Reassessing the role of oil price shocks and monetary policy in the Great Stagflation

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September 2017

Our Questions

What caused the Great Stagflation?

- Oil price shocks of 1973-74 and 1979-80 ?
- Bad monetary policy?

(Why no stagflation in aftermath of 2000's oil shocks?)

FRED

Spot Crude Oil Price: West Texas Intermediate (WTI)

Percent Change from Year Ago

200
160
120
80
40
0
-40
-80

1970
1975
1980
1985
1990
1995
2000
2005

Source: Federal Reserve Bank of St. Louis

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Consumer Price Index for All Urban Consumers: All Items
Real Gross Domestic Product

Percent Change from Year Ago

15.0
12.5
10.0
7.5
5.0
2.5
0.0
-2.5
-5.0

1970
1975
1980
1985
1990
1995
2000
2005

Sources: BEA, BLS

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Consumer Price Index for All Urban Consumers: All Items
Effective Federal Funds Rate

Percent Change from Year Ago , Percent

17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
-2.5

1960
1970
1980
1990
2000
2010

Sources: BLS, Board of Governors

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Key papers

Small NK models with passive monetary policy

- Clarida, Gali, Gertler (2000); Lubik and Schorfheide (2004)
- Coibion and Gorodnichenko (2011); Hirose, Kurozumi, van Zandweghe (2017)

NK models with oil

- Blanchard and Gali (2009); Blanchard and Riggi (2013)
- Bodenstein, Erceg, Guerrieri (2008); Nakov and Pescatori (2010)

Medium-scale models with cost-push shocks

- Smets and Wouters (2007); Justiniano and Primiceri (2008)
- Nicolò (2017)

What we do

Estimate NK model with oil over determinacy/indeterminacy region

- Sample period: 1966:I-1979:II
- Oil price shock treated as observable
- Test for indeterminacy

New Keynesian model with oil [Blanchard-Gali (2009)]

- Oil as input in production and consumption
- Real oil price as exogenous
- Habit formation in consumption
- Real wage rigidity
- Trend inflation

People

$$\max E_0 \sum_{t=0}^{\infty} \beta^t d_t \left[\ln \left(C_t - h\widetilde{C}_{t-1} \right) - \nu_t \frac{N_t^{1+\varphi}}{1+\varphi} \right]$$

where

$$C_t = \Theta_\chi C_{m,t}^{\chi} C_{q,t}^{1-\chi}$$

and

$$C_{q,t} = \left(\int_0^1 C_{q,t}(i)^{\frac{\varepsilon-1}{\varepsilon}} di \right)^{\frac{\varepsilon}{\varepsilon-1}}$$

subject to period budget constraint

$$W_t N_t + R_t B_{t-1} + \Pi_t \geq P_{c,t} C_t + B_t$$

Household's optimality conditions

$$\frac{d_t}{C_t - hC_{t-1}} = \beta E_t \left[\left(\frac{R_t}{\pi_{c,t+1}} \right) \frac{d_{t+1}}{C_{t+1} - hC_t} \right]$$

$$\frac{W_t}{P_{c,t}} = \left\{ \frac{W_{t-1}}{P_{c,t-1}} \right\}^{\gamma} \left\{ \nu_t N_t^{\varphi} \left(C_t - hC_{t-1} \right) \right\}^{1-\gamma}$$

$$P_{c,t} \equiv P_{q,t} S_t^{\chi}$$

where $S_t \equiv \frac{P_{m,t}}{P_{q,t}}$ follows exogenous process

Final good firm

$$\max_{Q_t(i)} P_{q,t} Q_t - \int_0^1 P_{q,t}(i) Q_t(i) di$$

subject to

$$Q_t = \left[\int_0^1 Q_t(i)^{\frac{\varepsilon-1}{\varepsilon}} di \right]^{\frac{\varepsilon}{\varepsilon-1}}$$

Intermediate good firm

$$\max_{P^*_{q,t}(i)} E_t \sum_{j=0}^{\infty} \xi^j \beta^j \frac{\lambda_{t+j}}{\lambda_0} \left[\begin{array}{c} \frac{P^*_{q,t}(i)}{P_{q,t+j}} Q_{t+j}(i) - \\ \frac{W_{t+j}}{(1-\alpha) P_{q,t+j} A_{t+j}^{1-\alpha}} \left\{ \frac{(1-\alpha) P_{m,t+j}}{\alpha W_{t+j}} \right\}^{\alpha} Q_{t+j}(i) \end{array} \right]$$

subject to

$$Q_{t+j}(i) = \left[\frac{P^*_{q,t}(i)}{P_{q,t+j}} \right]^{-\varepsilon} Q_{t+j}$$

$$Q_t(i) = \left[A_t N_t(i) \right]^{1-\alpha} M_t(i)^{\alpha}$$

Monetary Policy

$$R_t = R_{t-1}^{\rho_R} \widetilde{R}_t^{1-\rho_R} \exp\{\sigma_R \varepsilon_{R,t}\}$$

where

$$\widetilde{R}_t = (r\pi) \left\{ \left(\frac{\pi_{c,t}}{\pi} \right)^{\omega} \left(\frac{\pi_{q,t}}{\pi} \right)^{1-\omega} \right\}^{\psi_\pi} \left\{ \frac{x_t}{x} \right\}^{\psi_x} \left\{ \frac{Y_t}{Y_{t-1}} \right\}^{\psi_{\Delta y}}$$

Sunspot solutions

- Canonical form of LRE model

$$\Gamma_0(\theta)\varrho_t = \Gamma_1(\theta)\varrho_{t-1} + \Psi(\theta)\varepsilon_t + \Pi(\theta)\eta_t$$

- Sunspot equilibria

$$\varrho_t = \Phi(\theta)\varrho_{t-1} + \Phi_\varepsilon(\theta, \widetilde{M})\varepsilon_t + \Phi_\zeta(\theta)\zeta_t$$

- Priors for $\widetilde{M}$ centered at *continuity solution* $M^*(\theta)$

$$\widetilde{M} = M^*(\theta) + M$$

where $M \sim N(0, 1)$

Continuity of impulse responses at boundary (LS 2004)

$\forall \theta \in \Theta^I$, construct vector $\tilde{\theta} = g(\theta)$ that lies on the boundary

$M^*(\theta) = \arg\min$ discrepancy between $\frac{\partial Y_t}{\partial \epsilon_t'}(\theta, M^*(\theta))$ and $\frac{\partial Y_t}{\partial \epsilon_t'}(\tilde{\theta}, .)$

Bayesian estimation with Sequential Monte Carlo

- Sequence of tempered posteriors

$$\pi_n(\theta_S) = \frac{[p(X_T|\theta_S, S)]^{\phi_n} p(\theta_S|S)}{\int_{\theta_S} [p(X_T|\theta_S, S)]^{\phi_n} p(\theta_S|S) d\theta_S}$$

- Generate weighted draws from the sequence of posteriors

$$\{\pi_n(\theta)\}_{n=1}^{N_\phi} \Rightarrow \left\{\theta_n^i, W_n^i\right\}_{i=1}^{N}$$

- $N = 10000$ and $N_\phi = 200$

Calibrated Parameters

β	0.99
ε	11
φ	1
α	0.015 / 0.012
χ	0.023 / 0.017
ρ_s	0.995

Priors

Parameter	Range	Density	Prior Mean	St. Dev
ψ_π		Gamma	1.10	0.50
ψ_x		Gamma	0.125	0.10
$\psi_{\Delta y}$		Gamma	0.125	0.10
ρ_R		Beta	0.50	0.20
ω		Beta	0.50	0.20
π		Normal	1.0	0.50
R		Gamma	1.50	0.25
g		Normal	0.50	0.10
ξ		Beta	0.50	0.05
γ		Beta	0.50	0.20
h		Beta	0.50	0.10

Prior probabililty of determinacy is 0.50.

Priors (cont'd)

Name	Range	Density	Prior Mean	St. Dev
ρ_d	[0,1)	Beta	0.70	0.10
ρ_ν	[0,1)	Beta	0.70	0.10
σ_s	$\mathbb{R}^+$	Inv-Gamma	5.00	2.00
σ_g	$\mathbb{R}^+$	Inv-Gamma	0.50	0.20
σ_r	$\mathbb{R}^+$	Inv-Gamma	0.50	0.20
σ_d	$\mathbb{R}$	Inv-Gamma	0.50	0.20
σ_ν	$\mathbb{R}^+$	Inv-Gamma	0.50	0.20
σ_ζ	$\mathbb{R}^+$	Inv-Gamma	0.50	0.20
$M_{s,\zeta}$	$\mathbb{R}$	Normal	0.00	1.00
$M_{g,\zeta}$	$\mathbb{R}$	Normal	0.00	1.00
$M_{r,\zeta}$	$\mathbb{R}$	Normal	0.00	1.00
$M_{d,\zeta}$	$\mathbb{R}$	Normal	0.00	1.00
$M_{\nu,\zeta}$	$\mathbb{R}$	Normal	0.00	1.00

Data

Sample period: [1966:I - 1979:II] , [1984:I - 2008:II]

Observables: Δy_t, R_t, $\pi_{c,t}$, $\pi_{q,t}$, Δw_t

- Real GDP per capita (quarterly growth rate)
- Fed Funds rate
- CPI (quarterly growth rate)
- Core CPI (quarterly growth rate)
- Nominal Hourly Compensation in NFB sector, deflated with CPI (quarterly growth rate)

Indeterminacy test

	Log-data density		Probability	
Period	Det.	Indet.	Det.	Indet.
1966:I - 1979:II	-228.89	-241.06	1	0
1984:I - 2008:II	-230.03	-251.05	1	0

Robustness check #1

Observables: Δy_t, R_t, $\pi_{q,t}$, Δw_t, s_t

s_t : Spot Oil Price (West Texas Intermediate) deflated by core CPI

	Log-data density		Probability	
Period	Det.	Indet.	Det.	Indet.
1966:I - 1979:II	-451.89	-458.30	1	0
1984:I - 2008:II	-571.05	-608.87	1	0

Robustness check #2

Observables: Δy_t, R_t, $\pi_{c,t}$, $\pi_{q,t}$, Δw_t^1, Δw_t^2

w_t^1 : Nominal hourly compensation in NFB sector (NIPA), deflated by CPI

w_t^2 : Average hourly earnings of production and non-supervisory employees (BLS), deflated by CPI

	Log-data density		Probability	
Period	Det.	Indet.	Det.	Indet.
1966:I - 1979:II	-279.02	-292.54	1	0
1966:I - 1981:II	-353.18	-370.54	1	0
1984:I - 2008:II	-275.20	-311.88	1	0

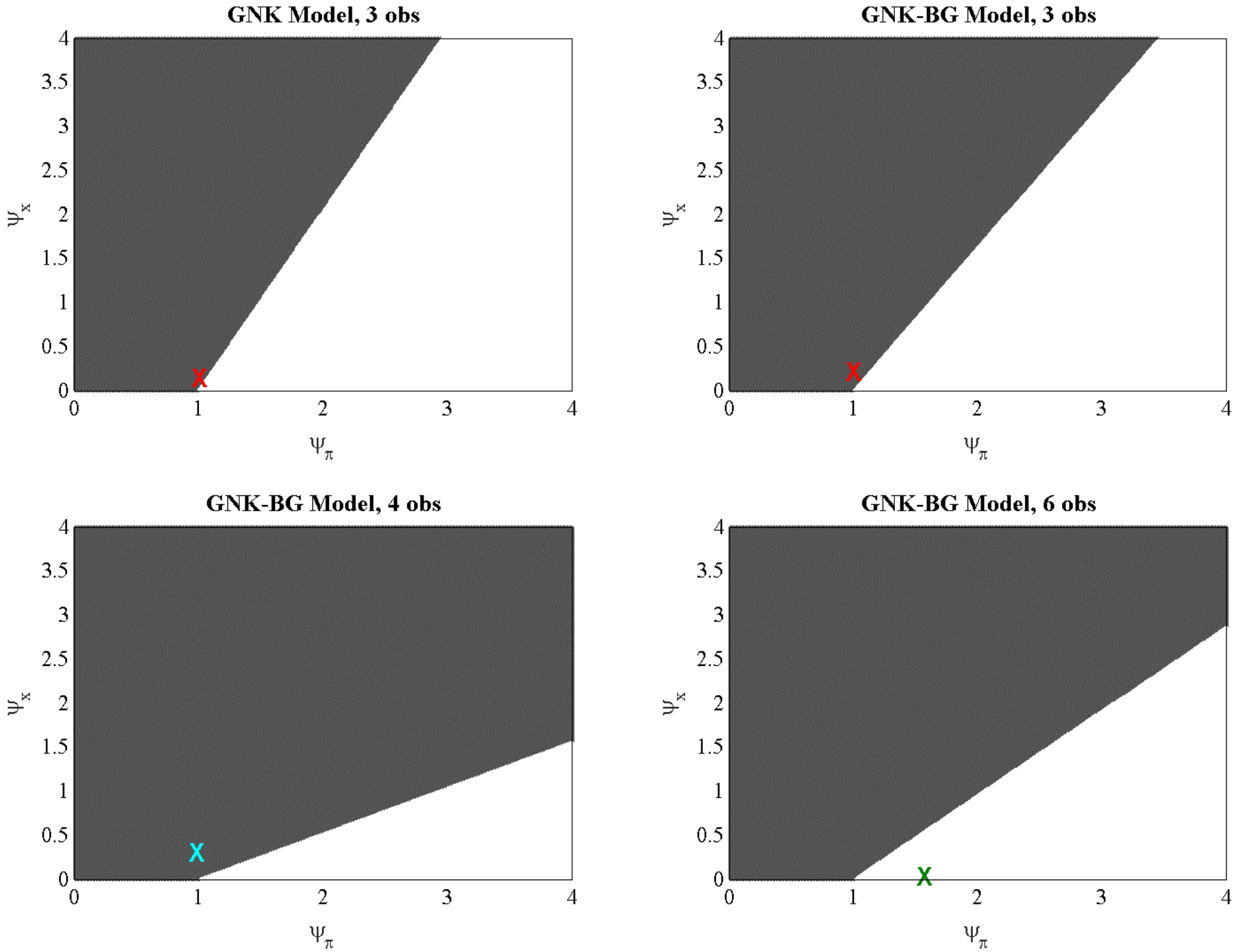
Understanding the 1970's determinacy outcome

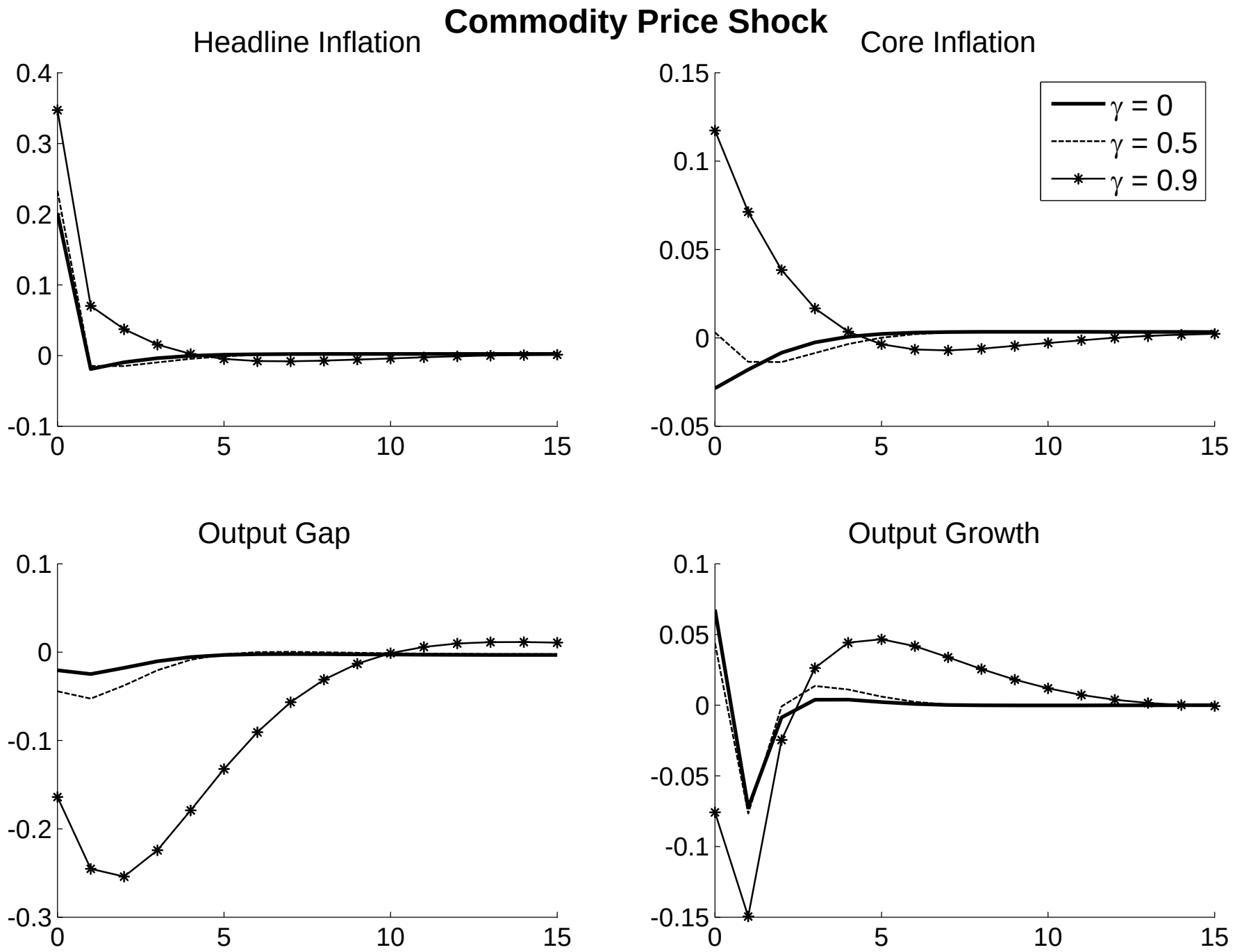
Determinacy vs Indeterminacy 1966:I - 1979:II

	Log density		Probability	
	Det.	Indet.	Det.	Indet.
NK$(\Delta y_t, R_t, \pi_{c,t})$ $[\alpha, \chi, \gamma = 0, \omega = 1]$	-121.1	-118.8	0.09	0.91
BG$(\Delta y_t, R_t, \pi_{c,t})$ $[\omega = 1]$	-123.0	-118.3	0.01	0.99
BG$(\Delta y_t, R_t, \pi_{c,t}, \pi_{q,t})$	-157.9	-157.6	0.41	0.59
BG$(\Delta y_t, R_t, \pi_{c,t}, \pi_{q,t}, \Delta w_t^1)$	-228.9	-241.1	1	0
BG$(\Delta y_t, R_t, \pi_{c,t}, \pi_{q,t}, \Delta w_t^1, \Delta w_t^2)$	-279.0	-292.5	1	0

Parameter Estimates 1966:I - 1979:II

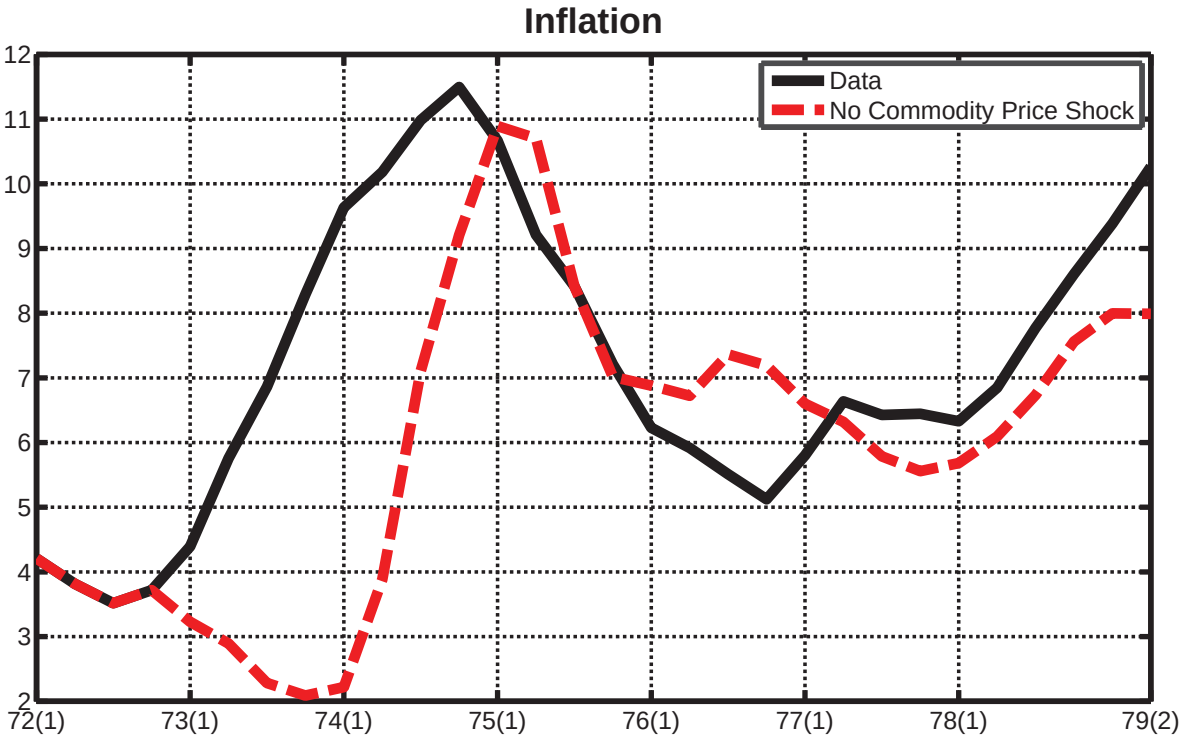
	NK (Indet) 3 obs	BG (Indet) 3 obs	BG (Indet) 4 obs	BG (Det) 5 obs	BG (Det) 6 obs
ψ_π	0.94 (0.11)	0.94 (0.11)	0.92 (0.12)	1.55 (0.19)	1.51 (0.17)
ψ_x	0.14 (0.11)	0.21 (0.14)	0.30 (0.11)	0.03 (0.02)	0.03 (0.03)
$\psi_{\Delta y}$	0.11 (0.07)	0.12 (0.07)	0.10 (0.05)	0.46 (0.16)	0.35 (0.14)
ρ_R	0.44 (0.08)	0.48 (0.08)	0.60 (0.10)	0.71 (0.05)	0.69 (0.05)
ω	1	1	0.35 (0.24)	0.57 (0.16)	0.58 (0.15)
π^*	1.42 (0.18)	1.34 (0.21)	1.37 (0.13)	1.36 (0.16)	1.36 (0.17)
ξ	0.50 (0.05)	0.54 (0.05)	0.66 (0.06)	0.62 (0.04)	0.60 (0.04)
γ	0	0.33 (0.17)	0.64 (0.25)	0.90 (0.03)	0.89 (0.04)
h	0.40 (0.07)	0.37 (0.07)	0.37 (0.05)	0.39 (0.07)	0.38 (0.07)
σ_s	–	5.34 (2.23)	17.30 (1.38)	17.30 (1.62)	17.24 (1.62)

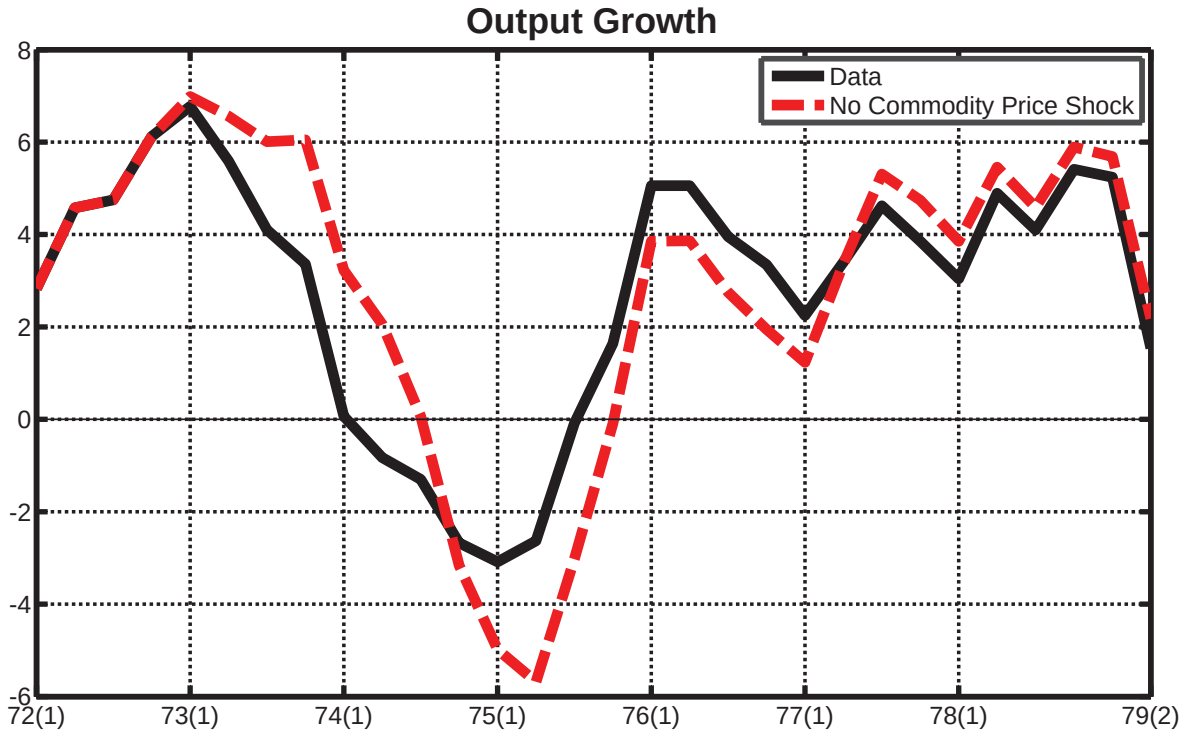

GNK Model, 3 obs
GNK-BG Model, 3 obs
GNK-BG Model, 4 obs
GNK-BG Model, 6 obs
ψ_x
ψ_π
0
0.5
1
1.5
2
2.5
3
3.5
4
Indeterminacy region

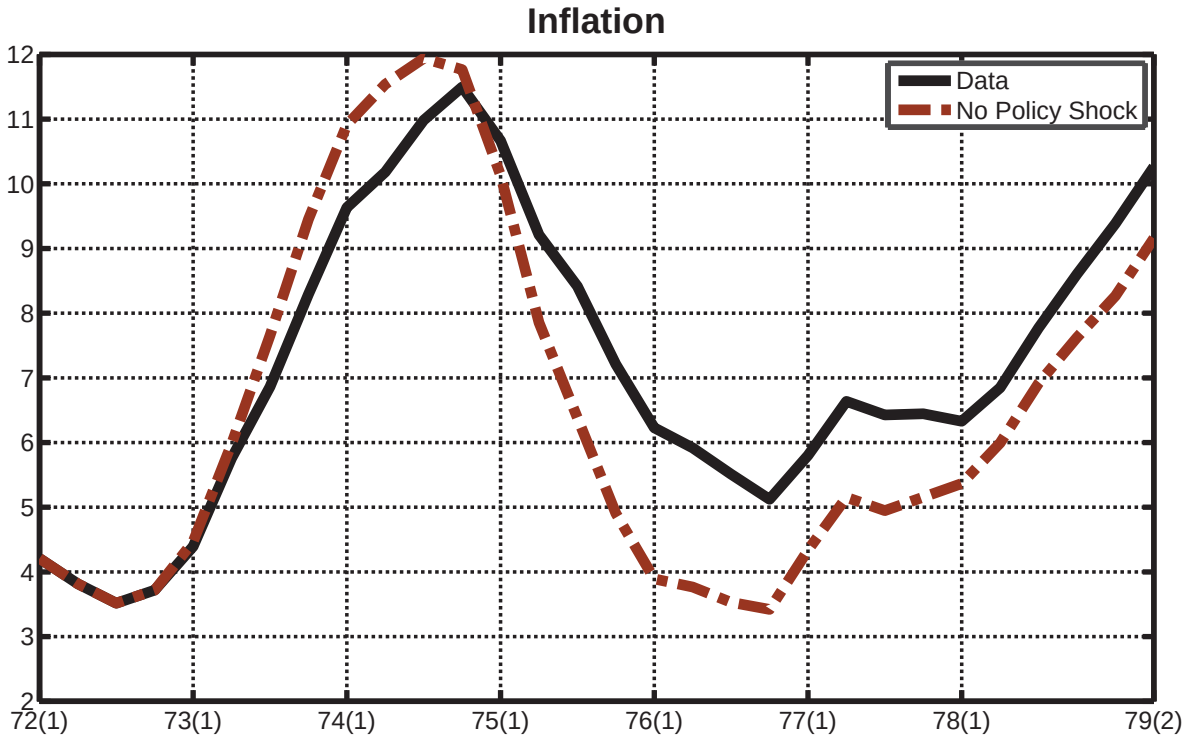

Commodity Price Shock
Headline Inflation
Core Inflation
Output Gap
Output Growth
γ = 0
γ = 0.5
γ = 0.9
0.4
0.3
0.2
0.1
0
-0.1
0.15
0.05
-0.05
-0.2
-0.3
-0.15
0
5
10
15

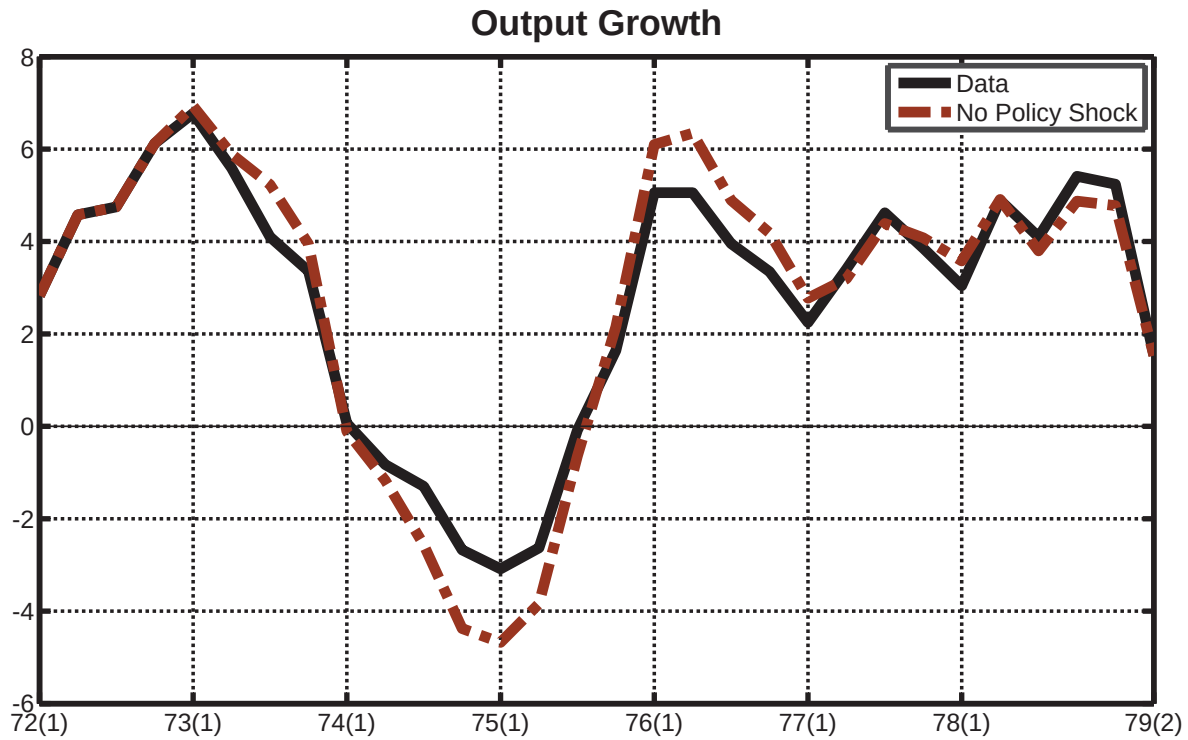
Monetary policy *active* in 70's. No indeterminacy!

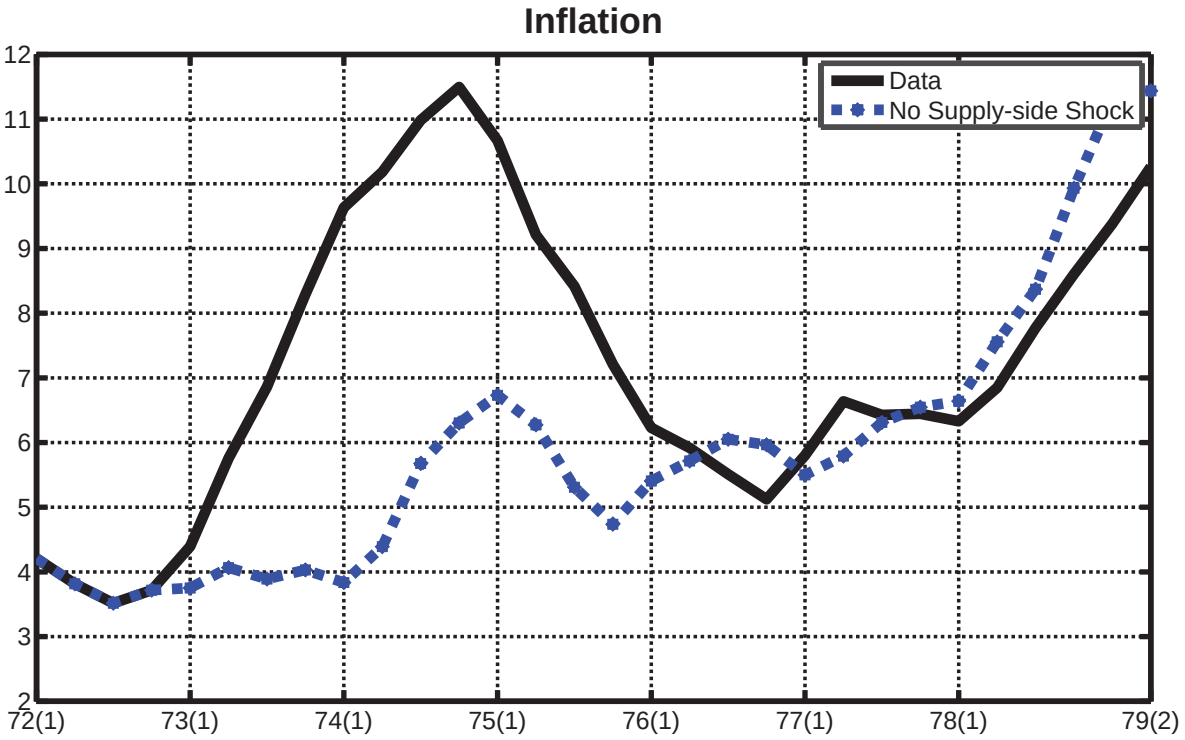
What caused the Great Stagflation?

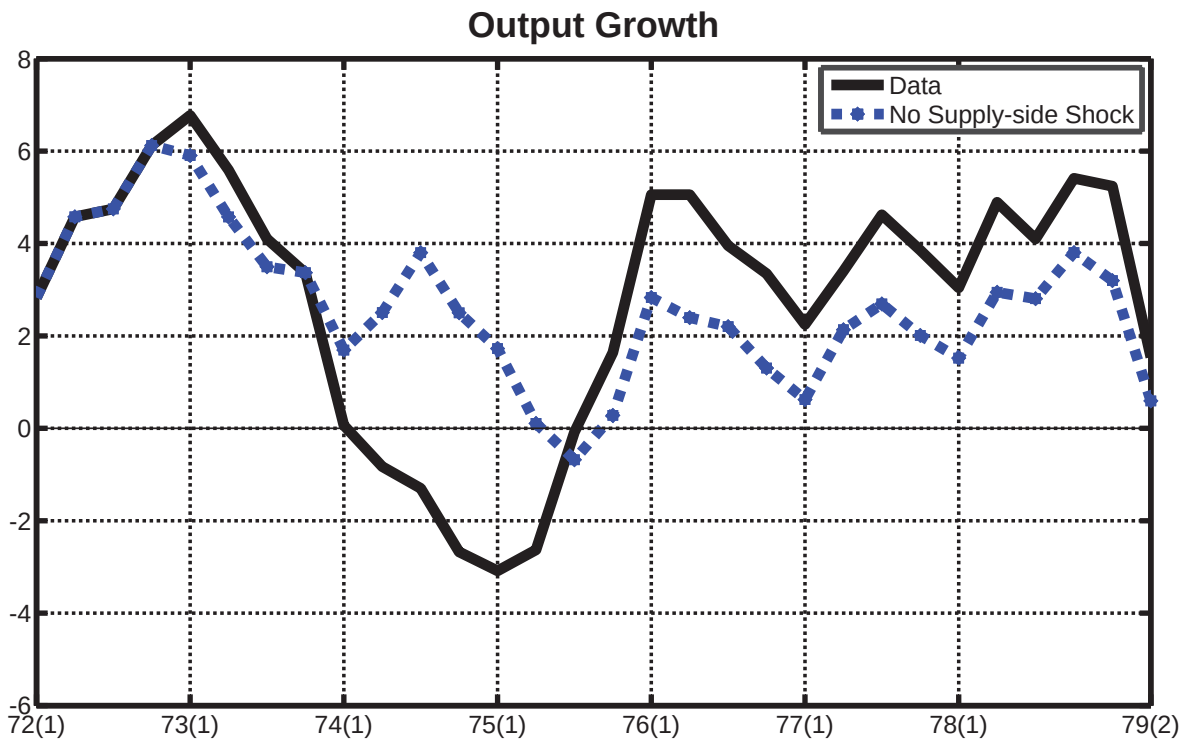

Inflation
Data
No Commodity Price Shock
12
11
10
9
8
7
6
5
4
3
2
72(1)
73(1)
74(1)
75(1)
76(1)
77(1)
78(1)
79(2)

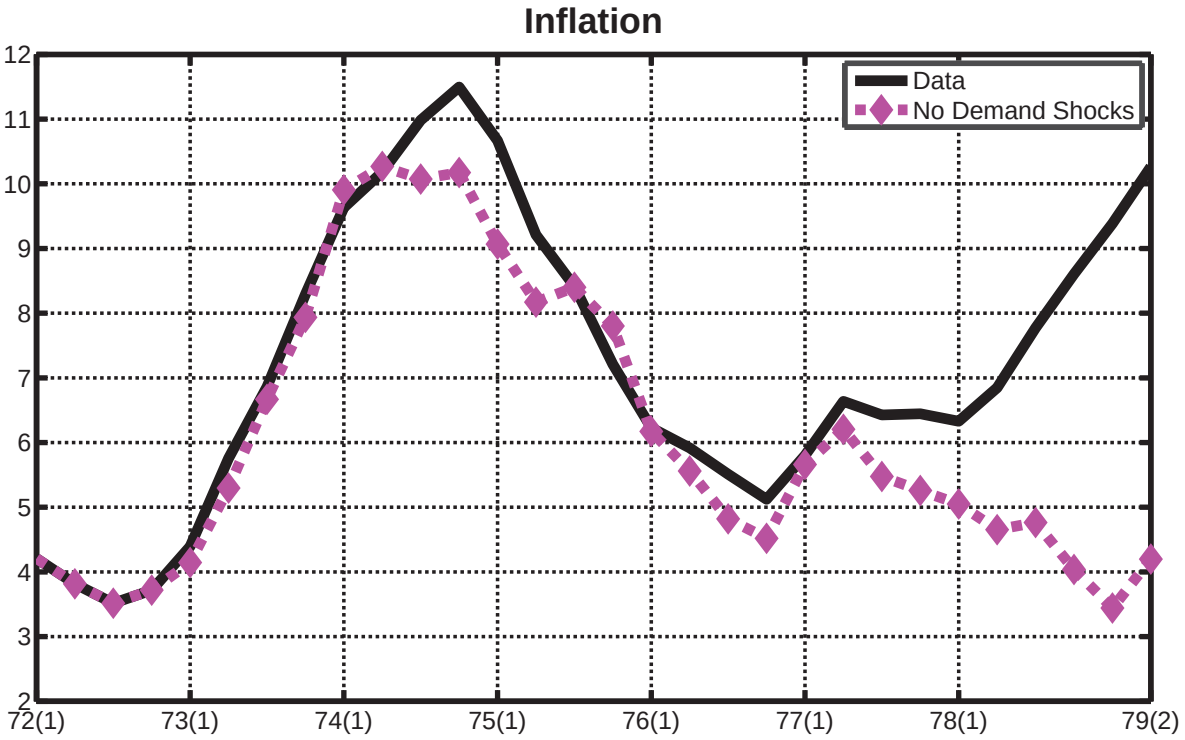

Output Growth
Data
No Commodity Price Shock
8
6
4
2
0
-2
-4
-6
72(1)
73(1)
74(1)
75(1)
76(1)
77(1)
78(1)
79(2)

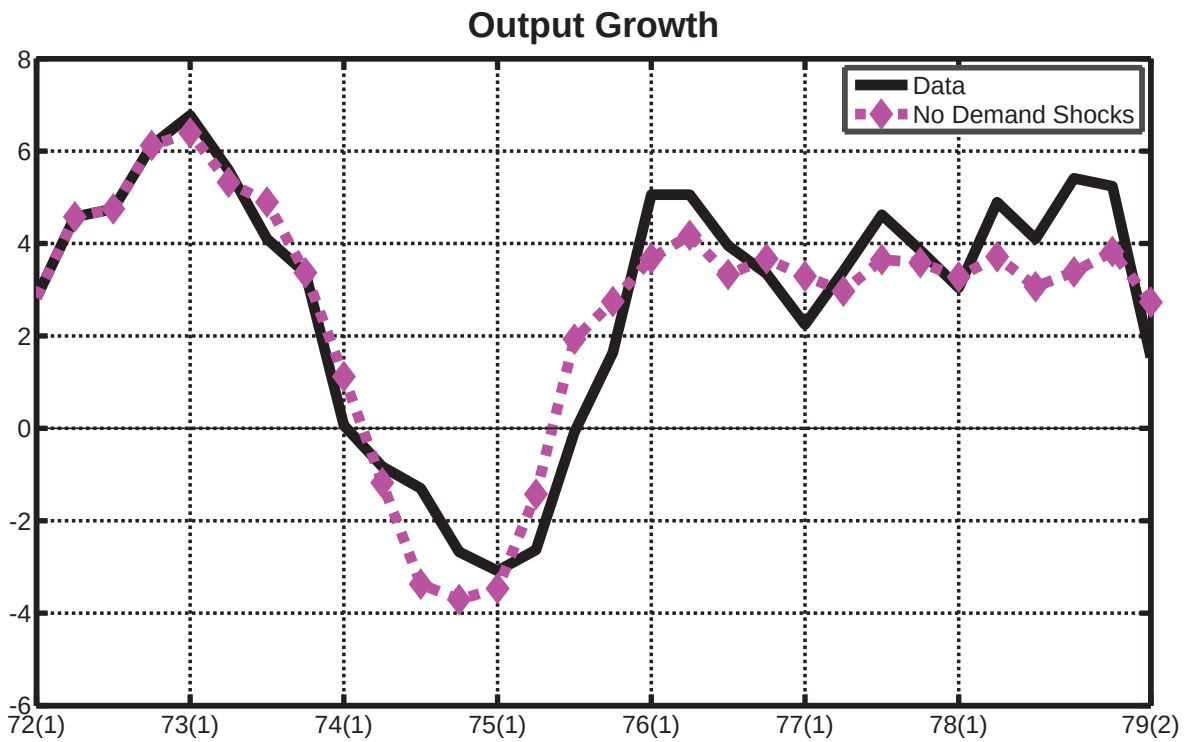

Inflation
Data
No Policy Shock
12
11
10
9
8
7
6
5
4
3
2
72(1)
73(1)
74(1)
75(1)
76(1)
77(1)
78(1)
79(2)


Output Growth
Data
No Policy Shock
8
6
4
2
0
-2
-4
-6
72(1)
73(1)
74(1)
75(1)
76(1)
77(1)
78(1)
79(2)


Inflation
Data
No Supply-side Shock
12
11
10
9
8
7
6
5
4
3
2
72(1)
73(1)
74(1)
75(1)
76(1)
77(1)
78(1)
79(2)


Output Growth
Data
No Supply-side Shock
8
6
4
2
0
-2
-4
-6
72(1)
73(1)
74(1)
75(1)
76(1)
77(1)
78(1)
79(2)


Inflation
Data
No Demand Shocks
12
11
10
9
8
7
6
5
4
3
2
72(1)
73(1)
74(1)
75(1)
76(1)
77(1)
78(1)
79(2)


Output Growth
Data
No Demand Shocks
8
6
4
2
0
-2
-4
-6
72(1)
73(1)
74(1)
75(1)
76(1)
77(1)
78(1)
79(2)

What caused the Great Stagflation?

1973-75 episode driven by supply-side shocks

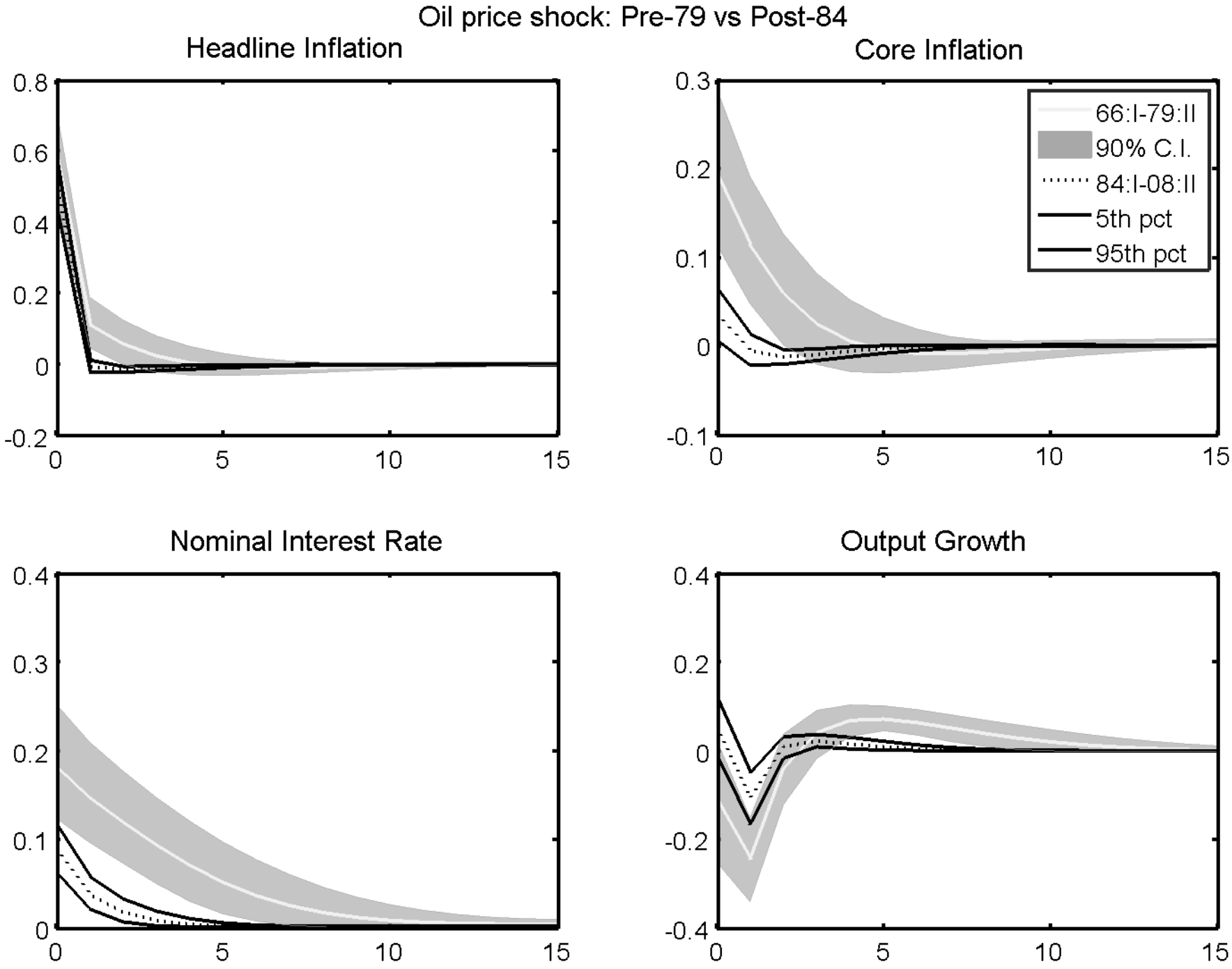
Second inflation peak fueled by demand shocks

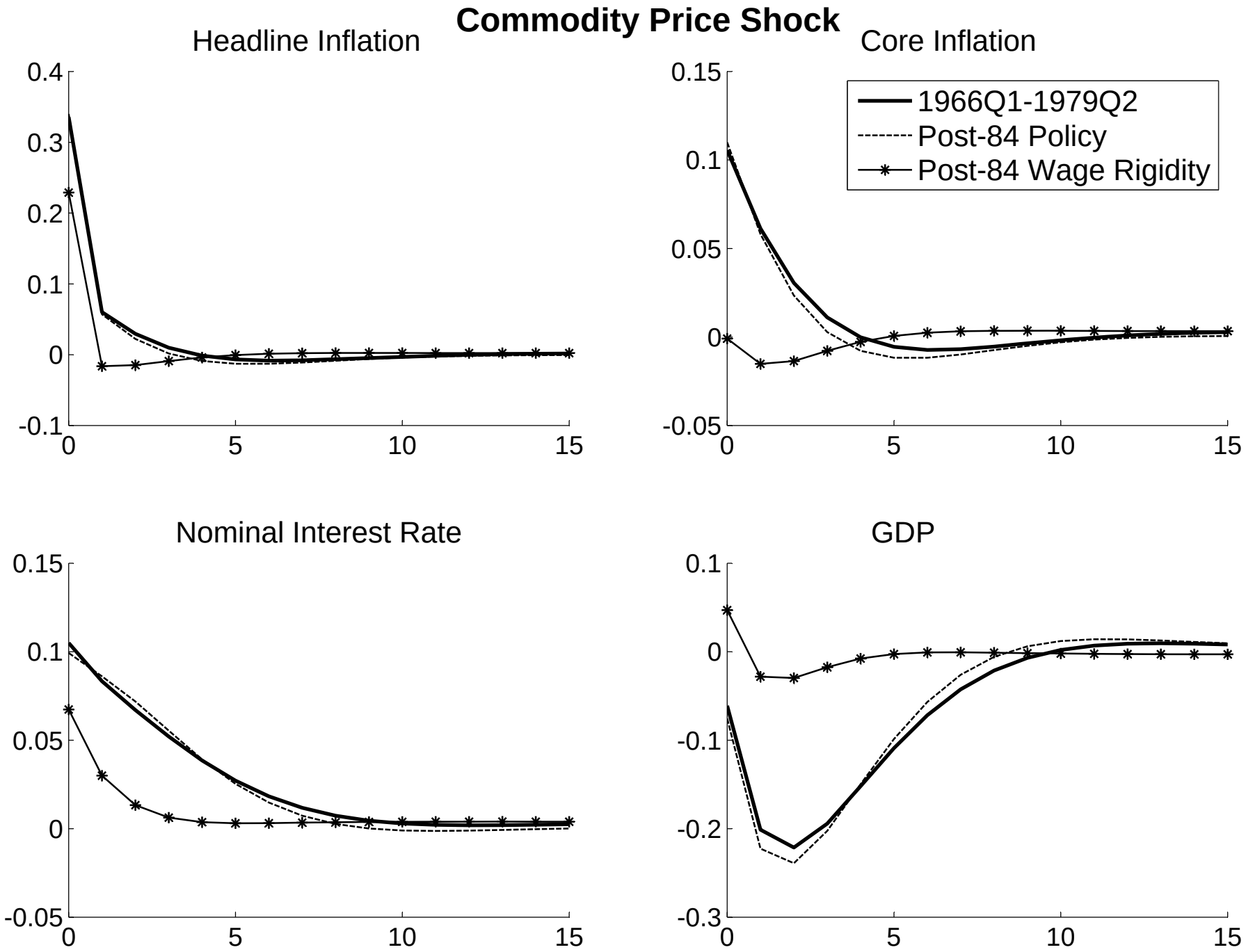
Post-1984 period: What changed?

Why no stagflation during 2000's oil shocks?

Parameter Estimates (6 obs)

	1966:I - 1979:II	1984:I - 2008:II
ψ_π	1.51 (0.17)	3.08 (0.36)
ψ_x	0.03 (0.03)	0.11 (0.06)
$\psi_{\Delta y}$	0.35 (0.14)	0.69 (0.15)
ρ_R	0.69 (0.05)	0.73 (0.04)
ω	0.58 (0.15)	0.14 (0.05)
π^*	1.36 (0.17)	0.95 (0.09)
ξ	0.60 (0.04)	0.62 (0.04)
γ	0.89 (0.04)	0.46 (0.12)
h	0.38 (0.07)	0.24 (0.05)
σ_s	17.24 (1.62)	20.41 (1.50)
λ	1.07 (0.24)	0.29 (0.08)


Oil price shock: Pre-79 vs Post-84
Headline Inflation
Core Inflation
Nominal Interest Rate
Output Growth
66:I-79:II
90% C.I.
84:I-08:II
5th pct
95th pct
0.8
0.6
0.4
0.2
0
-0.2
0.3
0.2
0.1
0
-0.1
0.4
0.3
0.2
0.1
0
-0.2
-0.4
0
5
10
15


Commodity Price Shock
Headline Inflation
Core Inflation
Nominal Interest Rate
GDP
1966Q1-1979Q2
Post-84 Policy
Post-84 Wage Rigidity
0.4
0.3
0.2
0.1
0
-0.1
0.15
0.05
-0.05
-0.2
-0.3
0
5
10
15

Conclusions

Monetary policy did not create indeterminacy in 1970's

Trade-off caused by oil price shocks has become less severe

Key changes since volative 1970's:

1. Increased real wage flexibility
    - dampens pass-through of oil price shocks to core inflation
2. Central bank focuses more on core inflation
    - attenuates effects of oil price shocks on real activity