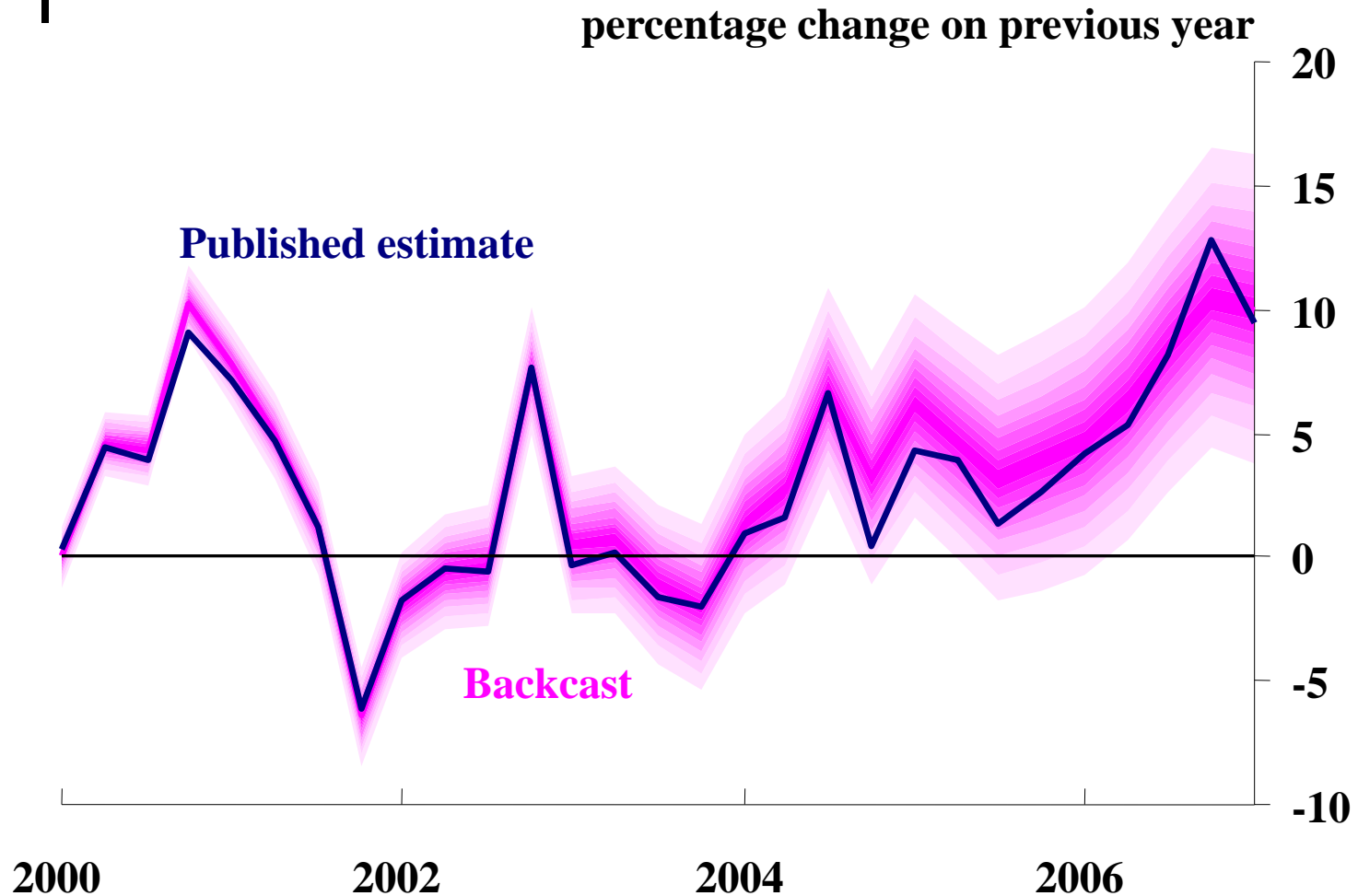


# Business investment backcast



- Model suggests stronger growth than recorded in ONS data over much of sample

# Business investment backcast



- But considerable uncertainty surrounding estimates



# What drives the results?

- Bias

- Decay rate of revisions

- Serially correlated revisions

- Alternative indicators



## What drives the results?

- Bias

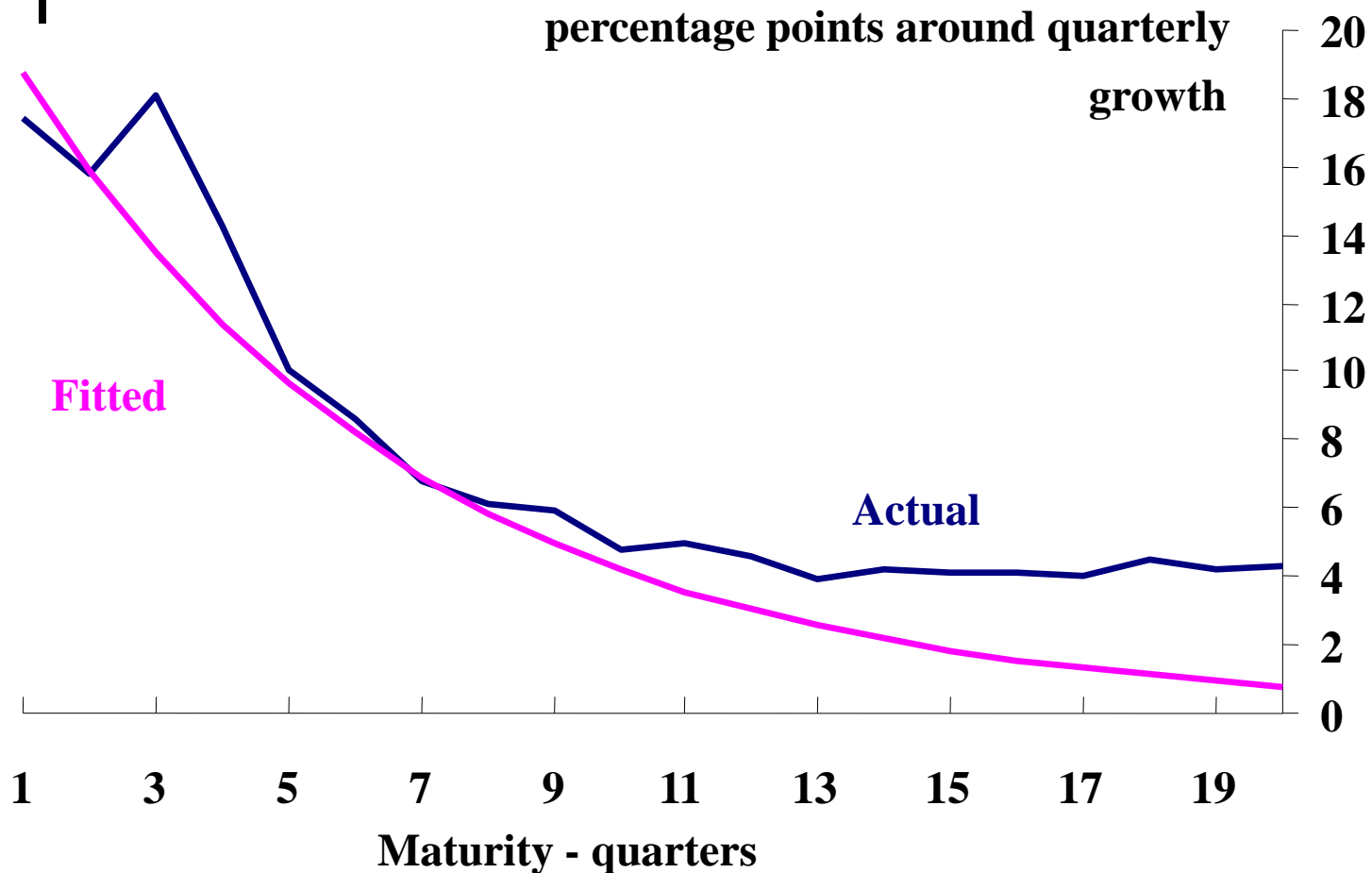
- Decay rate of revisions

- Serially correlated revisions

- Alternative indicators

# Revisions to business investment

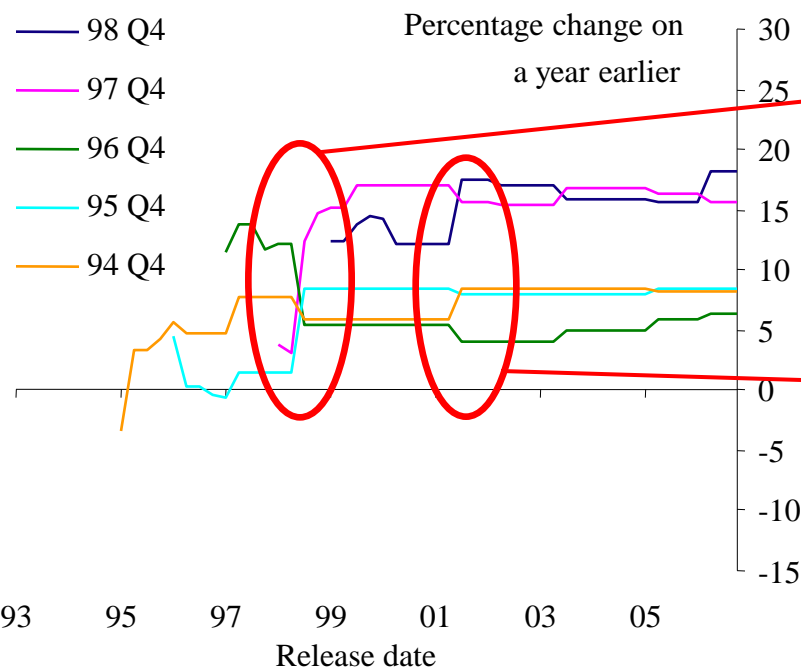
## *Measurement error variance*



- Variance decays over time
- But fitted trend is poor at older maturities

# Which revisions to use to proxy current uncertainty?

## *Evolution of estimates*



### **1998 “Blue Book”**

- *Inter alia*: ESA(95) classification system introduced

### **2001 Blue Book**

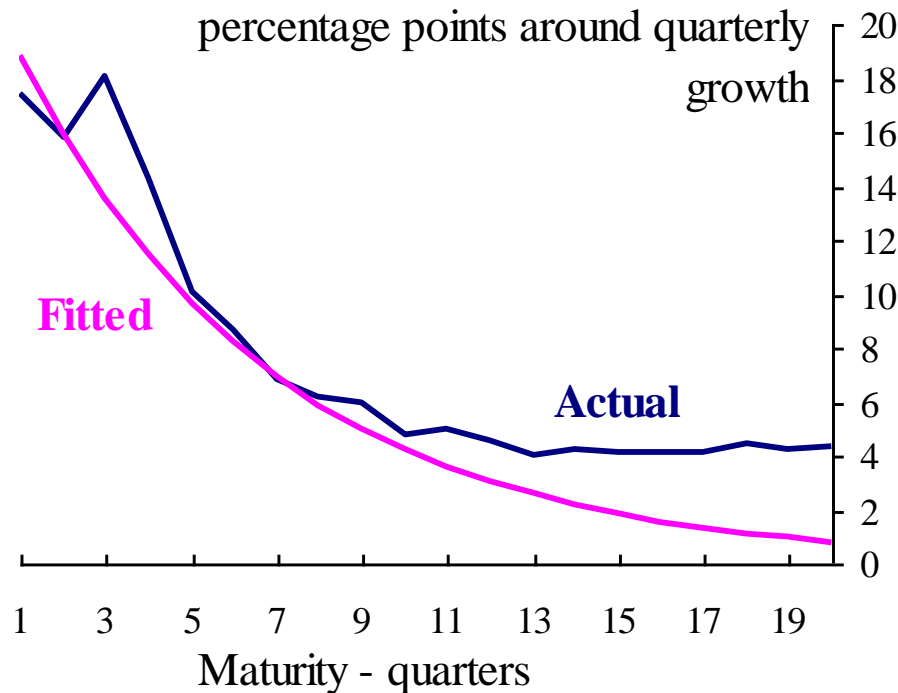
- *Inter alia*: Revisions to computer prices in producer price indices

- o Large revisions in two years dominating the analysis
- o Likely that these are not that informative about future revisions

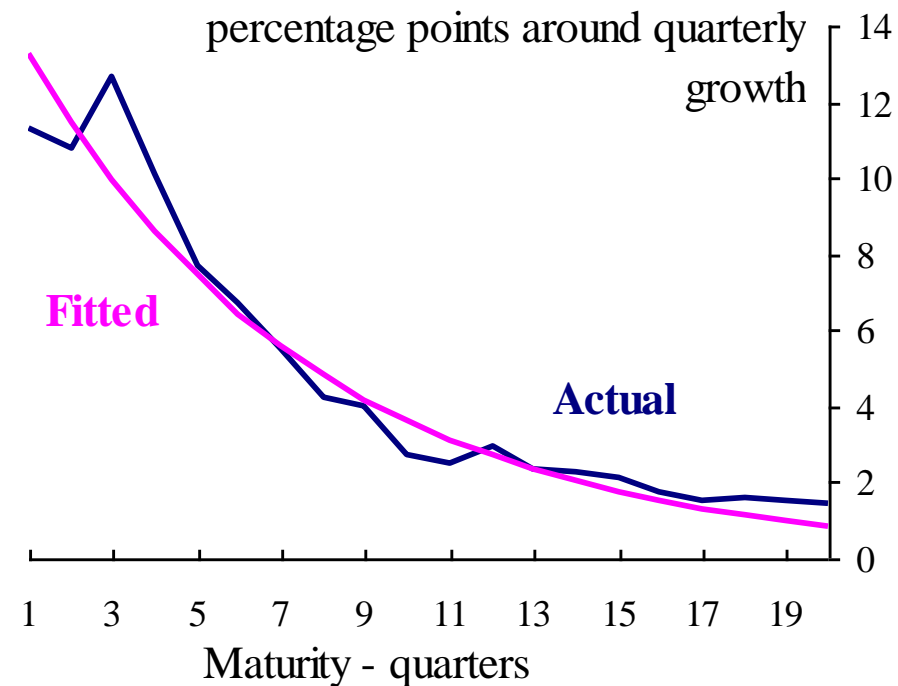
# Sensitivity to modelling choices

## *Measurement error variance*

All revisions



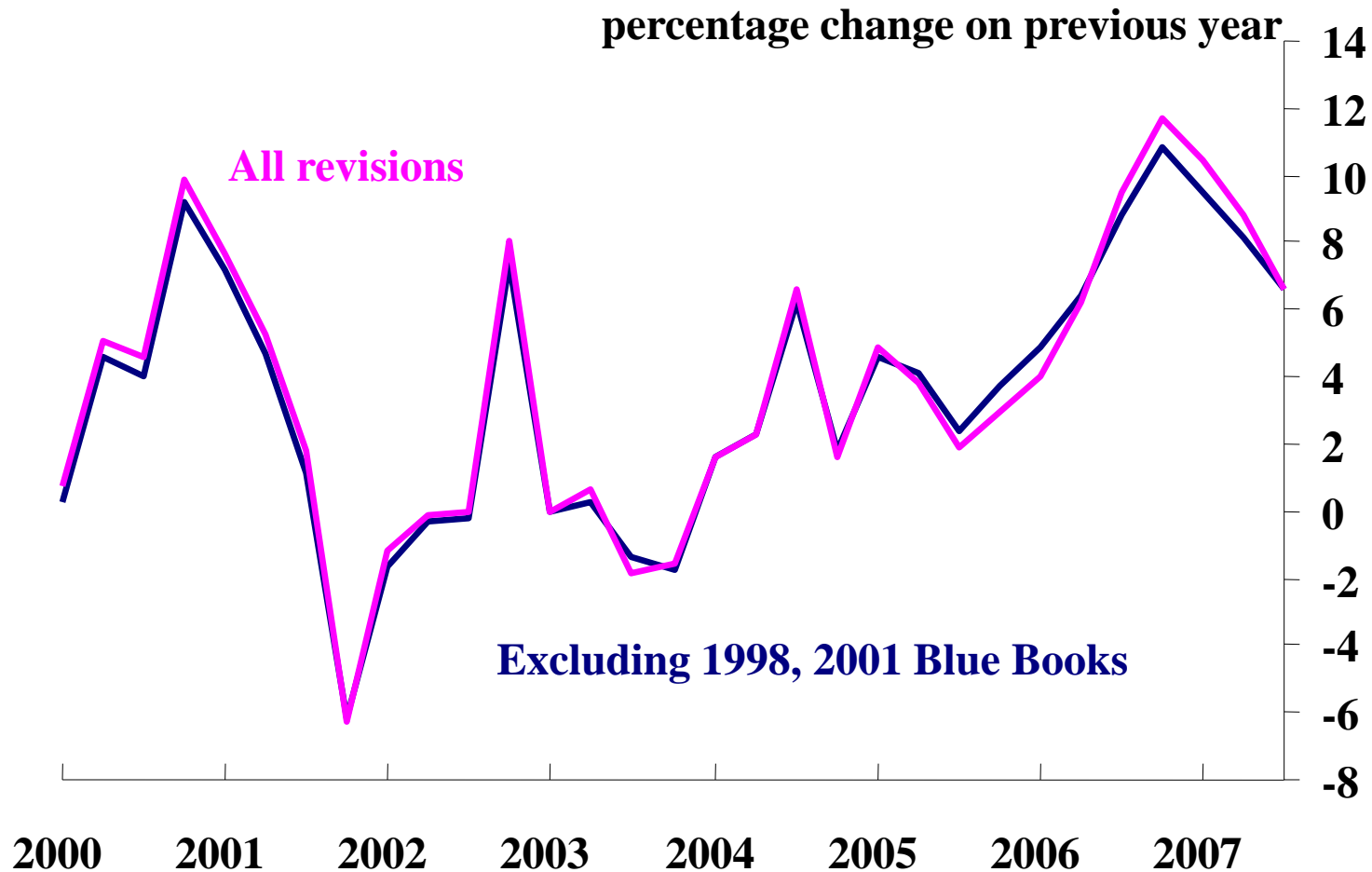
Excluding 1998, 2001 Blue Books



- Exclusions improve fit of model

# Sensitivity to modelling choices

## *Illustrative business investment backcasts*



- Results are fairly similar – maximum wedge of 0.9pp in annual growth –unlikely to be policy-significant?



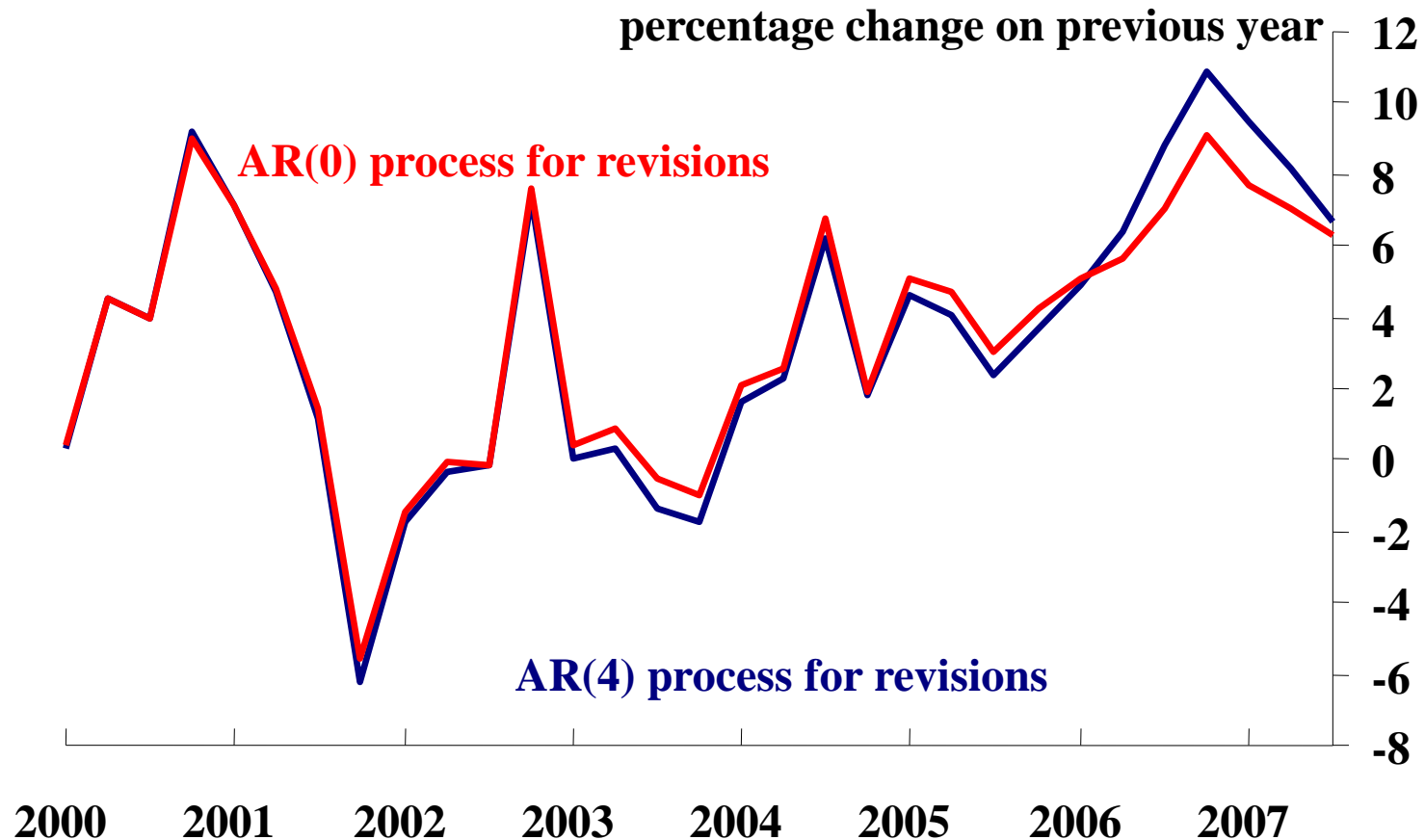


## What drives the results?

- Bias
- Decay rate of revisions
- **Serially correlated revisions**
- Alternative indicators

# Sensitivity to modelling choices

## *Illustrative business investment backcasts*



Both estimates exclude 1998, 2001 Blue Books

- Maximum difference 1.7pp on annual growth rate – likely would be policy significant



## What drives the results?

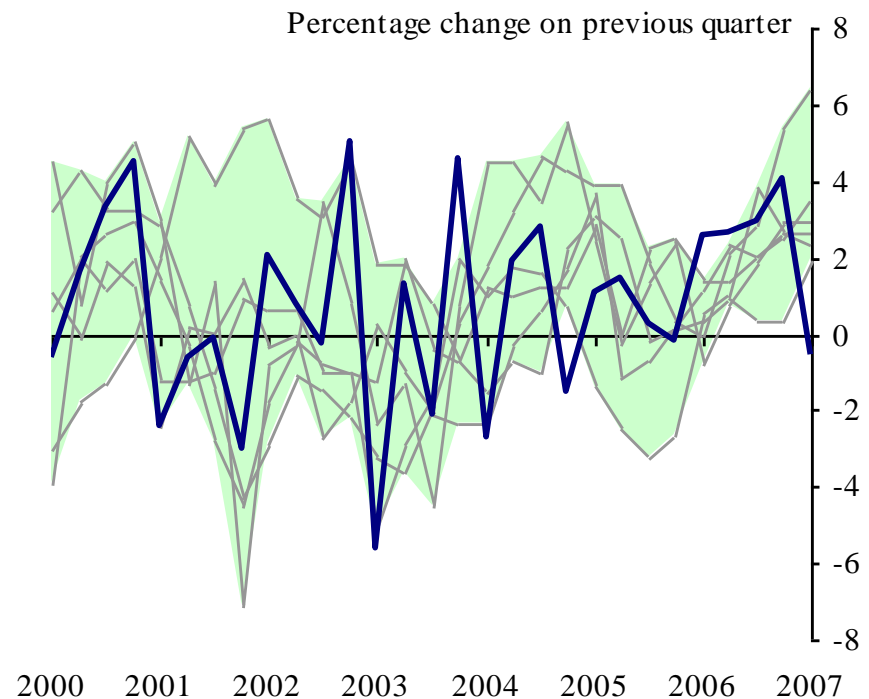
- Bias
- Decay rate of revisions
- Serially correlated revisions
- **Alternative indicators**

# Sensitivity to modelling choices

## *Choice of indicators (1)*

- There are many alternative indicators of business investment
- Plot a swathe of all indicators
  - But this says nothing about the quality of the indicators

**Swathe of survey indicators**



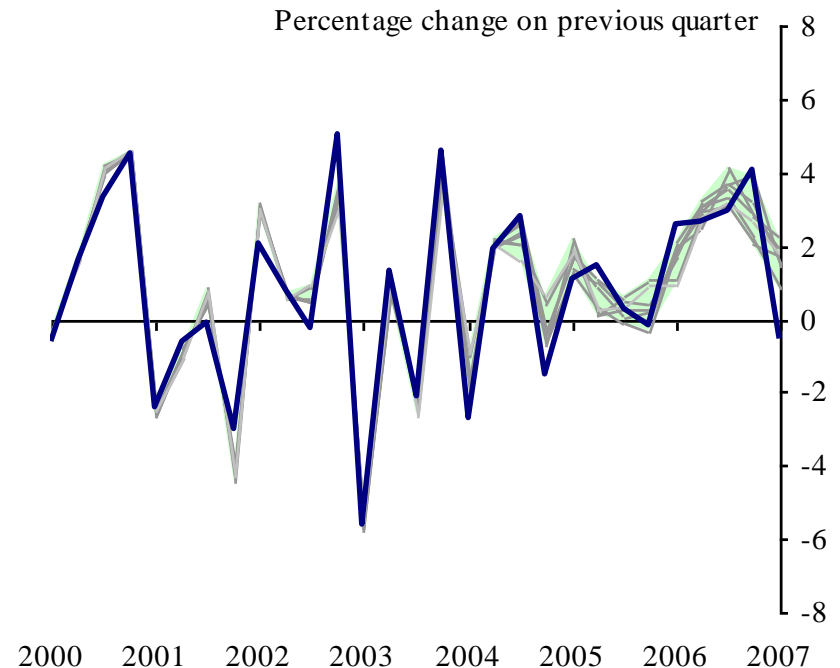
Indicators converted to a common mean and variance

# Sensitivity to modelling choices

## *Choice of indicators (2)*

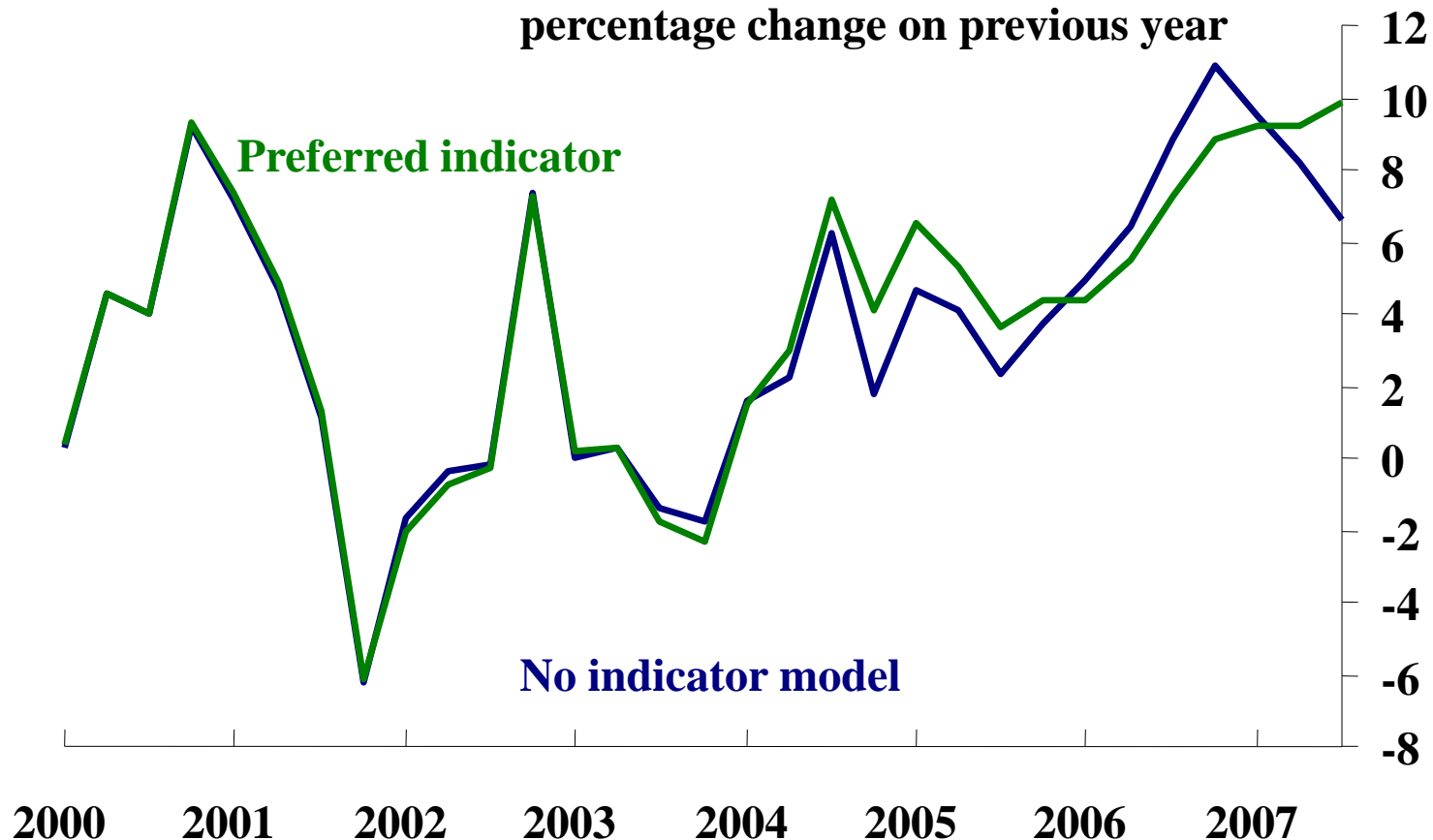
- Survey choice matters for backcast
- Trade-off between
  - parsimony vs. risk of throwing away useful information
  - Indicators that correspond well to concept vs. statistical significance
  - In practice not an easy choice

***Backcasts using variety of surveys***



# Sensitivity to modelling choices

## *Illustrative business investment backcasts*

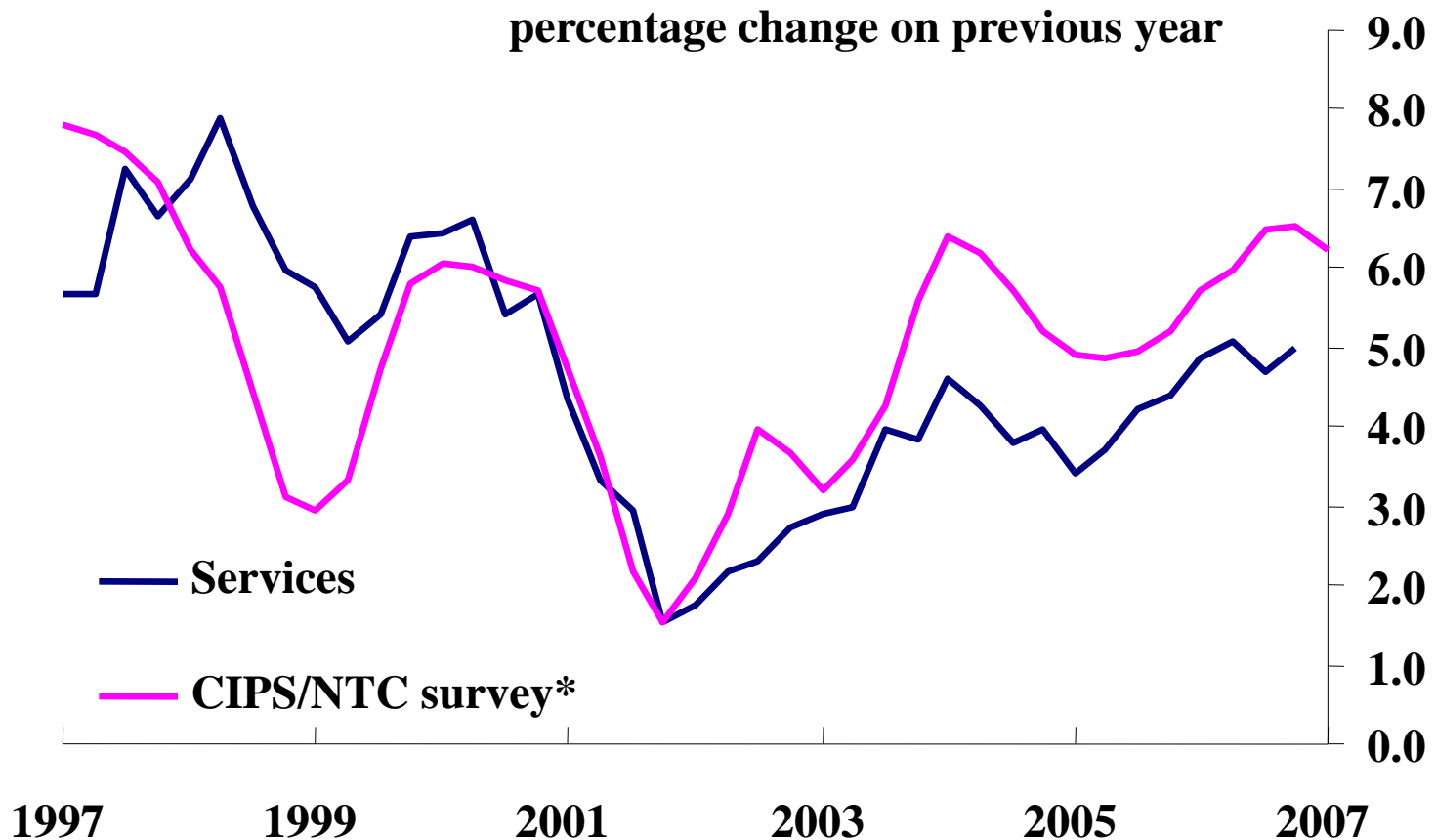


Both estimates exclude 1998, 2001 Blue Books, and allow AR(4) revisions process

- Clear difference in profile over recent past

# Choice of indicator

## *Possible survey structural break?*



\* 4-quarter average, adjusted to have same mean and variance as ONS data

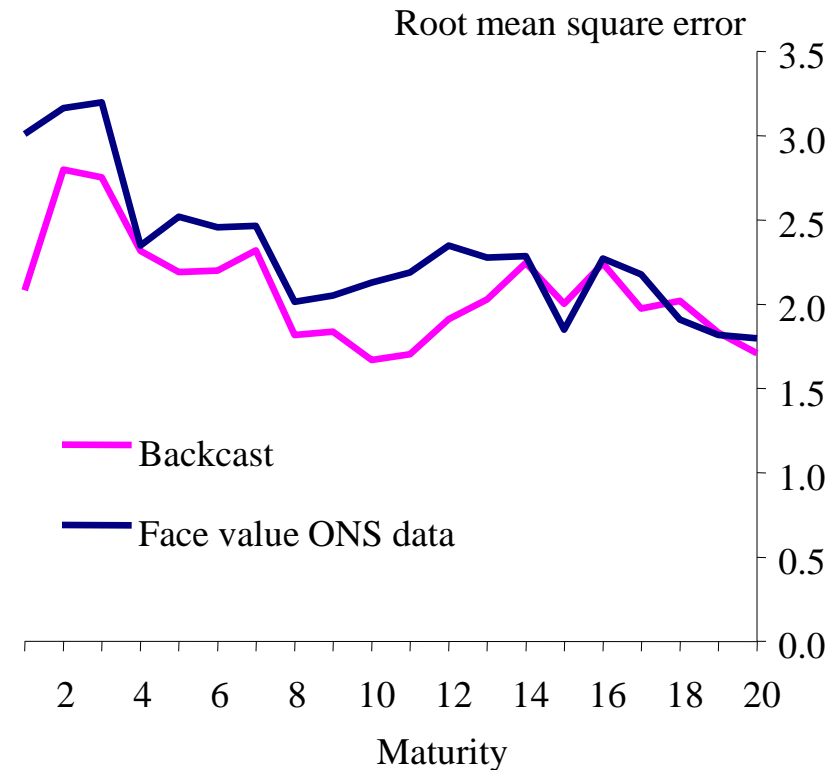
- CIPS has best correlation, but broken down over recent past?

# Model performance

## *Business investment example*

- Re-estimate model quarterly
  - 1998 Q3 to 2002 Q4
- Evaluate backcasting errors
  - Relative to latest ONS estimates
- RMSE lower than face value data at most maturities

### ***Out-of-sample performance***







## Conclusions and model limitations

- Model relies on past revisions as a good indicator of current uncertainty
  - Revisions may become less predictable in future (e.g. Garratt and Vahey (2006), ONS statistical modernisation program)
- Model relies on stable correlation with indicator variables
- Modelling judgements matter