EUROPEAN CENTRAL BANK

EUROSYSTEM

Estimation of euro area output gap using the NAWM

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European Central Bank

Refining monetary policy: Transparency and real stability

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Introduction

- **Goal of this paper is simple:**
  - **Start exploring the properties of the flexible-price output gap in the New Area-Wide Model of the ECB (Christoffel, Coenen and Warne, 2008);**
    - **What are the time series properties?**
    - **What are the sources of fluctuations?**
    - **What is the information content with respect to future inflation?**
    - **What are the stabilisation properties?**
  - **Note: “start”, “exploring”.**

Introduction

- **Why is this interesting?**
  - **Gali and Gertler (2007): "The natural (flexible price equilibrium) values of both output and the real interest rate provide important reference points for monetary policy – and may fluctuate considerably."**
    - **"they reflect the (constrained) efficient level of economic activity"**
    - **"monetary policy can not create persistent departures from the natural values without inducing either inflationary or deflationary pressures"**
  - **The time-series properties may be very different from more traditional output gaps that are typically modelled as smoothed trends.**

Definition of flexible-price output gap

- **The flexible-price output gap is "the deviation of actual output from the counterfactual level of output that would prevail in an environment of full nominal flexibility in goods and labour markets and absent price and wage mark-up shocks"**
  - **See Smets and Wouters (2003) and Edge, Kiley and Laforte (2006).**
  - **Justiniano and Primiceri (2008) call this potential output, as opposed to natural (or flexible-price) output.**
- **Confront with trend output gap, where the trend refers to the stochastic, labour-augmenting, unit-root productivity process.**

Definition

- **Take a simple New Keynesian model with sticky prices and wages as in Chapter 6 of Gali (2008):**

$$\pi_t^w = \beta \mathrm{E}_t\left\{\pi_{t+1}^w\right\} - \lambda_w\left(w_t - p_t - mrs_t - \mu_t^w\right)$$

$$\pi_t^p = \beta \mathrm{E}_t\left\{\pi_{t+1}^p\right\} - \lambda_p\left(p_t - (w_t - mpn_t) - \mu_t^p\right)$$

$$mrs_t = \nu l_t + c_t$$

$$y_t = a_t + \alpha l_t + (1-\alpha)k_t$$

$$mpn_t = \log\alpha + \frac{1}{\alpha}a_t + \frac{1-\alpha}{\alpha}(k_t - y_t)$$

- **With flexible prices:** $\lambda_w = \infty \quad \lambda_p = \infty$

$$y_t^n = a_t + (1-\alpha)k_t + \frac{\alpha}{1+\nu}\log\alpha - \frac{\alpha}{1+\nu}(\mu_t^p + \mu_t^w)$$

Definition: some comments

- **The flexible-price output gap does not include price and wage-mark-up shocks in the definition of potential output (different from natural output)**
  - **The idea is that mark-up variations are inefficient variations and as such should not necessarily be accommodated;**
  - **Of course, not including mark-up shocks is will create more of a trade-off between inflation and output gap stabilisation.**

Natural output

$$y_t^n = a_t + (1-\alpha)k_t + \frac{\alpha}{1+\nu}\log\alpha - \frac{\alpha}{1+\nu}(\mu_t^p + \mu_t^w)$$

Potential output

Definition: some comments

- **We analyse only the "unconditional flexible-price output gap", as opposed to the "conditional" one. See Adolfson et al (2008):**
  - **Pre-determined variables (like the capital stock) are not taken as given, but recalculated as if the economy had been flexible since day one.**
  - **This contrasts with the traditional production function approach where the capital stock is taken as given.**

Definition: some comments

- **The NAWM is an open-economy model where the rest of the world is modelled in reduced form (VAR):**
  - **All foreign shocks are assumed to potentially affect the flexible price output level**

NAWM?

- **Very similar to Ramses.**
- **See Christoffel, Coenen and Warne (2008)**

Model Structure: Agents

- The are five different types of economic agents:
  - **households:** consume, invest in physical capital, supply differentiated labour services, set wages, trade in domestic and foreign bonds
  - **intermediate-good firms:** use labour and capital as inputs, produce differentiated goods sold domestically and abroad, set prices
  - **final-good firms:** combine domestic and foreign intermediate goods into private and public consumption goods, and private investment goods
  - the **fiscal authority:** purchases public consumption goods, issues bonds, levies different types of taxes
  - the **monetary authority:** sets the nominal interest rate by following a Taylor-type interest-rate rule
- International linkages arise from trade in intermediate goods (accounting for imperfect exchange-rate pass-through) and foreign bonds.

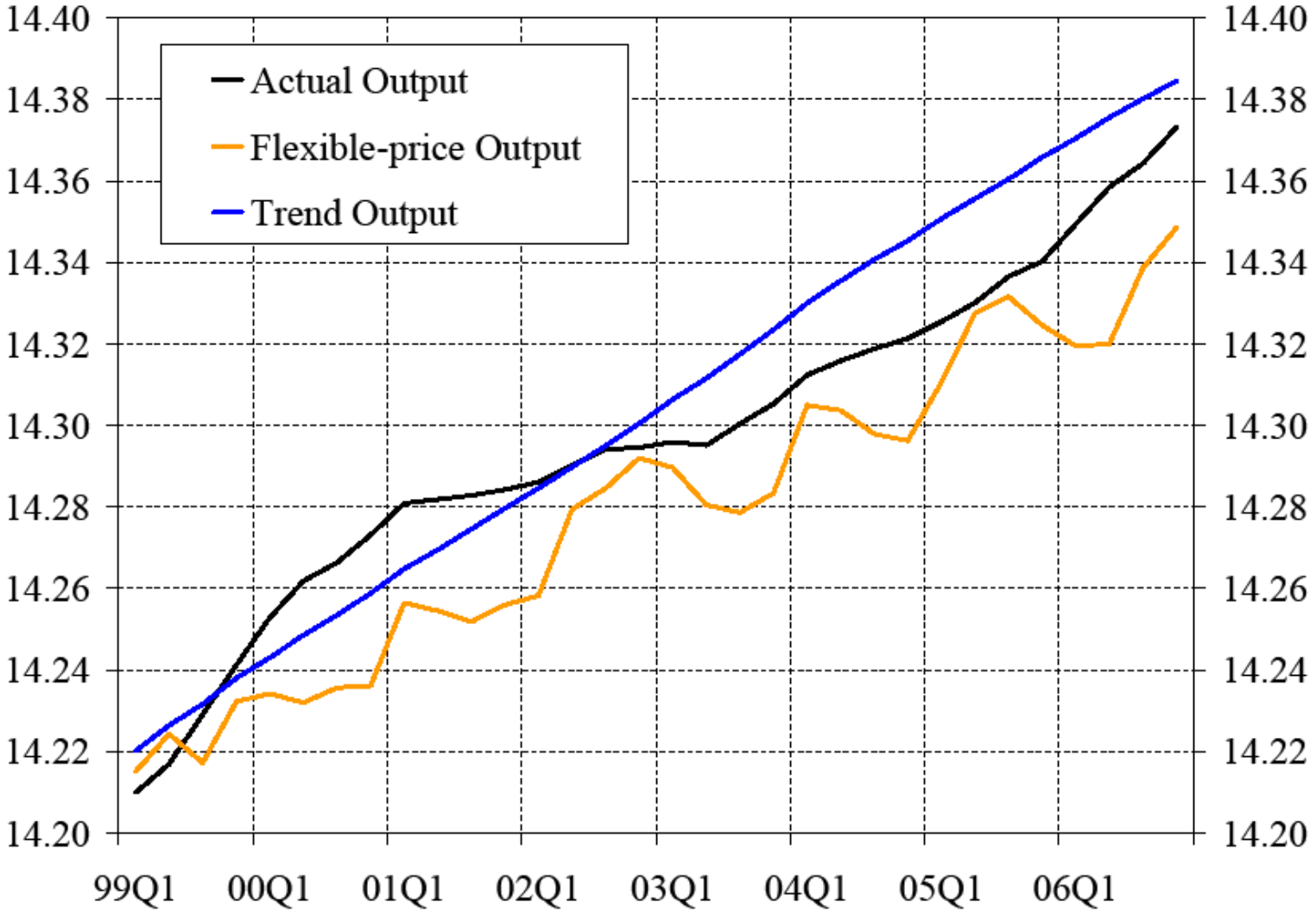
Model Structure: Frictions

- Households and firms face **nominal and real frictions**, which render re-adjustments of intertemporal decisions costly and give rise to empirically plausible adjustment dynamics:
  - external habit formation in consumption
  - generalised adjustment cost in investment
  - fixed cost in intermediate-good production
  - monopolistic competition in intermediate-good and labour markets
  - sticky prices and wages à la Calvo and (partial) dynamic indexation
  - generalised adjustment cost in the import content of final goods
- In addition, there are **financial frictions** in form of an "external finance premium" and intermediation costs for trading foreign bonds.

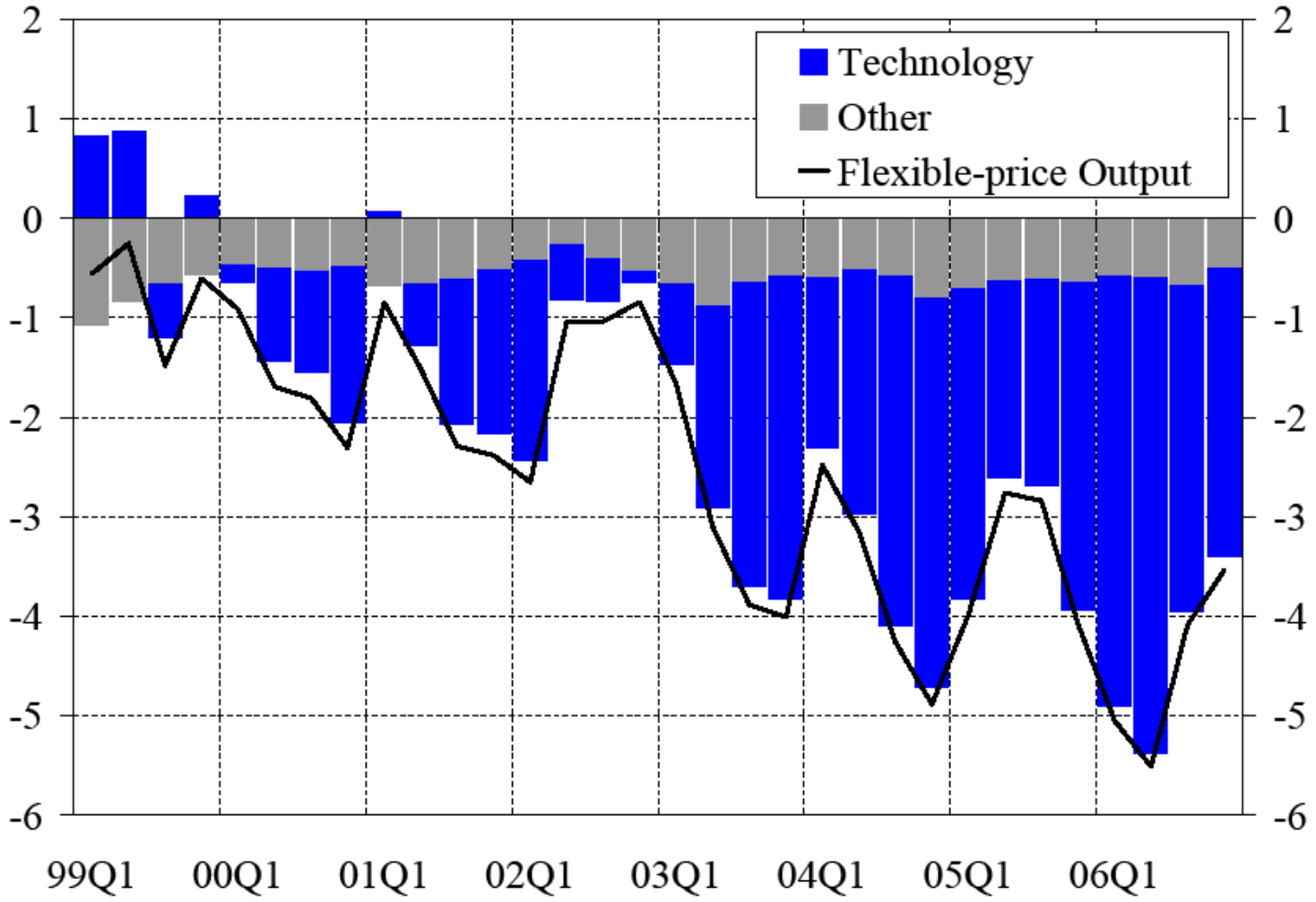
Empirical Strategy

- The NAWM is estimated as a system using **Bayesian techniques**:
  - formalises the use of *prior information* obtained from earlier studies at both the micro and macro level
  - permits constructing *probability distributions* for parameters, unobserved states (e.g., the output gap) and derived functions (e.g., forecasts)
  - permits evaluating the *data coherence* of the model as a whole
- A relatively large number of **17 macroeconomic time series** have been used to, inter alia, facilitate parameter identification.
- A corresponding number of **17 structural shocks** have been included to capture the stochastic nature of the macroeconomic data.
- Additional variables, like the HICP, are dealt with through **bridge equations**.

Flexible-price output in the NAWM



What are the sources of fluctuations?



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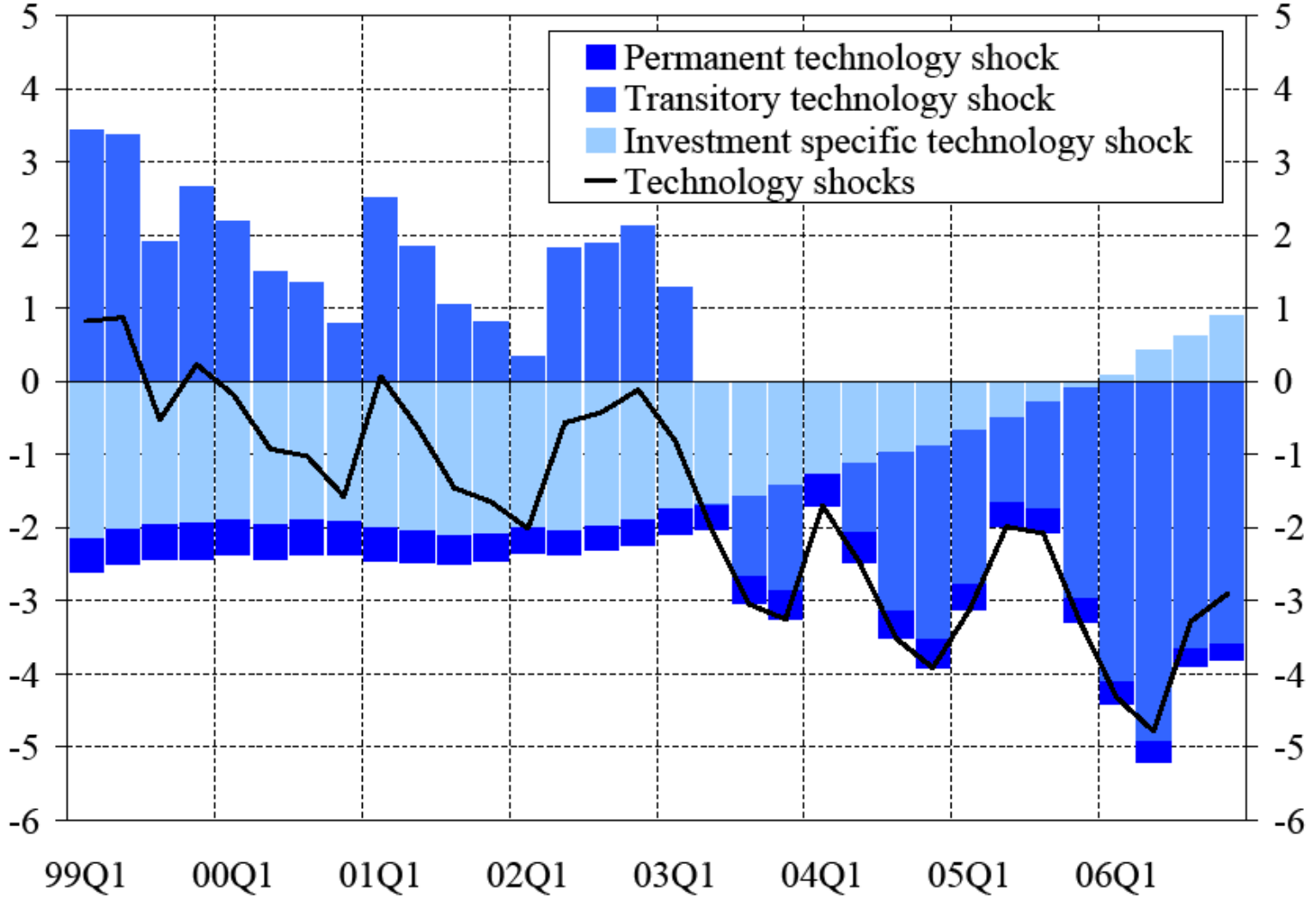
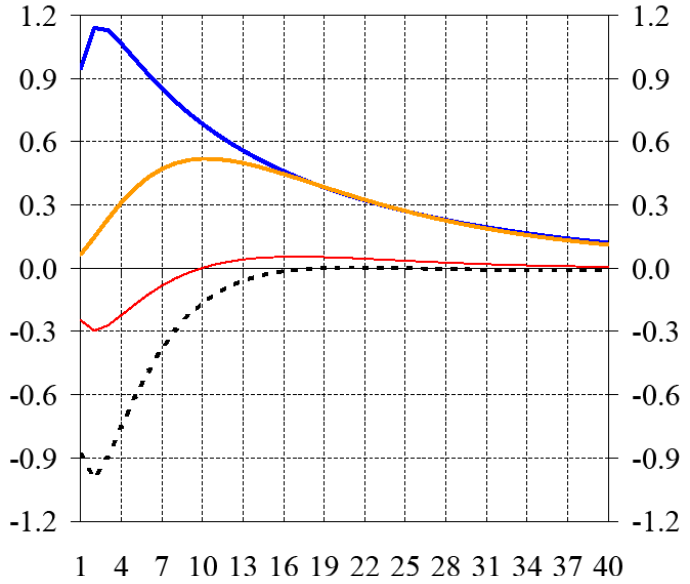
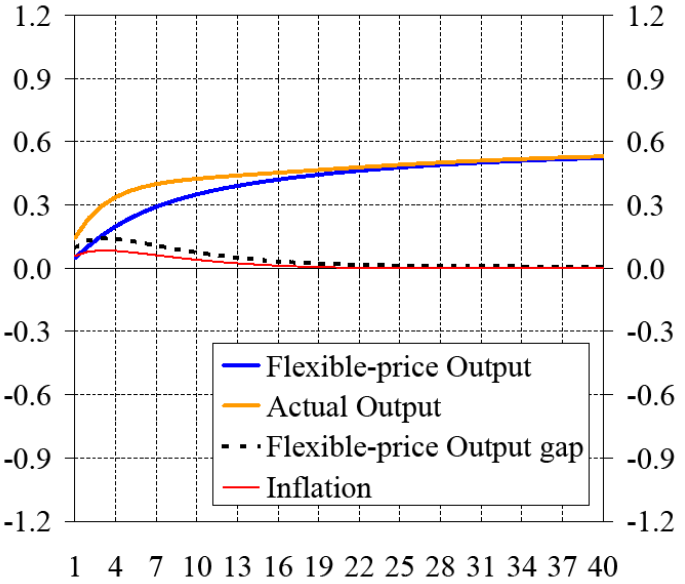
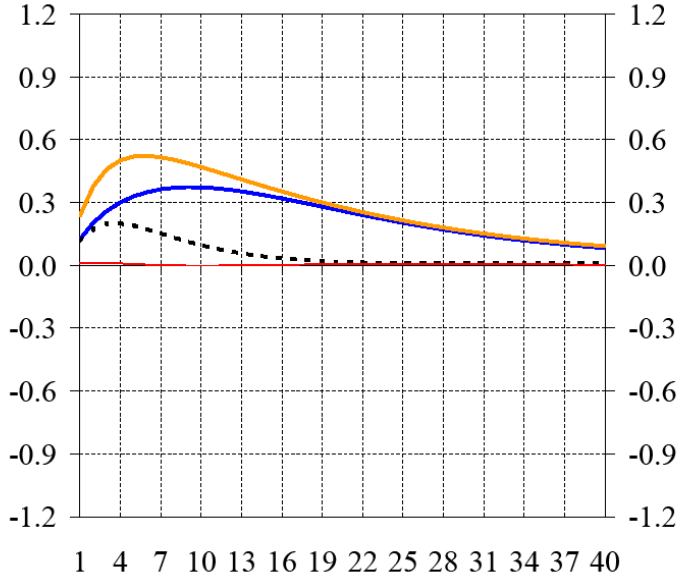
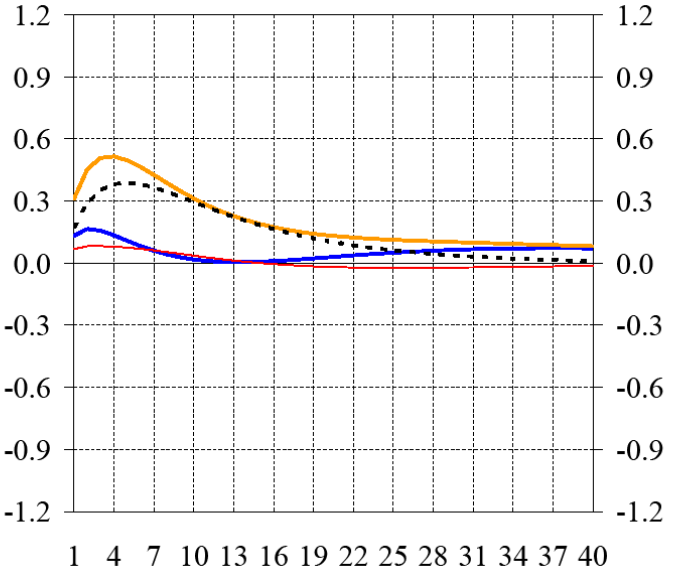


Why temporary technology shocks?









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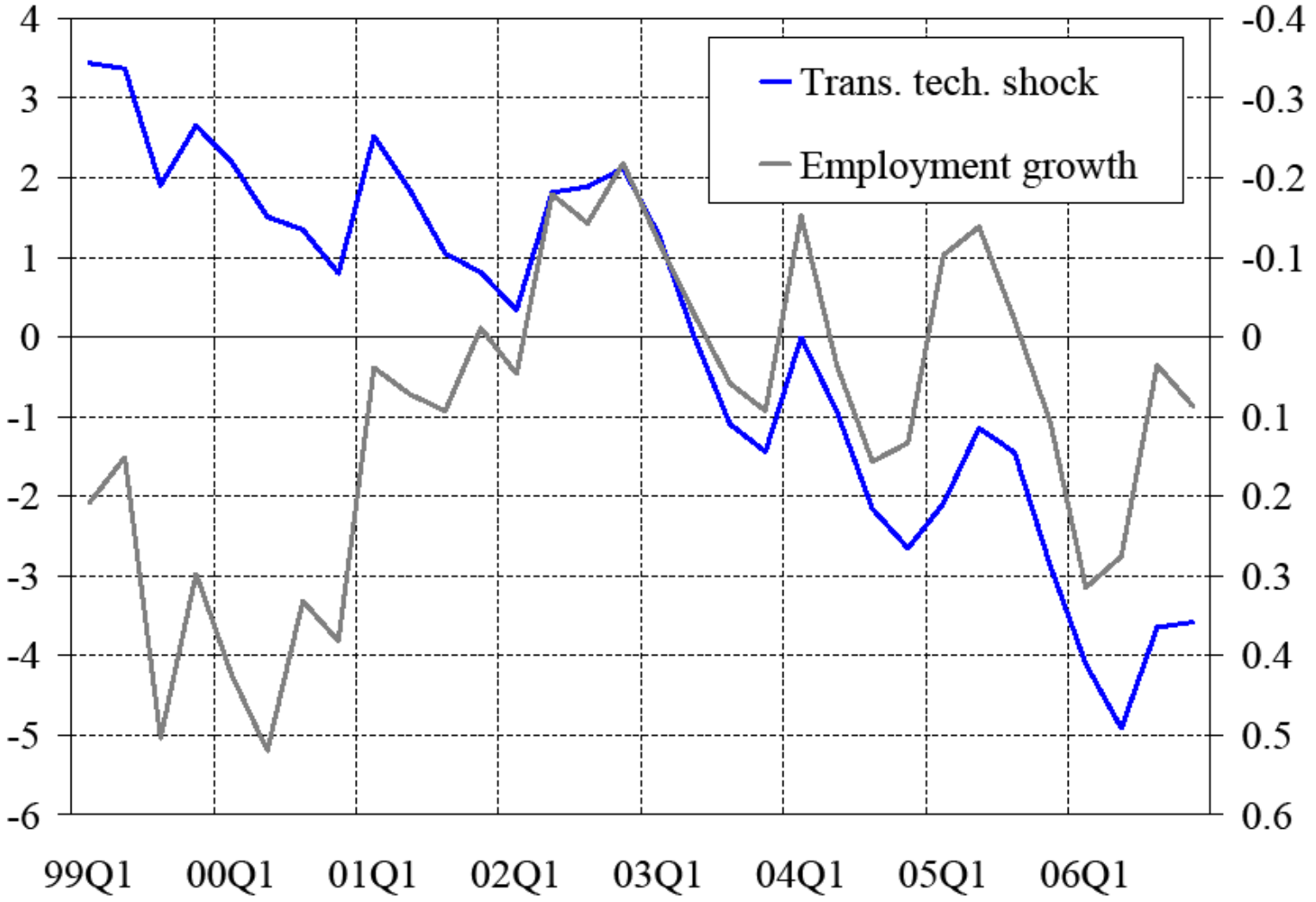
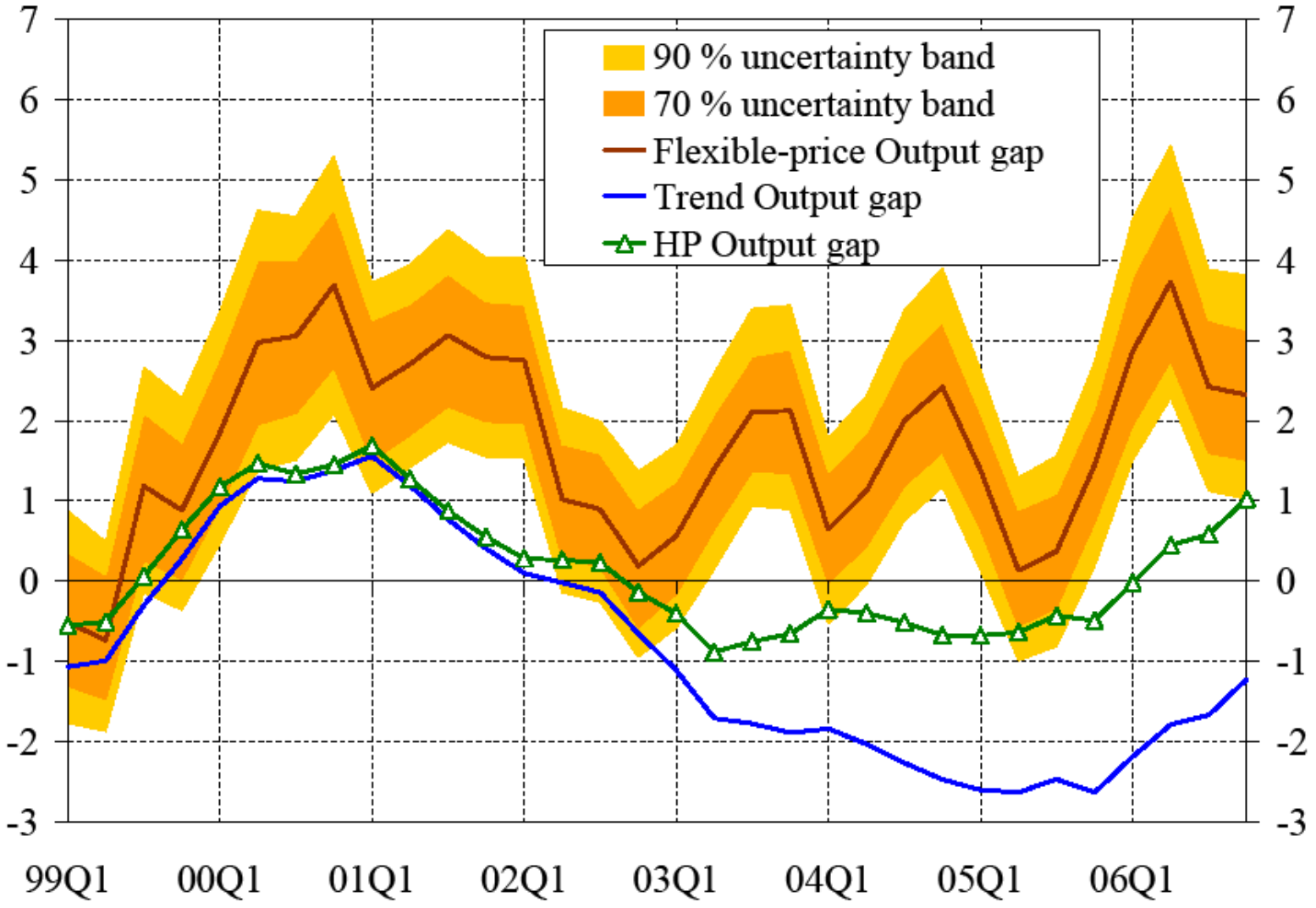
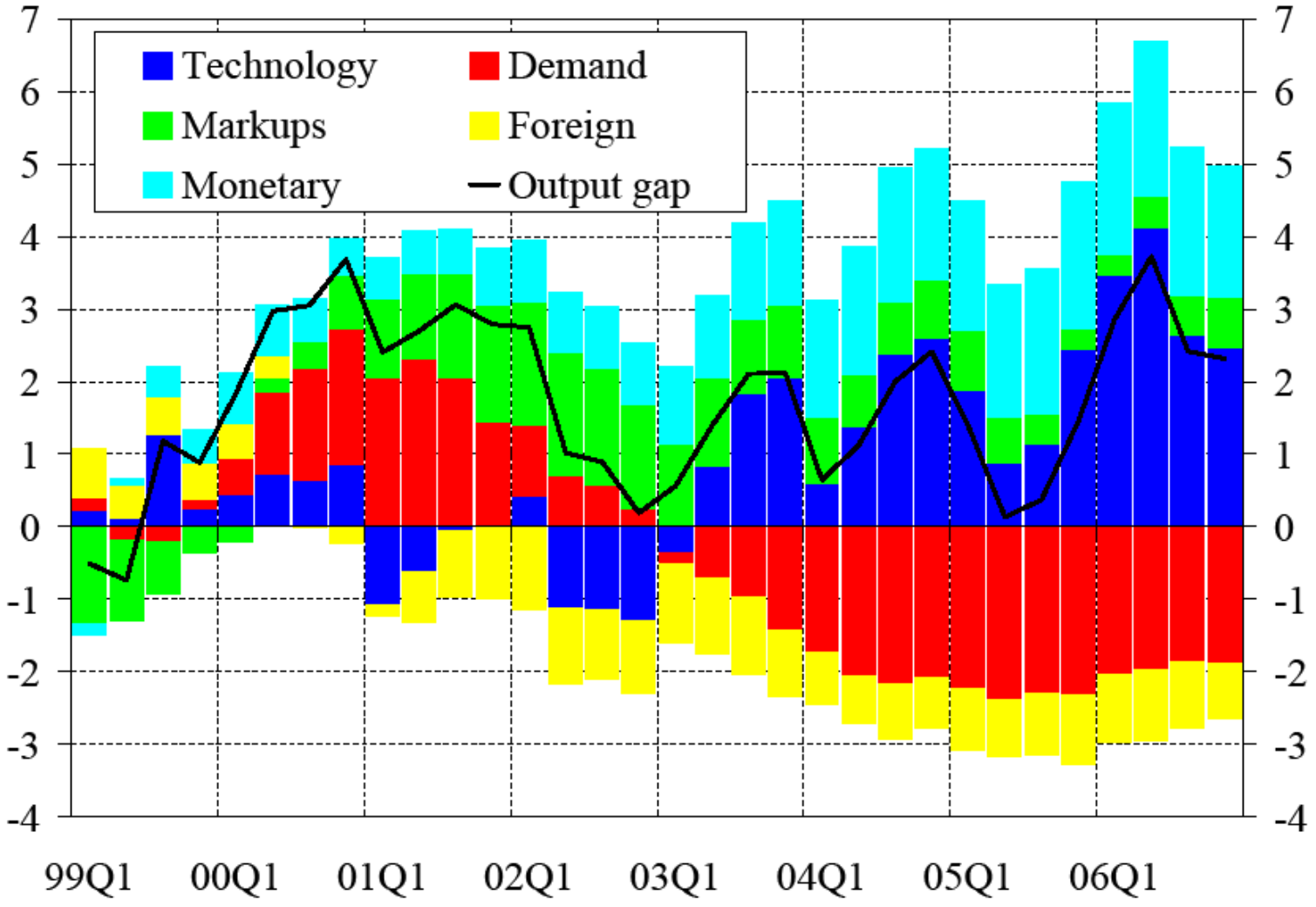


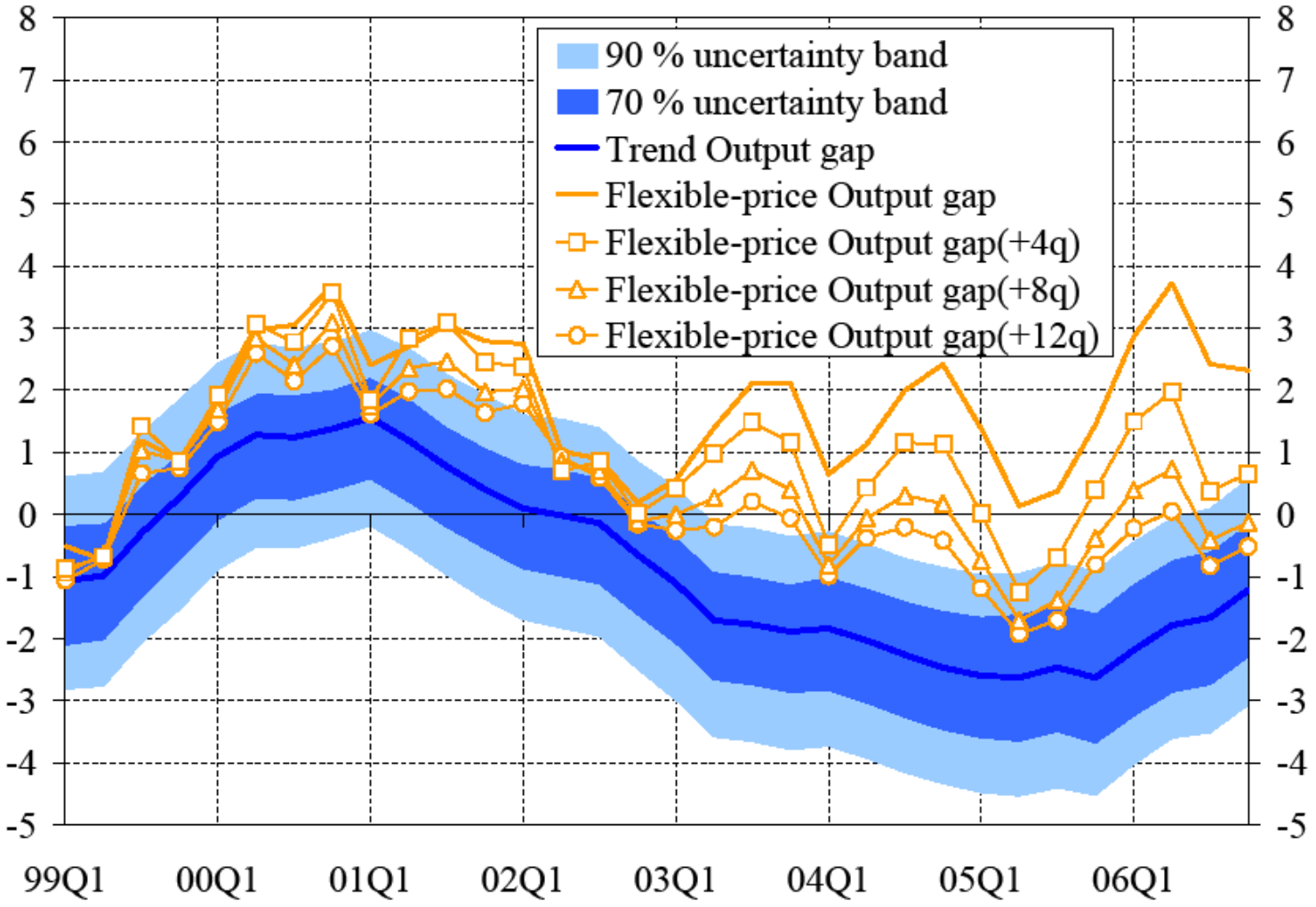
Flexible-price output gap in the euro area



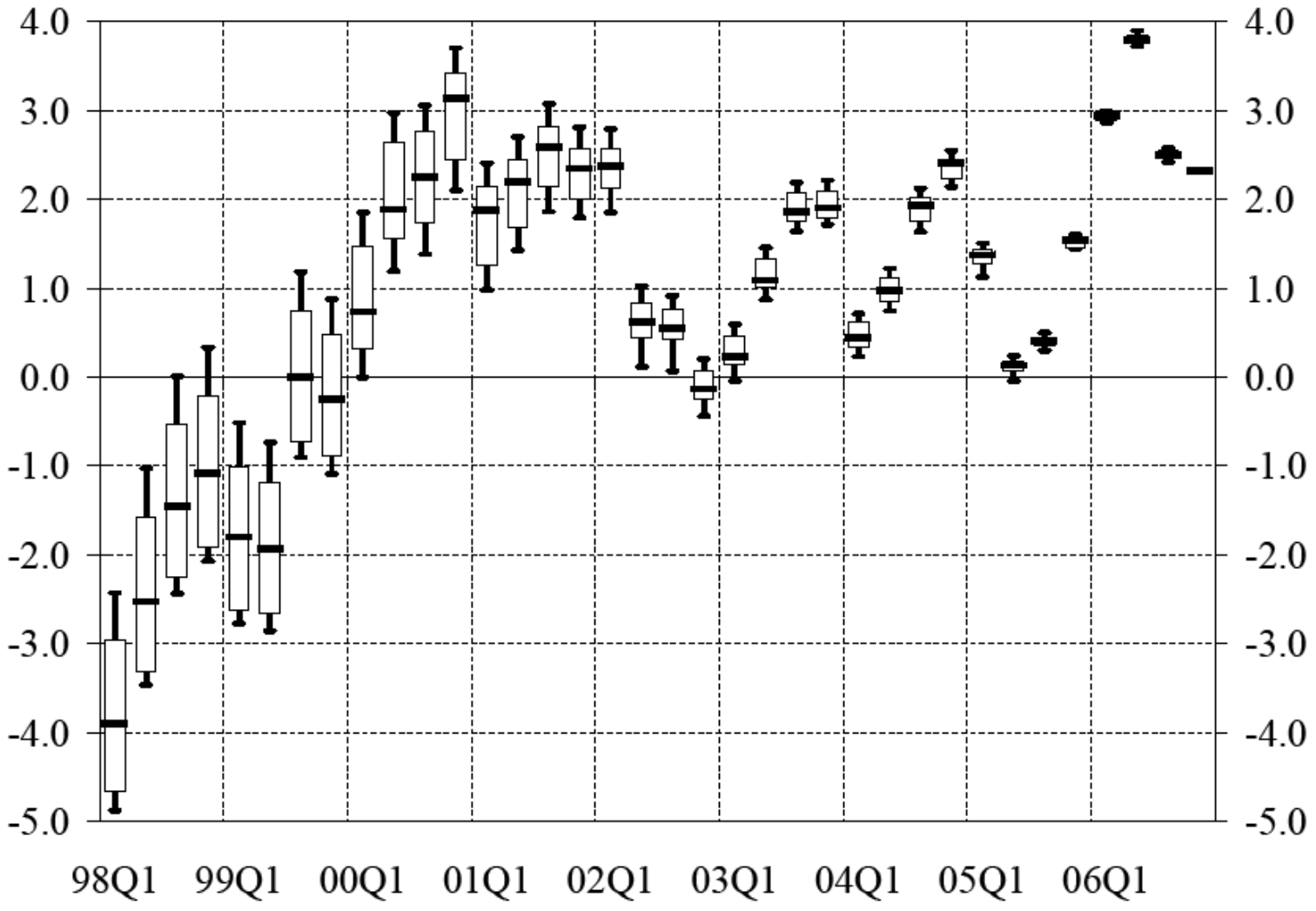
Sources of output gap fluctuations



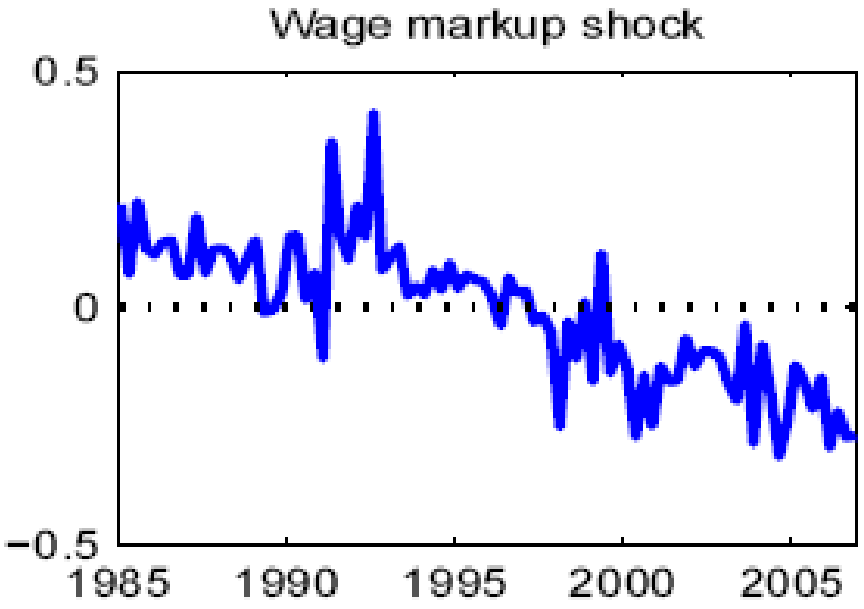
Robustness 1: medium-term notion



Robustness 2: new data



Robustness 2: wage mark-up shocks



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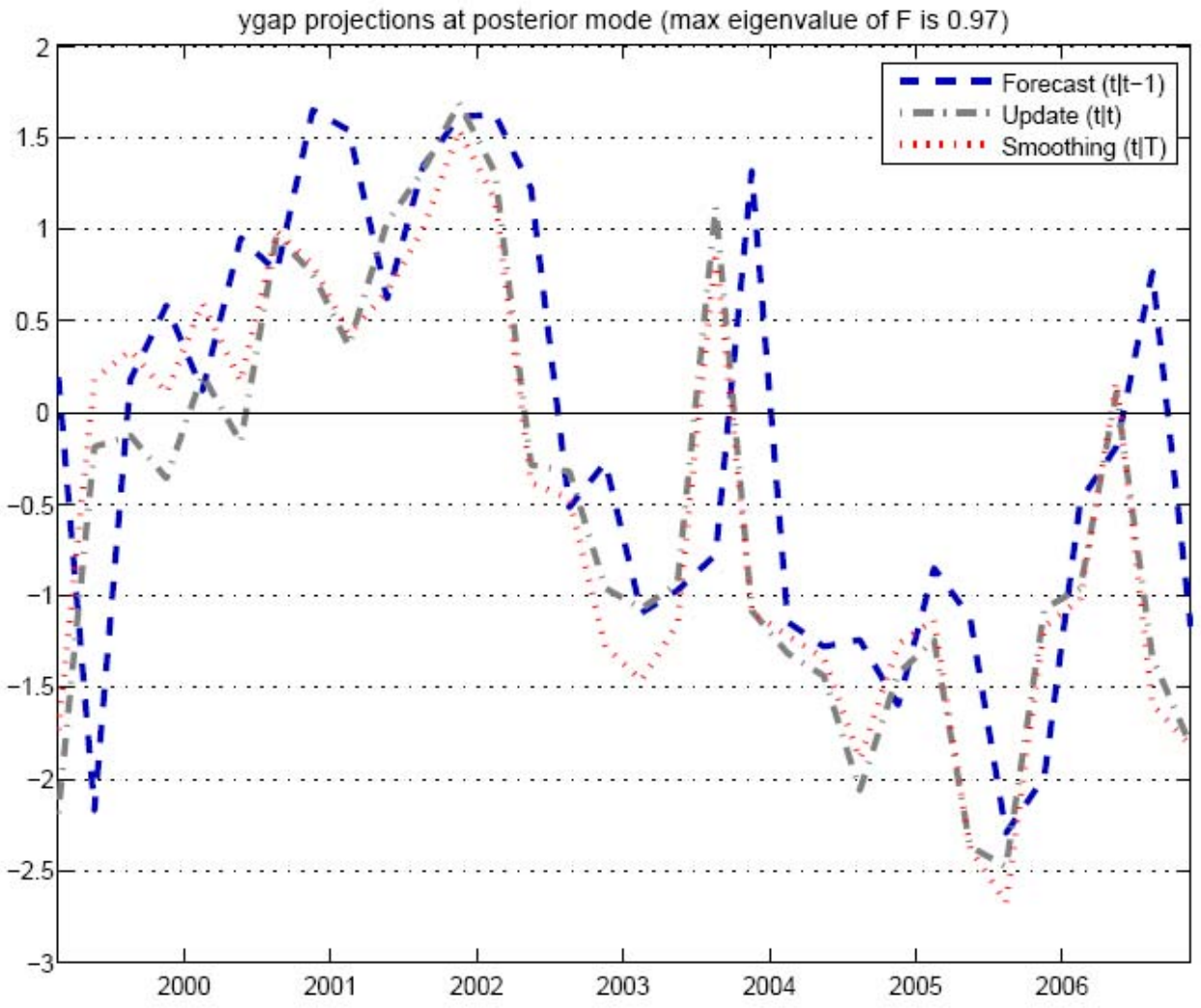


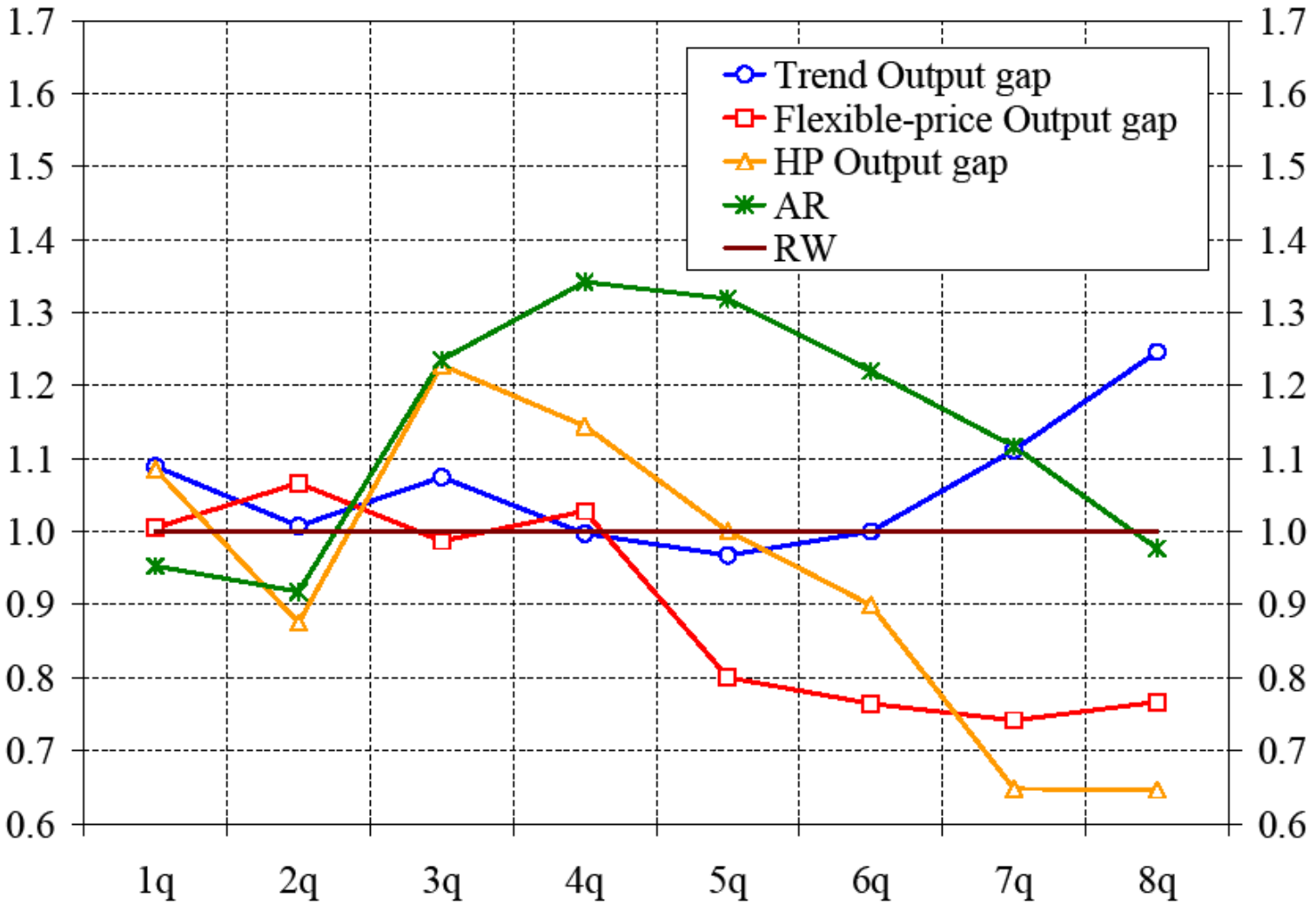
Predictive content for inflation?

- **Out-of-sample inflation forecast exercise (1999:1-2006:4)**

$$\pi_{v,t+h}^{h} = a_v + b_v(L)\,\pi_{v,t} + c_v(L)\,x_{v,t} + \epsilon_{v,t+h}^{h,x},$$

$$\pi_{v,t+h}^{h,RW} = 100 * \left(\frac{P_t}{P_{t-4}} - 1\right).$$

Predictive content for inflation?



Stabilisation properties?

- **What are the reaction coefficients in a simple optimised Taylor rule?**
  - **Optimal reaction coefficients are larger for flexible output gap than for trend output gap.**
- **What are the associated losses?**
  - **Inflation volatility is lower with flexible-price output gap**
- **How big are the mistakes when policy makers care about another output gap notion?**
  - **The mistake of responding to flexible-price output gap when trend output gap matters is lower than the reverse mistake.**

Conclusions?

- **Flexible-price output gaps can be quite different from more traditional output gaps based on smoothed trends;**
- **One of the main sources of this difference is persistent, but temporary TFP shocks, which tend to increase output, but reduce the output gap and inflation;**
- **In the euro area, much more work is needed to better understand the fall in the labour share, which in the NAWM are picked up by persistent mark-up shocks.**

Conclusions

- **Forecasting and stabilisation properties:**
  - **Probably too early to tell.**