Reputation and TFP shocks

Boyan Jovanovic (NYU) 
Julien Prat (CNRS-CREST, Paris)

NYU, Oct/4/2013
How does reputation investment respond to aggregate shocks? firms, workers, CEOs
RESULTS

1. A rise in idiosyncratic shock volatility is contractionary – yes for Publicly-owned vs. Private firms.
RESULTS

1 A rise in idiosyncratic shock volatility is contractionary yes for Publicly-owned vs. Private firms.

2 Reduces responses to aggregate shocks (“explains the great moderation”)
RESULTS

1. A rise in idiosyncratic shock volatility is contractionary yes for Publicly-owned vs. Private firms.

2. Reduces responses to aggregate shocks (“explains the great moderation”)

3. News shocks raise output, more so for young firms
Model: Holmstrom (99) + TFP shocks

reputation about ability

Spot markets – no contracts, no contingent payment
PLAN OF TALK:

1. Review the normal learning model
2. Model & results
3. Evidence
4. Literature
Learning the mean of a normal distribution.

Signal is

\[ x_t = \theta + \epsilon_t. \]  

(1)

\[ \epsilon_t \sim N(0, \sigma^2_{\epsilon}) = \text{i.i.d. shock, and } \sigma^2_{\epsilon} \text{ is known} \]

\[ \theta \sim N(m_0, \sigma^2_{\theta}) = \text{prior} \]
observations \((x_0, \ldots, x_{t-1}) \equiv x^t\), posterior distribution is

\[ \theta_t \sim \mathcal{N} \left( m_t, \sigma_{\theta,t}^2 \right), \]

where

\[ m_t = \frac{\sigma_{\theta}^{-2} m_0 + \sigma_{\epsilon}^{-2} \sum_{s=0}^{t-1} x_s}{\sigma_{\theta}^{-2} + \sigma_{\epsilon}^{-2} t}, \tag{2} \]

and

\[ \sigma_{\theta,t}^2 = \left( \sigma_{\theta}^{-2} + \sigma_{\epsilon}^{-2} t \right)^{-1} \tag{3} \]
One-step-ahead Bayes map.—starting with \((m_t, \sigma^2_{\theta, t}) = (m, \nu)\),

\[
\begin{align*}
m' &= m + \frac{\nu}{\nu + \sigma^2_{\epsilon}} (x - m) \\
\nu' &= \frac{\nu \sigma^2_{\epsilon}}{\nu + \sigma^2_{\epsilon}}
\end{align*}
\]
Model: Holmstrom 99 + aggregate shocks
risk neutral buyers and sellers in a spot market
Up-front pay only, no contingent contracts.
Reputation = only motive for effort.
Action is observed with noise.

“Signal jamming” or “belief manipulation.”
output (in efficiency units)

\[ y_t = z_t (\theta + a_t + \varepsilon_t) \]

\( a_t = \text{firm's (hidden) effort} \)

\( g(a_t) = \text{convex cost} \)

Histories are public info.
First best.——

\[ z_t = g'(a_t) . \] (6)

You would get it is you had piece rates
\[ y_t = z_t (\theta + a_t + \varepsilon_t) \]
\[ y_t = z_t (\theta + a_t + \epsilon_t) \]

Learning on the equilibrium path.

\[ a_t^* (z_t, x^t) = \text{equilibrium action} \]
\[ x^t \equiv (x_0, ..., x_{t-1}) \text{ and where} \]
\[ x_t \equiv \frac{y_t}{z_t} - a_t^* (z_t, x^t) = \theta + \epsilon_t. \]  \hspace{1cm} (7)
DEFINITION: *Idiosyncratic volatility of y:*

\[
\text{Var} \left\{ \frac{1}{z_t} (y - E_t(y)) \mid t, x^t, (a_s^*)^{t-1} \right\} = \sigma^2_{\theta,t} + \sigma^2_{\varepsilon}
\]

but $\sigma^2_{\theta,t}$ and $\sigma^2_{\varepsilon}$ operate differently
The seller’s decision problem.—

$$\max \left( E_0 \sum_{t=0}^{\infty} \beta^t \left[ R_t - g(a_t) \right] \right)$$

Equilibrium.—$$(R_t(x^t, z_t), a^*_t(x^t, z_t))_{t=0}^{\infty}$$ such that

$$R_t(x^t, z_t) = E \left[ \theta \mid t, x^t, (a^*_s)^{t-1}_0 \right] + a^*_t(x^t, z_t), \quad (8)$$

and

$$a_t(x^t, z_t) = \arg \max_{\{a_t(\cdot)_{t=0}^{\infty}\}} \left( E_0 \sum_{t=0}^{\infty} \beta^t \left[ R_t - g(a_t) \right] \right) \quad (9)$$
Belief manipulation.—since

\[ m_t = \frac{\sigma_\theta^{-2} m_0 + \sigma_\varepsilon^{-2} \sum_{s=0}^{t-1} x_s}{\sigma_\theta^{-2} + \sigma_\varepsilon^{-2} t} \]

\[ \sigma_{\theta,t}^2 = (\sigma_\theta^{-2} + \sigma_\varepsilon^{-2} t)^{-1} \]

a deviation at date \( t \) raises \( \sum_{s=0}^{T-1} x_s \) by one unit for all \( T > t \). Now

\[ \frac{\partial m_{t+s}}{\partial \left( \sum_{s=0}^{t-1} x_s \right)} = \frac{\sigma_\varepsilon^{-2}}{\sigma_\theta^{-2} + \sigma_\varepsilon^{-2} s} \quad \text{for } s > t \]  

(10)

FOC at \( t \)

\[ g' (a_t^*) = \sum_{s=t+1}^{\infty} \frac{\beta^{s-t}}{\sigma_\varepsilon^2 \sigma_\theta^{-2} + s} E_t (z_s) \cdot \]  

(11)
\[ g'(a^*_t) = \sum_{s=t+1}^{\infty} \frac{\beta^{s-t}}{\sigma^2 \sigma^2_{\theta}} + s \mathbb{E}_t(z_s). \] (12)
RESULT 1: The level of output, and its response to news decrease with $\sigma_\varepsilon^2$, and increase in $\sigma_\theta^2$. 
RESULT 2: (news shocks raise output, more so for young firms)

(i) News shocks raise $a_t^*$.

(ii) $z_t$ affects $a_t^*$ only through $E_t(z_s)$ for $s > t$. 
DEFINITION: Idiosyncratic volatility of \( R_t \equiv \text{Var}(\Delta_t) \), where

\[
\Delta_t \equiv \frac{R_{t+1}}{z_{t+1}} - \frac{R_t}{z_t} - (a_{t+1}^* - a_t^*) = m_{t+1} - m_t.
\]

RESULT 3B: \( \text{Var}(\Delta_t) \) is increasing in both \( \sigma^2_\theta \) and in \( \sigma^2_\varepsilon \) iff

\[
\frac{\sigma^2_\varepsilon}{\sigma^2_\theta} < \sqrt{t(t+1)} \approx t
\]

(13)
Recall that idiosyncratic volatility of $y$ is

$$\text{Var}\left\{ \frac{1}{z_t} (y - E_t(y)) \mid t, x^t, (a^*_s)^{t-1} \right\} = \sigma^2_{\theta,t} + \sigma^2_{\varepsilon}$$
RESULT 4: The great moderation caused by the rise in idiosyncratic volatility.

PROOF: Idiosyncratic volatility of $q_t$ and $\pi_t$ and if (13) holds $R_t$ as well are increasing in $\sigma^2_\varepsilon$. 
What evidence do we have for RESULT 4:

"The great moderation caused by the rise in idiosyncratic volatility."
From Davis et al.

**Figure:** From Davis, Haltiwanger, Jarmin & Miranda *NBER Macro Annual 06*
Cross sector evidence from Philippon-Comin 05

Response to aggregate shocks declined most in sectors that experienced the highest rise in volatility
Figure: FROM COMIN AND PHILIPPON (2005)
Figure 1

Transitory Variance of Log Male Annual Earnings, by Year

Figure: From Gottschalk & Moffit JEP 2009
Durables more cyclically volatile

Can higher $\sigma_\theta$ explain it?

Proxy for $\sigma_\theta$ by $\Delta p_k$?
Literature.
Signal confusion models. Li & Weinberg *IER* 03.

\[ y = \exp (z_t + \theta + \varepsilon_t) f(k_t) \]

Learning \( \theta \), Confusion of aggregate and local shocks.

\[ E(y) = e^{\sigma_\varepsilon^2 / 2} E[\exp(z_t + \theta) f(k_t)] \]

Therefore \( \sigma_\varepsilon^2 \) is expansionary.
Signal confusion models (cont’d).
Lucas 72: Confusing $z$ and $m$ if $\sigma_m^2 \downarrow$, response to $z \uparrow$. Doesn’t work for the great moderation.
Bounded rationality

Mackowiak & Wiederholt *AER* 09.

When $\sigma^2_{\varepsilon} \uparrow$ firm pays less attention to $x$
Other reputation models.

Fishman and Rob *JPE* 05

multiple equilibria because there are no types $\theta$ to anchor things.
Atkeson, Hellwig Ordonez 12

only one hidden action at entry
The human-capital-accumulation channel.

Quereshi (Ohio State U. PhD thesis 09)

Learning by doing
5. Prat-Jovanovic (TE forthcoming)

Agent's risk aversion + Contracts with commitment:

\[ \sigma^2_{\epsilon} \] is also contractionary, but so is \( \sigma^2_{\theta} \) and TFP shocks have bigger impact on old firms, old agents.
CONCLUSION

We asked how shocks interact with the reputation mechanism

RESULTS

1 news shocks raise output, more so for young firms

2 A rise in idiosyncratic shock volatility is contractionary

3 Reduces responses to aggregate shocks (“explains the great moderation”)