Time Variation in U.S. Wage Dynamics

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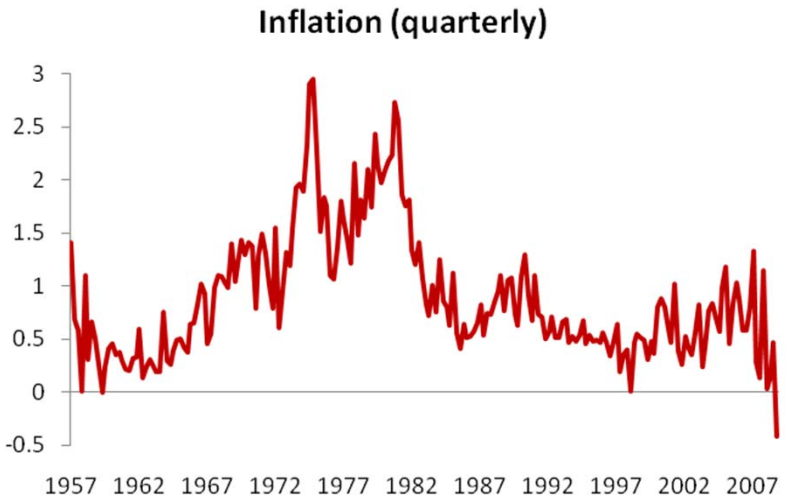
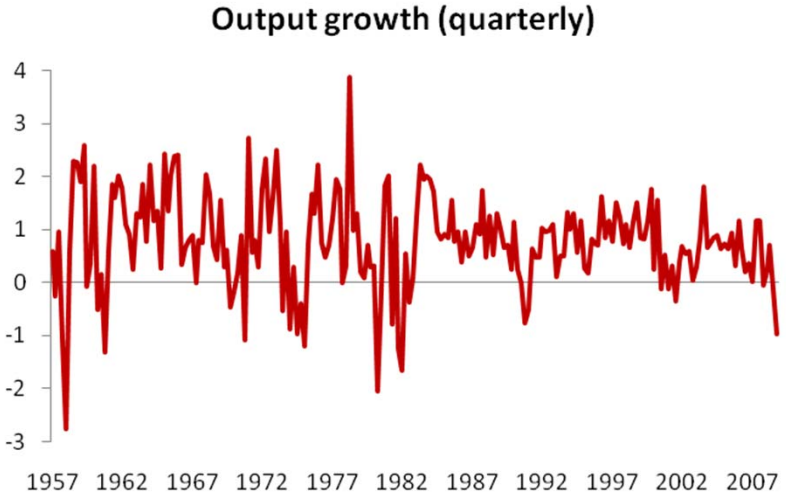
Motivation

- Two major U.S. macroeconomic phenomena



➢ *"Great Inflation"*

	Average inflation	Inflation variability
< 1965	0.40	0.29
1965 - 1982	1.46	0.60
> 1982	0.64	0.29



➢ *"Great Moderation"*

	Output growth variability
< 1984	1.19
> 1984	0.54

Motivation

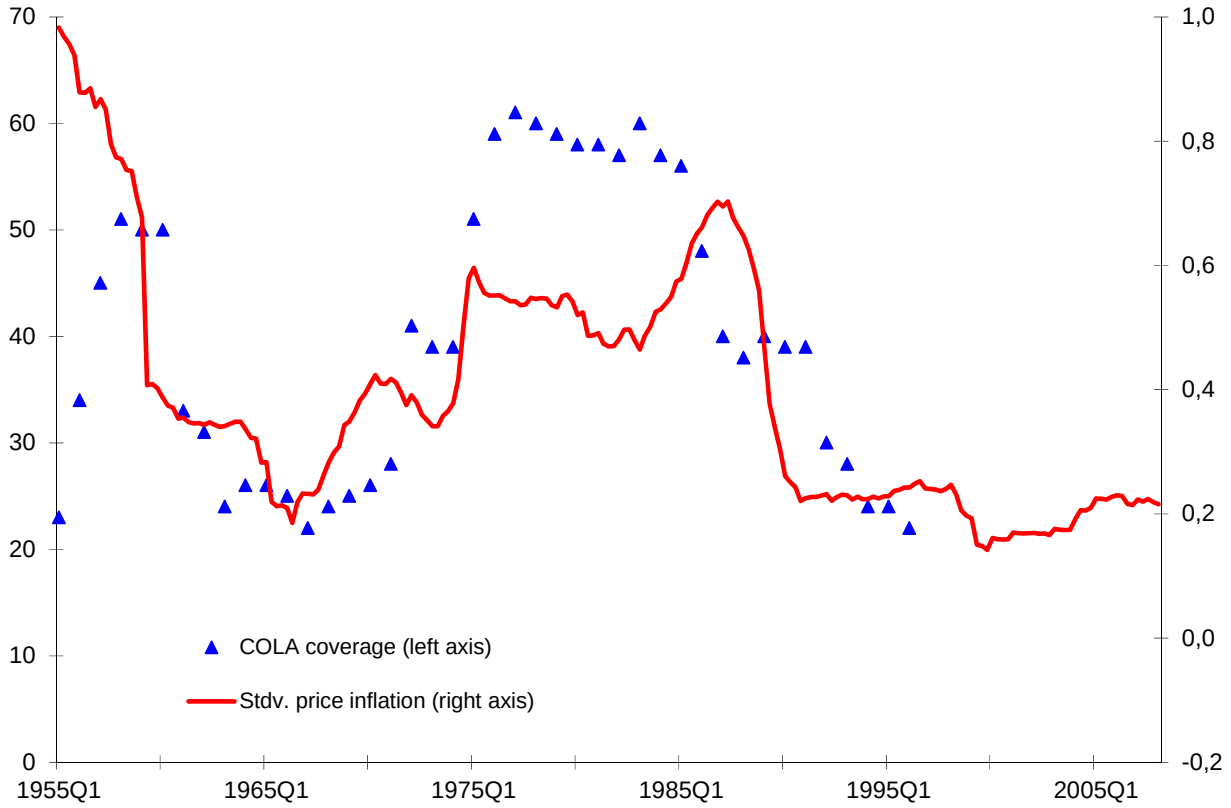
- Clarida et al. (2000); Gali et al. (2003); Lubik and Schorfheide (2004)
  - A shift in systematic monetary policy can explain these phenomena
  - Monetary policy did not stabilize inflation in 1970s, and became more aggressive with respect to inflation when Volcker became Fed chairman
  - “Bad policy – good policy hypothesis”
- Primiceri (2005); Sims and Zha (2006); Canova and Gambetti (2009)
  - Counterfactual simulations with alternate monetary policy rules
  - Shift in systematic component of monetary policy is insufficient or unable to explain the observed volatility break over time
  - Attribute break to changed variance of disturbances affecting the economy: “Bad luck – good luck hypothesis”

Motivation

- Time variation in wage dynamics has not been studied in this context
  - Surprising given important role of wages in macroeconomic models: inflation is typically driven by real marginal costs, which are directly linked to wages
  - Perception among e.g. policymakers (e.g. Bernanke 2004): second-round effects during “Great Inflation” period
    - Amplification inflationary effects of shocks via mutually reinforcing feedback between wages and prices arising from explicit or implicit wage indexation
    - Wage indexation protects for high inflation (variability), and has vanished with anchoring of inflation expectations in subsequent era of price stability
    - Larger shift in output (variability) is needed for inflation to return to baseline
    - Characteristic of monetary policy regime not captured by parameters of policy rule (reflects Lucas critique)

Motivation

- Institutional evidence supports conjecture that wage indexation has not been constant and could be linked to inflation regime



Present paper

- Explores patterns and sources of time variation in U.S. wage dynamics and its interlinkage with time variation in macroeconomic dynamics

- Two steps

  1. Estimation of a TVP-BVAR over the period 1957-2008 including nominal wages

     - Analysis of time variation in dynamic effects of supply and demand shock

     - Considerable time variation in wage dynamics

  2. Causes of time variation: estimation of parameters standard DSGE model for specific periods of time by matching impulse responses from TVP-BVAR

Time-varying parameters BVAR with stochastic volatility

- In spirit of Cogley and Sargent (2002); Primiceri (2005); Benati and Mumtaz (2007); Baumeister and Peersman (2008)

$$y_t = c_t + B_{1,t} y_{t-1} + \ldots + B_{p,t} y_{t-p} + u_t \equiv X_t' \theta_t + u_t$$

  - First difference of logs output, prices (GDP deflator), nominal wages and the level of the interest rate
  - Quarterly data: sample period with time-varying parameters covers 1957-2008 (1947-1956 used as a training sample)
  - Drifting coefficients to capture time variation in propagation mechanism

$$\theta_t = \theta_{t-1} + v_t \qquad v_t \sim N(0, Q)$$

Time-varying parameters BVAR with stochastic volatility

- Time-varying covariance matrix allows for heteroscedasticity of shocks and time variation in simultaneous relationships between variables

$$\Omega_t = A_t^{-1} H_t (A_t^{-1})'$$

$$A_t = \begin{bmatrix} 1 & 0 & 0 & 0 \\ \alpha_{21,t} & 1 & 0 & 0 \\ \alpha_{31,t} & \alpha_{32,t} & 1 & 0 \\ \alpha_{41,t} & \alpha_{42,t} & \alpha_{43,t} & 1 \end{bmatrix} \qquad H_t = \begin{bmatrix} h_{1,t} & 0 & 0 & 0 \\ 0 & h_{2,t} & 0 & 0 \\ 0 & 0 & h_{3,t} & 0 \\ 0 & 0 & 0 & h_{4,t} \end{bmatrix}$$

$$\alpha_t = \alpha_{t-1} + \varsigma_t \qquad \varsigma_t \sim N(0, S)$$

$$\ln h_{i,t} = \ln h_{i,t-1} + \sigma_i \eta_{i,t} \qquad \eta_{i,t} \sim N(0,1)$$

  - Error terms of transition equations are independent of each other and of the innovations of the observation equation, and block diagonal structure of S

- Estimated with Bayesian methods: Primiceri (2005)

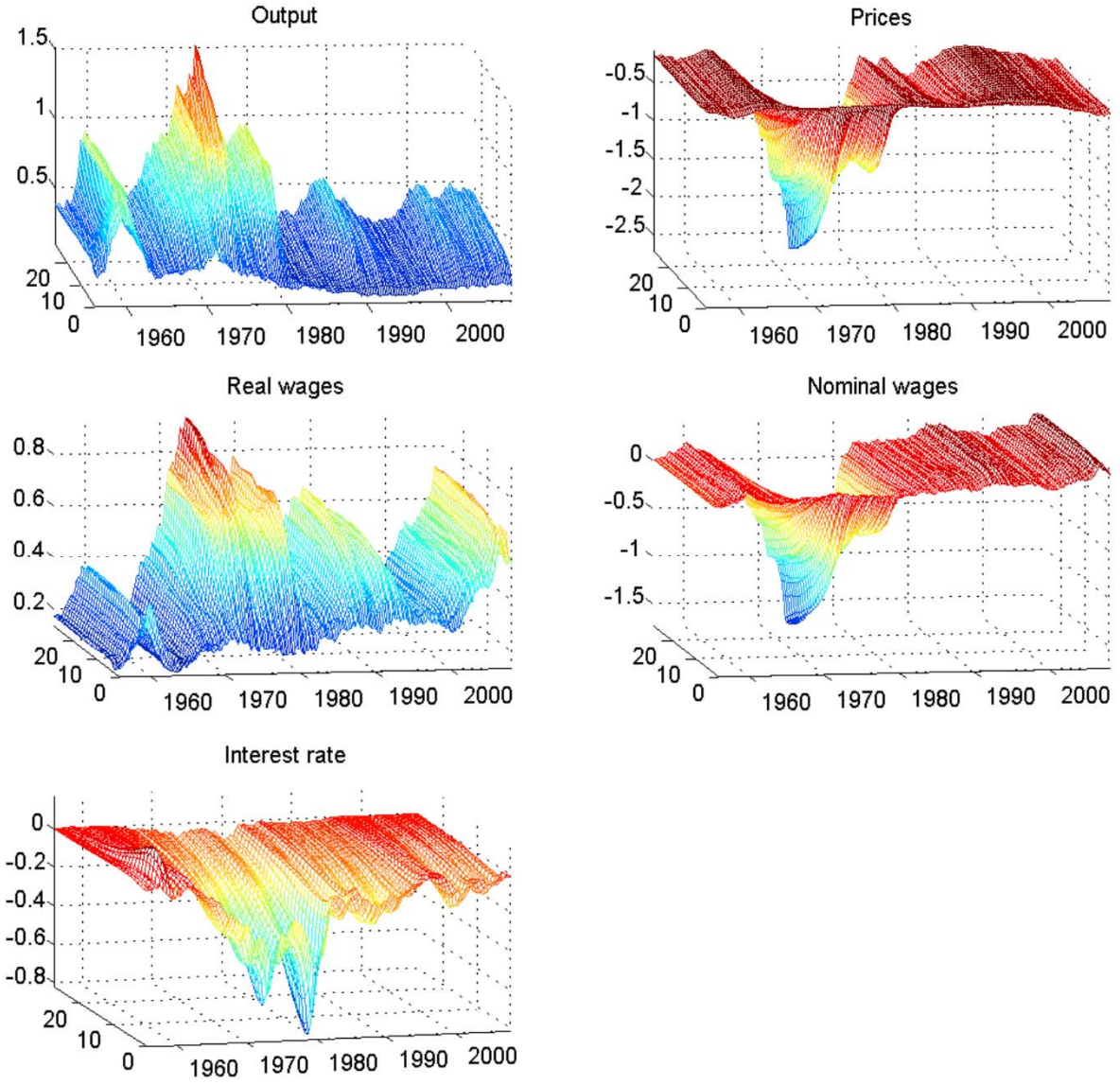
Identification of supply (technology) and demand shocks

- Peersman and Straub (2009): set of sign restrictions that are consistent with a large class of DSGE models and robust for parameter uncertainty

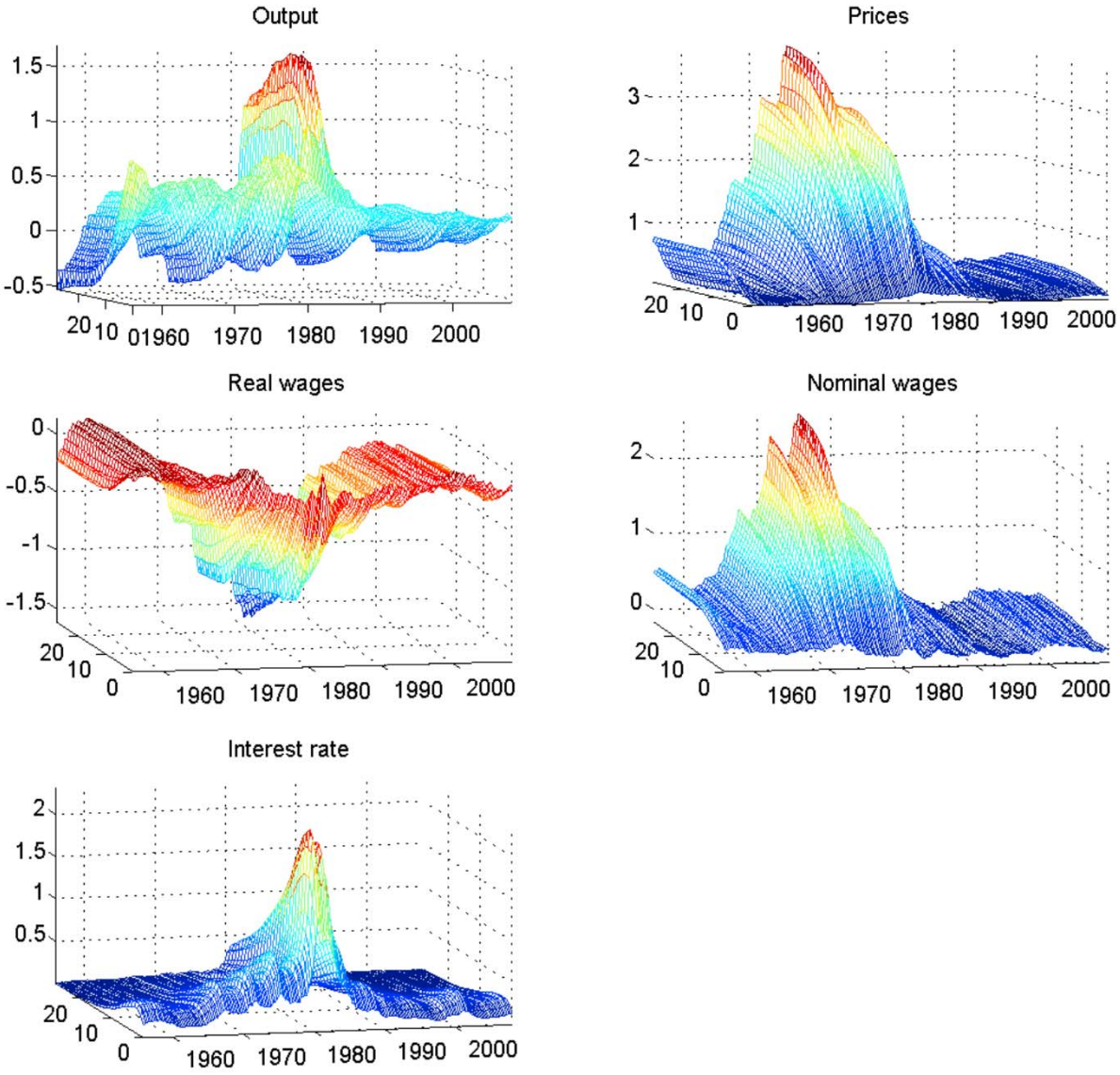
	Output	Prices	Interest rate	Nominal wages	Real wages
Technology	**+**	**-**			**+**
Labor supply	+	-			-
Aggregate demand	**+**	**+**	**+**		
Monetary policy	+	+	-		

  - Note: technology shock also captures supply-side shocks such as commodity prices or price mark-up shocks

Time-varying effects of supply shocks



Time-varying effects of demand shocks

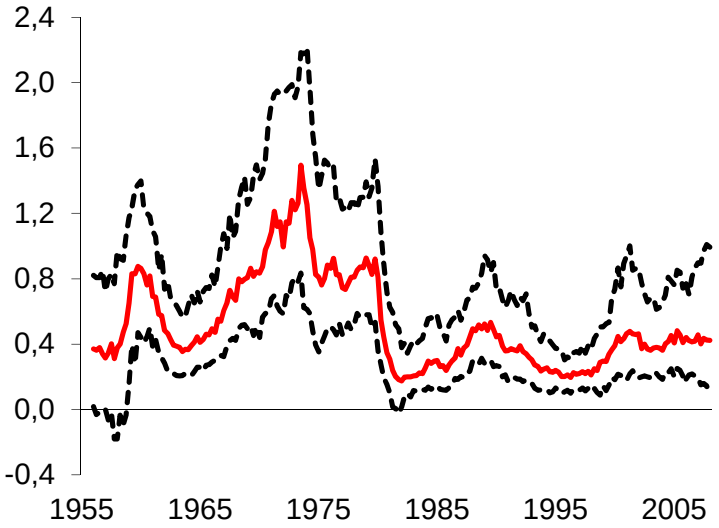


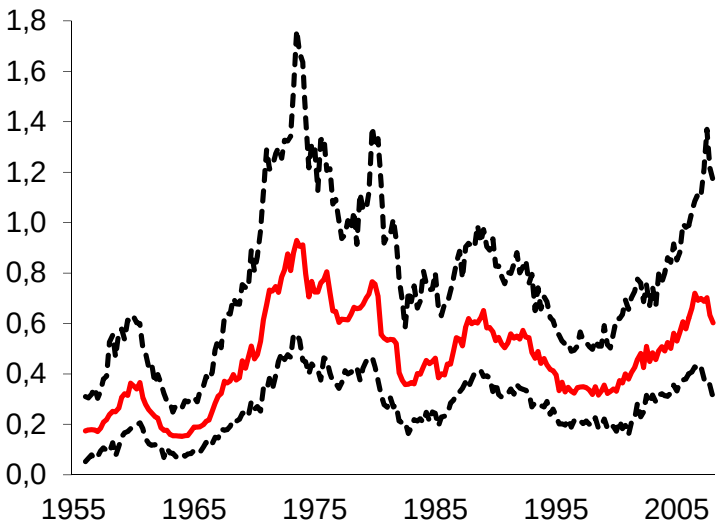
Impact of supply and demand shock over time

Output

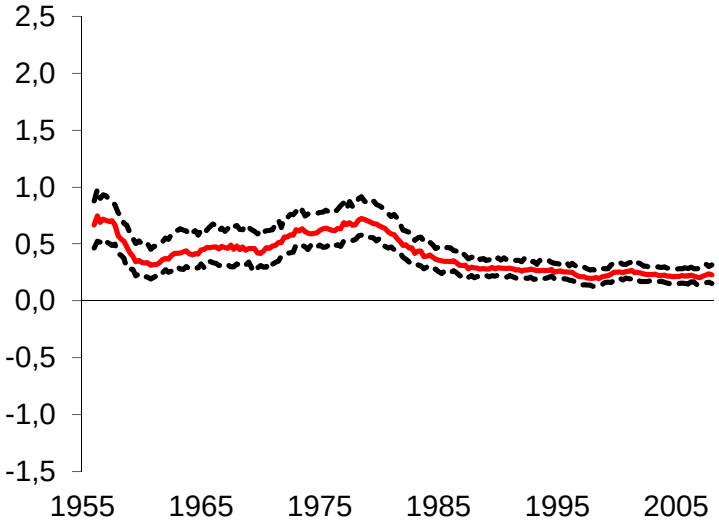
Real wages

Long-run Impact of Supply shock





Immediate Impact of Demand shock

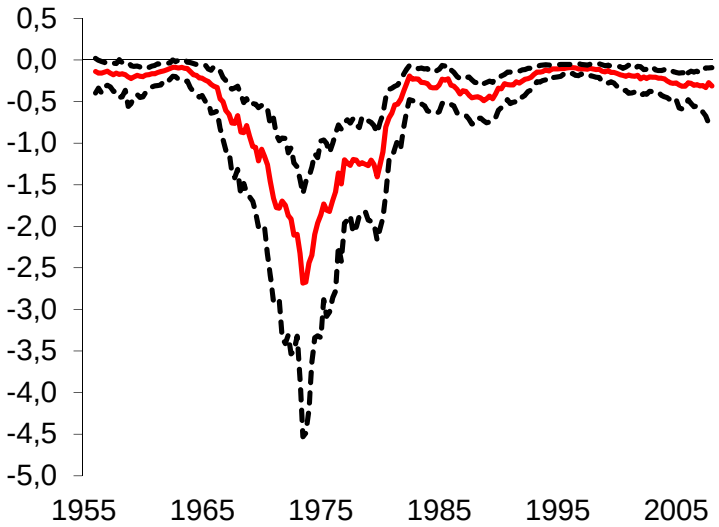


Size of shock could have contributed to time variation but cannot be the only explanation: magnitude and pattern clearly different from nominal wages/prices and cannot explain sign switch

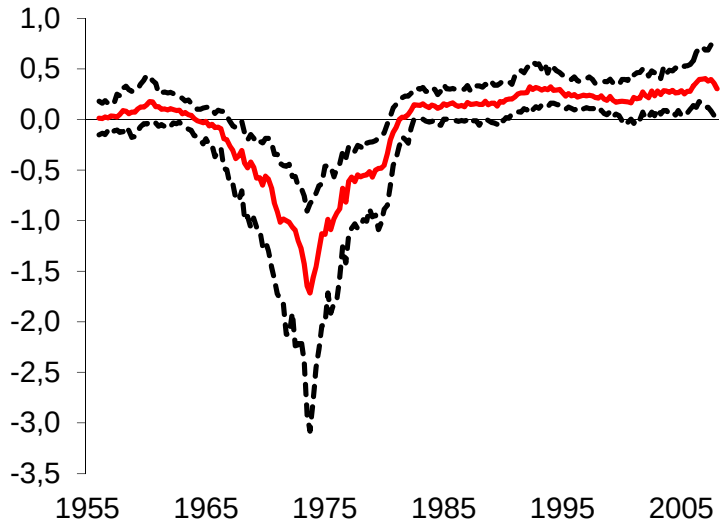
Impact of supply shock over time

Long-run impact

Prices



Nominal wages

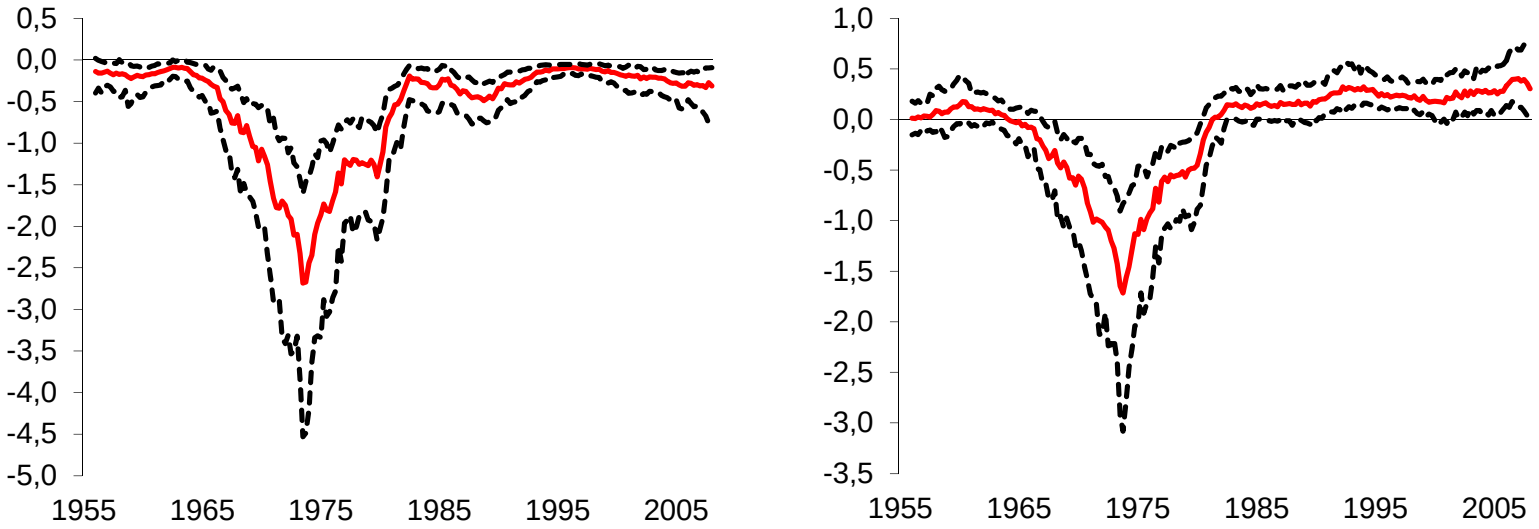


- Substantial stronger long-run impact on prices between second half 1960s and early 1980s: “Great Inflation”
  - Gali et al. (2003) already detected a much stronger impact on inflation in pre-Volcker period (54Q1-79Q2) relative to Volcker-Greenspan era (82Q3-98Q3)
  - Our evidence indicates that their first period covers two regimes

Impact of supply shock over time

Prices ***Nominal wages***

Long-run impact

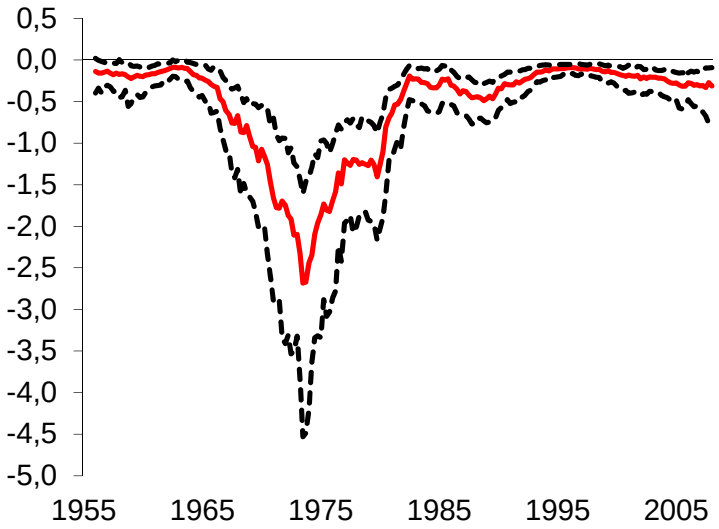


- Strong negative pass-through to nominal wages during “Great Inflation” is **new stylized fact**
  - Basu et al. (2006); Liu and Phaneuf (2007) use constant parameters SVARs and conclude that there is only a very weak negative or insignificant impact on nominal wages
  - Misleading since their findings are consequence of considerable time variation cancelling each other out

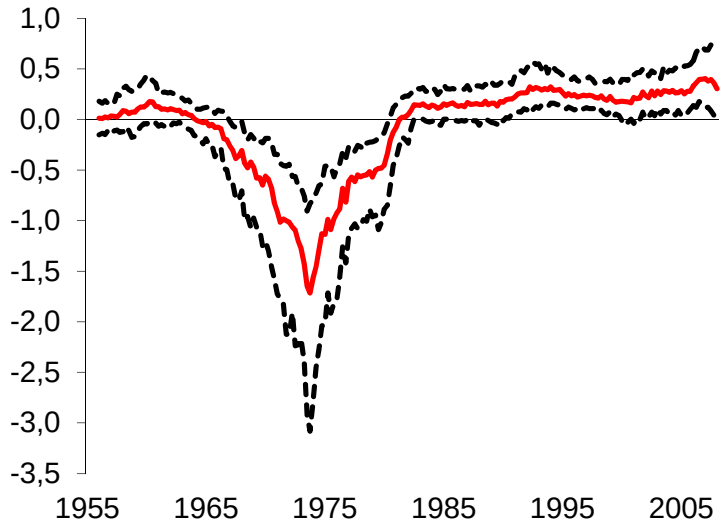
Impact of supply shock over time

Long-run impact

Prices



Nominal wages

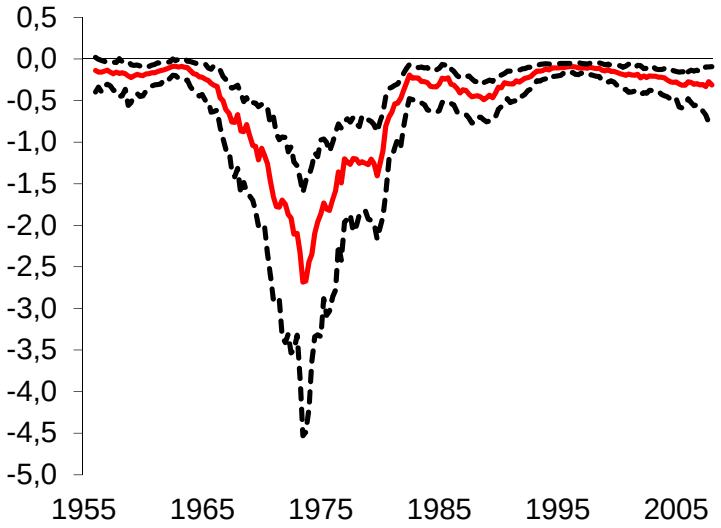


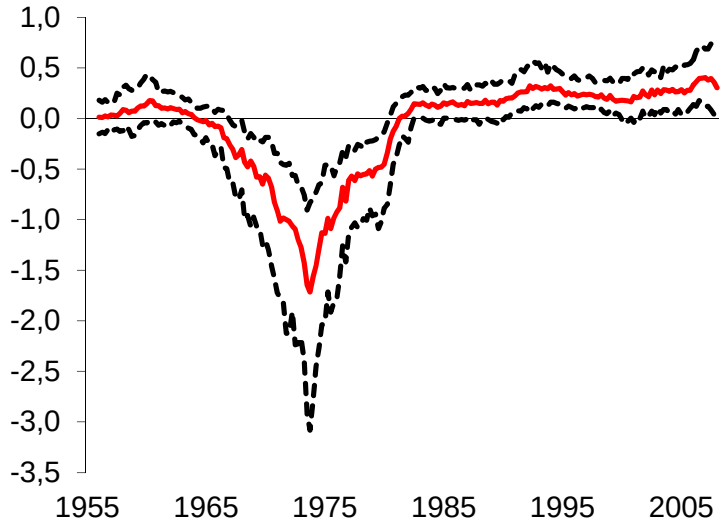
- Sign-switch of long-run nominal wage response striking
  - Before and after 1970s: nominal wages in opposite direction as the price level
  - During “Great Inflation”: nominal wages moved in same direction as prices
  - This is not the case for the contemporaneous impact: has always been positive and of a similar magnitude (see next slide)

Impact of supply shock over time

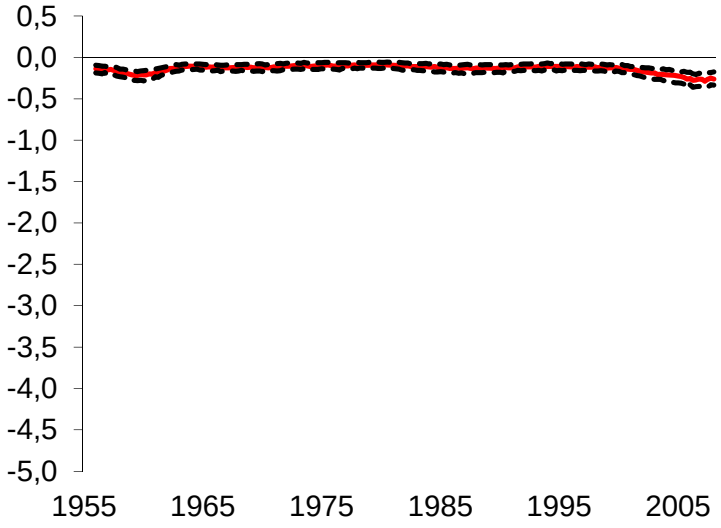
Prices ***Nominal wages***

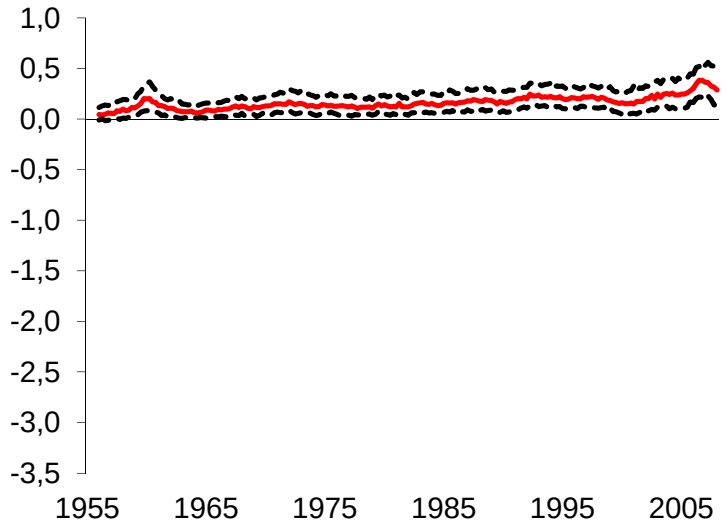
Long-run impact





Immediate impact

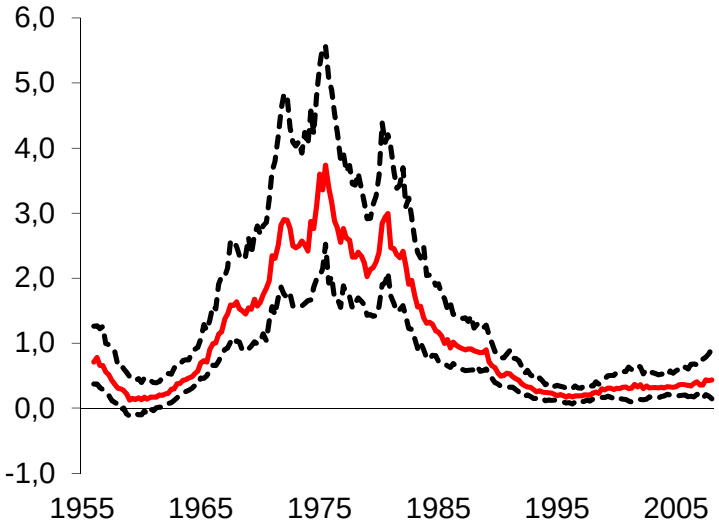




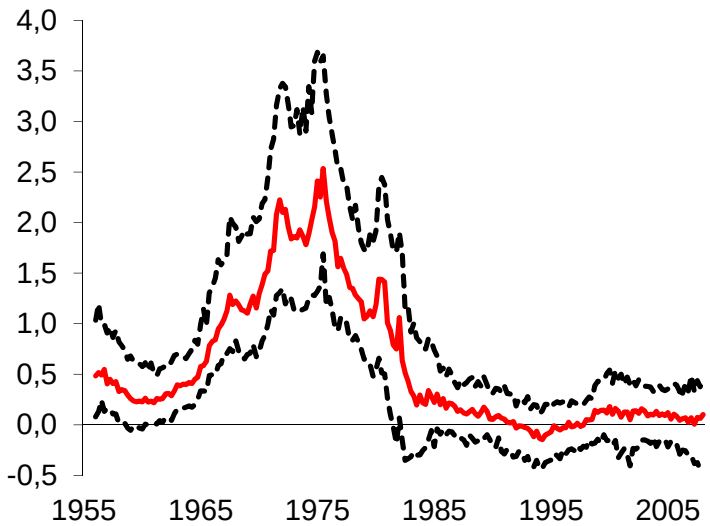
Impact of demand shock over time

Long-run impact

Prices



Nominal wages



- Also substantial stronger long-run impact of demand shocks on nominal wages and prices during same period

Explaining the time variation in wage dynamics

- Estimation of parameters standard DSGE model for specific periods to examine causes of time variation in a structural way
  - 1960Q1, 1974Q1 and 2000Q1
  - Bayesian impulse response matching procedure (Christiano et al. 2010)

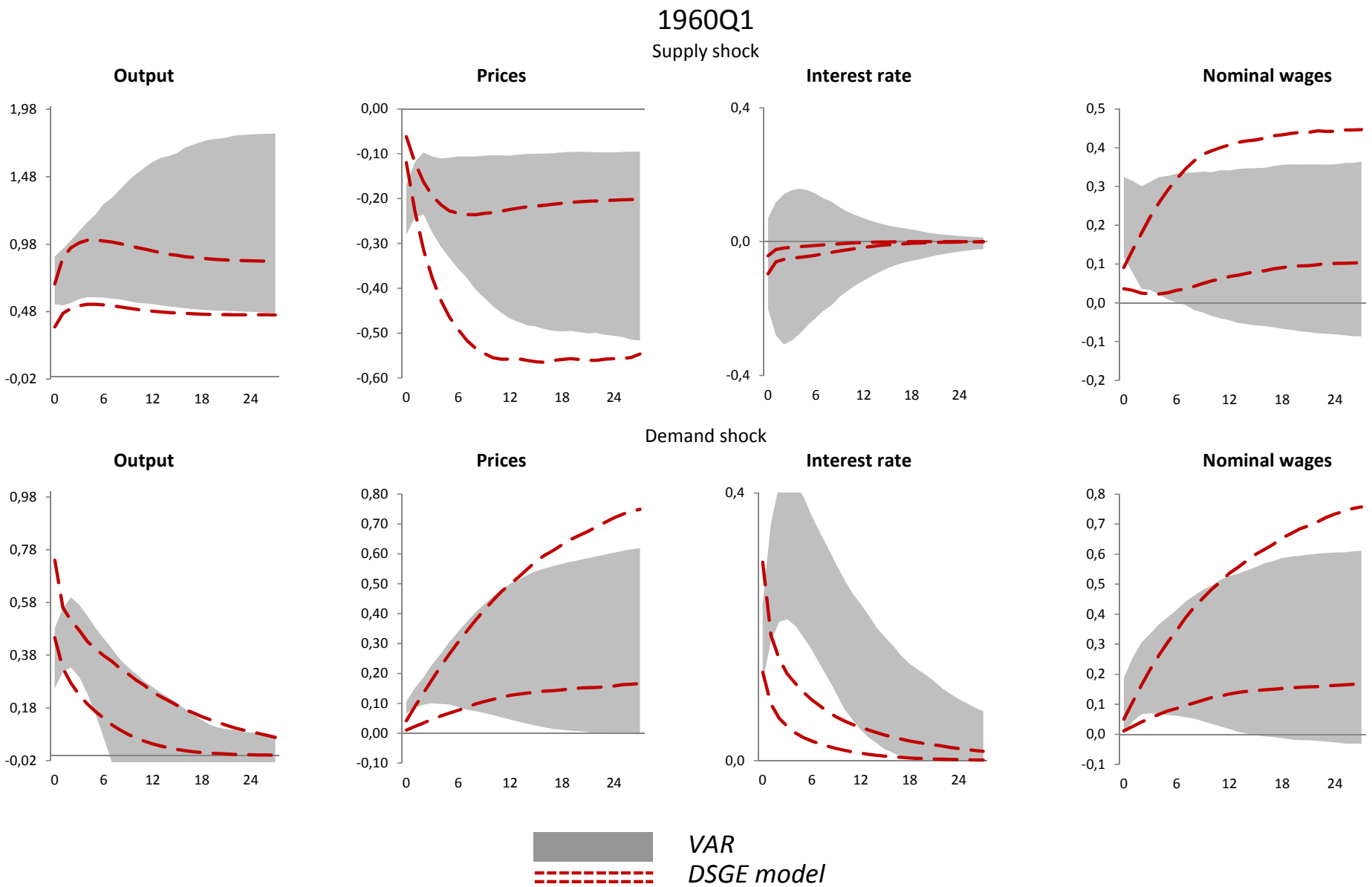
The DSGE model in a nutshell

- Simplified version of Smets and Wouters (2007); Christiano et al. (2005)
- Calvo sticky prices and wages, price and wage indexation, habit formation and a conventional Taylor rule
- Economy subject to (permanent) technology and government spending shock
- Fixed value for some of structural parameters
  - Discount factor, invers labor supply elasticity and degree of monopolistic competition in goods and labor market
- All other parameters estimated with Bayesian matching procedure

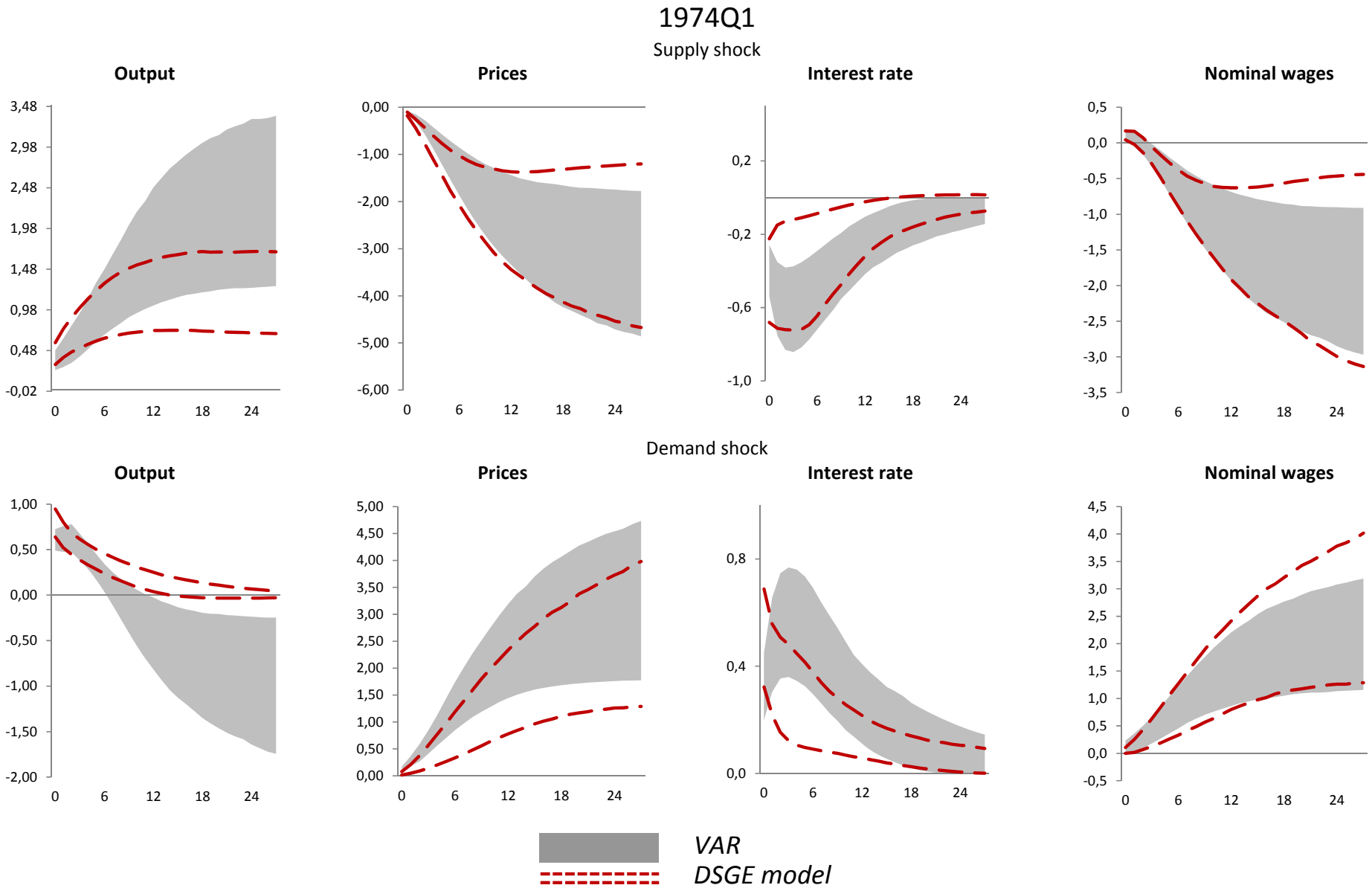
Bayesian matching procedure

- Structural parameters are estimated by minimizing distance between DSGE impulse response functions and those from the VAR for each period
- Impulse response functions that have to be matched are generated with a Bayesian VAR, while shocks are identified with sign restrictions
  - There is no point estimate to center minimum distance method
  - We first estimate posterior mode of structural parameters for each impulse response draw from the VAR
  - Distribution posterior modes of structural parameters is calculated in next step

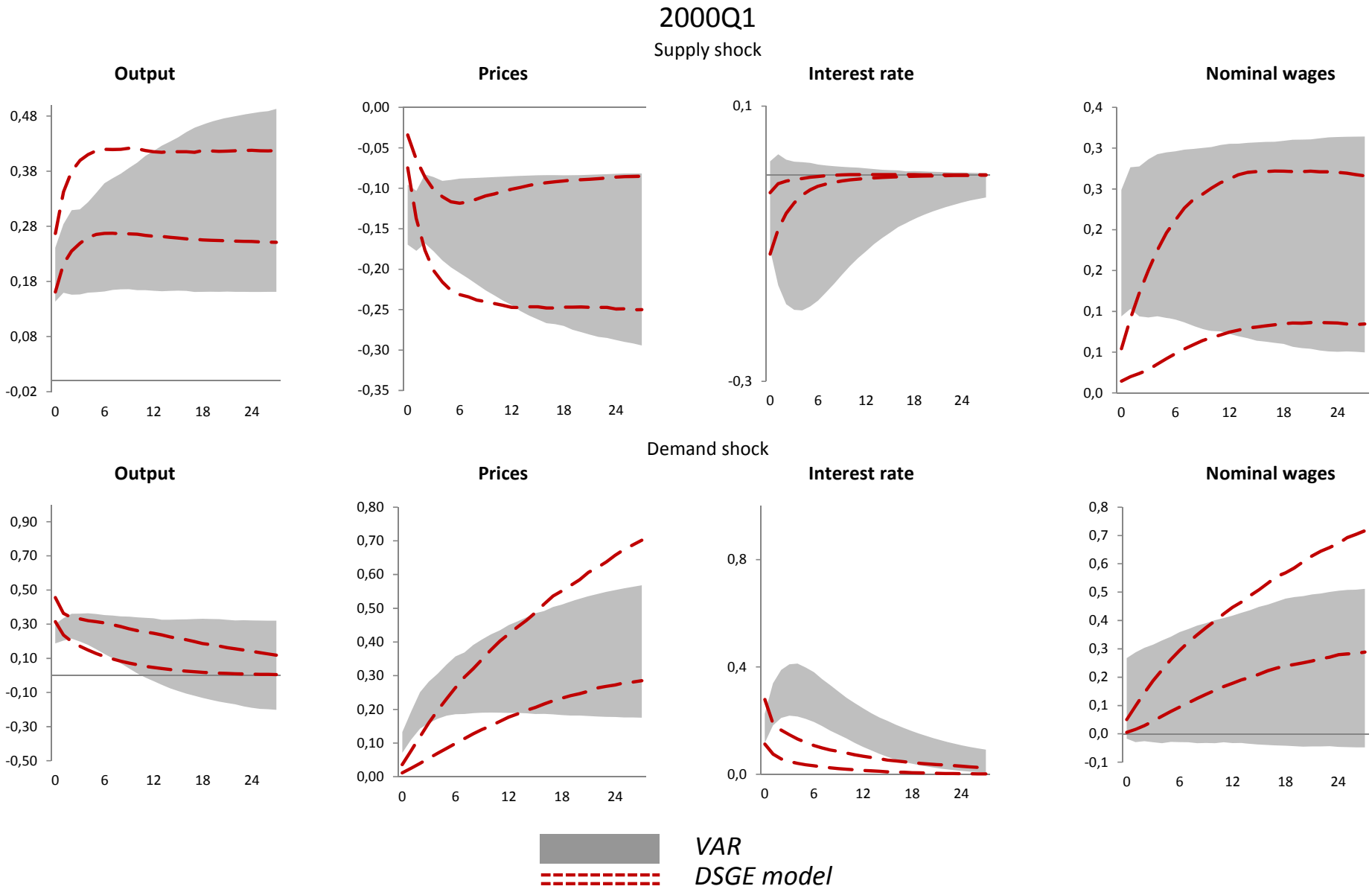
Impulse response matching



Impulse response matching



Impulse response matching



Estimated structural parameters I

	1960	1974	2000
Stdv. supply shock	**0,60** [0,46 – 0,85]	**1,02** [0,71 – 1,69]	**0,31** [0,25 – 0,42]
Stdv. demand shock	**4,75** [3,41 – 7,92]	**4,73** [3,94 – 5,95]	**3,25** [2,30 – 6,22]
Autocorr. demand shock	**0,87** [0,83 – 0,92]	**0,89** [0,86 – 0,93]	**0,91** [0,87 – 0,95]
Price stickiness	**0,81** [0,76 – 0,85]	**0,84** [0,81 – 0,87]	**0,78** [0,70 – 0,84]
Wage stickiness	**0,60** [0,46 – 0,85]	**0,64** [0,54 – 0,73]	**0,54** [0,43 – 0,69]
Consumption habit	**0,33** [0,21 – 0,40]	**0,71** [0,51 – 0,96]	**0,37** [0,18 – 0,57]

- Size of shocks has changed over time (good luck hypothesis)
- There is also a change in habit persistence over time

Estimated structural parameters II

	1960	1974	2000
Taylor rule inflation	**1,55** [1,34 – 1,74]	**1,11** [1,07 – 1,18]	**1,35** [1,24 – 1,49]
Taylor rule Δoutput	**0,30** [0,21 – 0,40]	**0,50** [0,27 – 0,84]	**0,39** [0,27 – 0,59]
Taylor rule output	**0,10** [0,07 – 0,16]	**0,11** [0,06 – 0,29]	**0,10** [0,07 – 0,15]
Taylor rule smoothing	**0,76** [0,68 – 0,82]	**0,69** [0,58 – 0,87]	**0,78** [0,70 – 0,88]

- Pattern of parameters of monetary policy rule consistent with literature on evolution of Fed monetary policy conduct (bad monetary policy in 1970s)
- Less aggressive policy response to inflation in 1970s and stronger focus on output stabilization

Estimated structural parameters III

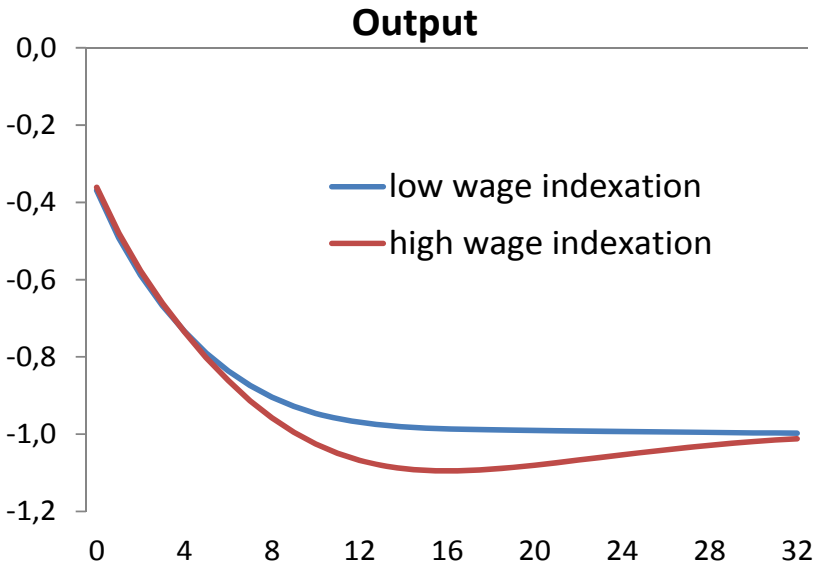
	1960	1974	2000
Price indexation	**0,15** [0,11 – 0,19]	**0,80** [0,58 – 0,93]	**0,17** [0,12 – 0,21]
Wage indexation	**0,30** [0,21 – 0,67]	**0,91** [0,74 – 0,96]	**0,17** [0,11 – 0,25]

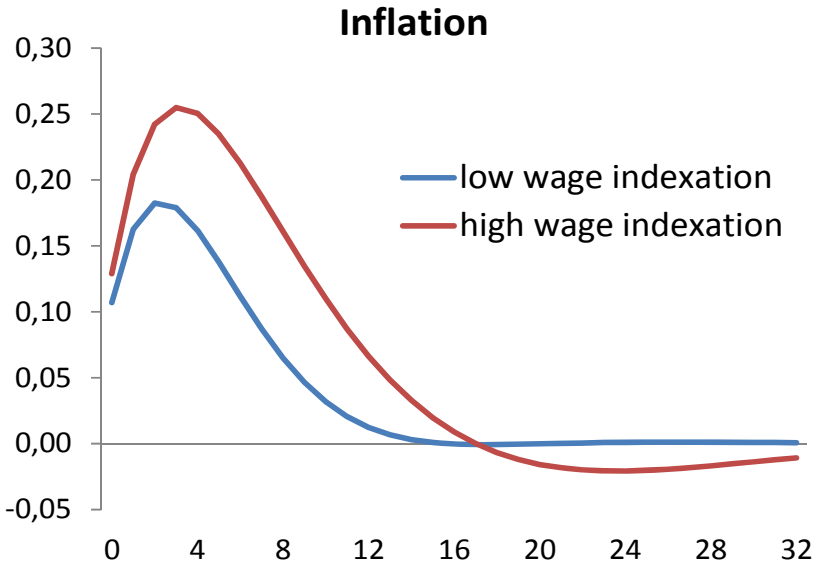
- Price indexation was higher in “Great Inflation” period
  - In line with studies documenting a rise of inflation persistence in 1970s
- Time variation in wage indexation parameter: much higher in “Great Inflation” compared to preceding and subsequent periods

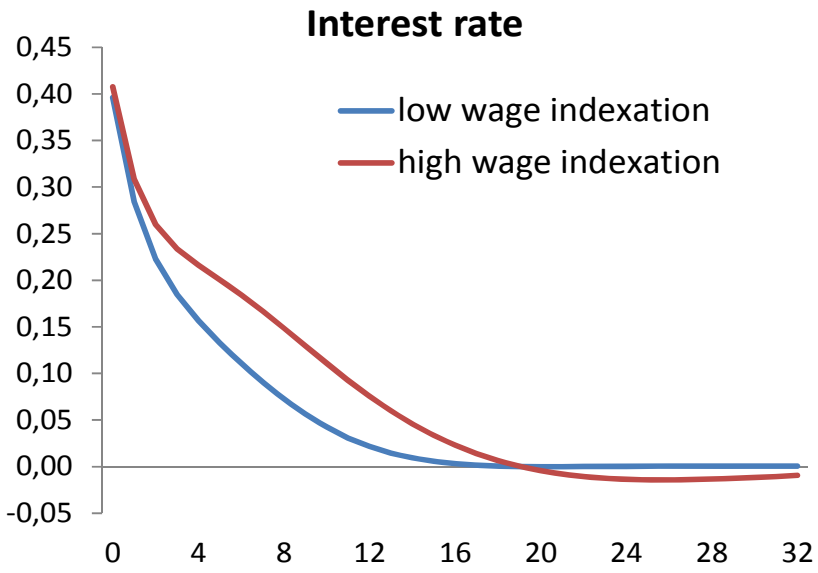
Relevance for macroeconomic dynamics

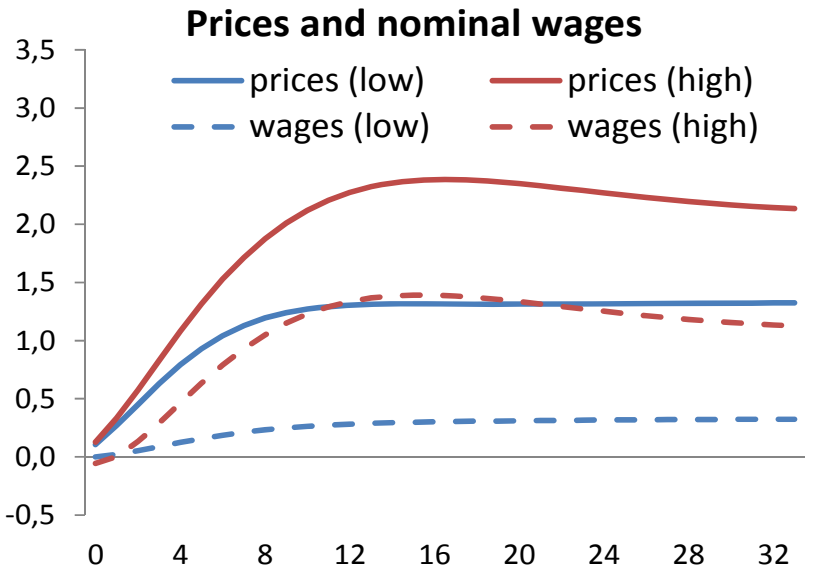
- Relevance of wage indexation for macro dynamics is considerable
- Simulation of DSGE model for 1974 and replacing wage indexation parameter by its 2000 posterior median value
  - Impact of supply and demand shock on prices respectively 44% and 39% lower
  - Note 1: for policy rule parameters, this is respectively 31% and 37%
  - Note 2: for price indexation, this is respectively 23% and 19%

Dynamic effects of 1% decline in productivity









Conclusions and consequences

- Considerable time variation in U.S. wage dynamics within TVP-BVAR
  - Much stronger long-run effects of supply and demand shocks on nominal wages and prices during “Great Inflation” than in preceding and subsequent periods
  - For supply shocks, there is even a sign switch in nominal wage response
    - Move in same direction as real wages and opposite direction of price level before and after “Great Inflation”
    - Nominal wages and prices move in same direction at longer horizons after the shock in 1970s (not on impact)
- Estimation of DSGE model: results reflect changes in conduct of monetary policy and, especially, changes in degree of wage indexation over time
  - Indexation very high in “Great Inflation”, but low before and after this period
  - Wage-price spirals amplified effects of inflationary shocks in “Great Inflation”

Conclusions and consequences

- Parameters of policy rule and degree of wage (price) indexation are two sides of same coin, i.e. monetary policy regime
  - Simultaneous switch of response to inflation and degree of indexation in data
  - Weakly inflation stabilizing policy rule is conducive to high and volatile inflation, which fosters use of indexation clauses as protection against inflation uncertainty
    - Indexation in turn contributes to inflation uncertainty by amplifying the effects of inflationary shocks
    - Regime of price stability with strong inflation stabilizing policy rule reduces the need for protection against inflation uncertainty, mitigating indexation
  - Reasoning reflects Lucas critique: change in policy regime could have wider effects on empirical macroeconomic regularities

Conclusions and consequences

- Hard-wiring certain degree of wage indexation in macro models potentially misleading when changes in monetary policy regime are analyzed
  - Wage (and price) indexation should be treated as endogenous
- Counterfactual experiments in context of “Great Inflation” and “Great Moderation” by altering solely the monetary policy rule do not capture the wider consequences of a change in the policy regime