Optimal QE and QT[1]

Paolo Gelain[1] Junior Maih[2] Eric Sims[3] Jing Cynthia Wu[4]

[1]Federal Reserve Bank of Cleveland

[2]Norges Bank

[3]Notre Dame and NBER

[4]University of Illinois Urbana-Champaign and NBER

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[1]The views stated herein are those of the authors and are not necessarily those of the Federal Reserve Bank of Cleveland or the Board of Governors of the Federal Reserve System or Norges Bank.

Motivation

- Quantitative easing has become part of the set of policies used by central banks to intervene in crises periods.
- Despite some studies have empirically investigated the effects of such policies on inflation and the real economy, there has been little assessment on how they should be optimally conducted.

What we do

- We want to analyze the set of optimal interest rate and quantitative easing policies that the Federal Reserve could have put in place.
- First, using a mix of US macroeconomic, financial, and central bank balance sheet data from 1998Q1 to 2019Q4, we estimate a New Keynesian dynamic stochastic general equilibrium model.
- We then proceed to run a counterfactual scenario analysis under optimal policy.

Related Literature

- Our analysis is similar in spirit to Justiniano, Primiceri and Tambalotti, AEJM, 2013 (JPT) and Furlanetto, Gelain and Sanjani Taheri, RED, 2021 (FGT).
- Small scale calibrated models with optimal QE: Harrison, BoE WP, 2017 and Karadi and Nakov, JME, 2021, Sims, Wu, Zhang, ReStat, 2023.
- Large scale estimated model with optimal policy: Darracq Pariès and Köhl, ECB WP, 2016 and Kabaca et al., EER, 2023.
- Toolkit: Harrison and Waldron, BoE WP, 2021, and De Groot et al., ECB WP, 2021.
- Large scale estimated model **without** optimal policy: Boehl, Goy and Strobel, ReStat, 2022.

Model Overview

- NK-DSGE model featuring all the standard bells and whistles, e.g., Smets and Wouters (2007), and all the necessary ingredients to evaluate QE policies, like in Sims and Wu (2021). Government and firms issue public and private long term bonds, respectively, and those can be purchased by financial intermediaries and by the central bank.
- Households.
- Labor unions and labor packers.
- Investment goods producers.
- Goods producers:
  - Wholesale goods producers.
  - Final goods producers.
  - Retail firms.
- Financial intermediaries.
- Monetary and fiscal policy.

Goods Producers - Wholesale Firm

- It produces output using capital labor according to a standard Cobb-Douglas function.
- It has outstanding coupon liabilities on long bonds of $F_{w,t-1}$. We follow Woodford (2001) in modeling these bonds as perpetuities with decaying coupon payments and κ the decay parameter. It can issue new long bonds for Q_t, where $Q_t(F_{w,t} - \kappa F_{w,t-1})$ is the value of new bond issuance.
- It is subject to an investment in advance constraint $\psi P_t^k I_t \leq Q_t(F_{w,t} - \kappa F_{w,t-1})$. A fraction of investments must be financed by debt.

Financial Intermediaries

- Intermediaries hold long-term private issued bonds and government bonds as well as bank reserves; and they finance themselves with their own equity as well as deposits,
  $Q_t F_{i,t} + Q_{B,t} B_{i,t} + RE_{i,t} = D_{i,t} + N_{i,t}$.
- Each period, an exogenous fraction σ of intermediaries stochastically die.
- Net worth can be shown to evolve according to:

$$N_{i,t} = \left(R_t^F - R_{t-1}^d\right) Q_{t-1} F_{i,t-1} + \left(R_t^B - R_{t-1}^d\right) Q_{B,t-1} B_{i,t-1} + \left(R_{t-1}^{re} - R_{t-1}^d\right) RE_{i,t-1} + R_{t-1}^d N_{i,t-1} + X$$

- At the end of period t, an intermediary can abscond with some of its assets and default. In particular, an intermediary can take $\theta_t Q_t F_{i,t}$ and $\theta_t \Delta Q_{B,t} B_{i,t}$, where $\theta \leq \Delta \leq 1$. θ_t is a credit shock. It evolves as follows:

$$\ln \theta_t = (1 - \rho_\theta) \ln \theta + \rho_\theta \ln \theta_{t-1} + \varepsilon_t^\theta$$

Financial Intermediaries

- There is the following enforcement constraint:

$$V_{i,t} \geq \theta_t(Q_t F_{i,t} + \Delta Q_{B,t} B_{i,t})$$

  where $V_{i,t}$ is the enterprise value of being an intermediary, so the cost of abscond with the assets and default, while $\theta_t(Q_t F_{i,t} + \Delta Q_{B,t} B_{i,t})$ is the benefit of doing so.

- The constraint says that creditors will only allow intermediaries to borrow up until the point where it is not optimal for them to default.

Conventional Monetary Policy

- The central bank sets the notional or desired interest rate on reserves, R_t^{tr}, according to a Taylor rule:

$$\ln R_t^{tr} = (1-\rho_r)\ln R^{tr} + \rho_r \ln R_{t-1}^{tr} + (1-\rho_r) f(\pi, Y_t) + u_t^r$$

  where

$$f(\pi, Y_t) = \left[\frac{\phi_\pi}{4} \left(\sum_{j=0}^{3} \ln \Pi_{t-j} - 4 \ln \Pi \right) + \frac{\phi_y}{4} (\ln Y_t - \ln Y_{t-4}) \right]$$

- The actual interest rate on reserves is assumed be subject to a zero lower bound:

$$R_t^{re} = \max\left\{1, R_t^{tr}\right\}$$

QE Policy

- We assume that the central bank can hold either private investment bonds or long-term government bonds. It finances this with reserves:

$$Q_t F_{cb,t} + Q_{B,t} B_{cb,t} = RE_t$$

- By defining $f^Y_{cb,t} = \frac{Q_t F_{cb,t}}{Y_t}$ and $b^Y_{cb,t} = \frac{Q_{B,t} B_{cb,t}}{Y_t}$, those obey the following rules:

$$f^Y_{cb,t} = (1-\rho_f) f^Y_{cb} + \rho_f f^Y_{cb,t-1} + u^f_t \quad \text{if } R^{tr}_t > 1$$

$$b^Y_{cb,t} = (1-\rho_B) b_{cb} + \rho_B b^Y_{cb,t-1} + u^B_t \quad \text{if } R^{tr}_t > 1$$

$$f^Y_{cb,t} = (1-\rho_f) f^Y_{cb} + \rho_f f^Y_{cb,t-1} - (1-\rho_f) f(\pi, Y_t) + u^f_t \quad \text{if } R^{tr}_t \leq 1$$

$$b^Y_{cb,t} = (1-\rho_B) b^Y_{cb} + \rho_B b^Y_{cb,t-1} - (1-\rho_B) f(\pi, Y_t) + u^B_t \quad \text{if } R^{tr}_t \leq 1$$

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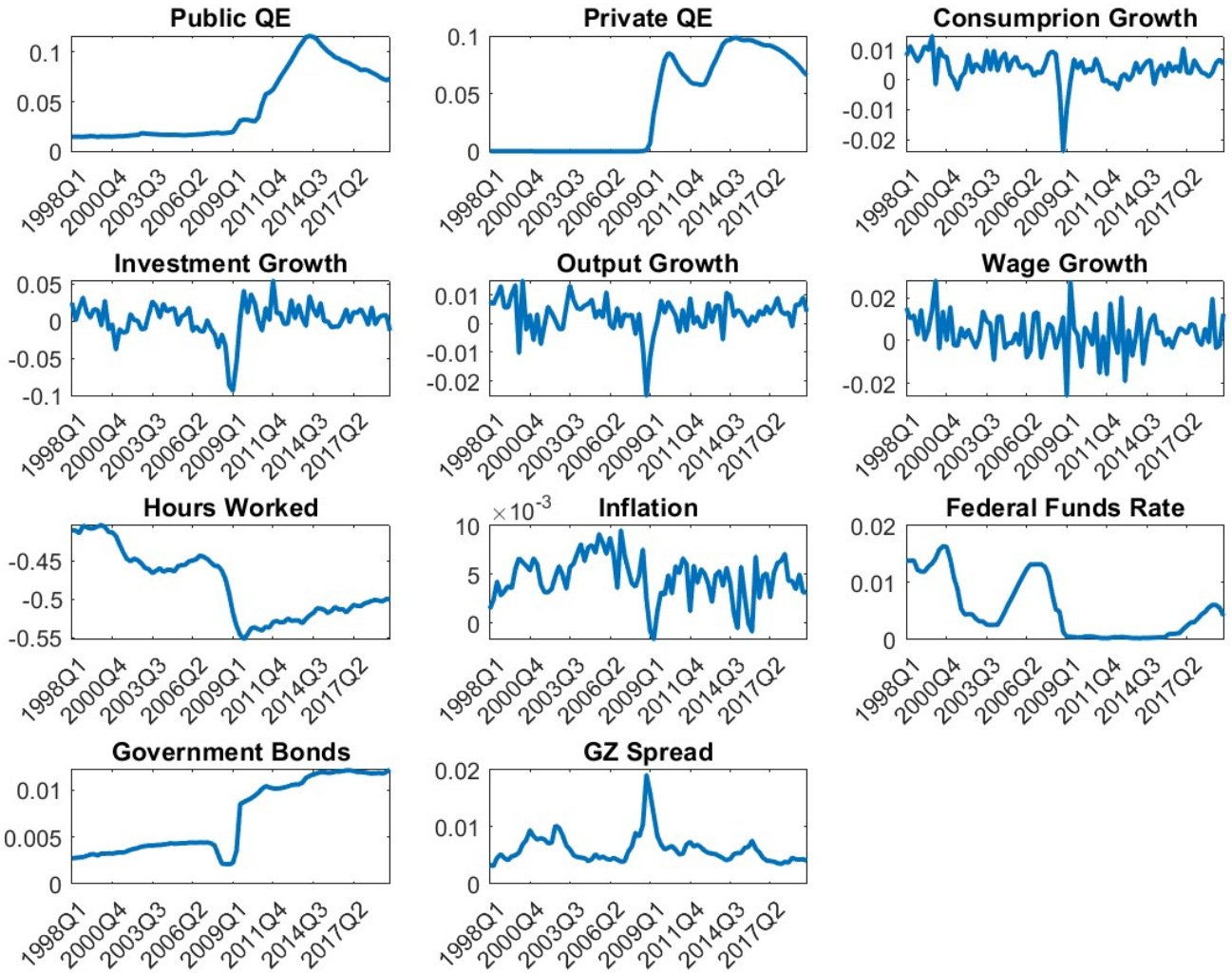
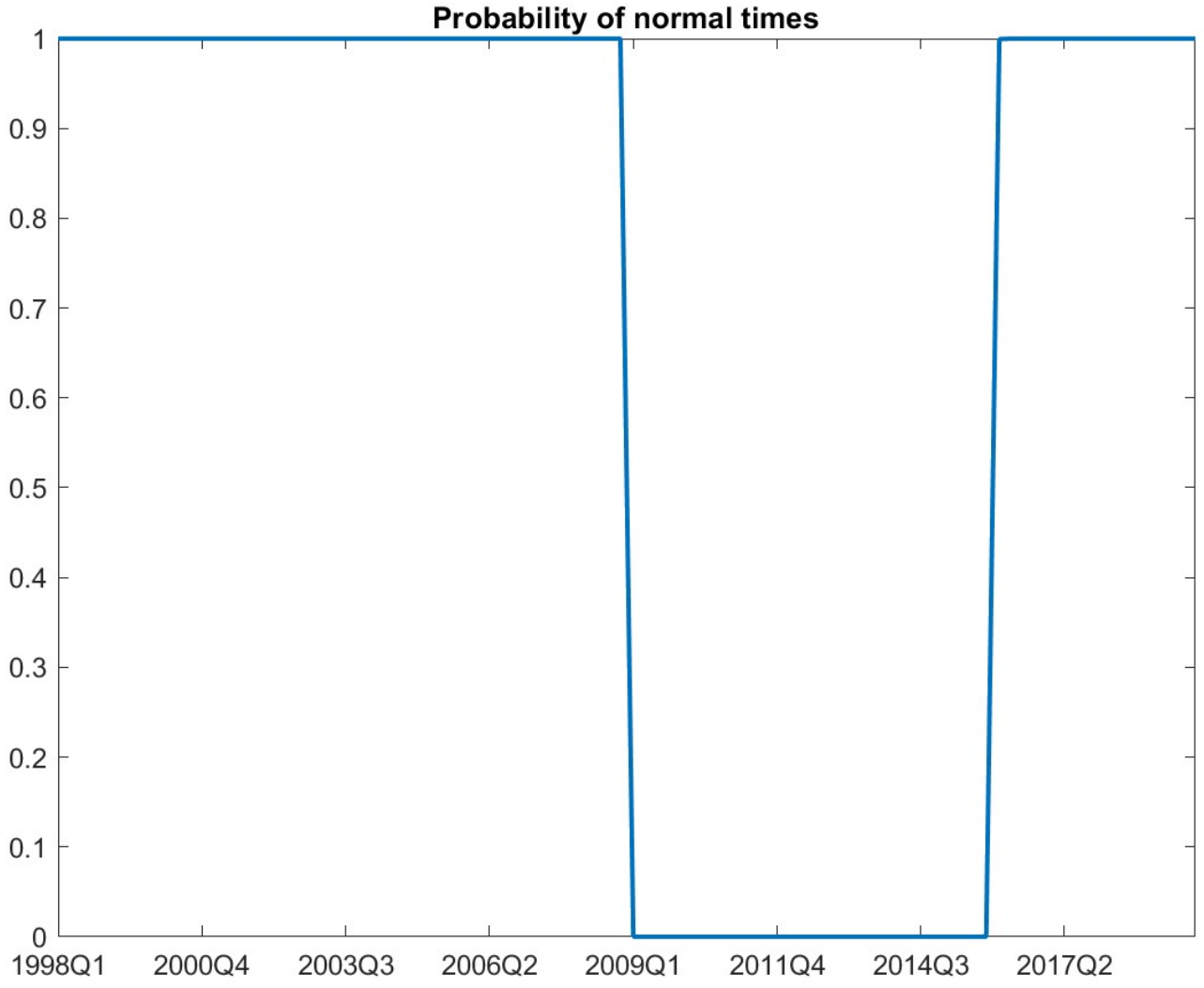
Data and Estimation Strategy

- Data: GDP growth, consumption growth, investment growth, wage growth, hours worked, inflation, fed funds rate, GZ spread, central bank holding of private and government bonds as share of GDP, long term government bonds.
- Sample: 1998Q1-2019Q4 (2023Q4).
- We estimate the model using RISE toolbox.

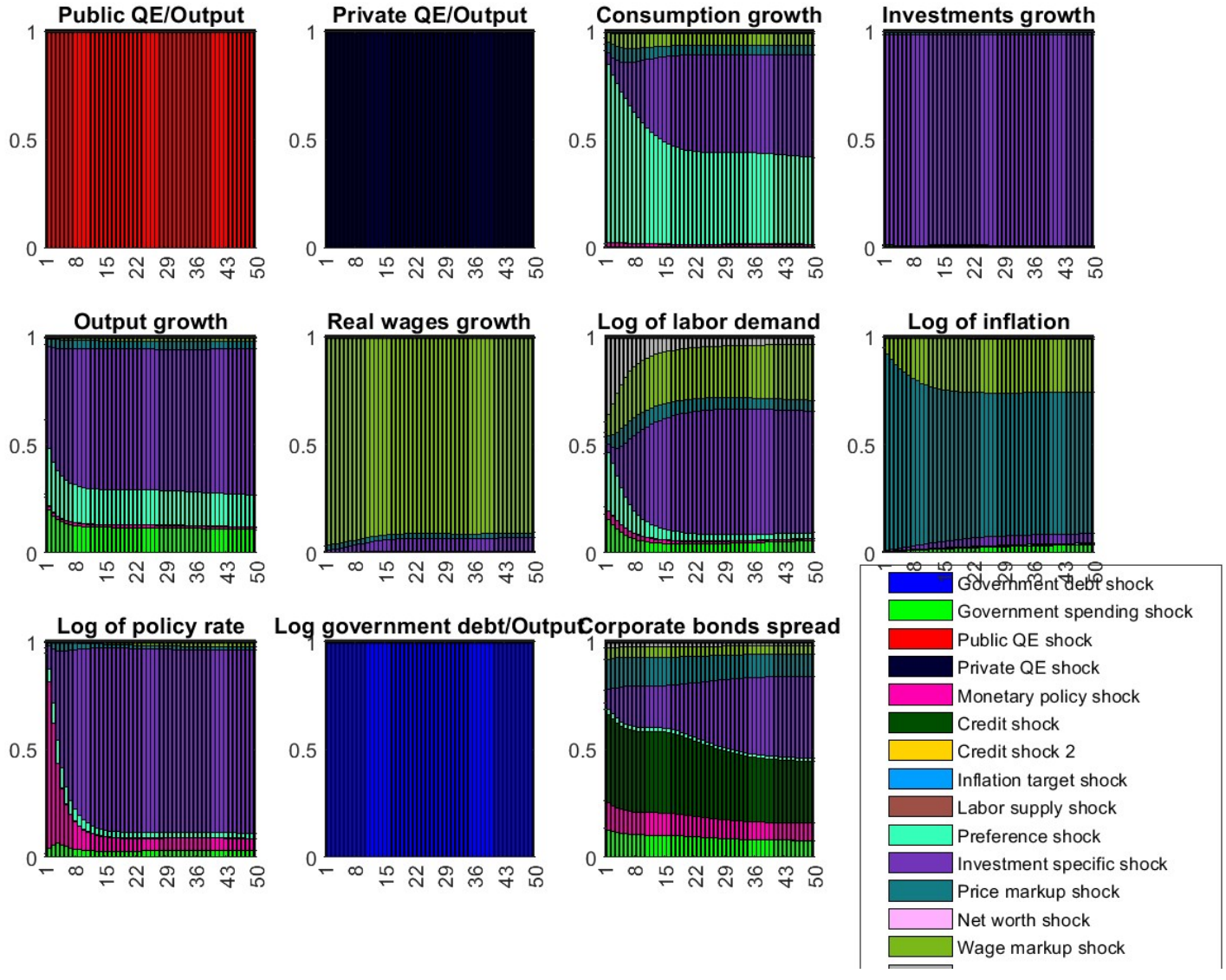
Observables



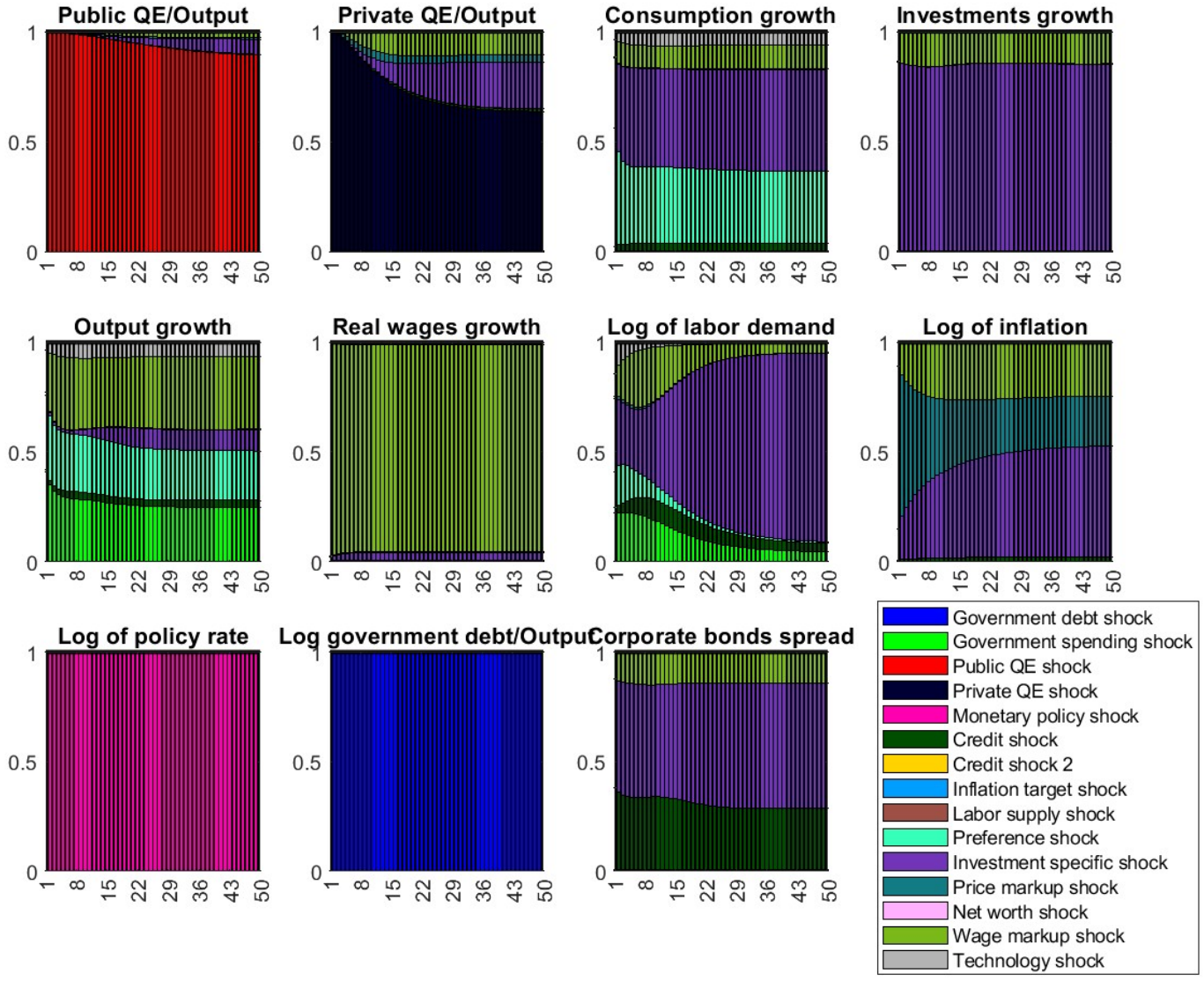
Smoothed Probabilities



Variance Decomposition - Normal Times



Variance Decomposition - ZLB Times



Optimal Policy

Different options

- Maximize the true welfare function.
- Maximize the second order approximation of the utility function (LQ approach).
- Minimize an ad-hoc loss function.
- Optimize simple rules in order to:
  - Maximize the true welfare function
  - Maximize the second order approximation of the utility function
  - Minimize an ad-hoc loss function.
- All with or without the ZLB.
- Commitment versus discretion.

Optimal Policy

Different options

- Maximize the true welfare function.
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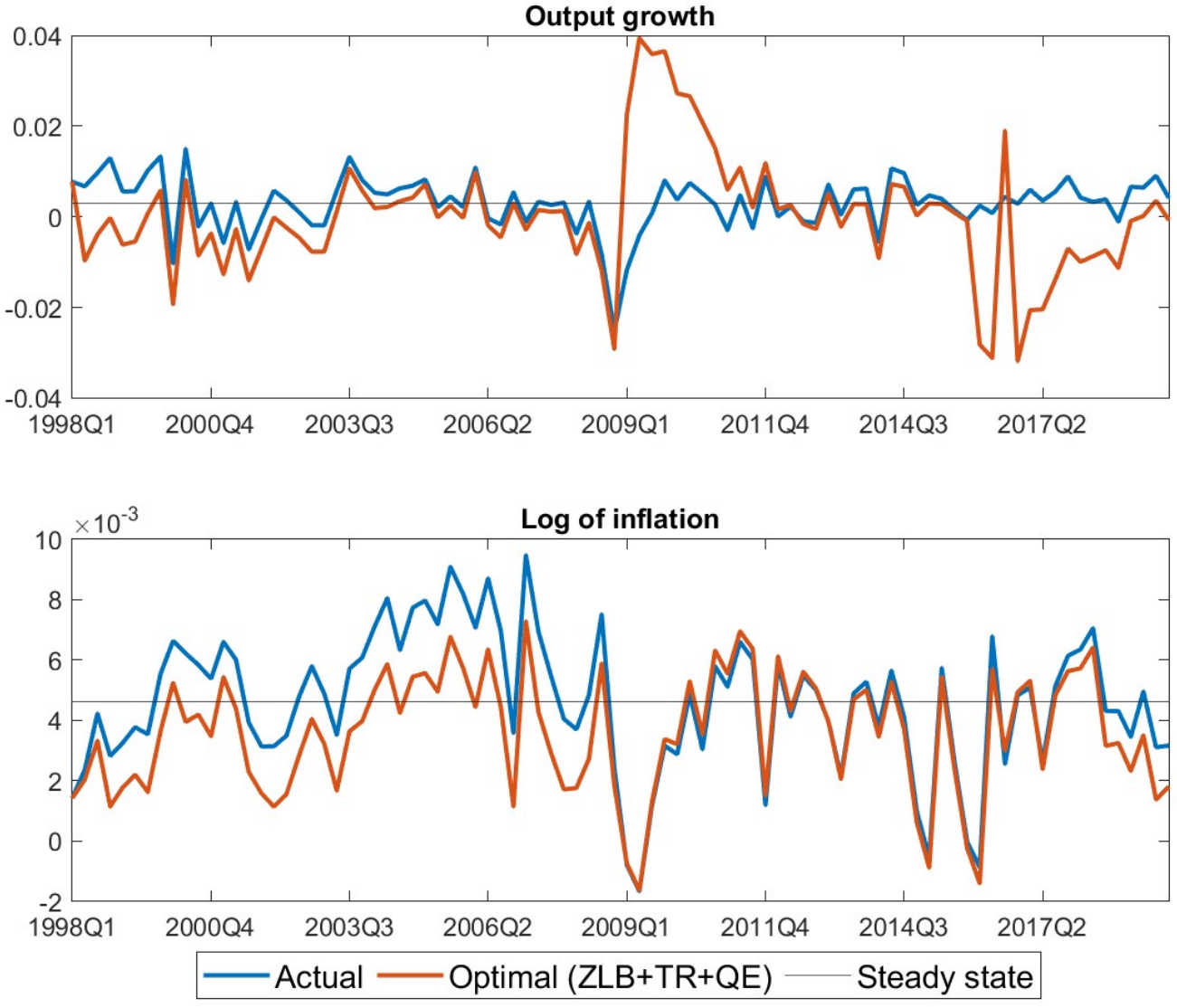
- Minimize an ad-hoc loss function.
- Optimize simple rules in order to:
  - Maximize the true welfare function
  - Maximize the second order approximation of the utility function
  - Minimize an ad-hoc loss function with inflation only.
- All with or without the ZLB.
- Commitment versus discretion.

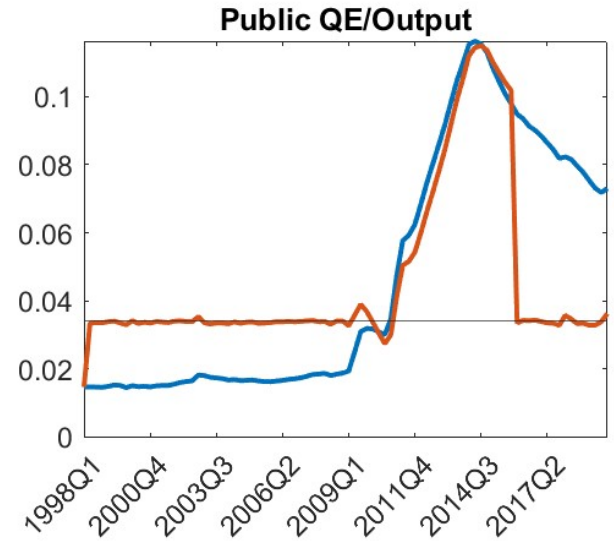
Optimal Policy - JPT and FGT

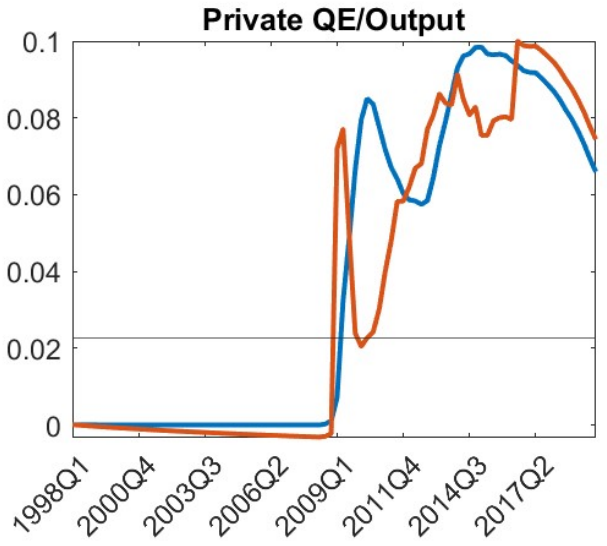
- What do we know about policy trade-offs from the empirical literature?
  - JPT and FGT both show that monetary policy trade-offs are empirically small.
- What are the implications for optimal policy?
  - JPT and FGT both show that optimal (conventional) monetary policy can achieve a trinity, i.e., very good stabilization of output gap, price inflation, and wage inflation (a sort of an extension of the divine coincidence concept).
- All that might not be the case in our model, where we have other features, shocks, but most importantly QE policy.

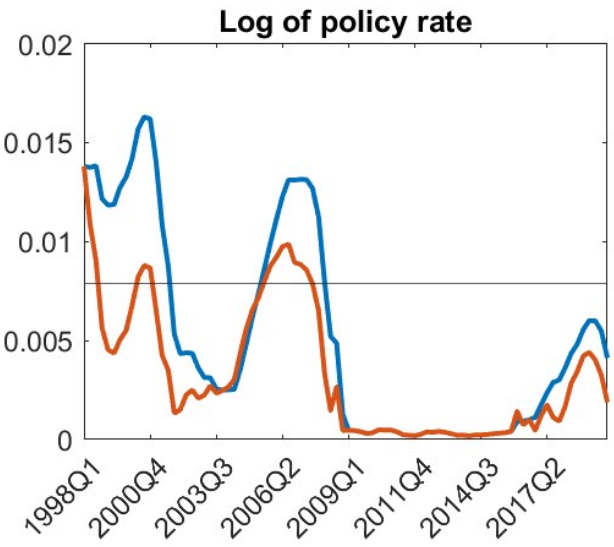
Counterfactual - Output and Inflation

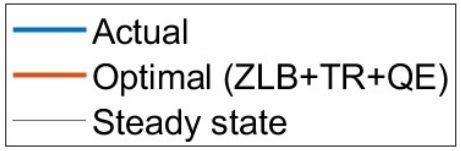


Counterfactual - Instruments







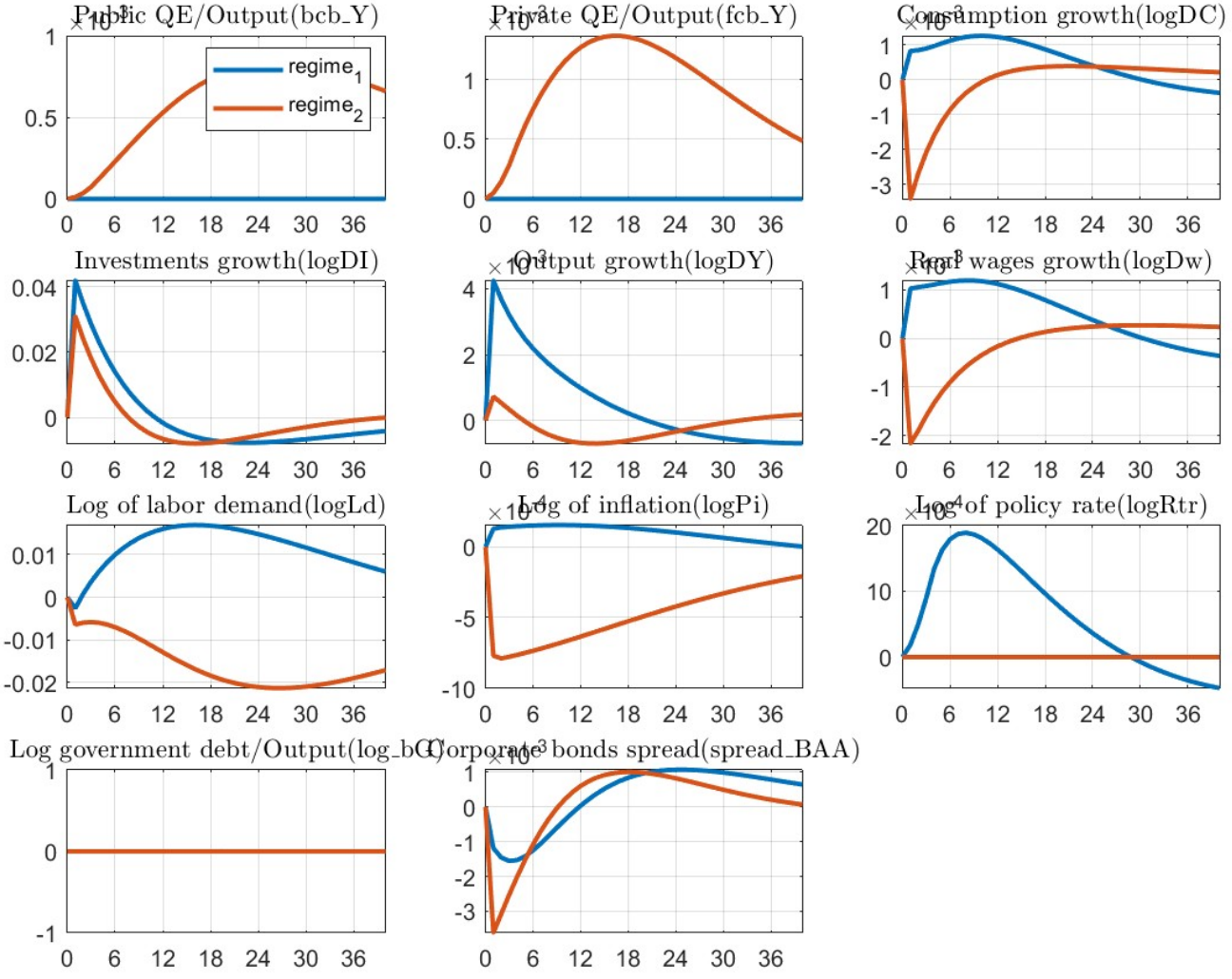


Conclusions

- We study the mix of optimal conventional and quantitative easing policies that the Fed could have put in place.
- We first quantify the relevant trade-offs by estimating a NK-DSGE model with banks and QE policy.
- We find that trade-offs are not very small, as previously found.
- The implication for optimal policy, in the form of optimized simple rules, is that it can achieve some stabilization of inflation and the real economy, but not a strong one (somewhat a large deviation from the divine coincidence result).
- **Results are preliminary and could change by the inclusion of most recent data in the estimation and by considering other characterizations of optimal policy, most notably the welfare maximization, instead of relying on optimized simple rules**.

THANKS!

Impulse Response Functions - Investment Specific Shock



Historical Decomposition