

# Inflation Puzzles

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*25<sup>th</sup> Annual DNB Research Conference  
Inflation strikes back: drivers and policy reactions*

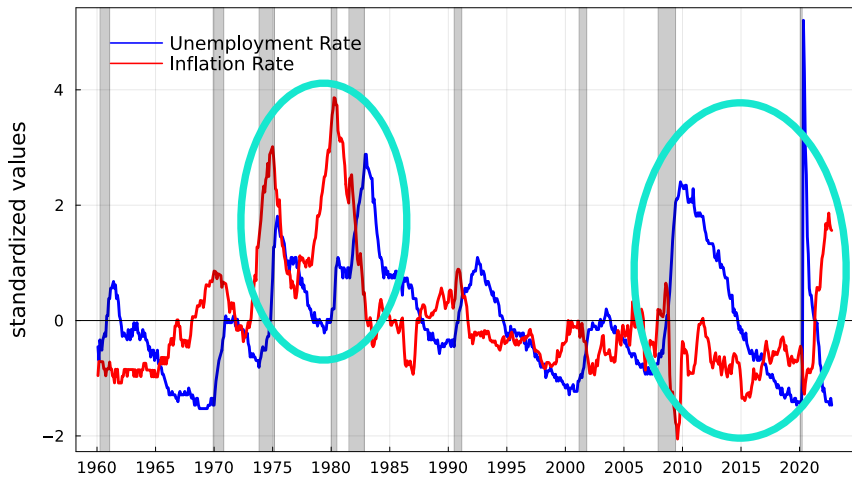
November 10, 2022

# 1 Inflation facts and puzzles

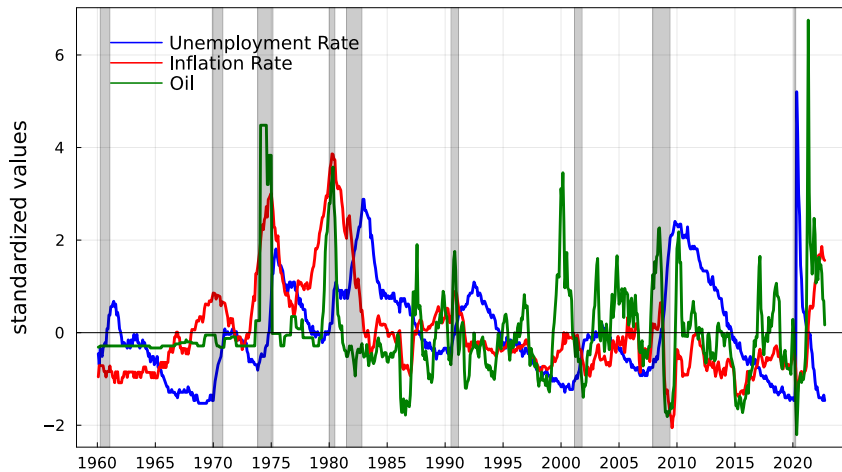
# Many inflation puzzles

1. Period of high volatility and stability;
2. Inflation has variable trends;
3. Correlation between unemployment is unstable both in sign and strength;
4. Oil has unstable relation with real and nominal variables

# Inflation and Unemployment



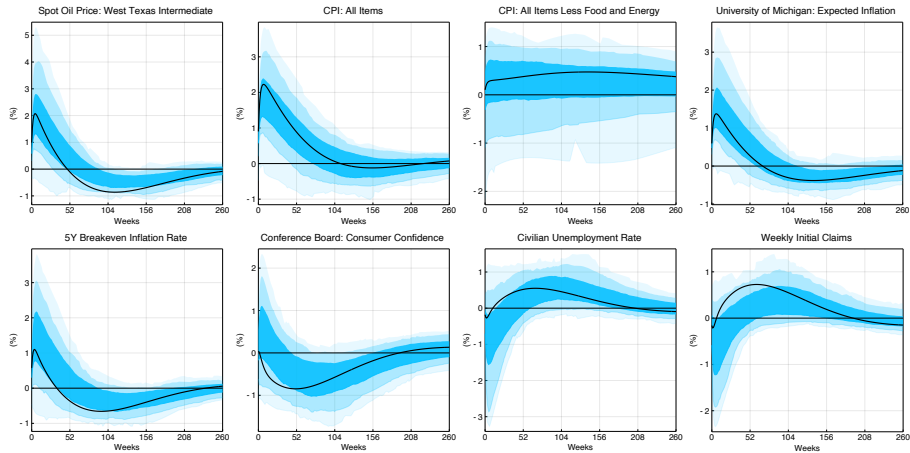
# Adding Oil Prices



# Comments

- ⇒ Unstable relationship with inflation;
- ⇒ Volatility of oil prices not always related to volatility of inflation and unemployment

# Oil Supply Shock (OPEC announcements computed by Känzig, 2021): Impulse Response Functions



# Ambiguous interpretation

1. Results point to large positive effect on prices and small negative delayed effect on real variables
2. Ambiguous interpretation. Effect may depend on the policy response



# This presentation

Use different empirical models estimated in different sub-samples to analyse:

1. Stability of Phillips curve relationship
2. Stability of correlations between oil prices and the economy
3. Covid recovery and role of oil and relationship

⇒ US data since 1960;

⇒ Some comparison with the euro area for the Covid sample;

## 2 Model 1

# Trend Inflation, Phillips curve and Oil Prices

## Two Perspectives

1. **Statistical approach:** Trend-Cycle decomposition<sup>1</sup>

$$y_t = \mu_t^y + \hat{\psi}_t + \psi_t^y$$

$$\pi_t = \mu_t^\pi + \delta_\pi \hat{\psi}_t + \psi_t^\pi$$

$$\hat{\psi}_t = \text{output gap}$$

2. **Theory:** Hybrid New Keynesian Phillips Curve

$$\hat{\pi}_t = \sum_i \delta_i \hat{\pi}_{t-1} + \beta E_t[\hat{\pi}_{t+1}] + \kappa \hat{y}_t + v_t$$

If  $\hat{\psi}$  is the solution of the HNKPC, the two perspective are congruent

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<sup>1</sup>Hat variables are in detrended form

## Bringing the model to the data

- ⇒ Model trends and cycles;
- ⇒ Extract them from multivariate system including expectational variables;
- ⇒ Variable common and idiosyncratic trends;
- ⇒ Introduce lags.
- ⇒ Oil affects inflation via the Phillips curve. Relative price adjustments do not matter for aggregate inflation otherwise.

# Empirical Model

## ⇒ Cycles

1. CPI inflation, core CPI, expectations (SPF and consumers) share a common cycle (gap) with heterogeneous loadings – this is the Phillips curve.
2. The gap is the common cycle between real output, employment and unemployment.

## ⇒ Trends

1. CPI inflation, core CPI, expectations (SPF and consumers) share a common random walk trend (trend inflation).
2. Real output, employment and unemployment have independent unit roots trends.

# Puzzles

1. Inflation can be best forecasted by univariate models with variable trends (large literature);
2. Weak empirical evidence on the PC: flattening, disappearing, re-emerging (large literature);
3. Missing inflation, missing deflation, re-emergence of high inflation...

# Modelling Oil

⇒ This approach cannot take into account the volatile oil component;

⇒ Idea: **decompose oil** into two orthogonal components:

$$\hat{oil}_t = \delta_{oil}(L)\hat{\psi}_t + \delta_{oil*}\psi_t^{o*} + \psi_t^{oil}$$

$\hat{oil}_t =$  *component driven by output gap* +  
*component driven by oil cycle* + *idiosyncratic cycle*

⇒ **Oil cycle** is that part of the oil cycle that is orthogonal to the output gap but not to inflation expectations

# New Specification of Inflation

$$\pi_t = \mu_t^\pi + \delta_\pi(L)\hat{\psi}_t + \delta_{oil*}\hat{\psi}_t^{O*} + \psi_t^\pi$$

$$\pi_t = \textit{trend} + \textit{Phillips Curve cycle} + \textit{Oil cycle} * + \textit{noise}$$

- ⇒ **Econometric point**: omitting the oil cycle bias the estimate of  $\delta_\pi$  (the coefficient of the Phillips curve);
- ⇒ Phillips Curve cycle and oil cycle linked via **expectations**.



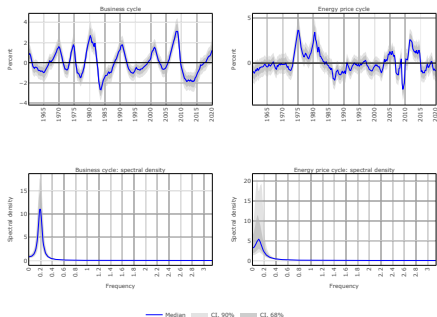
# Modified Empirical Model

## ⇒ Cycles

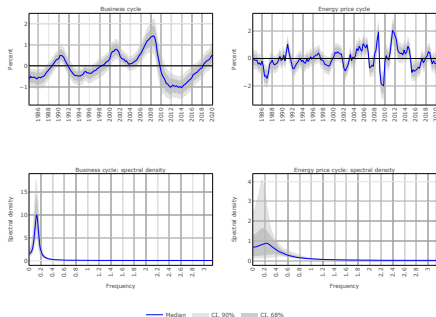
1. CPI inflation, core CPI, expectations (SPF and consumers) share a common cycle (gap) with heterogeneous loadings – this is the Phillips curve.
2. The gap is the common cycle between real output, employment and unemployment.
3. Extra feature: the oil cycle is the common cycle between inflation, inflation expectations and oil
4. Extra feature: oil prices load the real gap and the oil cycle.

# Business cycles and oil cycles: comparison 1960-2019 and 1984-2019 Samples

1960 - 2019 Sample

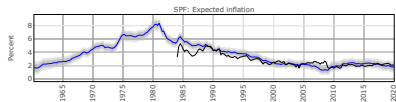
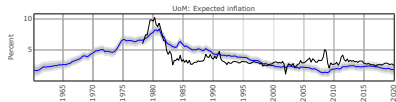


1984 - 2019 Sample

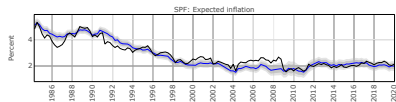
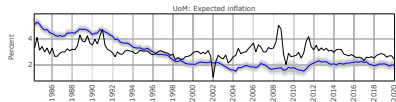


## Trend Inflation

1960 - 2019 Sample

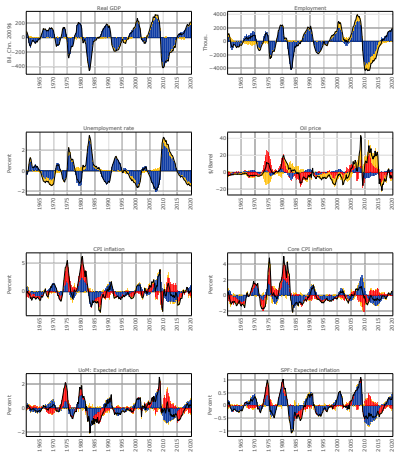


1984 - 2019 Sample



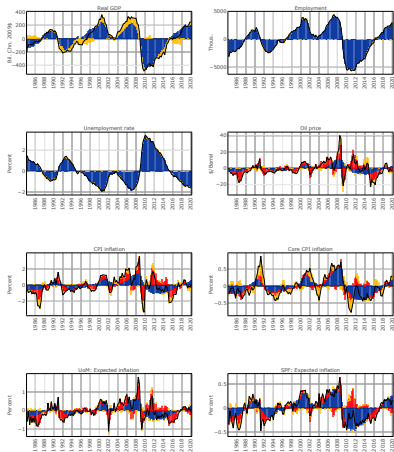
# Cycle Decomposition

1960 - 2019 Sample



Business cycle Energy price cycle Misallocative cycle Total cycle

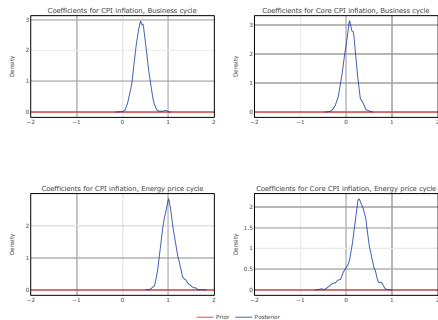
1984 - 2019 Sample



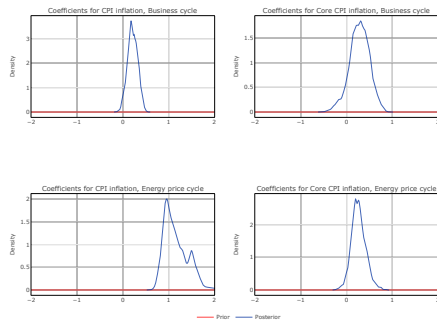
Business cycle Energy price cycle Misallocative cycle Total cycle

# Loadings: Posterior Distributions

1960 - 2019 Sample

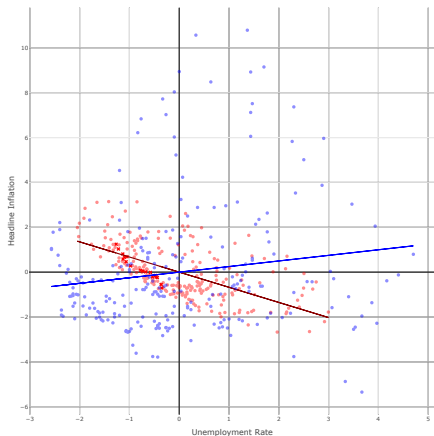


1984 - 2019 Sample

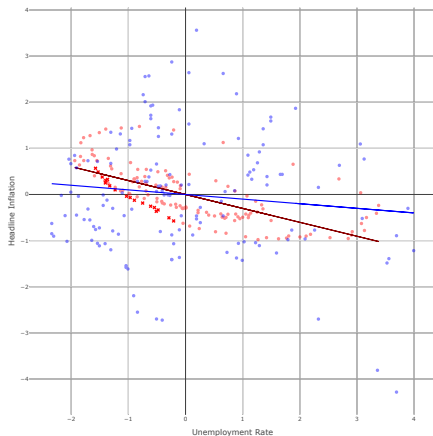


## Phillips Curve: Observed and Non-Observed

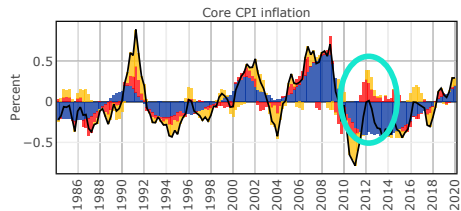
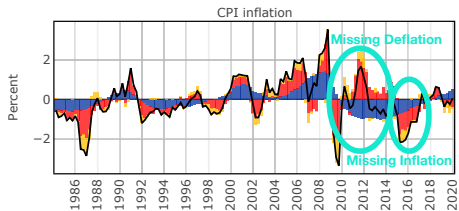
1960 - 2019 Sample



1984 - 2019 Sample



## Pre-Covid Puzzles



## Comments

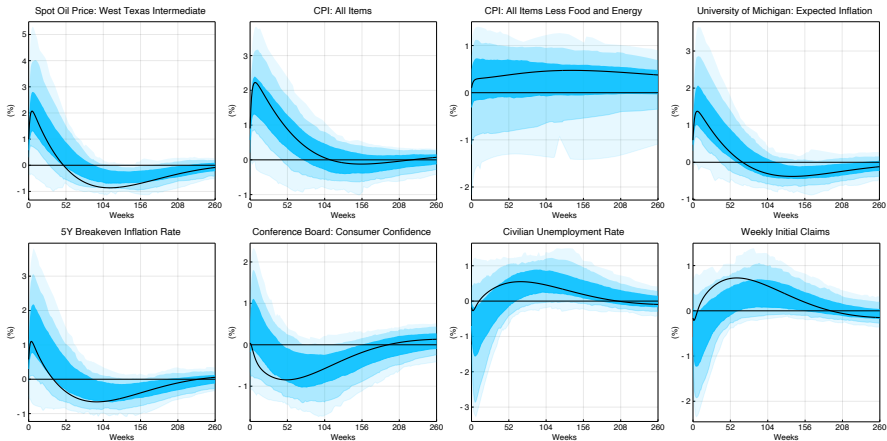
- ⇒ Inflation, core and inflation expectation cycles are explained by both the Phillips curve and the oil\* cycle;
- ⇒ Trend inflation is stable since 2000;
- ⇒ Loadings of the Phillips curve are stable and so is the model implied Phillips curve;
- ⇒ The model implied Phillips curve is negatively sloped and relatively steep;
- ⇒ Observed PHillips curve either flatter or positively sloped;
- ⇒ Oil\* fluctuations explain post great financial crisis - pre-covid puzzles.

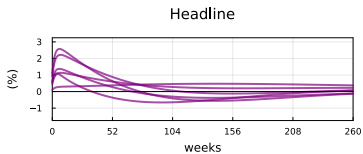
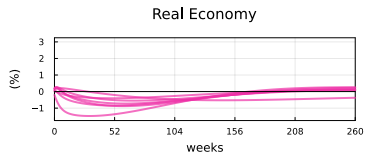
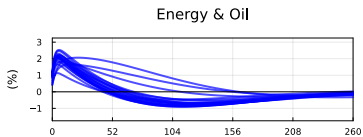
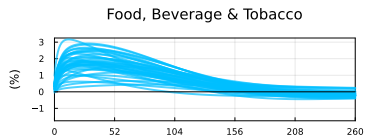
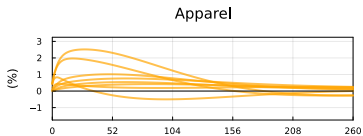
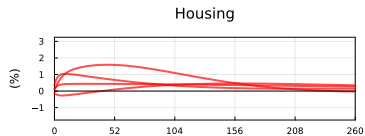
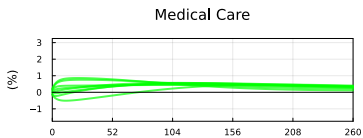
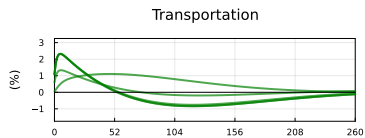


## 3 Model 2

## Large factor model

- ⇒ Mixed frequency (weekly and monthly variables), US data from 1985;
- ⇒ Dataset: aggregate inflation variable, sectoral inflation variables, expectations and real economic indicators  $n = 120$ ;
- ⇒ Structural dynamic factor model with three factors and three shocks;
- ⇒ Partial identification - oil supply shock; the other two non identified;
- ⇒ Identification: using OPEC announcements as instruments [Känzig \(2021\)](#).





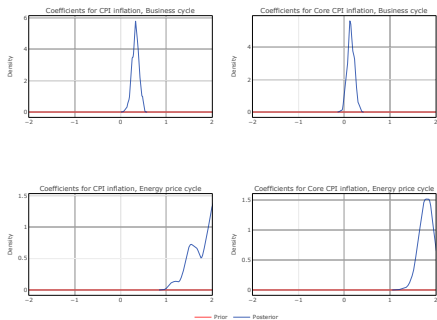
## Some questions on the role of oil

- ⇒ Inflation cycles are explained by both PC relationships and a oil\* cycle;
- ⇒ Model 1 indicates that oil\* cycle is a large component of inflation and inflation expectations but is uncorrelated with real variables;
- ⇒ Model 1 also says that the size of the oil\* cycle on inflation is unstable across samples;
- ⇒ Model 2 says that oil supply shock has small, negative and uncertain effect on real variables and large effect on inflation;
- ⇒ Although the two models are not clearly comparable, it looks like the identified oil shock captures at least a big part of Model 1 oil\* cycle ;
- ⇒ This instability of oil\* and the effect that it has on the observed Phillips curve may reflect either changing size of shocks affecting inflation mainly via expectations or changes in the response of policy to oil shocks.

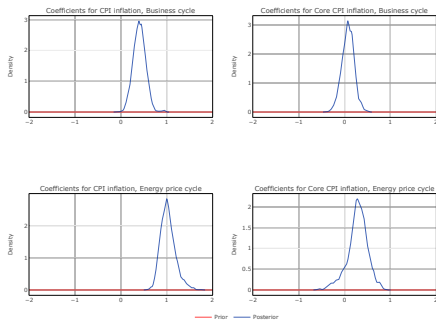
## 4 What Changed with Covid?

## Loadings

1960 - 2022 Sample

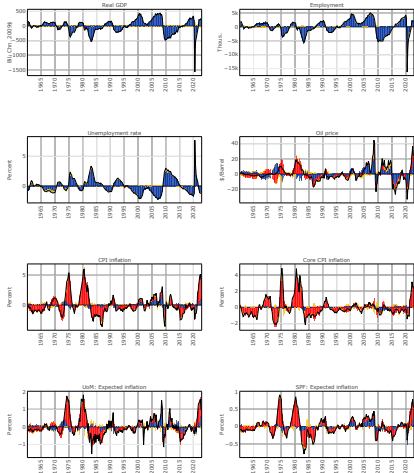


1960 - 2019 Sample

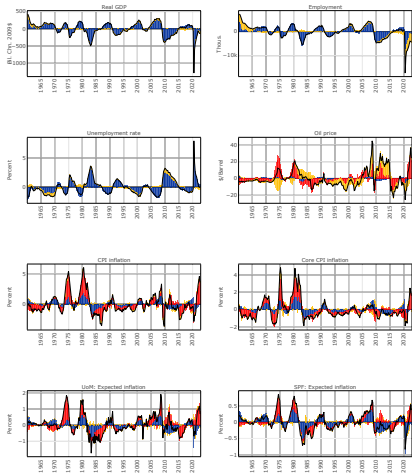


## Cycle Decomposition

1960 - 2022 Sample

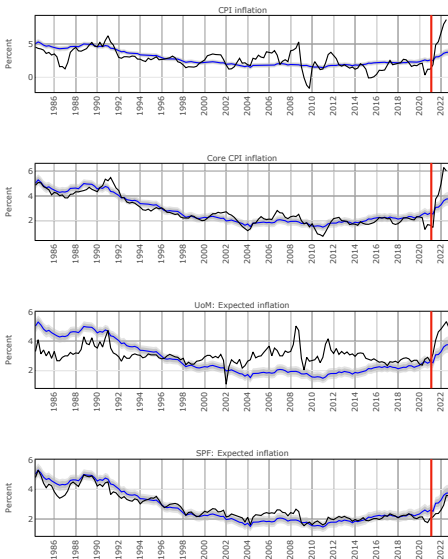


1960 - 2022 Parameters est. up to 2019



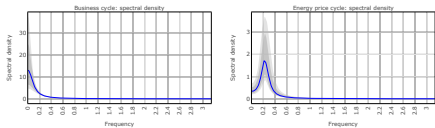
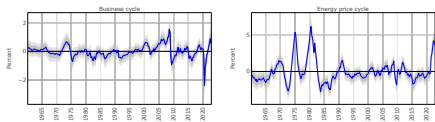


## Trend Inflation



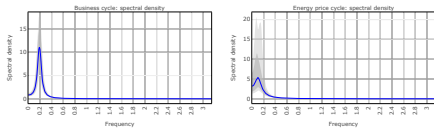
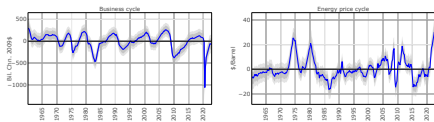
## What about the business cycle?

1960 - 2022 Sample



— Median — CI, 90% — CI, 68%

1960 - 2022 Parameters est. up to 2019



— Median — CI, 90% — CI, 68%

## Comments

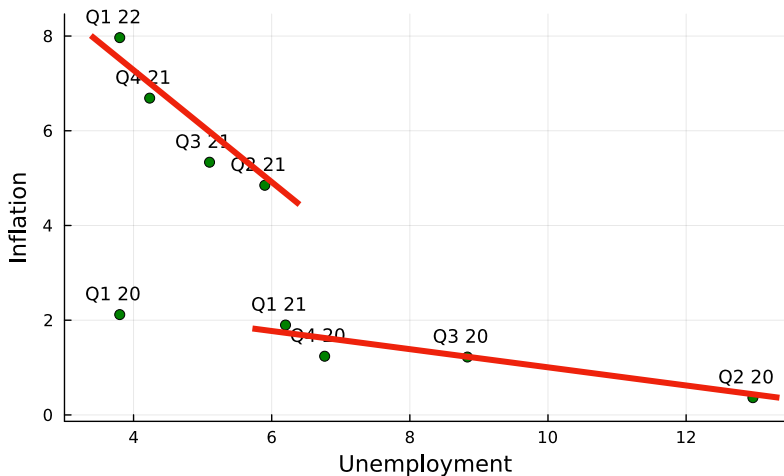
- ⇒ Coefficient of oil cycle on inflation became bigger – the others are stable.
- ⇒ 1960-2022: model cannot distinguish between Phillips curve and oil shock.
- ⇒ Inflation persistence reflected in trend inflation estimates.
- ⇒ Estimation of the business cycle is stable.

## Conjecture

- ⇒ Larger **pass-through** oil supply-inflation;
- ⇒ This acts as a **shift upward** of the observed Phillips curve;
- ⇒ Indeed the data suggests steep observed Phillips curve during the Covid recovery.

## Steepening Observed Phillips Curve

### Covid Recovery



## Interpretation?

### What is going on?

1. Supply shock dominates – policy does not respond;

or

2. Both demand and supply shocks matter – policy does not respond.

### Analysis

1. Experiment with **Structural Factor Model**: identified negative oil supply shock Q3 2021;
2. Conditional Forecast with and without the shock using Kalman Filter & Smoother.

## 5 Event study

## Event study

Shock of interest: **oil supply shock** of W4 Q3 2021. Forecast origin: W3 Q3 2021.

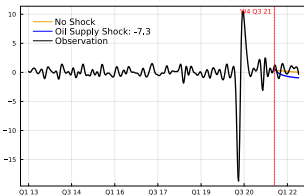
Given our estimates of the parameters, compute:

1. **Unconditional forecast**: Kalman Filter & Smoother given the information set available at W3 Q3 2021;
2. **Conditional forecast**: Shock the KF&S recursion by the oil supply shock at time  $T+1$

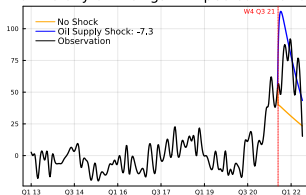


## Event Study

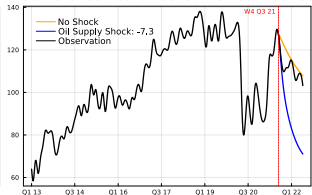
Gross Value of Products



University of Michigan: Expected Inflation



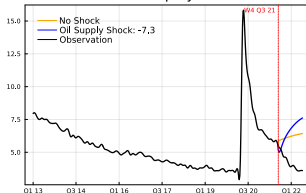
Conference Board: Consumer Confidence



5Y Breakeven Inflation Rate



Civilian Unemployment Rate



CPI: All Items



## Comments

- ⇒ Output higher than expectation conditional on oil supply shock;
- ⇒ Consumer expectation similar after few weeks, 5Y expectations more persistent;
- ⇒ Consumer confidence more robust;
- ⇒ Labor market more resilient and inflation more persistent than if dynamics were driven by just the oil shock;
- ⇒ Inflation more persistent than conditional on oil shock and this was gradually absorbed by trend inflation.

## Takeaways Event Study

- ⇒ Conjecture is the gap between conditional and unconditional expectations is explained by demand;
- ⇒ Consistent with the idea that the Fed was behind the curve;
- ⇒ The question is why: miss-interpretation of the shocks? Evaluation of the cost of the trade-off?

## 6 Is the Euro Area Different?

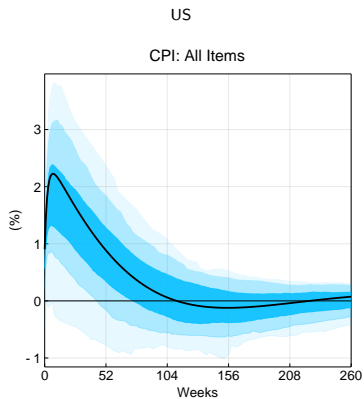
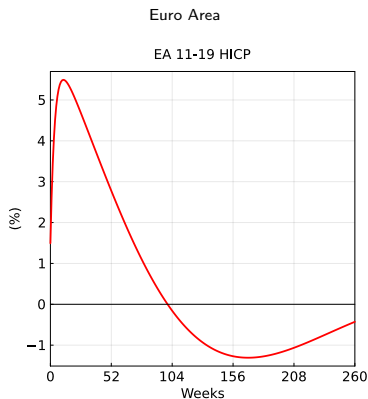
## Model

### Large factor model

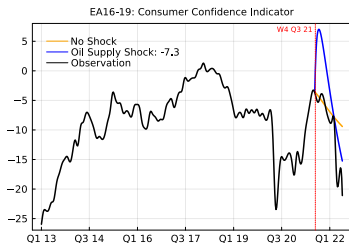
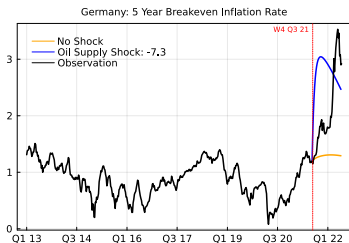
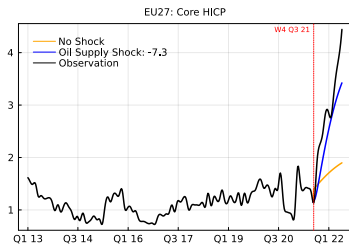
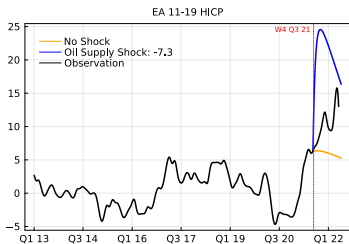
- ⇒ Mixed frequency (weekly and monthly variables), EA data from 1985;
- ⇒ Dataset: aggregate inflation variable, sectoral inflation variables and expectations,  $n = 128$ ;
- ⇒ Structural dynamic factor model with three factors and three shocks;
- ⇒ Partial identification - oil supply shock; the other two non identified;
- ⇒ Identification: using OPEC announcements as instruments [Känzig \(2021\)](#).

## Comparison US and euro area

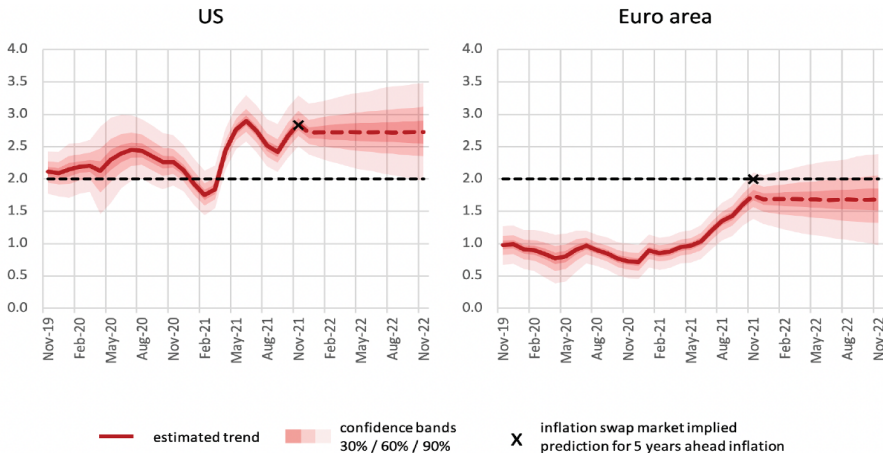
⇒ The effect of the oil shock is larger in the euro area



## Event Study - Euro Area



## The View in Q4 2021: Model 1 forecast of inflation and Expectations - US and euro area





## Different stories for the US and the euro area

- ⇒ Historically, **oil shock larger** in the euro area – larger trade-off;
- ⇒ **Effect of the end of 2021 oil shock in the euro area**: Observed inflation lower than inflation conditional on the oil shock – demand acts as a depressing force;

*Thank You!*