New Forecasting Model of the CNB

Forecasting and Policy Analysis

Macroeconomic Forecasting Division
Monetary and Statistics Dept

Meeting with Analysts, Prague, 15 August 2008

Outline of the Talk

(i) New core model used for baseline

(ii) Basic structure of the model

(iii) Real marginal costs & output-gap concepts

(iv) Brief digression on initial conditions identification

The King is Dead. Long live the King!

The **g3** model has replaced **QPM** as a core model of the Czech National Bank.

- CNB is one of the first central banks to use a DSGE (Dynamic Stochastic General Equilibrium) model as a **core policy tool**
- Joining the "club" with Sveriges Riksbank (RAMSES), Bank of Finland (Aino) or Bank of Canada (ToTEM) . . .
- The g3's features & tools provoked interest in the model (BoF, ECB, Riksbank, BoE. . .)

- CNB used the g3 model since Jan 2007 along with the QPM model for "shadow forecast" and analytical insights
- The g3 FPAS expands analytical scope and brings brand new, powerful tools while preserving the CNB's view of the economy

The Model is Tested and Ready (i)

After intensive and thorough testing the g3 is ready to take-off!

How we tested. . .

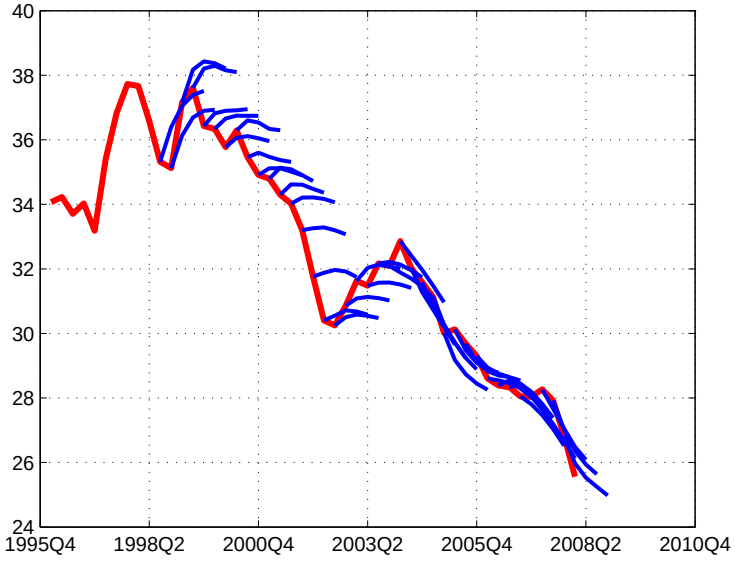
- Real-time forecasting exercises since Jan 2007
- Time & frequency-domain properties
- Historical recursive filtering & forecasting
- FEVD, GSA, . . .

Note:
The “fit” of recursive forecast may vary also due to

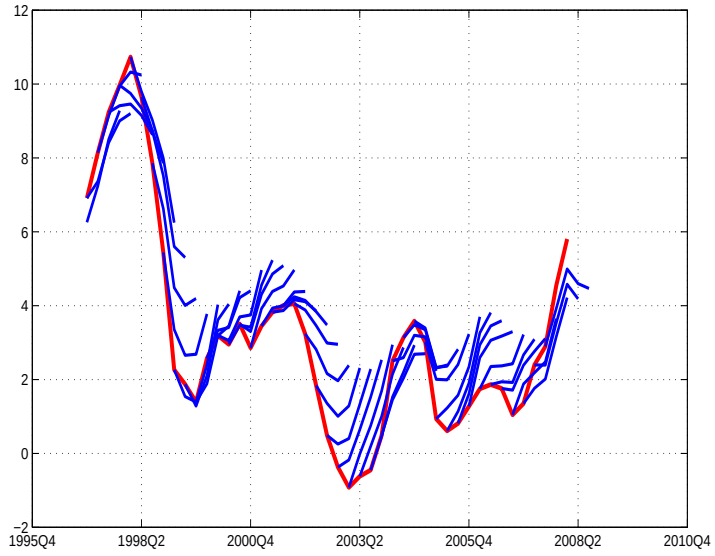
- information set considered
- unconditional nature of the forecast (i.e. endogenous monetary policy)

The Model is Tested and Ready (ii)

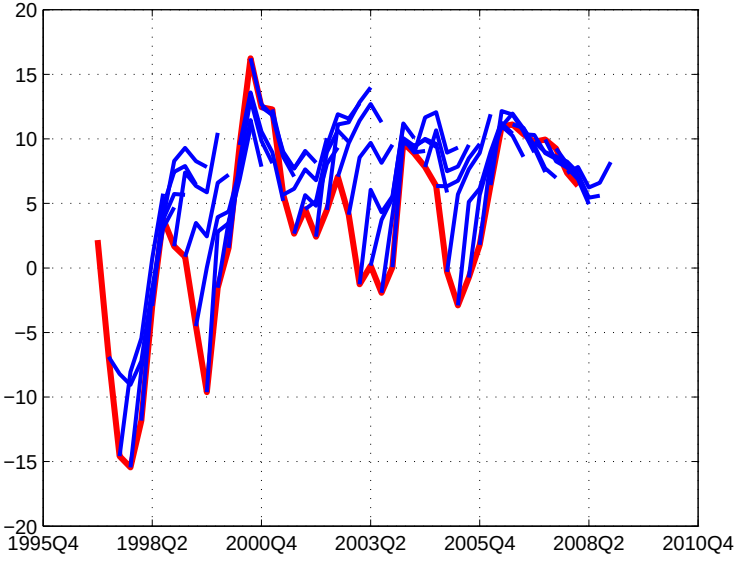
Exchange-rate CZK/EUR (T+4)



Consumer Inflation, YoY % (T+4)



Gross Investment (T+4)



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Bird's Eye View

(i) Small open economy model, taylor-made for the Czech economy

(ii) Designed mainly for forecasting and policy analysis

(iii) Based on behavioral principles and production structure of the economy

(iv) Consistent with quarterly national accounts

(v) Cascade of wage and price rigidities, imperfect exchange rate pass-through

(vi) Rich set of real rigidities and frictions

(vii) Emphasis on foreign trade issues
(import intensity of exports, openness, non-price competitiveness, . . .)

(viii) No use of ad-hoc detrending and/or pre-filtering

(ix) Trends and cycles are not separable

Structure of the Model (i)

Households and Government

(i) Households consume consumption goods, offer labor, own firms

(ii) Government collects tax revenues, consumes goods, issues nominal bonds

Firms

(i) Production structure – firms operate in multiple final-goods sectors (consumption goods, export goods, . . .)

(ii) Nominal wages (contracts) are rigid

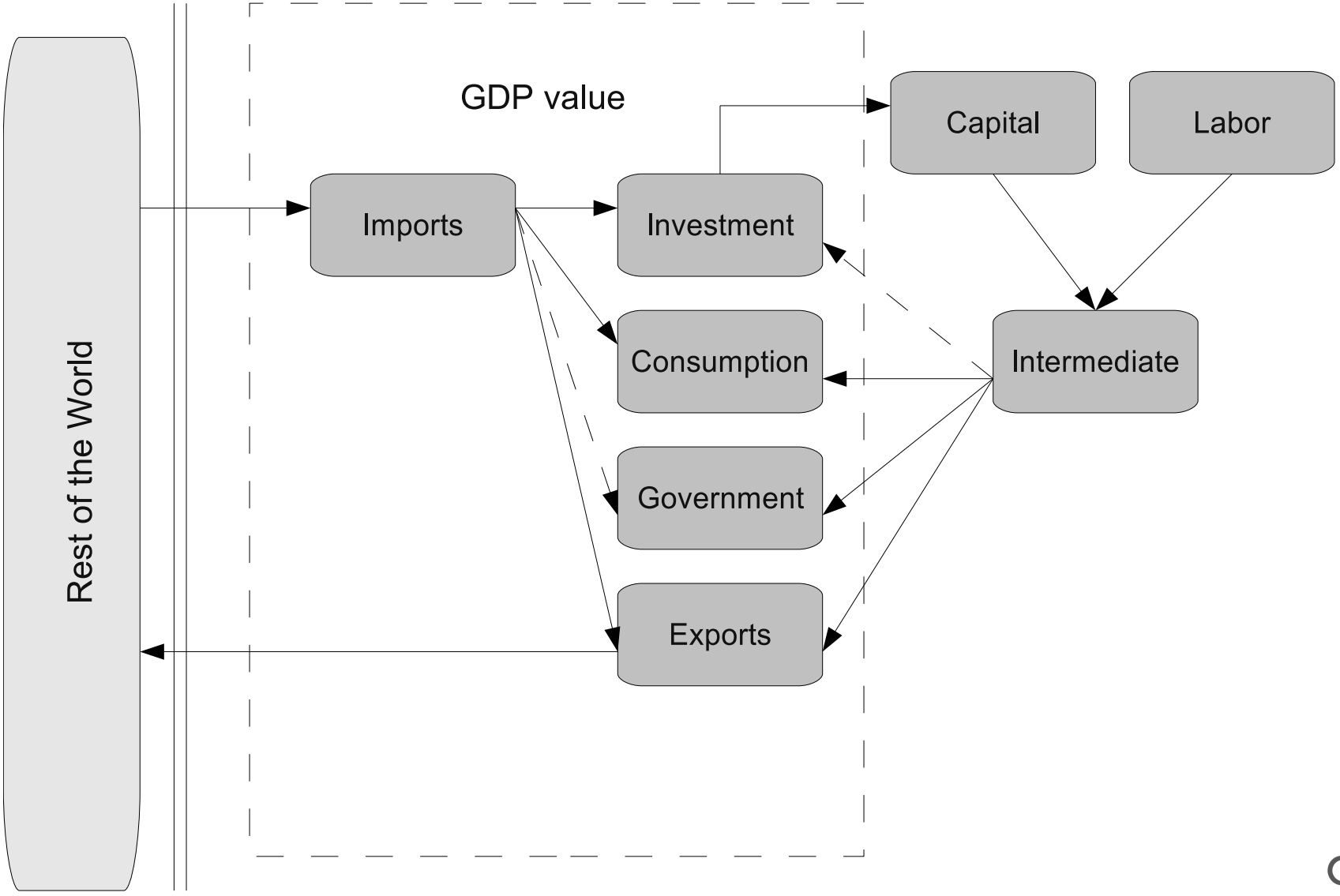
(iii) Various degrees of price-stickiness in each sector (Calvo-Yun Pricing) (exporters sticky in foreign currency, other firms in home currency . . .)

Monetary Policy

(i) Forward-looking central bank implements **inflation targeting regime** using interest rate policy

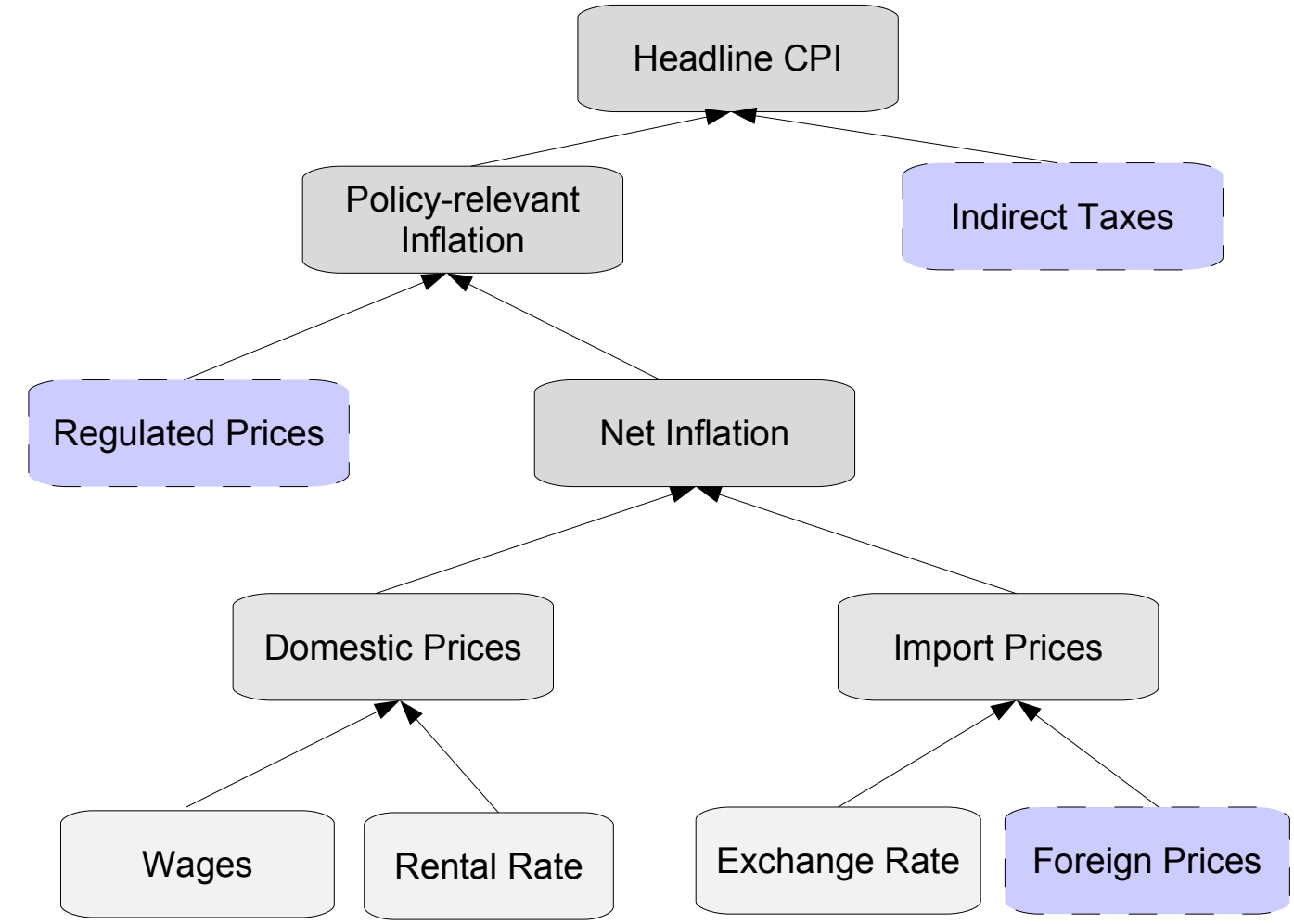
Structure of the Model (ii)

Flow of goods & services



Structure of the Model (iii)

Consumer prices cost structure example...



Real Marginal Costs and Pricing Behavior (i)

(i) Pricing behavior is modelled via extended Calvo-Yun setup

(ii) Individual firm chooses an optimal price, given an expected time of keeping the price unchanged and expected development of costs and demand

(iii) The firm set prices in order to achieve a desired profit markup on average

(iv) Real marginal costs (RMC) – ratio of nominal costs to price
$RMC_t = Costs_t / P_t$

(v) Real marginal costs are an indicator of inflation pressures

(vi) We inspect RMC in consumption, export, production, etc. sectors

Note: RMC definition of g3 and QPM are different!

Real Marginal Costs and Pricing Behavior (ii)

(i) **RMC gap** determines the difference between actual and firms' desired profit markup

(ii) For a given desired markup, positive RMC gap can be closed either by future price increase $\uparrow P$ or decrease in nominal costs $\downarrow Costs$.

(iii) With flexible prices, desired and actual markup coincide...

$$RMC_t = Costs_t / P_t \tag{1}$$

$$P_t^{\text{desired}} = markup_t^{\text{desired}} \times Costs_t \tag{2}$$

$$RMC_t^{\text{desired}} = 1 / markup_t^{\text{desired}}$$

$$RMC_{gap,t} = \frac{RMC_t}{RMC_t^{\text{desired}}} = \frac{markup_t^{\text{desired}}}{markup_t} \tag{3}$$

What about the Output-Gap?

The g3 model does not work with **the** “outpug-gap” à la QPM, due to its different theoretical foundation.

- The concept of output-gap is not explicitly needed in the model
- The g3 model however introduces **technologies**, e.g. labour-augmenting technology or export-specific technology, that are estimated using the model

Output-gap is a useful but only an *univariate* measure with many definitions and estimation procedures. . .

CNB continues to calculate output-gap using various methods to support policymaking:

- production function approach
- semi-structural unobserved components (à la QPM)
- freqency-domain filtering

What about the Output-Gap?

Although the model does not explicitly need an output-gap, still variants can be calculated. . .

In theory and in a DSGE model like g3 we can think of output and all variables in terms of

- *potential* (efficient) level/growth – that would prevail if products and labor markets were perfectly competitive
- *(Neo-Wicksellian) natural level/growth* – level that would prevail under imperfect markets, but with flexible prices and wages
- deviation of output from a Balanced Growth Path (BGP) of the (model) economy

However, these natural/potential outputs may not correspond to smoothly trending ouputs and their identification is highly model-dependent.

Forecasting and Policy Analysis with the Model

1. Initial state of the economy – identification & interpretation
2. Unconditional forecast
3. Scenaria analysis & forecast dynamics decomposition
4. Difference analysis with respect to previous forecasts, factor-by-factor

Initial Conditions – Identification and Analysis (i)

Initial state of the economy is identified using **model-consistent filtering** to estimate unobservables.

Intuition:

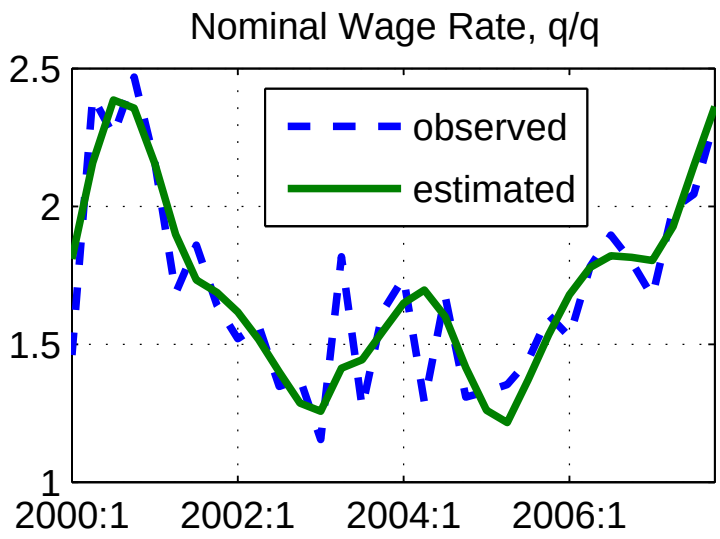
- Model works with observed and unobserved/unobservable variables
- **Filtering** – given all observables, what are the values of unobservables that would generate these observations using the model?
- **Measurement errors** used if plausible for non-reliable and/or noisy data
- More than 17 observables used to interpret the economy brings many complex cross-resctrictions
  (GDP components and deflators, CPI, interest rates, exchange rates, wages, foreign variables. . .)

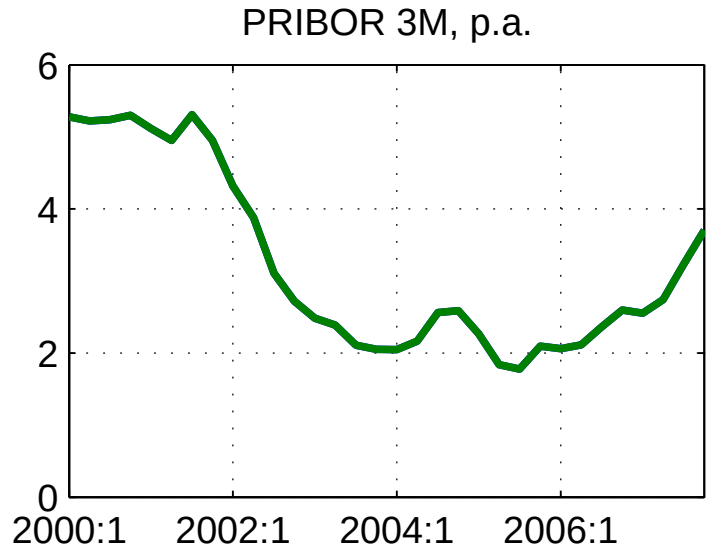
Formally:

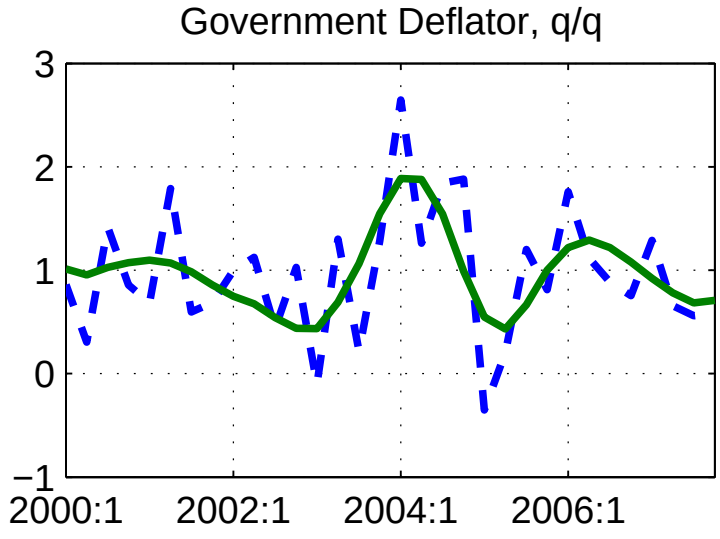
- Multivariate, structural time-invariant, two-sided filter (smoother) with a state-space structure
- Nonstationary, init. conds. either diffuse or fixed-unknown

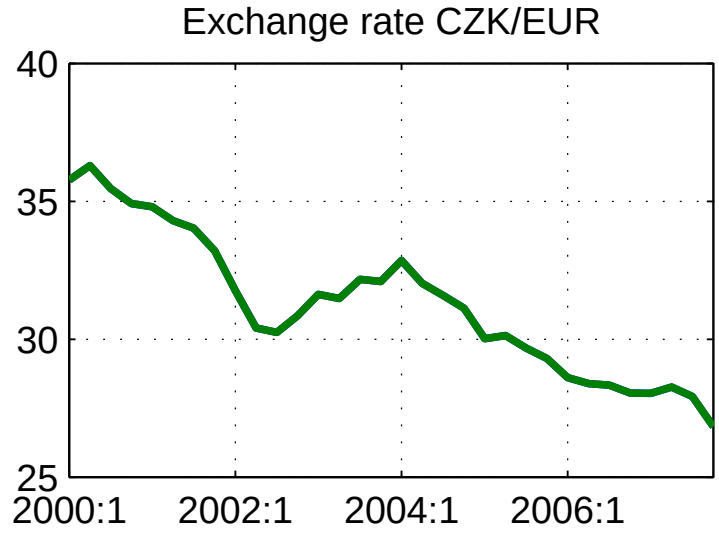
Initial Conditions – Identification and Analysis (ii)

Measurement errors – capturing data-uncertainty & noise









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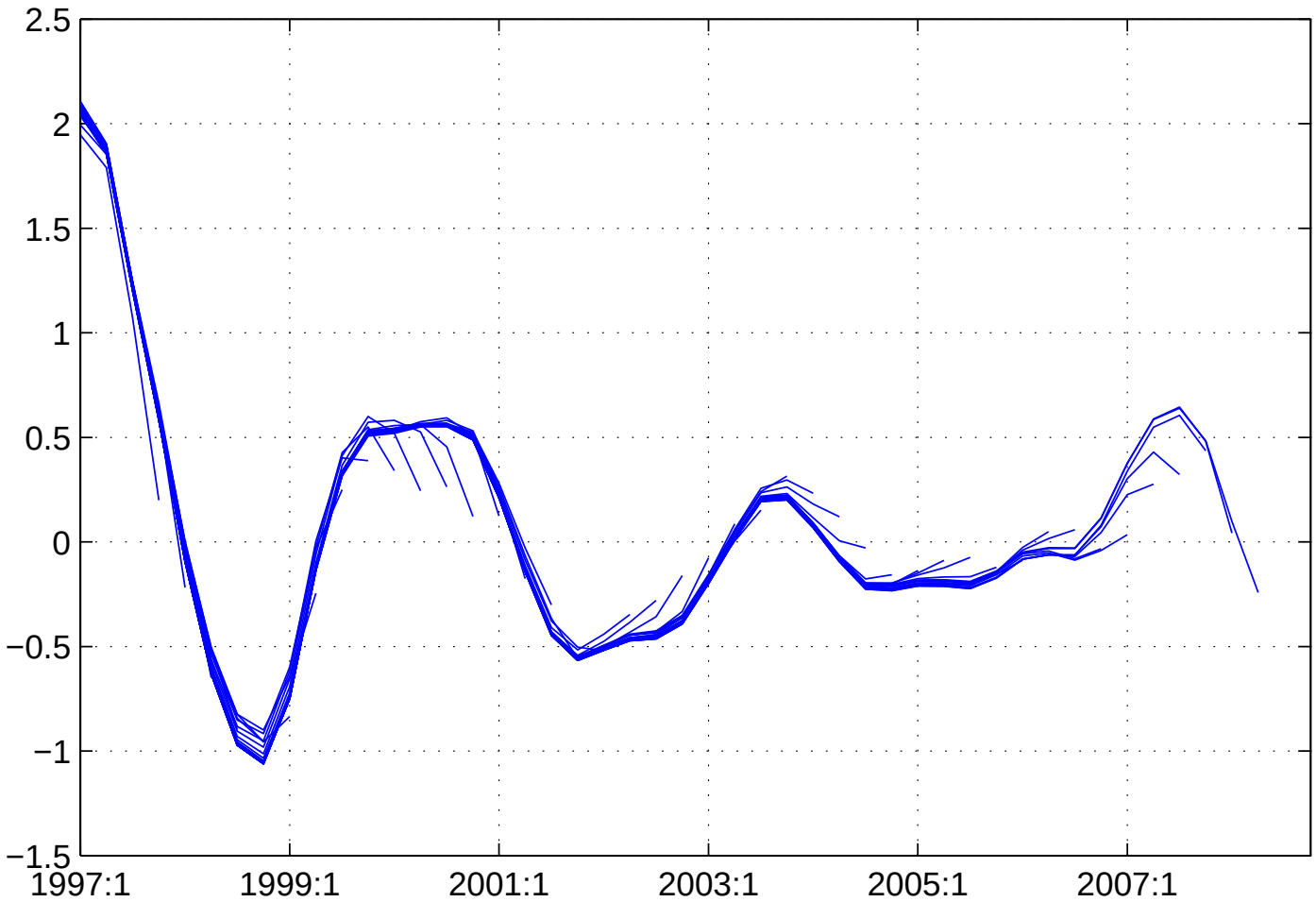
Initial Conditions – Identification and Analysis (iii)

Cross-restrictions of many observables mitigate revisions and sharpen the accuracy of estimates

Real Marginal Costs in Consumption Sector, %



Initial Conditions – Identification and Analysis (iv)

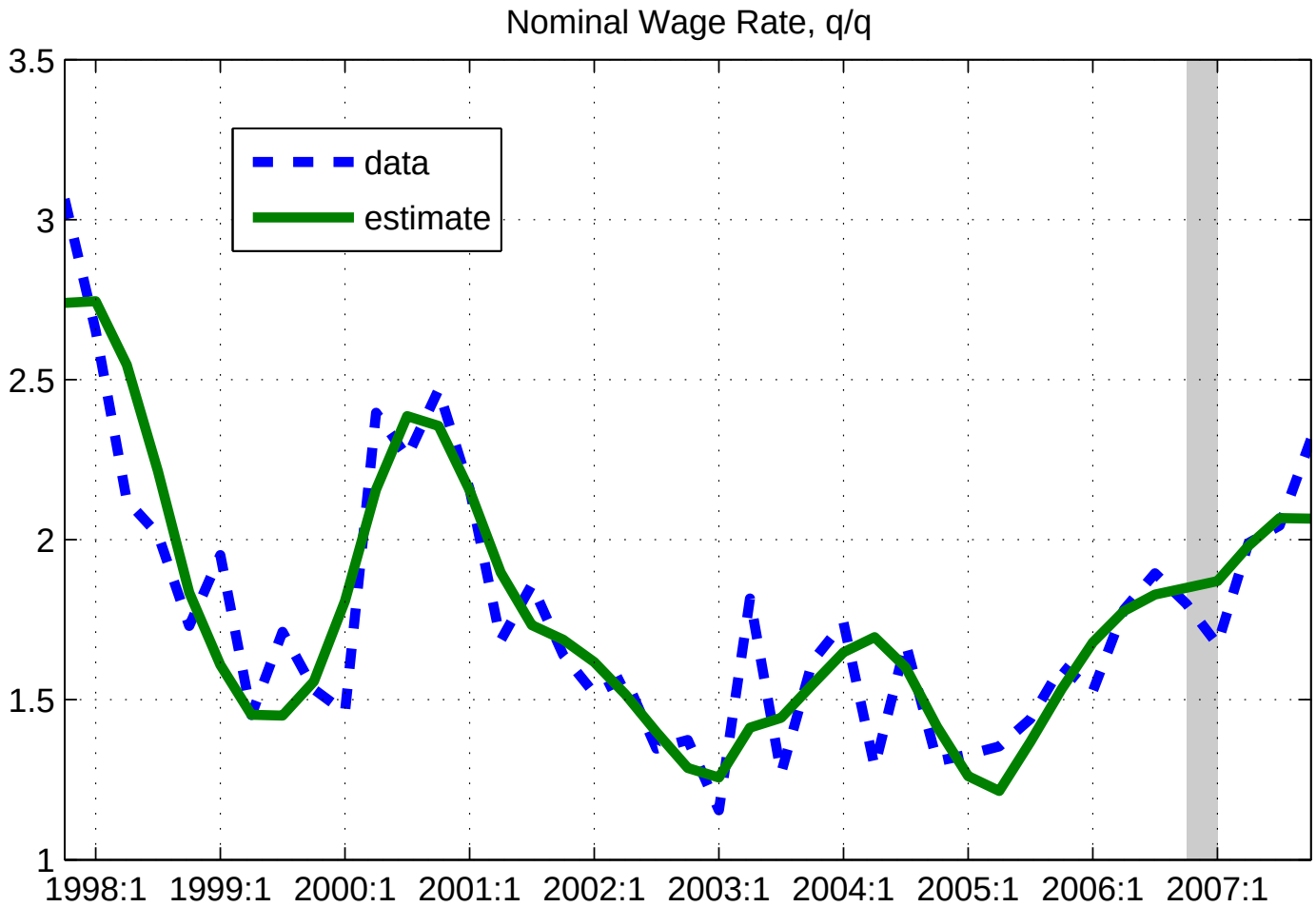
Our filtering framework allows us to

- Carry-out decomposition into structural shocks (shock $\longrightarrow$ observables)
- Understand how each observable contributes to estimation of unobservable (observables $\longrightarrow$ shocks)
- Analyze in detail how data-revisions & new observations change the economics behind the data. . .
- Estimate certain “unreliable” observables conditioned on observing other variables
- . . .

Initial Conditions – Identification and Analysis (v)

Simple example: nowcasting & data checks

Imagine nominal wage rate would be unobserved in 2007:1–2007:4, we can obtain model-consistent estimate conditioned on other series. . .



Thank You For Your Attention

APPENDIX – QPM vs. g3

g3	QPM
explicit derivation using ”behavioral principles”	reduced form
model-consistent expectations	model-consistent expectations
consistence of stocks & flows	flows only
replicates national accounts	no GDP structure
works with level variables	“gaps”
BGP, technology trends	equilibrium trends
simple fiscal block	implicit treatment
forward-looking interest rate rule	forward-looking interest rate rule
carefully chosen ”structural shocks”	residuals for each equation