Demand Shocks with Dispersed Information

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Class notes, 06 March 2007

Nominal rigidities: imperfect information

- How to model demand shocks in a baseline environment with imperfect info?
- Need consumer's decisions to be richer:
  - Forward looking
  - No fully revealing prices

1. Embed in something closer to neo-keynesian benchmark
2. Add shocks to expected productivity

Ingredients

Model of “fundamental” and “sentiment” shocks

- Fundamental information is dispersed across the economy
- Agents know “potential output” in their own sector, but not the aggregate
- Demand shocks: shifts in average beliefs about aggregate potential output

Model

Households: consumer/producer on $[0,1]$.

Preferences:

$$\mathbb{E}\sum_{t=0}^{\infty}\beta^t\left(\log C_{it}-\frac{1}{1+\eta}N_{it}^{1+\eta}\right)$$

$$C_{it}=\left(\int_{J_{it}} C_{ijt}^{\frac{\sigma-1}{\sigma}}dj\right)^{\frac{\sigma}{\sigma-1}}$$

random consumption basket: $J_{it}\subset[0,1]$

Technology:

$$Y_{it}=A_{it}N_{it}$$

Shocks

Individual productivity (*private signal*) is

$$a_{it} = logA_{it} = a_{t-1} + \theta_{it}$$

aggregate component and idiosyncratic component

$$\theta_{it} = \theta_t + \varepsilon_{it}$$

Aggregate productivity is

$$a_t = a_{t-1} + \theta_t$$

Shocks (continued)

Public signal about aggregate innovation

$$s_t = \theta_t + e_t$$

- news
- aggregate statistics
- stock market
- ...

$\theta_t =$ fundamental shock

$e_t =$ sentiment shock

Trading

Agents have nominal balances B_{it-1} with CB (*cashless economy*)

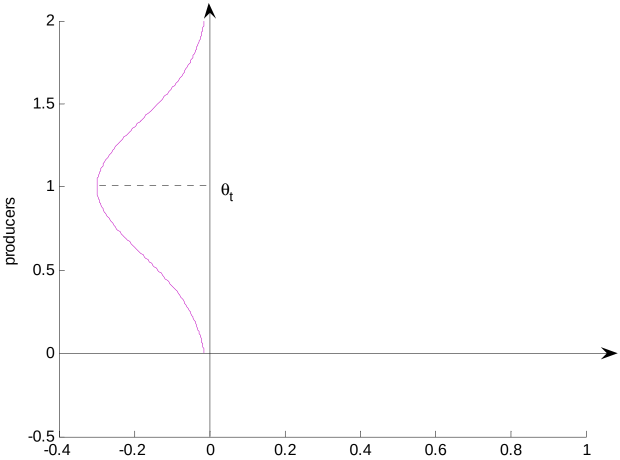
- Before observing current shocks: state contingent contracts
- CB sets nominal interest rate on balances R_t
- Producer set price P_{it}
- Consumer observes prices in consumption basket P_{jt} for $j \in J_{it}$
- Consumer buys goods
- All shocks publicly revealed, state contingent contracts settled

Budget constraint

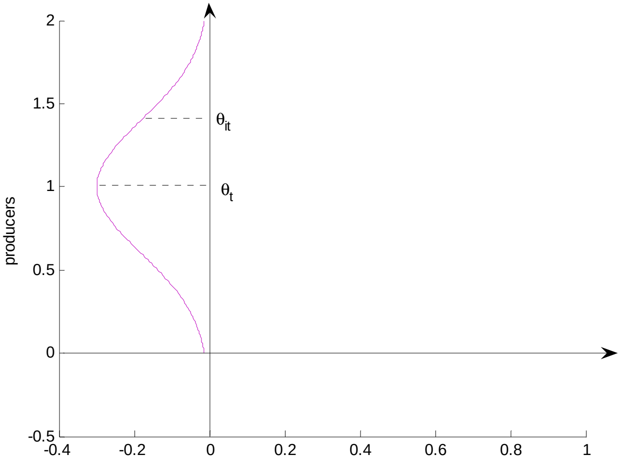
$$B_{it} = R_t \left(B_{it-1} + (1+\tau) P_{it} Y_{it} - \overline{P}_{it} C_{it} + Z_{it}(h_t) - T_t \right) - \int q_t(\tilde{h}_t) Z_{it}(\tilde{h}_t) \, d\tilde{h}_t.$$

- $\overline{P}_{it}$ price index for goods in J_{it}
- Z state contingent contracts
- subsidy τ to correct for monopolistic distortion
- T_t lump sum tax to finance subsidy

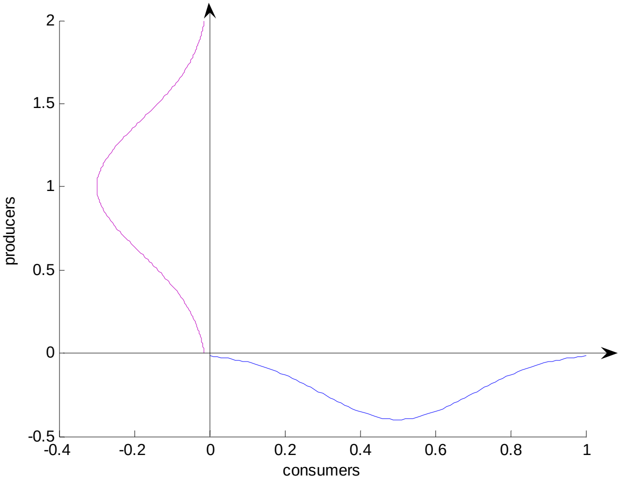
Random consumption baskets



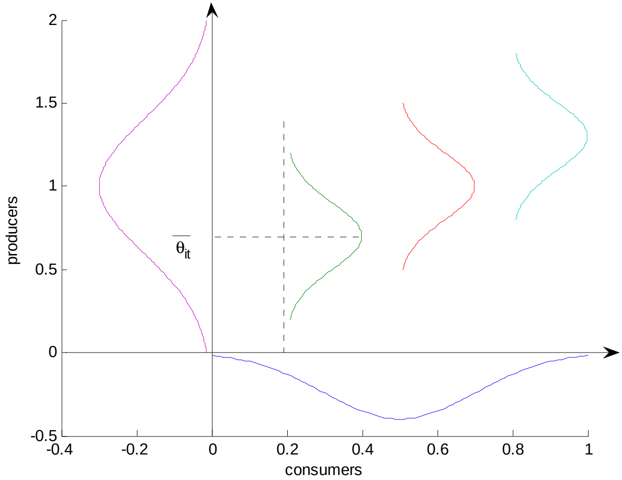
Random consumption baskets



Random consumption baskets



Random consumption baskets



Random consumption baskets (continued)

$$\overline{\theta}_{it} = \left\{ \theta_{jt} : j \in J_{it} \right\}$$

additional idiosyncratic shock: sampling shock v_{it}

$$\overline{\theta}_{it} = \theta_t + v_{it}$$

Monetary policy rule

Interest rate rule

$$r_t = r + \xi \left(p_{t-1} - p^*_{t-1}\right)$$

Price target

$$p^*_t = \phi_\theta \theta_t + \phi_s s_t$$

- no superior information
- only trying to keep nominal prices stable
- $\xi > 1$ 'active' rule
- all lowercase = logs

Linear equilibrium

Individual prices and consumption

$$
\begin{aligned}
p_{it} &= \phi_0 + \phi_\theta \theta_{it} + \phi_s s_t \\
c_{it} &= \psi_0 + a_{t-1} + \psi_\varepsilon \theta_{it} + \psi_v \overline{\theta}_{it} + \psi_s s_t
\end{aligned}
$$

- in equilibrium $p_t = p_t^*$
- interest rate constant

Proposition

Linear equilibrium exists under given policy rule, determinate if $\xi > 1$

Linear equilibrium (continued)

Potential output

$$c_t^* \quad = \quad \psi_0^* + a_{t-1} + \theta_t$$

- aggregate output under first best allocation
- = aggregate output under full information (with right τ)
- = linear equilibrium iff

$$\psi_\theta = 1 \quad \psi_s = 0$$

Linear equilibrium (continued)

Mechanics and remark 1

- full insurance + normal sampling shocks + iso-elastic preferences

  $\Rightarrow$ closed form linear equilibrium

- e.g.: the price index for consumer i is

$$\overline{P}_{it} = V_p \exp\{p_t + \phi_\theta v_i\}$$

where

$$V_p = \exp\{\frac{1-\sigma}{2}\phi_\theta^2 \hat{\sigma}_\varepsilon^2\}$$

Linear equilibrium (continued)

Mechanics and remark 2

- consumers observe whole distribution P_{jt} for $j \in J_{it}$
- a sufficient statistic is $\overline{\theta}_{it}$
- this is like having two noisy signals of θ_t:

$$\theta_{it} = \theta_t + \varepsilon_{it}$$
$$\overline{\theta}_{it} = \theta_t + v_{it}$$

Linear equilibrium (continued)

Mechanics and remark 2

- consumers observe whole distribution P_{jt} for $j \in J_{it}$
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$$\theta_{it} = \theta_t + \varepsilon_{it}$$
$$\overline{\theta}_{it} = \theta_t + v_{it}$$

- $\rightarrow$ information structure is independent of monetary policy

Pricing

Optimality condition

$$p_{it} = \eta \left(\mathbb{E}^I_{it} \left[c_t + \sigma \left(p_t - p_{it} \right) \right] - a_{it} \right) + \\ + \left(\mathbb{E}^I_{it} \left[\overline{p}_{it} + c_{it} \right] - a_{it} \right) + \eta \left(\psi_v + \sigma \phi_\theta \right) \mathbb{E}^I_{it} \left[v_{jt} \right]$$

- $\mathbb{E}^I_{it}$ expectation at pricing stage
- high demand relative to prod $\rightarrow$ high price
- high consumption relative to prod $\rightarrow$ high price

Consumption

Euler equation

$$c_{it} = \mathbb{E}^{II}_{it}\left[\underbrace{a_{t+1}}_{\text{exp. income}} - (r - p_{t+1} + \overline{p}_{it})\right]$$

- $\mathbb{E}^{II}_{it}$ expectation at consumption stage

Demand shocks

Properties of monetary regime

- $E_t [p_{it+1}] = 0$
- stable price level in expectation
- equilibrium r_t constant

Simple case

$$\frac{\sigma_\varepsilon}{\sigma_\theta} \longrightarrow \infty$$

agents disregard their private info

$$E_t^P [.] = E [.|a_{t-1}, s_t]$$

Effects of e_t and θ_t

$$p_t = \frac{1+\eta}{1+\sigma\eta}\left(E_t^P[a_t] - a_t\right)$$

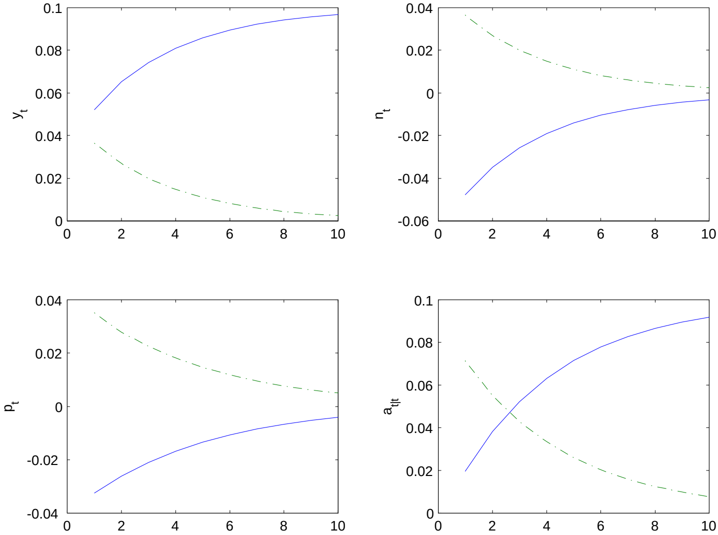
$$y_t = \lambda E_t^P[a_t] + (1-\lambda)a_t$$

Effects of $e_t > 0$

- only temporary effects
- raise c_t, p_t and n_t

Effects of $\theta_t > 0$

- permanent effects
- raise c_t
- lower p_t and n_t



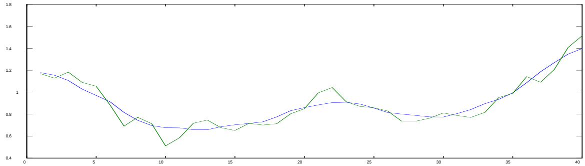
Dynamic responses to u_t (solid) and e_t (dash).

What restrictions does the theory impose?

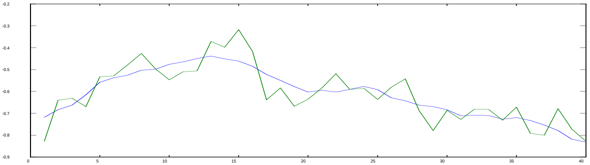
- evidence on 'signals' gives testable implications
- evidence on aggregate beliefs
- basic restrictions on joint behavior of error and actual series

$$y_t = \lambda E_t^P [a_t] + (1 - \lambda) a_t$$

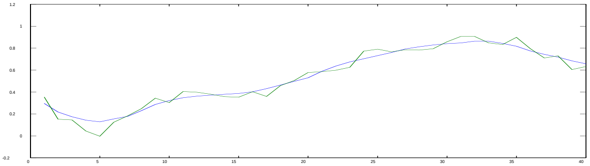
fraction of variance of y_t due to demand shocks over total variance is **bounded**



$\sigma_e^2/\sigma_u^2 = 0.2$

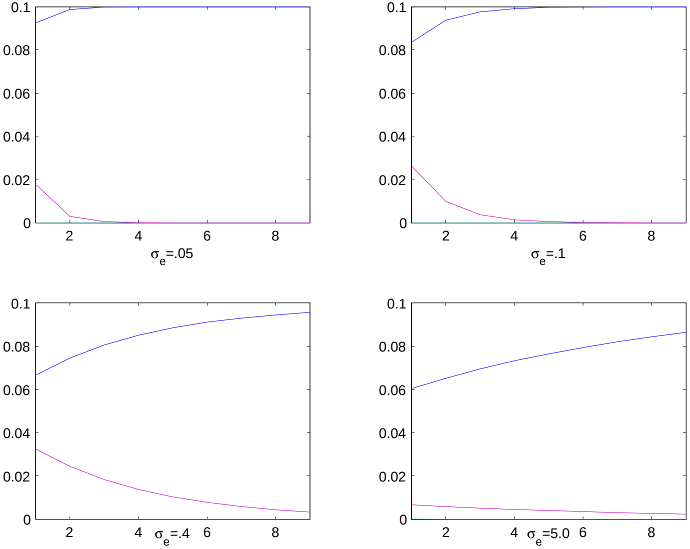


$\sigma_e^2/\sigma_u^2 = 1.0$



$\sigma_e^2/\sigma_u^2 = 5$

Changing σ_e



A richer policy rule

Interest rate rule

$$r_t = r + \xi \left(p_{t-1} - p^*_{t-1} \right)$$

Price target

$$p^*_t = \mu a_{t-1} + \phi_\theta \theta_t + \phi_s s_t$$

- use past information
- p_t aggregate price index
- note the term μa_{t-1} *inertial rule*

Monetary Policy (continued)

Consumption under $\mu \neq 0$

Euler equation

$$c_{it} = \mathbb{E}^{II}_{it} \left[\underbrace{a_{t+1}}_{\text{exp. income}} - (r_t - \underbrace{p_{t+1}}_{\text{future price}} + \overline{p}_{it}) \right]$$

A richer policy rule

Interest rate rule

$$r_t = r + \xi \left(p_{t-1} - p^*_{t-1} \right)$$

Price target

$$p^*_t = \mu a_{t-1} + \phi_\theta \theta_t + \phi_s s_t$$

- use past information
- p_t aggregate price index
- note the term μa_{t-1} *inertial rule*

Power of policy rule

Agents have different expectations about future output

...but also different expectations about real interest rate

$$\mathbb{E}_{it}^{II}\left[r - \mu_\theta \theta_t + \overline{p}_{it}\right]$$

2 crucial ingredients:

- agents forward looking
- in the future more information than now

$\rightarrow$ policy rule allows to 'manage expectations'

Power of policy rule (continued)

The choice of μ_θ feeds back into optimal prices $\overline{p}_{it}$
It also affects response to s_t and response of relative prices
An increase in μ_θ

- increases ψ_θ
- reduces ϕ_θ
- increases ϕ_s
- decreases ψ_s

Achievable linear equilibria

vector $\psi_\theta, \phi_\theta, \phi_s, \psi_s$
s.t.

$$
\begin{aligned}
\psi_v &= \psi_\varepsilon \delta_v / \delta_\varepsilon - \phi_\theta \\
(1+\sigma\eta)\,\phi_\theta &= \eta\left(\left(\psi_\theta + \sigma\phi_\theta\right)\beta_\theta - 1\right) + \left(\left(\psi_\theta + \phi_\theta\right)\beta_\theta / \delta_\theta - 1\right) + \\
&\quad + \eta\left(\psi_v + \sigma\phi_\theta\right)\gamma\left(1-\beta_\theta\right), \\
0 &= \eta\left(\psi_\theta + \sigma\phi_\theta\right)\beta_s + (1+\eta)\,\psi_s + \\
&\quad + \left(\psi_\theta + \phi_\theta\right)\left(\beta_s - \delta_s\right)/\delta_\theta - \eta\left(\psi_v + \sigma\phi_\theta\right)\gamma\beta_s,
\end{aligned}
$$

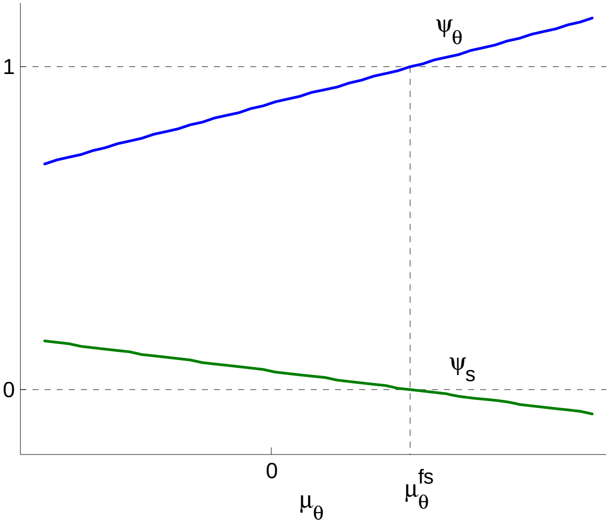
Another divine coincidence?

Proposition

There is a μ_θ^{fs} that achieves ***full stabilization****:*

$$\psi_\theta = 1 \qquad \psi_s = 0$$

- here output is always equal to potential
- induce agents to respond more to private productivity


ψθ
1
ψs
0
0
μθ
μθfs

More on the relation between ψ_θ and ϕ_θ

- increase response of output to fundamental
- increase response of demand to local productivity
- reduce price adjustment ($\phi_\theta < 0$)

Welfare

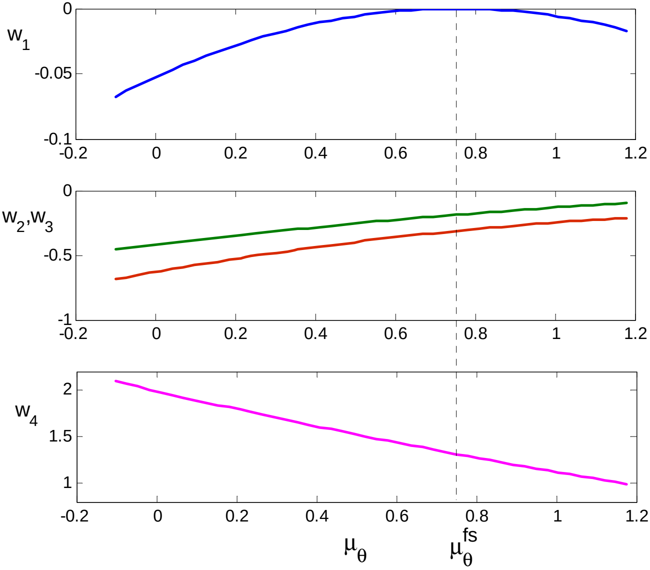
4 components:

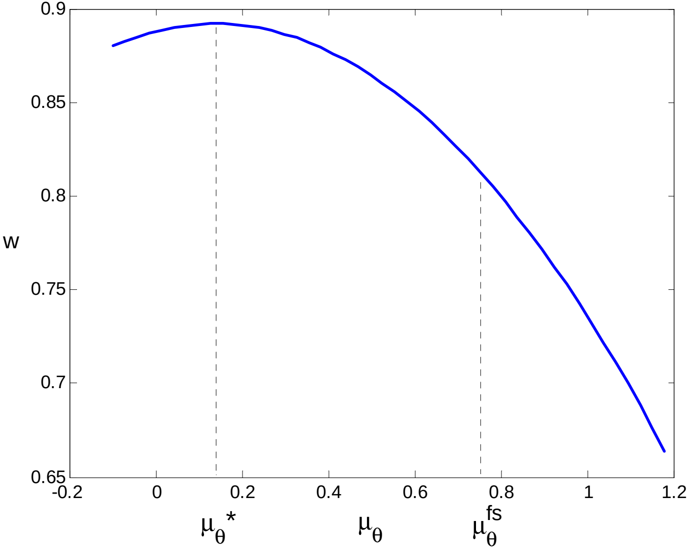
$$-(1+\eta)\,\mathbb{E}\left[(c_t - c_t^*)^2 \,|a_{t-1}\right] - (1+\eta)\,Var\,(n_{it}) +$$
$$-Var\left(c_{jt} + \sigma\bar{p}_{jt}|j \in \tilde{J}_{it}\right) + \sigma\,(\sigma - 1)\,Var\left(p_{jt}|j \in J_{it}\right)$$

1. aggregate output gap (-)
2. labor supply cross sectional dispersion (-)
3. demand cross sectional dispersion (-)
4. relative price dispersion (+)

σ	7		
η	2		
σ_θ^2	1	σ_ε^2	1
σ_e^2	1/3	γ	0.5

Table: Parameters for the example


0
-0.05
-0.1
w_1
-0.2 0 0.2 0.4 0.6 0.8 1 1.2
0
-0.5
-1
w_2, w_3
-0.2 0 0.2 0.4 0.6 0.8 1 1.2
2
1.5
1
w_4
-0.2 0 0.2 0.4 0.6 0.8 1 1.2
μ_θ
μ_θ^{fs}


0.9
0.85
0.8
0.75
0.7
0.65
W
-0.2
0
0.2
0.4
0.6
0.8
1
1.2
μ_θ^*
μ_θ
μ_θ^{fs}

Optimal monetary policy

Proposition

Full stabilization is typically not optimal
Some accommodation of demand shocks is optimal

- It is optimal $\mu^* < \mu^{fs}$
- It is optimal to partially accomodate $\psi_s > 0$
- Price dispersion is larger at optimal monetary policy than under full stabilization

Special case

$$\eta = 0$$

- now it is optimal $\psi_\theta = 1$
- $\phi_\theta = -1$
- decreasing prices proportionally to productivity gives:

  1. right relative prices
  2. right response of consumption

Special case (continued)

$$p_{it} = \left(\mathbb{E}_i^I \left[\overline{p}_{it} + c_{it} \right] - a_{it} \right)$$

$$c_{it} = \mathbb{E}_i^{II} \left[a_{t+1} + p_{t+1} \right] - \overline{p}_{it}$$

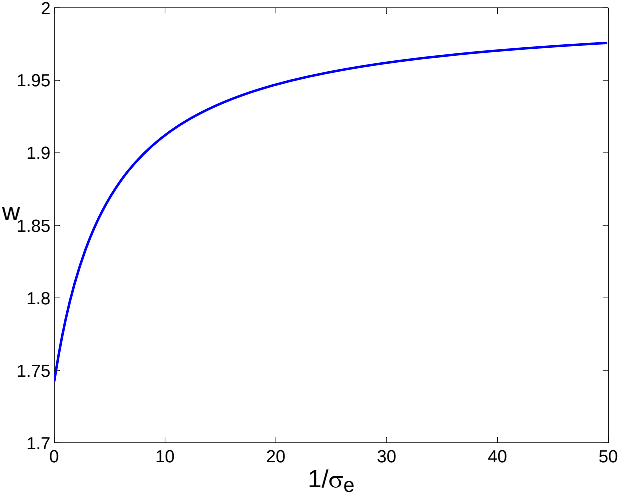
- unit intertemporal elasticity of substitution
- proportional response is optimal

Transparency

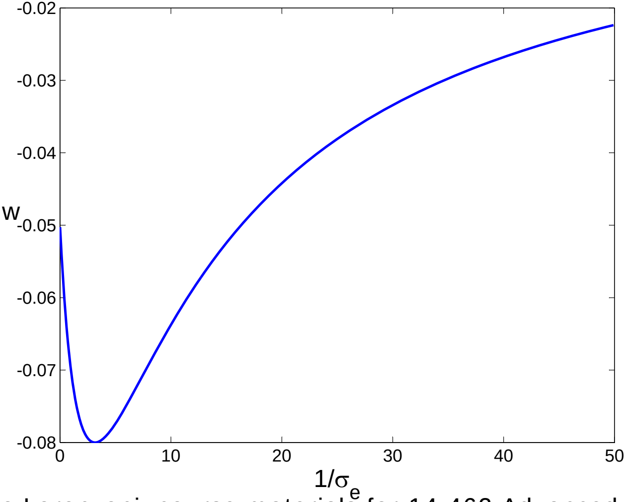
Is better public information good? (Morris and Shin (2002))

- Effect on output gap may be bad
- Total effect always good

Effect on welfare



Effect on output gap volatility



Compare with Hellwig (2005)

Lucas style model with unobserved money supply shocks

- more precision about monetary shocks is good:
  - reduce output gap
  - reduce price variance (spurious)

Here uncertainty about real shocks

- more precision is good:
  - ambiguous on output gap
  - increase price variance (good)
  - second effect dominates

Expectations' shocks and business cycles

- Business cycles driven by news (Beaudry and Portier (2006), Jaimovich and Rebelo (2006))
- **Problem 1**: in neoclassical setting 'demand disturbances' have hard time generating right response of hours/consumption/investment
- Euler equation

$$c_t = \mathbb{E}_t \left[\underbrace{a_{t+1}}_{\text{exp. income}} - (r_t - p_{t+1} + p_t) \right]$$

- with flexible prices the real rate increases automatically

Expectations' shocks and business cycles (continued)

- Nominal rigidity can help (Christiano, Motto and Rostagno (2006))
- **Problem 2**: monetary policy accommodation of demand shocks is typically suboptimal
- Euler equation

$$c_t = \mathbb{E}_t \left[\underbrace{a_{t+1}}_{\text{exp. income}} - (r_t - p_{t+1} + p_t) \right]$$

- with full information optimal to increase r

Expectations' shocks and business cycles (continued)

- Imperfect information + nominal rigidity can help
- **Problem 3**: policy rules still able to wipe out demand shocks
- ...but this is not optimal
- a theory of demand shocks that survive optimal policy

Concluding

- Future superior information + forward looking consumers

  $\rightarrow$ policy can induce efficient use of dispersed information

- Related themes: King (1982), Svensson and Woodford (2003), Aoki (2003)

- Efficient use of dispersed information $\neq$ full stabilization output gap
- Still some offsetting of demand shocks is feasible and desirable
- Clearly this requires commitment, which may be tough (bubble example)