Prima sobre la Inflación y la Volatilidad del Precio del Petróleo

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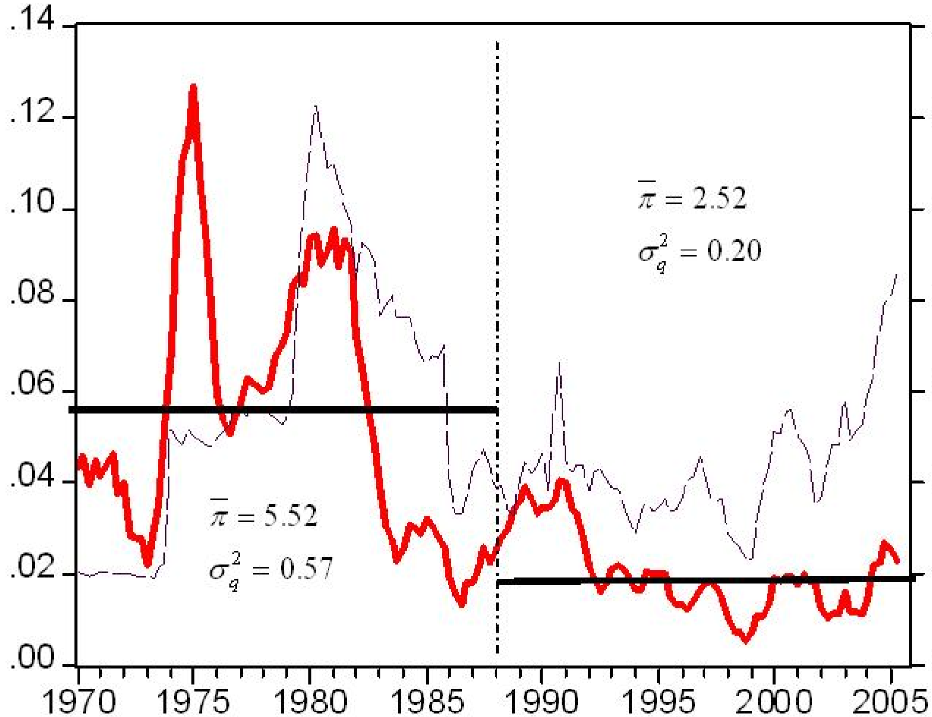
Motivation : Can oil price shocks explain high average inflation levels? For instance the 70s in the US



Two alternative explanations

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

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

- Hamilton (1983):Oil shocks are a central driven force of business cycles.

High order moments might be important

- Sims and Zha emphasize the previous literature not allowing for heteroskedasticity in their estimations might have biased their results towards finding significant shifts in the monetary policy rule coefficients

- Clarida, Gertler and Gali: Oil shocks can induce persistent inflation only under an accommodating monetary policy (passive Taylor Rule), but they use a log-linear model where volatility is irrelevant

Our contribution

- We explain the role of oil price shocks in generating a inflation risk premium in a standard new keynesian model whose solution takes into account second moments

- We find the determinants of the inflation risk premium in general equilibrium using a particular strategy in the application of the Perturbation method that allows us to obtain analytical solutions

- We shock how the central bank should respond to oil price shocks

What do we do?

- Add oil price shocks to a standard sticky price model

- Oil is modeled as a non produced input into a CES production function.

- Obtain a second order solution using the Perturbation method

- Check implications of second order solution and oil shocks for inflation dynamics and monetary policy.

The model

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

- Linear version of the model looks identical to standard model

$$\pi_t = \beta E_t \left(\pi_{t+1}\right) + \lambda mc_t$$

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

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

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

What is the difference?

- **Second order approach** allows interaction of non linearities with uncertainty.

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

- Without **non linearities**, linear and quadratic solutions are the same.

Sources of non linearities: Preferences and production function

- The auxiliary parameters $\{\omega_\pi, \omega_y, \Omega_\pi, \Omega_{mc}\}$ are the main sources of the risk premium

- Ω_{mc} captures the nonlinearity of the production function 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.$\Omega_\pi > 0 \rightarrow$ convex Phillips curve

- $\omega_\pi > 0$:captures the direct effect of uncertainty on future expected inflation ($\omega_\pi > 0$).

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

- In general equilibrium all these effects interact, the Second Order Rational Expectations Solutions tell us how those effects interact.

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 risk Premium is defined as: $RP = \frac{1}{2}(b_o + b_2)\sigma_q^2$

Is it the case that $E\pi_t > 0$?

- The algebraic solution of the model answer this question:

$$E(\pi) = \frac{1}{2}\left(\frac{\varphi_y(b_2+\omega_\pi)+\sigma\kappa_1\left(a_2+\omega_y\right)}{\Delta_0}\right)\sigma_q^2$$

$$b_2 = \left[\sigma\left(1-\rho^2\right)+\varphi_y\right]\frac{\kappa(\Omega_\pi+\Omega_{mc})}{\Delta_2}$$

- In order to generate a positive risk premium, the necessary and sufficient condition is:

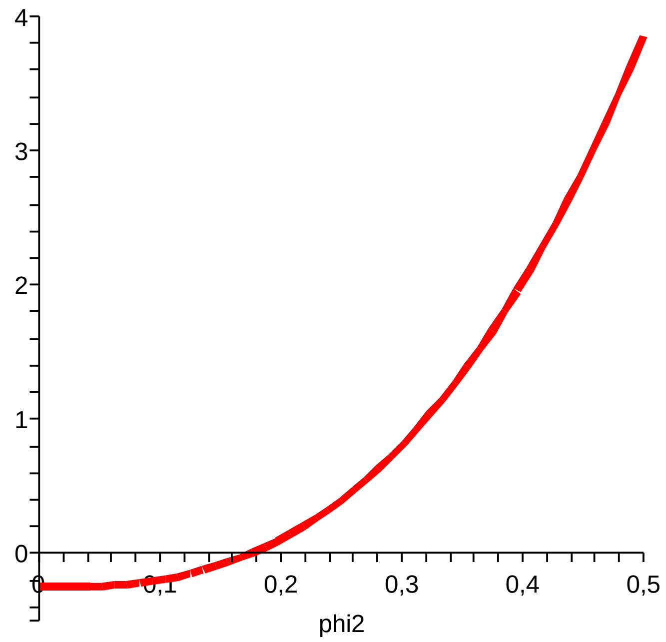
$$\varphi_y(b_2+\omega_\pi) > -\sigma\kappa_1\left(a_2+\omega_y\right)$$

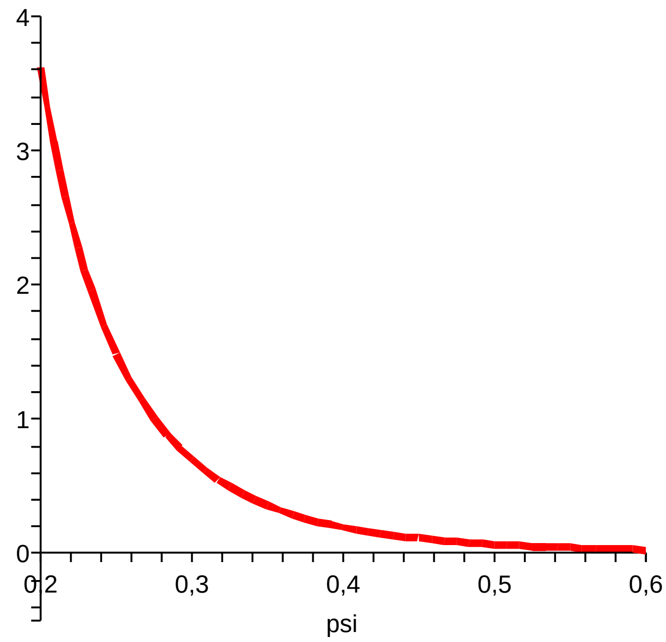
What are the determinants of Risk Premium?

- Risk premium is positive if:
  - Monetary policy reacts partially to supply shocks (monetary policy determines how volatility is distributed between inflation and output risk premium.$\varphi_y > 0$
  - Convex Phillips curve (makes inflation to depend on output volatility) $\Omega_\pi > 0$
  - Convex marginal costs $\Omega_{mc} > 0$

Comparative Statics

- Risk Premium is higher, higher φ_y, and lower ψ





High Risk Premium can explain the high average US inflation of the 70s

- We calibrate the model using standard parameters in the literature.

Table 4: Baseline Calibration

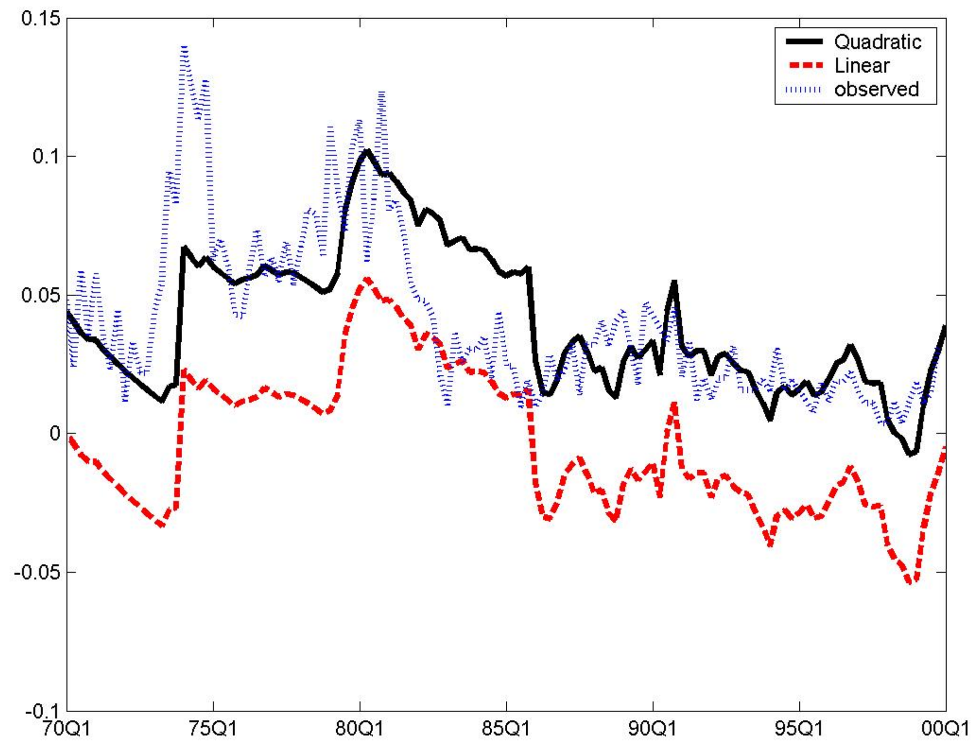
$\beta = 0.99$	$\alpha = 0.028$	$\nu = 3$
$\theta = 0.65$	$\sigma_{\epsilon,1} = 0.14$	$\phi_\pi = 1.5$
$\varepsilon = 7.66$	$\sigma_{\epsilon,2} = 0.12$	$\phi_y = 0.5$
$\mu = 1.15$	$\rho_1 = 0.95$	$\psi = 0.59$
$\sigma = 2$	$\rho_2 = 0.82$	

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

Table 2: Moments Generated by the Benchmark Model

	Pre and Volcker		Post Volcker	
	Simulated	Observed	Simulated	Observed
$\overline{\pi}$	**1.29**	**1.38**	**0.26**	**0.53**
$\overline{y}$	−1.30	−0.36	−0.27	−0.22
$\overline{R}$	1.28	1.91	0.26	1.34
σ_q	0.57	0.57	0.20	0.20

Counterfactual exercise: Oil prices can reproduce inflation evolution in US



What does this prove?

- Linear models with oil and active monetary policy do not explain high inflation levels because they can not generate a positive risk premium

- Second order approach restores the link between oil price shocks volatility and inflation expectations through a positive risk premium

- Support to the finding of SZ: Second order moments of shocks matter for inflation determination

But does it make sense for a Central Bank to partially react to oil price shocks?

- Standard New Keynesian models usually imply that supply shocks are not capable of generating a meaningful trade off for the central bank, flexible price equilibrium coincides with efficient equilibrium.

- Zero inflation and output gap are optimal. Therefore, also zero risk premium becomes optimal.

- We prove that this is not the case with oil price shocks. Oil price shocks generate a trade off when we have a distorted steady-state and a CES production function

Oil prices and endogenous trade off

- The linear approximation of the model can be written in terms of the efficient output gap as follows;

$$
\begin{aligned}
x_t &= E_t x_{t+1} - \frac{1}{\sigma}\left(i_t - E_t \pi_{t+1} - r_t^E\right) \\
\pi_t &= \beta E_t \pi_{t+1} + \kappa x_t + \tau\left(\alpha^F - \alpha^E\right) q_t
\end{aligned}
\qquad (1)
$$

- In our model the efficient level of output does not coincide with the flexible level of output.

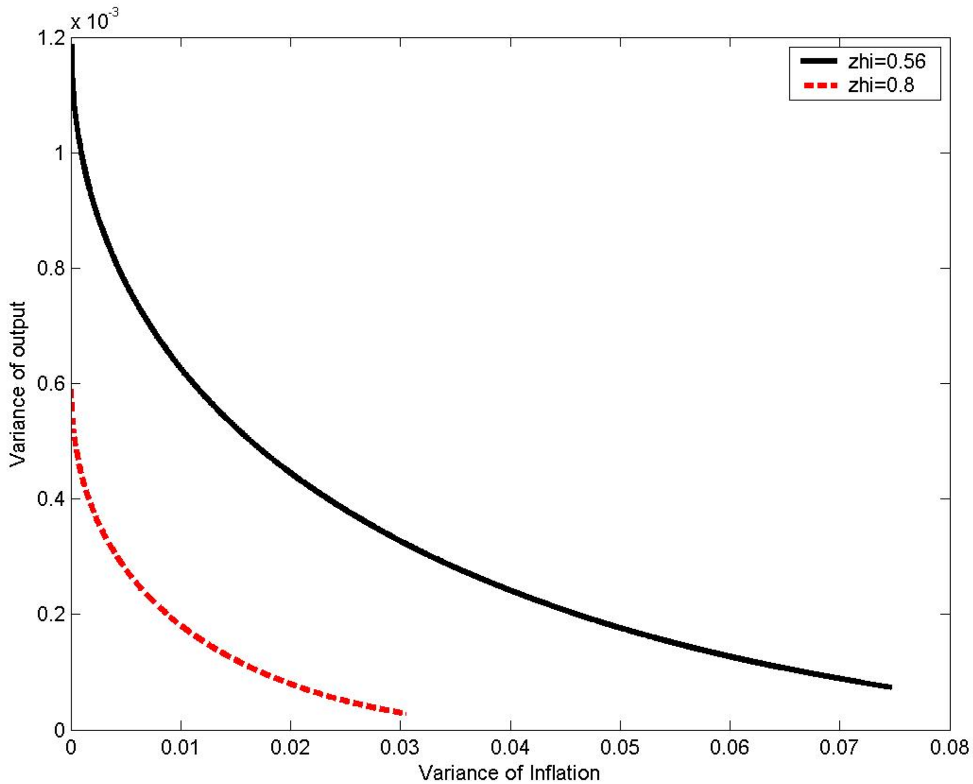
$$y_t^E = \frac{\alpha^E}{\left(1-\alpha^E\right)} \frac{\left(1-\alpha^F\right)}{\alpha^F} y_t^F$$

- Difference is explained by monopolistic distortion and elasticity of substitution between oil and labor.

$$\alpha^F - \alpha^E = \alpha^\psi \left(Q^{1-\psi}\left(\mu^{1-\psi} - 1\right)\right)$$

- When $\psi = 1$, $\alpha^F = \alpha^E$ and the trade off disappears, the same happens when $\mu = 1$, where there is no monopolistic distortion

Policy frontier improves if oil becomes easier to substitute



Conclusions

- Risk premium important in explaining the dynamics of inflation.

- Passive monetary policy is not a necessary condition to explain high average inflation levels in the US during 70s, active monetary policy that partially reacts to oil price shocks plus convexity of Phillips curve explain this fact.

- It is optimal to partially react to oil prices when there exists monopolistic competition and oil and labor are poor substitutes.