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Inflation Premium and Oil Price Uncertainty

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1 Motivation : Can oil price shocks explain high average inflation levels?

For instance the 70s in the US:

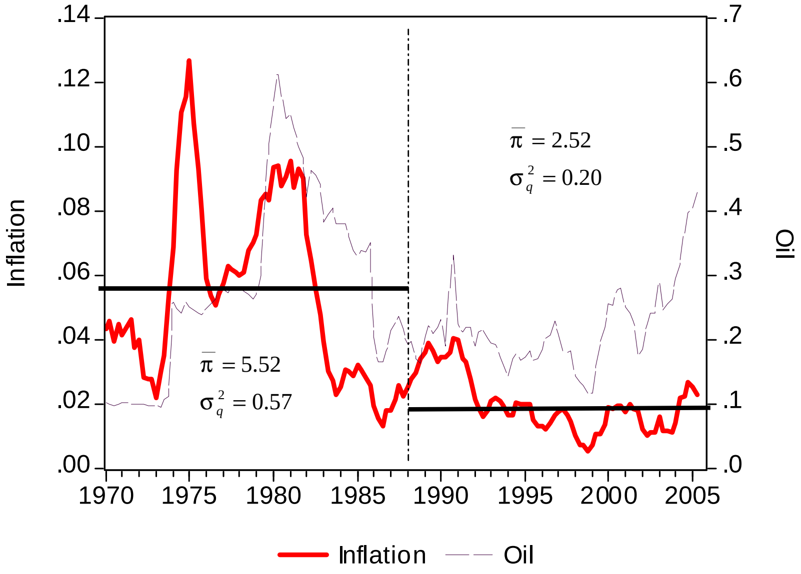


Figure 1: US inflation and Oil Prices.

2 Explanations in the literature:

- Poor monetary policy during the 70s: Clarida, Galí and Gertler(2002),Cogley and Sargent (2002) and Lubick and Shorfhedie (2005)

- Change volatility of business cycle driven forces: Sims and Zha (2005). Weak evidence of change in monetary policy response

3 What do we do?

- Add oil price shocks to a standard DSGE model with sticky prices
- Solve it, analytically, up to second using the Perturbation method
- Use this solution to show the determinants of the link between inflation and oil price volatility
- Evaluate the implications of this link for monetary policy.

4 We find

- Oil prices generate an endogenous trade off between stabilizing inflation and output gap.
- Given this trade off, oil price volatility generate an inflation premium that, with a sensible parametrization, matches US data.
- Analytical solution shows that this inflation premium increases when:
  - The elasticity of substitution between oil and labor is smaller
  - reaction of the Central bank to output is larger
  - The Phillips curve is more convex

5 The model

- Standard New Keynesian Model with sticky prices a la Calvo.

- Only difference oil and labor are poor substitutes,

$$Y_t = \left[(1-\alpha)\left(L_t\right)^{\frac{\psi-1}{\psi}} + \alpha\left(M_t\right)^{\frac{\psi-1}{\psi}} \right]^{\frac{\psi}{\psi-1}}$$

then, marginal costs become:

$$MC_t = \left[(1-\alpha)^{\psi}\left(\frac{W_t}{P_t}\right)^{1-\psi} + \alpha^{\psi}\left(Q_t\right)^{1-\psi} \right]^{\frac{1}{1-\psi}}$$

6 Linear version of the model

$$\pi_t = \beta E_t \pi_{t+1} + \lambda mc_t$$

$$y_t = E_t y_{t+1} - \frac{1}{\sigma}\left(i_t - E_t \pi_{t+1}\right)$$

$$mc_t = \chi\left(\nu + \sigma\right) y_t + \left(1 - \chi\right) q_t$$

$$\overline{\alpha} = \alpha^{\psi}\left(\frac{\overline{Q}}{\overline{MC}}\right)^{1-\psi}, \chi = \frac{1-\overline{\alpha}}{1+\upsilon\psi\overline{\alpha}}$$

Similar to a standard New-Keynesian model.

7 What does second order add ?

- Interaction of non linearities with uncertainty.

$$\begin{aligned} \pi_t &= \kappa_y y_t + \kappa_q q_t + \beta E_t \pi_{t+1} + \frac{1}{2}\omega_v \sigma_q^2 + \frac{1}{2}\left(\Omega_\pi + \Omega_{mc}\right) q_t^2 + O\left(\|q_t, \sigma_q\|^3\right) \\ y_t &= E_t\left(y_{t+1}\right) - \frac{1}{\sigma}\Big(\left(\phi_\pi - 1\right) E_t \pi_{t+1} + \phi_y y_t\Big) + \frac{1}{2}\omega_y \sigma_q^2 + O\left(\|q_t, \sigma_q\|^3\right) \end{aligned}$$

- In particular, convexity of marginal costs respect to oil prices.

8 Sources of non linearities: Preferences and production function

- Ω_{mc} captures the **nonlinearity of the marginal cost respect to oil prices** that depends crucially on the elasticity of substitution ψ. When $\psi < 1$ ($\psi > 1$), $\Omega_{mc} > 0$ ($\Omega_{mc} < 0$)

- Ω_{π} captures the convexity of the Phillips curve.$\Omega_{\pi} > 0 \longrightarrow$ convex Phillips curve

- $\omega_y < 0$ accounts for precautionary savings effect.

9 Intuition in partial equilibrium:

Optimal firm´s relative price, when prices are set one period in advance:

$$\frac{P_t^*(z)}{P_{t-1}} = \mu E_{t-1}\left[\Psi_t MC_t\right]$$

where $\Psi_t = \frac{\Pi_t^{\varepsilon+1}}{E_{t-1}\Pi_t^{\varepsilon}}$ is a measure of the responsiveness of the optimal price to future marginal costs, with a second order taylor expansion (in expected value):

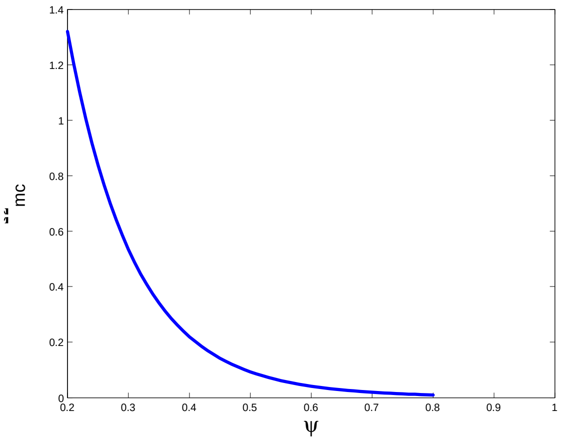
$$E_{t-1}\left[\Psi_t\right] = E_{t-1}\left[\pi_t + \frac{1}{2}\left(2\varepsilon+1\right)\pi_t^2\right]$$

Also:

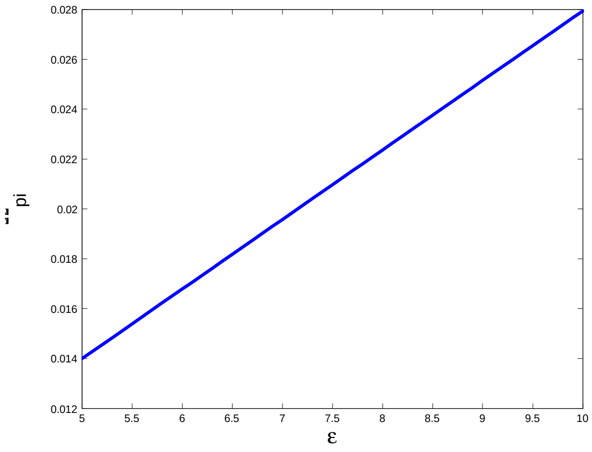
$$MC_t = \phi_1 q_t + \frac{\phi_2}{2} q_t^2$$

10 Comparative Statics (1) - components

- Risk Premium is higher: lower ψ and higher ε



Ω_{mc} and ψ (inputs elasticity of substitution)



Ω_{π} and ε (goods elasticity of substitution)

11 Rational expectations solution

- The previous two equations represent a second order system of difference equations: how do we solve? **Perturbation Method**

- Solution can be represented as follows:

$$\pi_t = \frac{1}{2} b_o \sigma_q^2 + b_1 q_t + \frac{1}{2} b_2 q_t^2$$

- The inflation premium is defined as:$IP_t = \frac{1}{2}\left(b_o \sigma_q^2 + b_2 q_t^2\right)$, thus,

$$E\pi = \frac{1}{2}\left(b_o + b_2\right)\sigma_q^2$$

12 Is it the case that $E(\pi) > 0$?

$$E(\pi) = \frac{1}{2}\frac{1}{\Lambda_0}\left[\phi_y(\Omega_{mc} + \Omega_\pi)(1 + \Theta) + \phi_y\omega_v + \sigma\kappa_y\omega_y\right]\sigma_q^2$$

for Λ_0 and $\Theta > 0$

Answer: **yes**, as long as $\phi_y > 0$

13 Endogenous trade-off

With $\psi < 1$

$$|y_t^*| < |y_t^n|$$

Also: Montoro (2006) microfounded welfare function for a New Keynesian model with oil.

- Thus, when $\psi < 1$ endogenous trade-off appears

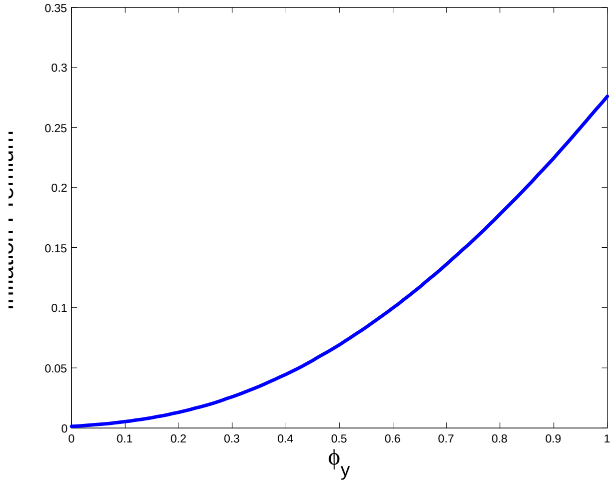
$$\begin{aligned} x_t &= E_t x_{t+1} - \frac{1}{\sigma}\left(i_t - E_t \pi_{t+1} - r_t^E\right) \\ \pi_t &= \beta E_t \pi_{t+1} + \kappa_y x_t + u_t \end{aligned} \tag{1}$$

  where $u_t \equiv \omega q_t$

- Only when $\psi = 1$, $u_t = 0$

14 Comparative Statics (2) - monetary policy

- Risk Premium is positive for $\phi_y > 0$



The inflation premium and the output parameter (ϕ_y) in the Policy rule

15 Can inflation premium explain the high average US inflation in the 70s?.

- We calibrate the model using standard parameters in the literature + Oil structure.

Baseline Calibration

$\alpha = 0.01$	$\psi = 0.6$
$\rho_1 = 0.95$	$\sigma_{\epsilon,1} = 0.14$
$\rho_2 = 0.82$	$\sigma_{\epsilon,1} = 0.12$

16 Yes, the calibrated model generates a inflation premium of around 5 percent for the Pre-and Vocker Period.

Unconditional Moments Generated by the Benchmark Model (CGG)

	Pre-Volcker		Post-Volcker	
	Simulated	Observed	Simulated	Observed
Mean Inflation	1.09	1.38	0.19	0.53
Mean Output Gap (HP)	-1.35	-0.20	-0.23	0.26
Standard Deviation Real Oil Price	0.46	0.57	0.22	0.21

Al variables are quarterly

17 Which effects are present?

Inflation Premium - Effects Decomposition

	CGG	
	Pre-Volcker	Post-Volcker
Convexity Phillips curve (Ω_π)	58.9	55.4
Marginal costs (Ω_{mc})	45.2	48.2
Indirect effect: price dispersion	27.4	24.8
Direct effect: convexity respect to oil prices	17.9	23.4
Precautionary Savings (ω_y)	-0.3	-0.6
Total	100.0	100.0

18 Robustness: Alternative Policy Rules

Alternative Policy Rules

	CGG		Orphanides		Judd-Rudebush	
	Pre-Volcker	Post-Volcker	Pre-Volcker	Post-Volcker	Pre-Volcker	Post-Volcker
Eπ	1.09	0.19	0.19	0.05	6.38	0.64
Ey	-1.35	-0.23	-0.57	-0.15	-3.49	-0.35
σ_q	0.46	0.22	0.46	0.22	0.46	0.22

19 What does this show?

- When marginal cost are convex in oil prices, there exist a trade off between stabilizing inflation and output gap that generates an inflation premium, which is increasing in oil prices volatility.

- Support to the finding of Sims Zha: second order moments of shocks matter for inflation determination.

20 Conclusions

- Volatility of oil price is an important determinant of inflation, how important?, depends on degree of substitution between oil and labor.

- Passive monetary policy is not necessary condition to explain high average levels of inflation in the US during 70s, active monetary policy in an economy where oil has a low elasticity of substitution, can explain this fact.

- After all it seems it was bad luck.