Technology shocks and Monetary Policy: Assessing the Fed's performance

(J.Gali et al., JME 2003)

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March 5, 2010

Contents

Introduction: Three famous chiarmans of the Fed

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- Alan Greenspan (1987 - 2006)
  - The "Maestro" of the economy
  - *The Age of Turbulence*
- Paul A. Volcker (1979 - 1987)
  - Second oil shock
  - Typical Hawkish

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- What is the Fed's job?
- The Federal Reserve Act says "...to promote **maximum sustainable output and employment** and to promote **stable prices**"

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Introduction: How well the Fed does its job

- To answer *how well* the Fed does its job, the paper
- identifies technology shock as the only source of the unit root in labor productivity
- characterizes the Fed's systematic response to technology shocks and its implications for U.S. output, hours and inflation based on a structural VAR model
- compares the empirical responses to the simulated ones from three simple monetary policies in the context of a standard business cycle model with sticky prices
  1. **optimal policy**: one that fully stabilizes prices
  2. simple Taylor rule
  3. monetary targeting rule

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- Key feature of New Keynesian model: Nominal rigidities
- Representative household, continuum of firms ($i \in [0, 1]$), monetary policy
- Two key features of the baseline model
  1. imperfect competition: differentiated goods, i.e. firms set their prices
  2. sticky prices: only a fraction of firms can reset their prices in any given period

Baseline model: Household

- Infinitely lived representative household solving

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\varphi}}{1+\varphi}\right)$$

subject to

$$\int_0^1 P_t(i) C_t(i) di + Q_t B_t \leq B_{t-1} + W_t N_t$$

$$\lim_{T \to \infty} E_t B_T \geq 0$$

$$\text{where } C_t \equiv \left(\int_0^1 C_t(i)^{1-\frac{1}{\epsilon}} di\right)^{\frac{\epsilon}{\epsilon-1}}$$

Baseline model: Household

- $P_t(i)$: price of good i at t
- $P_t \equiv (\int_0^1 P_t(i)^{1-\epsilon} di)^{\frac{1}{1-\epsilon}}$: aggregate price index at t
- $C_t(i)$: amount consumed of good i at t
- C_t: aggregate consumption index as previously defined
- B_t: quantity of 1 period risk-free discount bonds purchased at t
- Q_t: its price at t
- W_t: nominal wage (per hour) at t
- N_t: hours worked at t

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- Solving the problem and taking the log, we get the *labor supply schedule*

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- Letting $r_t \equiv -logQ_t$, $rr \equiv -log\beta$ and taking the first-order Taylor expansion, we also get the *log-linearized Euler equation*

$$c_t = -\frac{1}{\sigma}(r_t - E_t\pi_{t+1} - rr) + E_t c_{t+1}$$

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$$c_t = -\frac{1}{\sigma}(r_t - E_t\pi_{t+1} - rr) + E_t c_{t+1}$$

- and from the clearing of each market i ($Y_t(i) = C_t(i)$, so $Y_t = C_t$), we get

$$y_t = -\frac{1}{\sigma}(r_t - E_t\pi_{t+1} - rr) + E_t y_{t+1}$$

Baseline model: Firm

- Continuum of firms each producing a *differentiated good* with technology

$$Y_t(i) = A_t N_t(i), i \in [0,1]$$

with $a \equiv logA_t$ following

$$\Delta a_t = \rho \Delta a_{t-1} + \epsilon_t$$

$$\text{where } \rho \in [0,1)$$

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- Assumptions
  1. variations in aggregate productivity are the only sources of fluctuations
  2. no capital accumulation (most results and implications not affected)

Baseline model: Firm's profit maximization

under flexible prices

Firms put markup on marginal cost to maximize profits

- MC_t = real marginal cost at t = real wage/marginal product = $\frac{W_t}{P_t A_t}$

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  $\rightarrow$ the common marginal cost for all firms

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- same CRS technology, same isoelastic demand, same real marginal cost across all firms

$$Y_t(i) = A_t N_t(i), \quad C_t(i) = (\frac{P_t(i)}{P_t})^{-\epsilon} C_t$$

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- under flexible prices, the markup is common across all firms, given by $\epsilon/(\epsilon - 1)$ and $mc_t = -\log \epsilon/(\epsilon - 1) = mc$ (not depending on t)

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$$y_t^* = \gamma + \psi a_t$$

$$\text{where } \psi \equiv (1+\varphi)/(\sigma+\varphi),\ \gamma \equiv mc/(\sigma+\varphi)$$

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$$n_t^* = \gamma + (\psi \ - 1)a_t$$

- Natural rate of real interest rate

$$rr_t^* = rr + \sigma\rho\psi\Delta a_t$$

where rr_t: real interest rate at t

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- Assumption: $\Pr_{i,t}$(reset its price in this period) $= 1$-θ

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- Then we can derive the new Phillips curve

$$\pi_t = \beta E_t \pi_{t+1} + k x_t, k \equiv \frac{(1-\theta)(1-\beta\theta)(\sigma+\varphi)}{\theta}$$

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- and $y_t = -\frac{1}{\sigma}(r_t - E_t \pi_{t+1} - rr) + E_t y_{t+1}$ can be rewritten as

$$x_t = -\frac{1}{\sigma}(r_t - E_t \pi_{t+1} - rr_t^*) + E_t x_{t+1}$$

The Basic New Keynesian Model

- New Keynesian Phillips curve
  $\pi_t = \beta E_t\{\pi_{t+1}\} + \kappa x_t$
- Dynamic IS Equation
  $x_t = -(\frac{1}{\sigma})(r_t - E_t\{\pi_{t+1}\} - rr^*) + E_t\{x_{t+1}\}$
- Monetary Policy Rule

Alternative specifications of the systematic component of monetary policy that will try to lead us to the optimal allocation:

- A simple Taylor rule
- Constant money growth

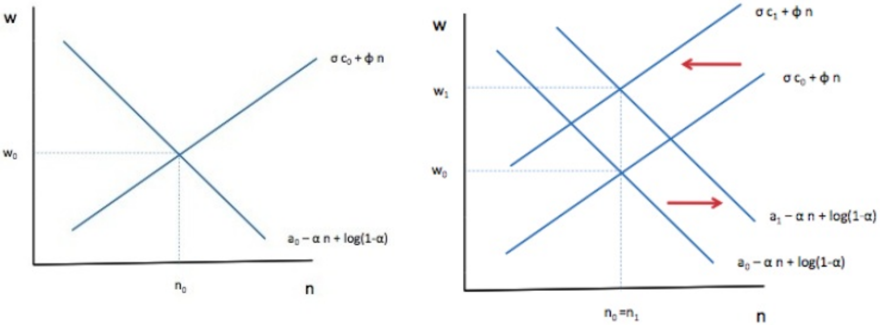
How the nature of the monetary policy affects the equilibrium responses of different variables to a permanent shock to technology?

Optimal monetary policy

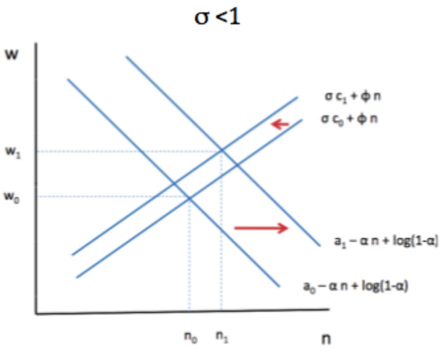
- Aim of monetary policy: to replicate the allocation associated with the flexible price equilibrium.
- The optimal policy requires that $x_t = \pi_t = 0$, for all t.
- Flexible price equilibrium replicated with the following interest rule: $r_t = rr + \sigma\rho\psi\triangle a_t + \o_\pi \pi_t$ for any $\phi_\pi > 1$
- The equilibrium response of output and unemployment will match that of their natural levels

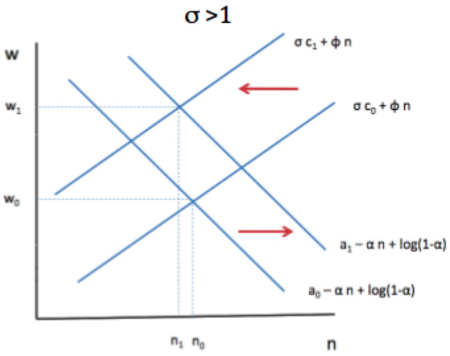
- The sign of the response of employment depends on the size of σ ($1/\sigma$: intertemporal elasticity of substitution between consumption in 2 periods)

  $E_0 \sum \beta^t \left(\frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\varphi}}{1+\varphi} \right)$



Optimal monetary policy

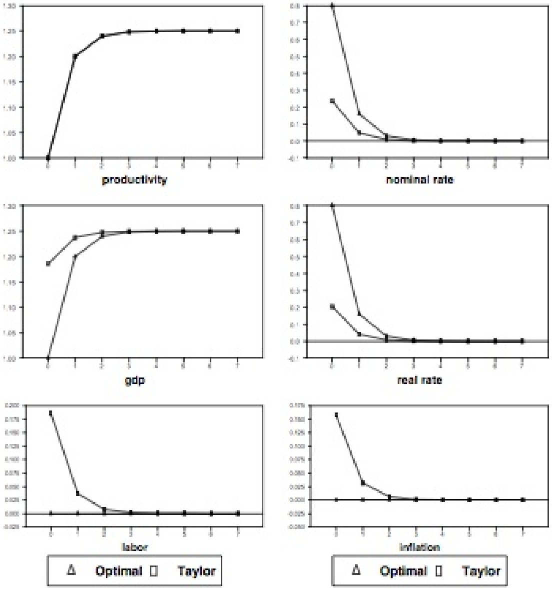




A simple Taylor rule

- The central bank follows the rule:
  $r_t = rr + \phi_\pi \pi_t + \phi_x x_t$
- Calibration
  $\phi_\pi = 1.5 \quad \phi_x = 0$
  $\sigma = 1 \quad \beta = 0.99 \quad \varphi = 1 \quad \rho = 0.2 \quad \theta = 0.75$

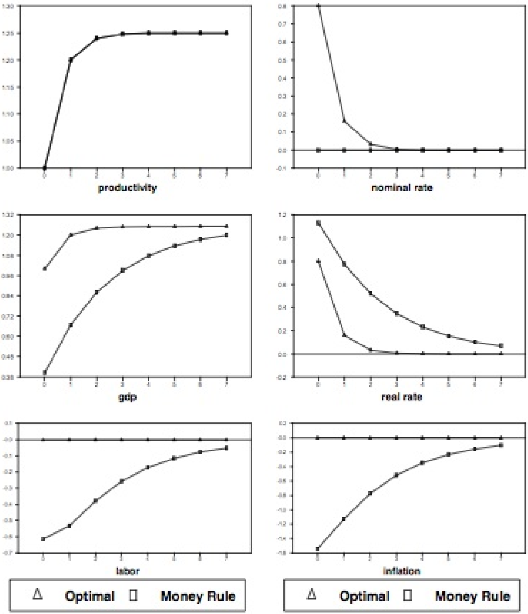
Optimal vs Taylor



A monetary targeting rule

- $m_t - m_{t-1} = \Lambda_m$
- Without loss of generality assume $\Lambda_m = 0$, which is consistent with zero inflation in the steady state.
- The demand for money is assumed to be $m_t - p_t = y_t - \eta r_t$
- Letting $m_t^* \equiv m_t - p_t - \psi a_t$
  $m_t^* = x_t - \eta r_t$
  $m_{t-1}^* = m_t^* + \pi_t + \psi \triangle a_t$
- $r_t = rr + (\frac{\sigma-1}{1+\eta}) \sum (\frac{\eta}{1+\eta})^{\kappa-1} E_t\{\triangle y_{t+\kappa}\}$

Optimal vs Money Rule



The Fed's response to technology shocks:evidence

- Evidence on the Fed's systematic response to technology shocks and its implications for U.S. output, hours and inflation.
- Are those responses consistent with any of the rules considered in the previous section?
- Sample period 1954:I-1998:III. Pre-Volcker Period (1954:I-1979:II) - Volcker-Greenspan Period(1982:III-1998:III).
- The empirical effects of technology shocks are determined through the estimation of a structural VAR.

Clarida, Galí and Gertler, QJE 2000

- Estimation of a forward-looking monetary policy reaction function for the post-war US economy. (1954:I-1998:III)
- Results
    - Differences in estimated rule across across periods
    - Volcker-Greenspan (1982:III-1998:III) interest rate policy more sensitive to changes in expected inflation than in the Pre-Volcker era (1954:I-1979:II)
    - The Volcker-Greenspan rule is stabilizing over the equilibrium properties of inflation and output

- We are considering a structural $VAR(4)$ with four variables.
- Only interested in exogenous variations in technology.

$$Y_t = \begin{pmatrix} Productivity_t \\ \pi_t \\ hours_t \\ real \ \ interest \ \ rate_t \end{pmatrix}$$

$$Y_t = F_1 Y_{t-1} + F_2 Y_{t-2} + F_3 Y_{t-3} + F_4 Y_{t-4} + E_t$$

- Identification restriction: Only technology shocks may have a permanent effect on the level of labor productivity (Gali AER 1999)

$$Productivity_t = z_t + \zeta_t(K_t, L_t, Z_t, U_t, N_t)$$

Table 1
Estimated VAR model: summary statistics

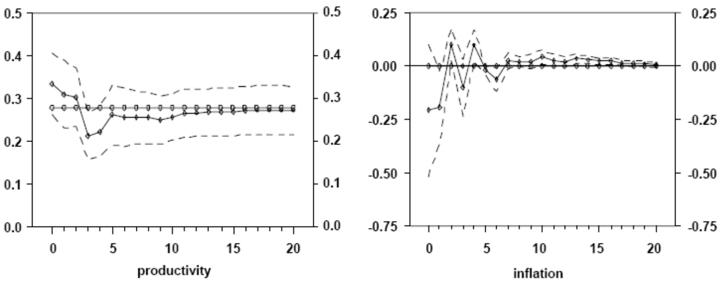
Equation		Own lags	Other lags	R^2	DW
Labor productivity	Pre-Volcker	0.02	0.00	0.49	1.97
	Volcker–Greenspan	0.20	0.15	0.43	1.92
Hours	Pre-Volcker	0.00	0.20	0.94	1.98
	Volcker–Greenspan	0.00	0.01	0.96	1.95
Real interest rate	Pre-Volcker	0.30	0.20	0.60	1.96
	Volcker–Greenspan	0.00	0.03	0.89	1.96
Inflation	Pre-Volcker	0.00	0.00	0.95	1.99
	Volcker–Greenspan	0.00	0.60	0.90	1.95

Note: Values in the third and fourth columns are p-values for the F tests. The Pre-Volcker period corresponds to 1954:2-1979:3; and the Volcker–Greenspan period corresponds to 1982:4-1998:4.

The Fed's response to technology shocks:evidence

The Volcker-Greenspan Era 1982:III-1998:III

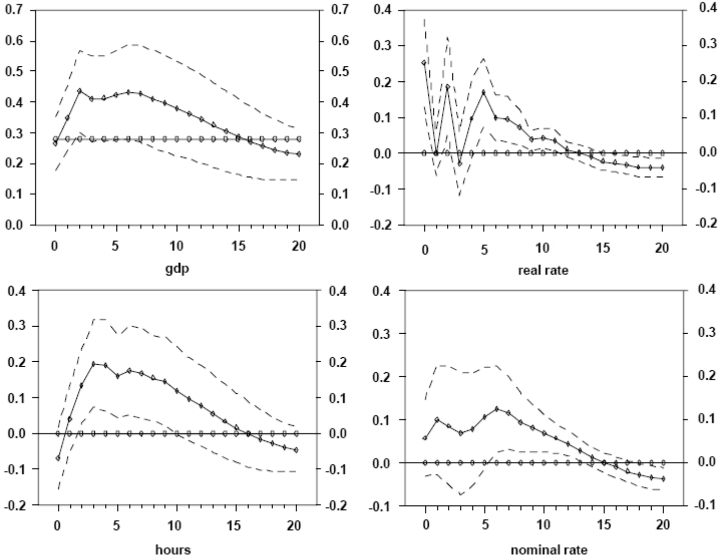
- Estimated response to a positive technological shock ($sd = 1$) vs Impulse response under optimal policy.



- Optimal Policy: $x_t = \pi_t = 0$
- $\rho = 0$, $\Delta a_t = \rho \Delta a_{t-1} + \epsilon_t$, $y_t^* = \gamma + \left(\frac{1+\varphi}{\sigma+\varphi}\right) a_t$
- $n_t^* = \gamma + \left(\frac{1+\varphi}{\sigma+\varphi} - 1\right) a_t$, $rr_t^* = rr + \sigma\rho \left(\frac{1+\varphi}{\sigma+\varphi}\right) \Delta a_t$

The Fed's response to technology shocks:evidence

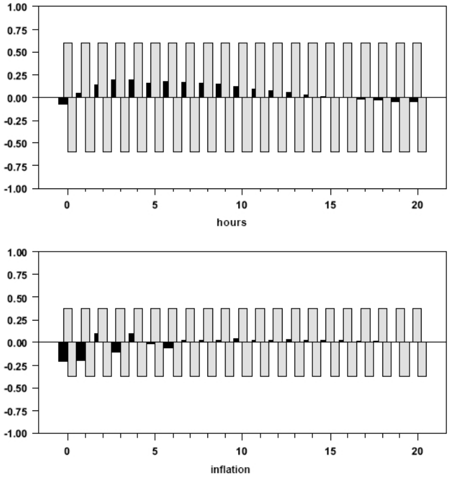
The Volcker-Greenspan Era 1982:III-1998:III



The Fed's response to technology shocks:evidence

The Volcker-Greenspan Era 1982:III-1998:III

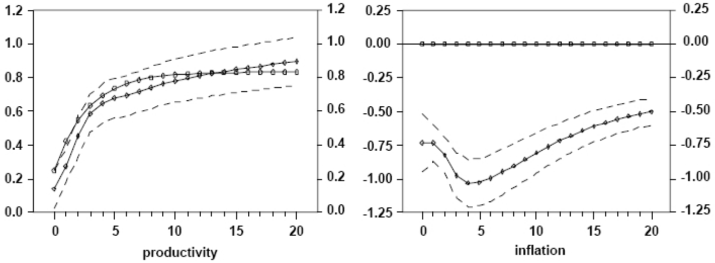
- Both hours and inflation response functions are not significant



- Volcker-Greenspan period consistent with the optimal policy

The Fed's response to technology shocks:evidence
The Pre-Volcker Period (1954:I-1979:II)

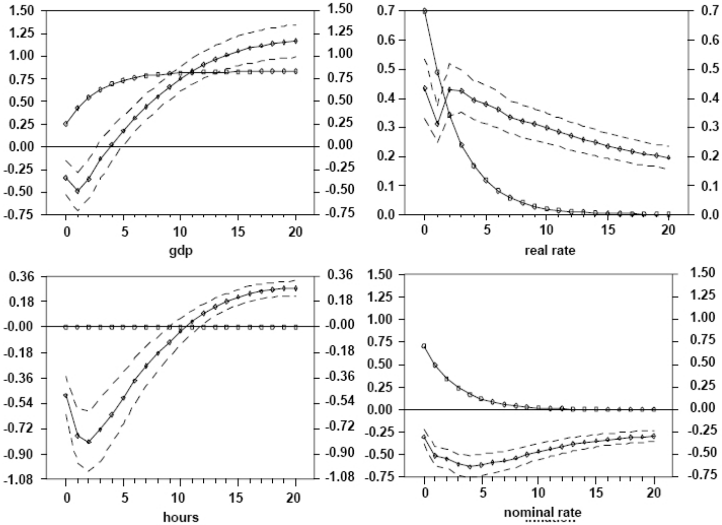
- Estimated response to a positive technological shock ($sd = 1$) vs Impulse response under optimal policy.



- Optimal Policy: $x_t = \pi_t = 0$
- $\rho = 0.7$, $\Delta a_t = \rho \Delta a_{t-1} + \epsilon_t$, $y_t^* = \gamma + \left(\frac{1+\varphi}{\sigma+\varphi}\right) a_t$
- $n_t^* = \gamma + \left(\frac{1+\varphi}{\sigma+\varphi} - 1\right) a_t$, $rr_t^* = rr + \sigma\rho\left(\frac{1+\varphi}{\sigma+\varphi}\right) \Delta a_t$

The Fed's response to technology shocks:evidence

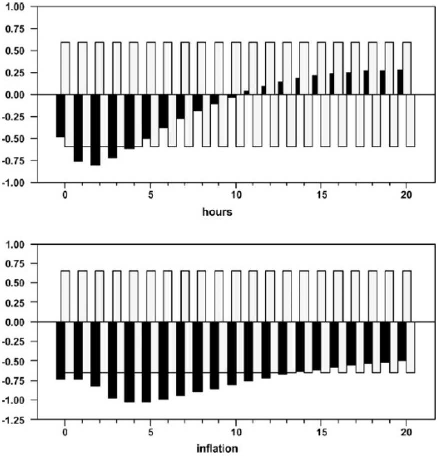
The Pre-Volcker Period (1954:I-1979:II)



The Fed's response to technology shocks:evidence

The Pre-Volcker Period (1954:I-1979:II)

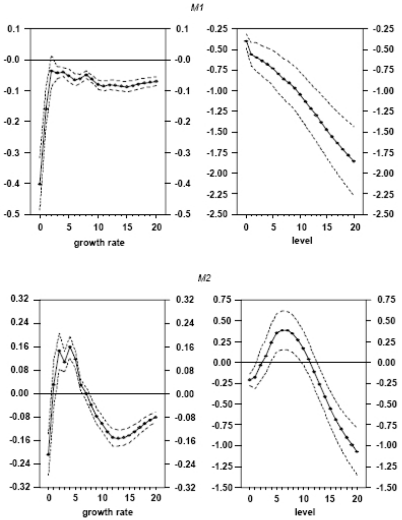
- Both hours and inflation response functions deviate from optimal path



- Pre-Volcker period is not consistent with the optimal policy

The Fed's response to technology shocks:evidence

The Pre-Volcker Period vs Monetary Targeting Rule



Conclusions

- Analysis of the Fed's response to technology shocks and its implications for U.S. output, hours and inflation.
- Consistency of the Fed's (Volcker-Greenspan period) response to a technology shock with a rule that seeks to stabilize prices and the output gap.
- The Fed's policy in Pre-Volcker period tended to overstabilize output thus generating excess volatility in inflation.