Reputation and TFP shocks

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How does reputation investment respond to aggregate shocks?
firms, workers, CEOs

RESULTS

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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

$$x_t = \theta + \varepsilon_t. \tag{1}$$

$\varepsilon_t \,\tilde{}\, N\left(0, \sigma_\varepsilon^2\right) =$ i.i.d. shock, and σ_ε^2 is known

$\theta \sim \mathcal{N}\left(m_0, \sigma_\theta^2\right) =$ prior observations $(x_0, ..., x_{t-1}) \equiv x^t$, posterior distribution is

$$\theta_t \sim \mathcal{N}\left(m_t, \sigma^2_{\theta,t}\right),$$

where

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

and

$$\sigma^2_{\theta,t} = \left(\sigma_\theta^{-2} + \sigma_\varepsilon^{-2} t\right)^{-1} \tag{3}$$

One-step-ahead Bayes map.—starting with $\left(m_t, \sigma^2_{\theta,t}\right) = (m, v)$,

$$m' = m + \frac{v}{v + \sigma^2_\varepsilon}(x - m) \quad (4)$$

$$v' = \frac{v\sigma^2_\varepsilon}{v + \sigma^2_\varepsilon} \quad (5)$$

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 = firm's (hidden) effort

$g(a_t)$ = convex cost

Histories are public info.

First best.—

$$z_t = g'(a_t) . \tag{6}$$

You would get it is you had piece rates

$$y_t = z_t \left(\theta + a_t + \varepsilon_t\right)$$

$$y_t = z_t \left(\theta + a_t + \varepsilon_t\right)$$

Learning on the equilibrium path.

$a_t^* \left(z_t, x^t\right) =$ equilibrium action

$x^t \equiv \left(x_0, ..., x_{t-1}\right)$ and where

$$x_t \equiv \frac{y_t}{z_t} - a_t^* \left(z_t, x^t\right) = \theta + \varepsilon_t. \quad (7)$$

DEFINITION: *Idiosyncratic volatility of* y:

$$\operatorname{Var}\left\{ \frac{1}{z_t} \left(y - E_t \left(y \right) \right) \mid t, x^t, \left(a_s^* \right)_0^{t-1} \right\} = \sigma_{\theta,t}^2 + \sigma_\varepsilon^2$$

but $\sigma_{\theta,t}^2$ and σ_ε^2 operate differently

The seller's decision problem.—

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

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

$$R_t\left(x^t, z_t\right) = E\left[\theta \mid t, x^t, \left(a_s^*\right)_0^{t-1}\right] + a_t^*\left(x^t, z_t\right), \tag{8}$$

and

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

Belief manipulation.—since

$$
\begin{aligned}
m_t &= \frac{\sigma_\theta^{-2} m_0 + \sigma_\varepsilon^{-2} \sum_{s=0}^{t-1} x_s}{\sigma_\theta^{-2} + \sigma_\varepsilon^{-2} t} \\
\sigma_{\theta,t}^2 &= \left(\sigma_\theta^{-2} + \sigma_\varepsilon^{-2} t\right)^{-1}
\end{aligned}
$$

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

$$
\frac{\partial m_{t+s}}{\partial \left(\sum_{s=0}^{t-1} x_s\right)} = \frac{\sigma_\varepsilon^{-2}}{\sigma_\theta^{-2} + \sigma_\varepsilon^{-2} s} \quad \text{for } s > t \tag{10}
$$

FOC at t

$$
g'\left(a_t^*\right) = \sum_{s=t+1}^{\infty} \frac{\beta^{s-t}}{\sigma_\varepsilon^2 \sigma_\theta^{-2} + s} E_t\left(z_s\right) \ . \tag{11}
$$

$$g'\left(a_t^*\right) = \sum_{s=t+1}^{\infty} \frac{\beta^{s-t}}{\sigma_\varepsilon^2 \sigma_\theta^{-2} + s} E_t\left(z_s\right) \quad . \tag{12}$$

RESULT 1: The level of output, and its response to news decrease with σ_ε^2, and increase in σ_θ^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

$$\Delta_t \equiv \frac{R_{t+1}}{z_{t+1}} - \frac{R_t}{z_t} - \left(a^*_{t+1} - a^*_t\right) = m_{t+1} - m_t.$$

RESULT 3B: $\text{Var}(\Delta_t)$ is increasing in both σ^2_θ and in σ^2_ε iff

$$\frac{\sigma^2_\varepsilon}{\sigma^2_\theta} < \sqrt{t\,(t+1)} \approx t \tag{13}$$

Recall that idiosyncratic volatility of y is

$$\text{Var}\left\{\frac{1}{z_t}\left(y - E_t\left(y\right)\right) \mid t, x^t, \left(a_s^*\right)_0^{t-1}\right\} = \sigma_{\theta,t}^2 + \sigma_\varepsilon^2$$

RESULT 4: The great moderation caused by the rise in idiosyncratic volatility.

PROOF: *Idiosyncratic volatility of* q_t and π_t and if (13) holds R_t as well *are increasing in* σ_ε^2

What evidence do we have for **RESULT 4:**

"The great moderation caused by the rise in idiosyncratic volatility."

From Davis et al.

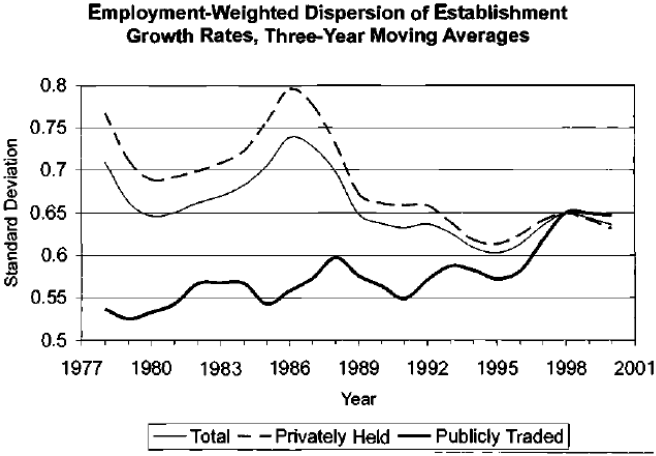
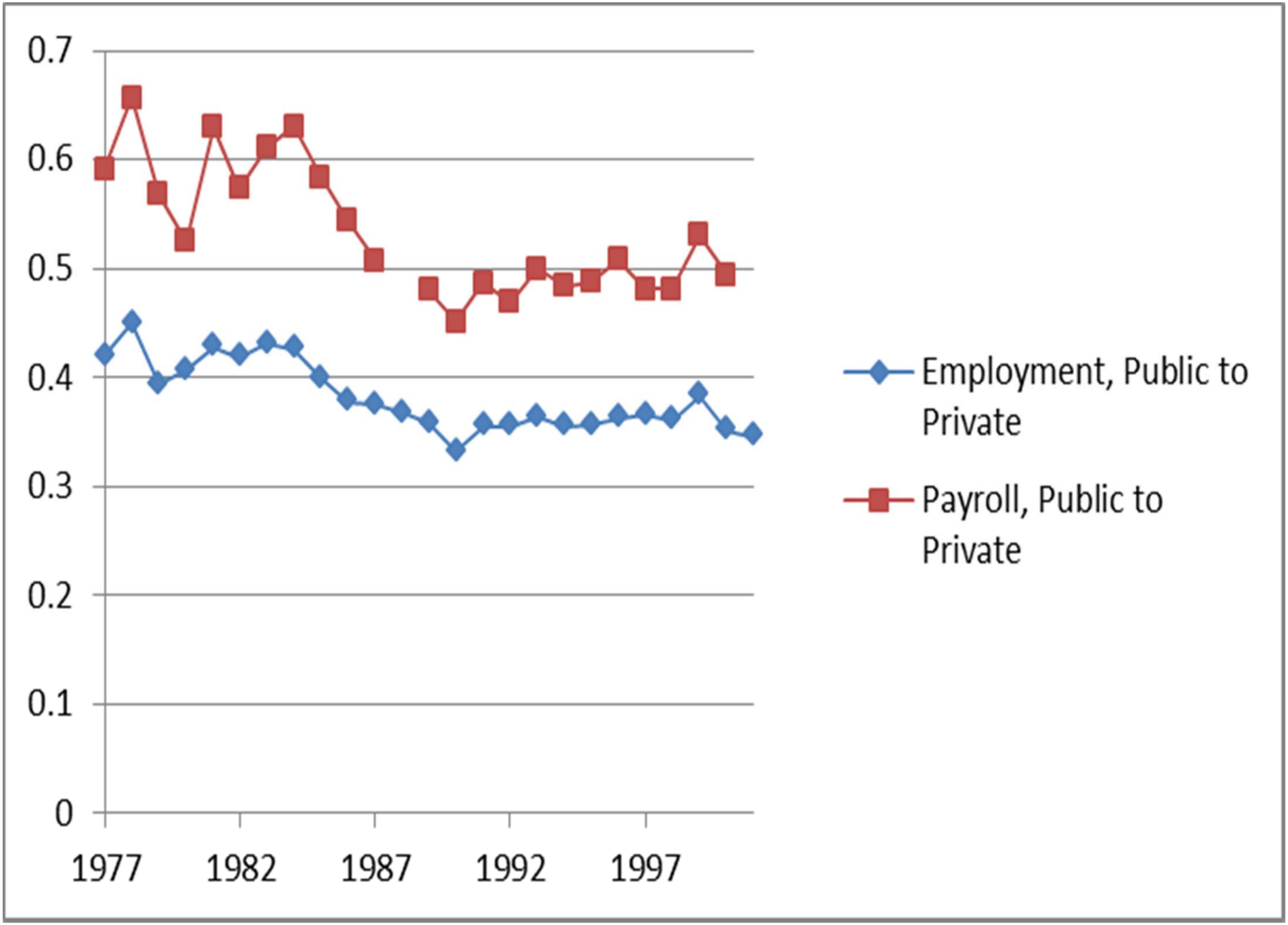


Figure: FROM DAVIS, HALTIWANGER, JARMIN & MIRANDA *NBER Macro Annual 06*


0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1977
1982
1987
1992
1997
Employment, Public to Private
Payroll, Public to Private

Cross sector evidence from Philippon-Comin 05

Response to aggregate shocks declined most in sectors that experienced the highest rise in volatility

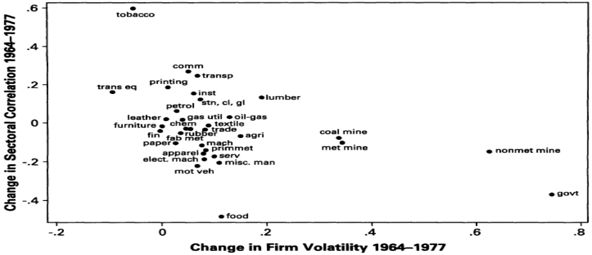


Figure 3.10a
Firm Volatility and Sectoral Correlation, 1964–1977

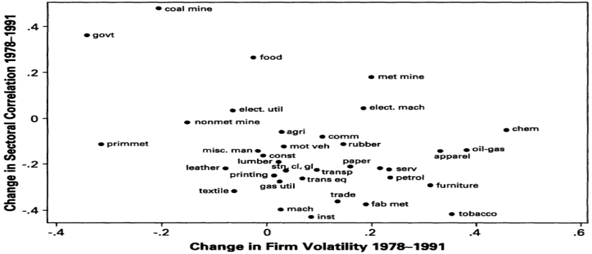
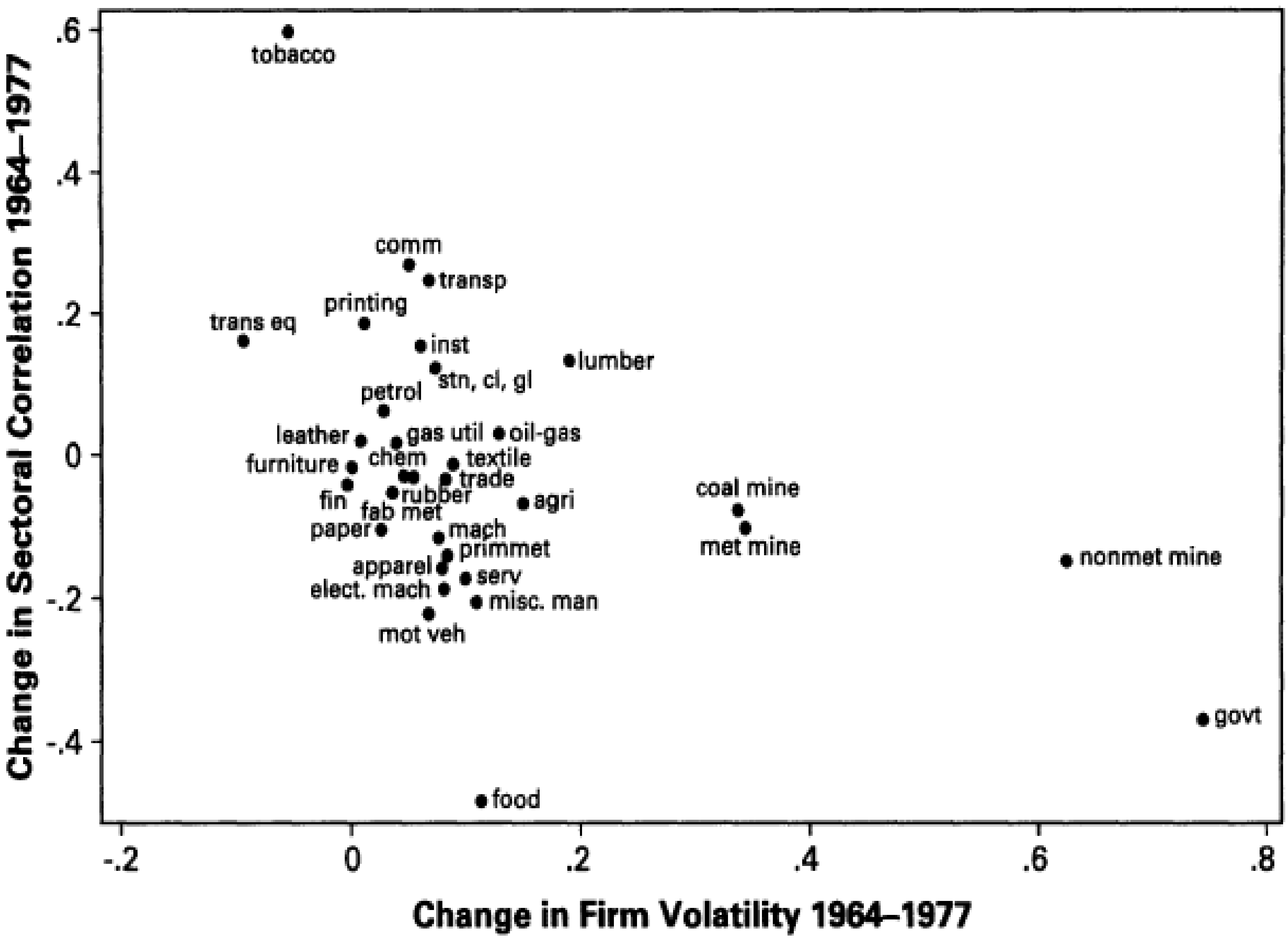


Figure 3.10b
Firm Volatility and Sectoral Correlation, 1978–1991

Figure: From Comin and Philippon (2005)



Change in Sectoral Correlation 1964–1977
Change in Firm Volatility 1964–1977
.6
.4
.2
0
-.2
-.4
-.2
0
.2
.4
.6
.8
tobacco
comm
transp
printing
trans eq
inst
lumber
stn, cl, gl
petrol
leather
gas util
oil-gas
furniture
chem
textile
trade
fin
rubber
fab met
agri
coal mine
met mine
paper
mach
primmet
apparel
serv
elect. mach
misc. man
mot veh
nonmet mine
govt
food

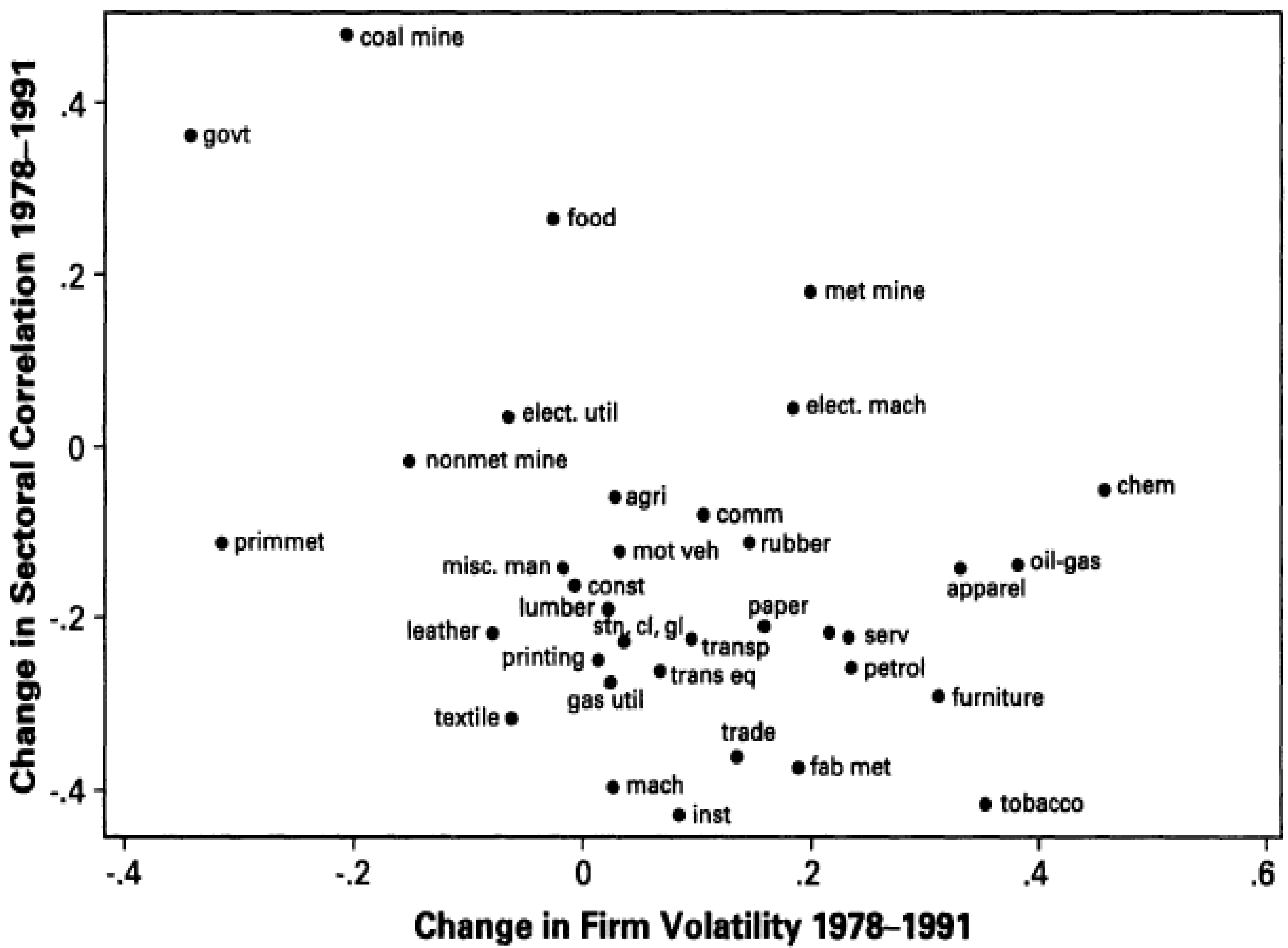

coal mine
govt
food
met mine
elect. util
elect. mach
nonmet mine
chem
agri
comm
primmet
rubber
mot veh
misc. man
oil-gas
apparel
const
lumber
paper
leather
stn, cl, gl
transp
serv
printing
petrol
trans eq
gas util
furniture
textile
trade
fab met
mach
inst
tobacco
.4
.2
0
-.2
-.4
-.4
-.2
0
.2
.4
.6
Change in Sectoral Correlation 1978–1991
Change in Firm Volatility 1978–1991

Figure 1
Transitory Variance of Log Male Annual Earnings, by Year

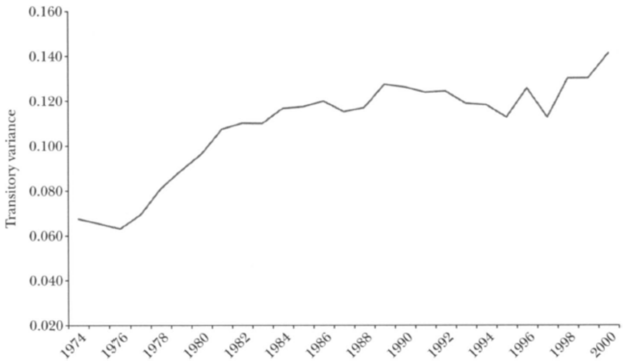


Figure: From Gottschalk & Moffit JEP 2009

Durables more cyclically volatile

Can higher σ_θ explain it?

Proxy for σ_θ by Δp_k?

Literature.

Signal confusion models. Li & Weinberg *IER* 03.

$$y = \exp\left(z_t + \theta + \varepsilon_t\right) f\left(k_t\right)$$

Learning θ, Confusion of aggregate and local shocks.

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

Therefore σ_{ε}^2 is expansionary.

Signal confusion models (cont'd).
Lucas 72: Confusing z and m If $\sigma_{\text{m}}^2 \downarrow$, response to $z \uparrow$. Doesn't work for the great moderation

Bounded rationality

Mackowiak & Wiederholt *AER* 09.

When $\sigma_\varepsilon^2 \uparrow$ firm pays less attention to x

Other reputation models.

Fishman and Rob *JPE* 05

multiple equilibria because there are no types θ 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:

σ_ε^2 is also contractionary, but so is σ_θ^2 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)