Risk Shocks and Economic Fluctuations

Summary of work by Christiano, Motto and Rostagno

Outline

- Simple summary of standard New Keynesian DSGE model (CEE, JPE 2005 model).
- Modifications to introduce CSV financial frictions into model.
- Bayesian estimation of the model.
- Implication of estimated model: risk shocks are important.
- Policy analysis with estimated model.

Standard Model

'Marginal Efficiency of Investment'

Firms

$$Y_t = \left[\int_0^1 Y_{jt}^{\frac{1}{\lambda_{f,t}}} dj\right]^{\lambda_{f,t}}, \; 1 \leq \lambda_{f,t} < \infty,$$

$$Y_{jt} = \epsilon_t K_{jt}^{\alpha} (z_t l_{jt})^{1-\alpha}$$

consumption

Investment goods

$$G_t + C_t + \frac{I_t}{\mu_{\Upsilon,t}} \leq Y_t.$$

Supply labor

Rent capital

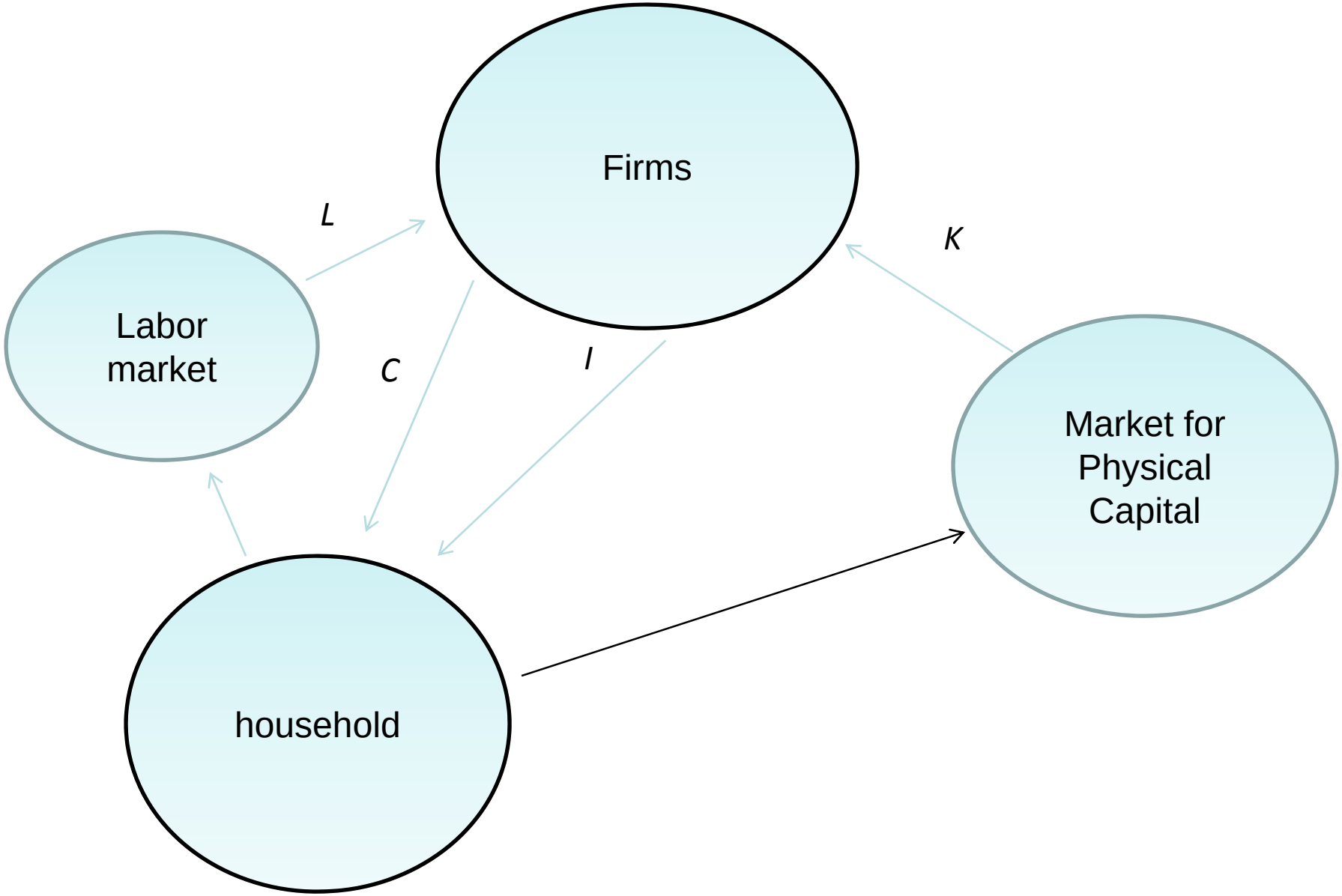
Households

Backyard capital accumulation: $\bar{K}_{t+1} = (1-\delta)\bar{K}_t + G(\zeta_{i,t}, I_t, I_{t-1})$

$$u_{c,t} = E_t \beta \zeta_{c,t} u_{c,t+1} \frac{R_{t+1}^k}{\pi_{t+1}}$$

$$R_{t+1}^k = \frac{u_{t+1} r_{t+1}^k + (1-\delta) P_{k',t+1}}{P_{k',t}}$$

Standard Model



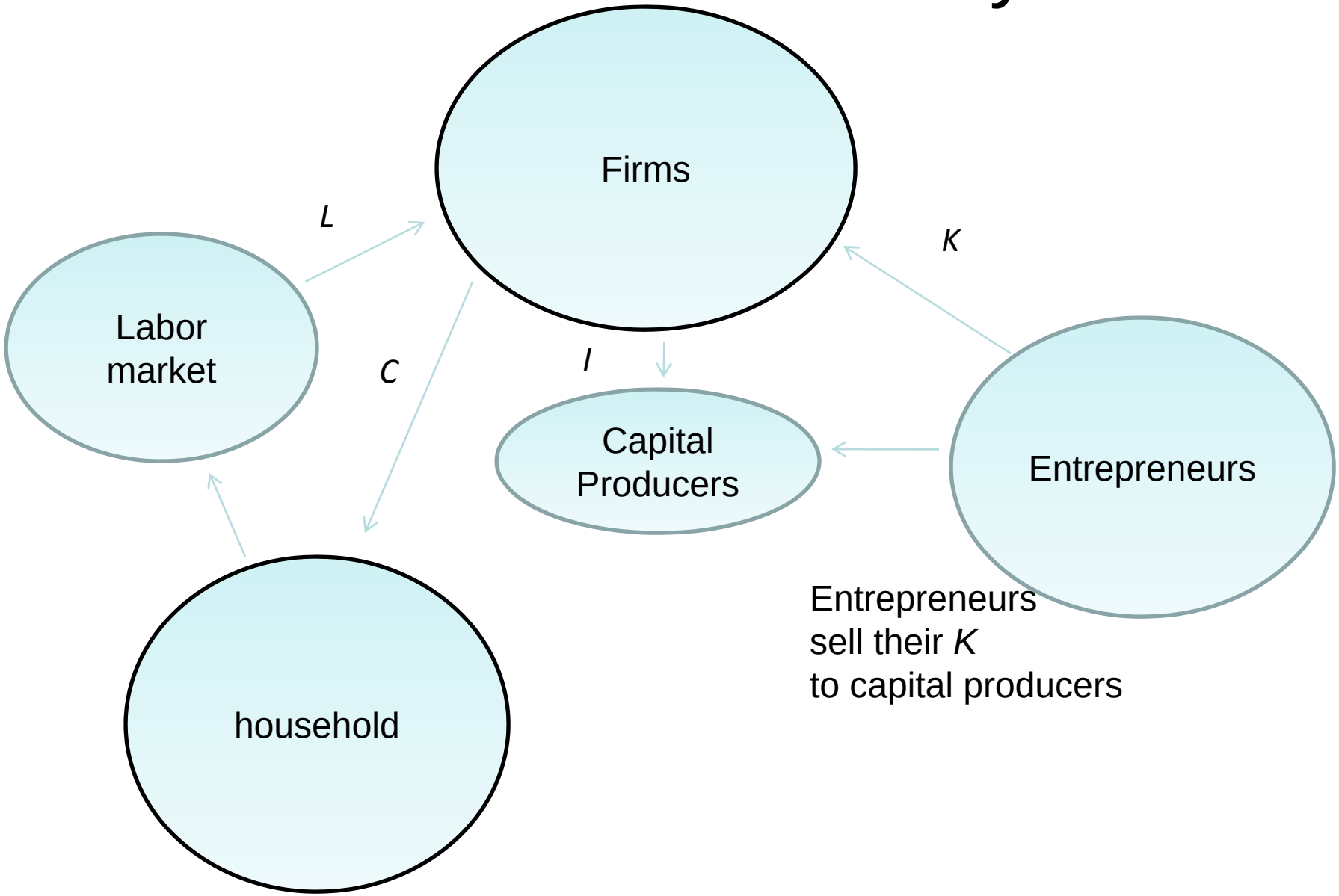
Financing

- In the standard model, already have borrowing by firms for working capital.
  - will now have banks intermediate this borrowing between households and firms.

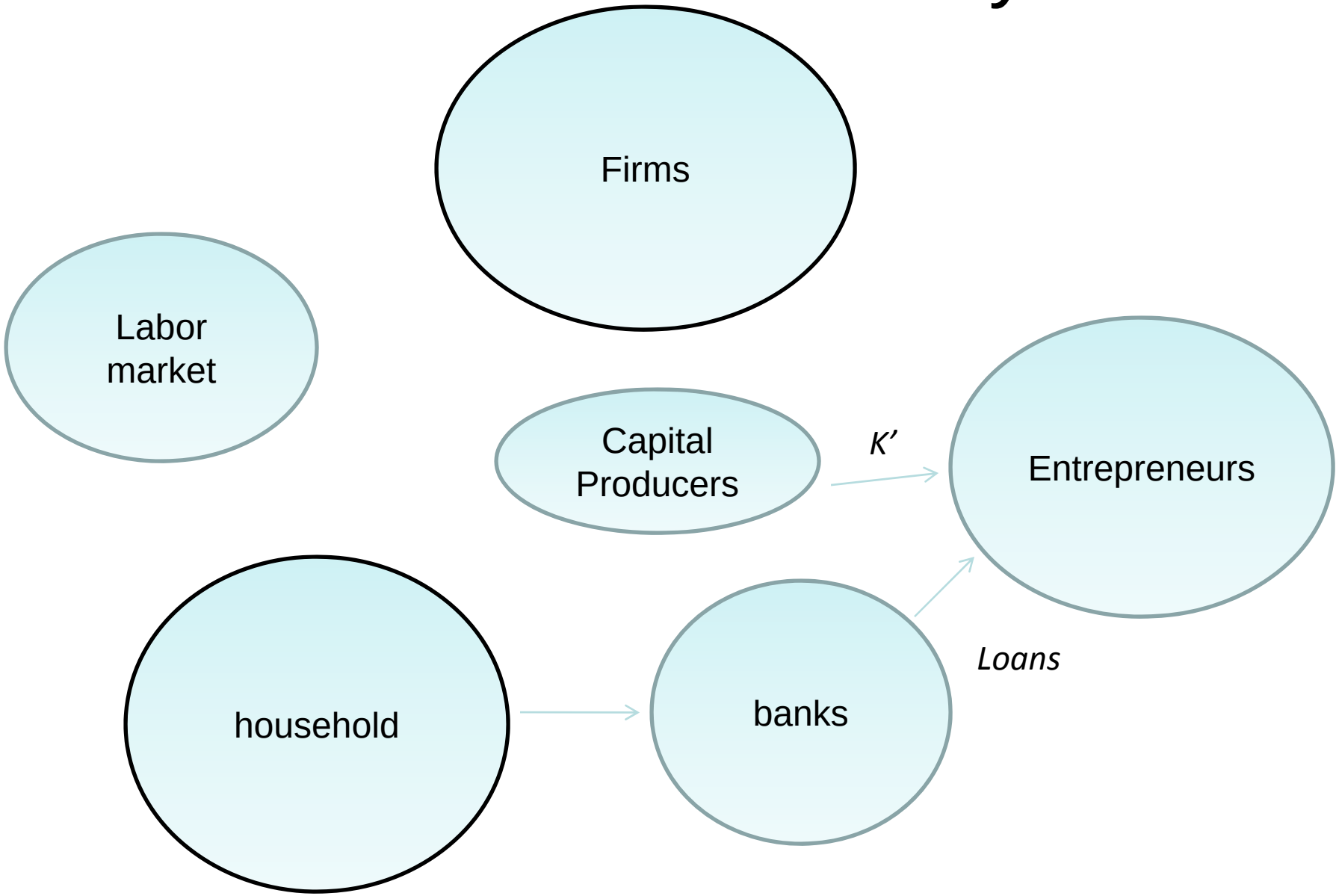
- In standard model, ‘putting capital to work’ is completely straightforward and is done by households. They just rent capital into a homogeneous capital market.

- Now: ‘putting capital to work’ involves a special kind of creativity that only some households – entrepreneurs – have.
  - Entrepreneurs finance the acquisition of capital in part by themselves, and in part by borrowing from regular ‘households’.
  - Conflict of interest, because there is asymmetric information about the payoff from capital.
  - Standard sharing contract between entrepreneur and household not feasible.

Financial Frictions with Physical *K*



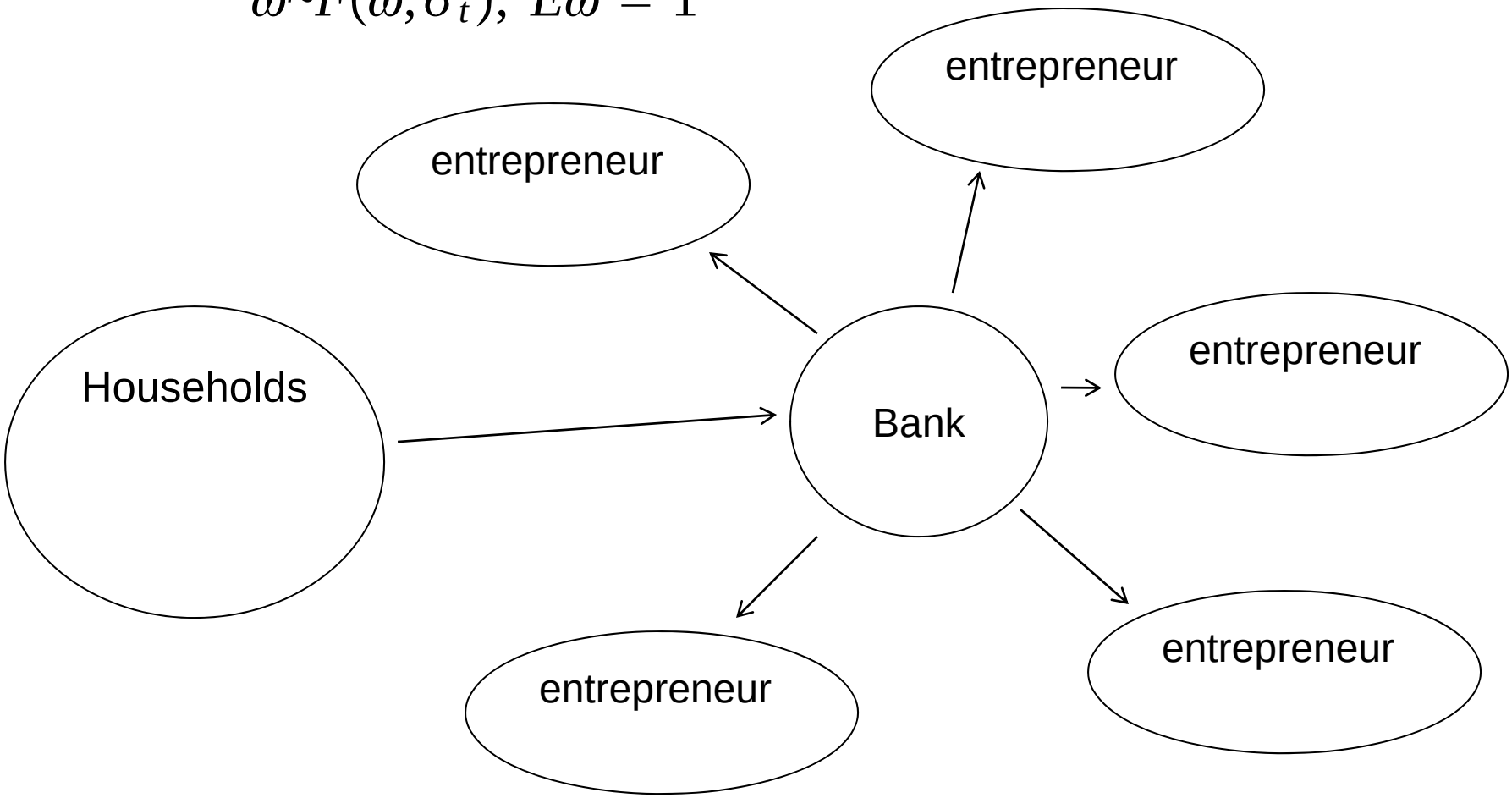
Financial Frictions with Physical *K*



Accounts for over 50% of GDP

Banks, Households, Entrepreneurs

$$\omega \sim F(\omega, \sigma_t),\ E\omega = 1$$



Standard debt contract

- Net worth of an entrepreneur who goes to the bank to receive a loan in period *t*:

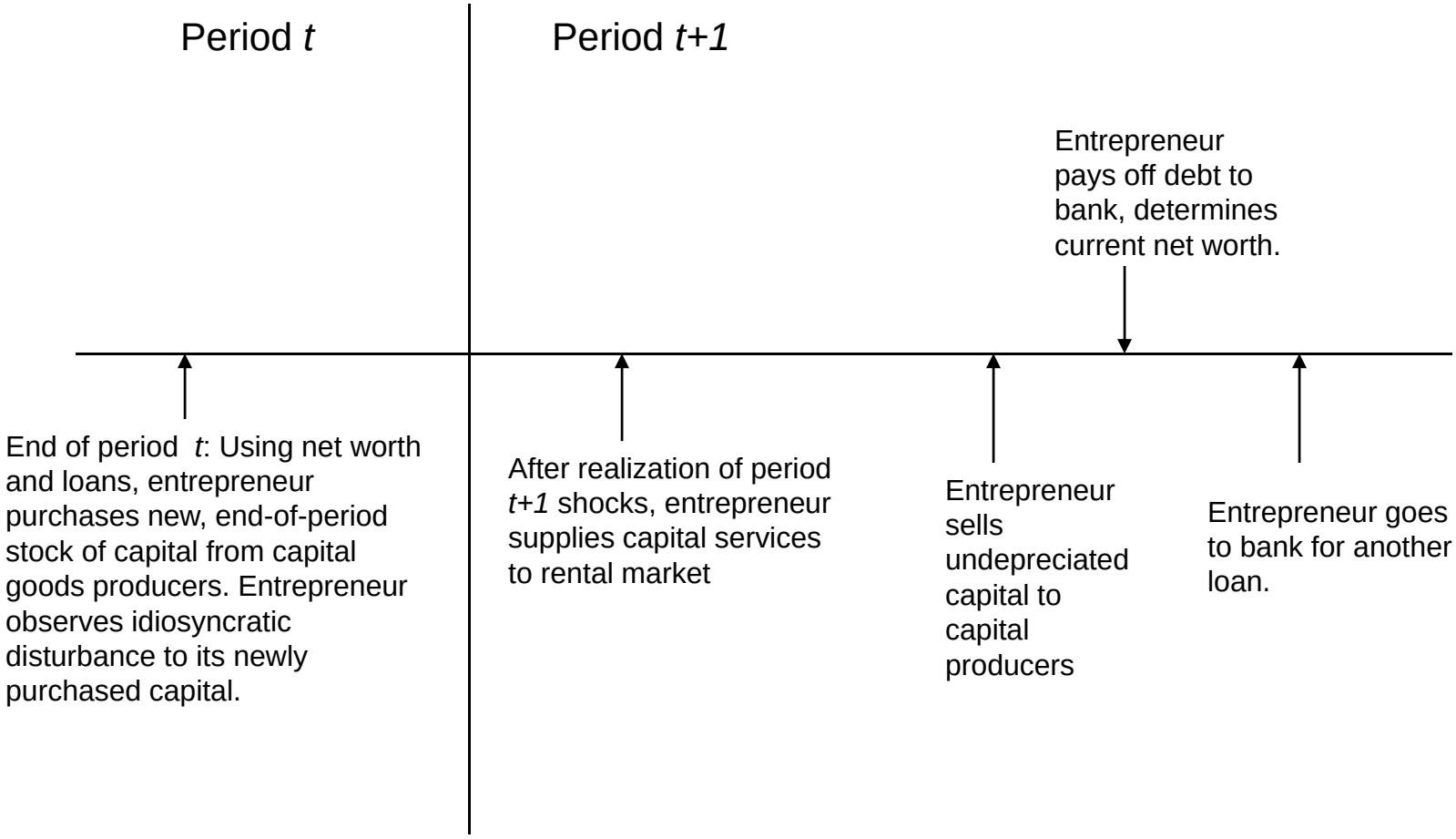
value of capital after production — earnings from capital after utilization costs

$$n_t = \overbrace{P_{k',t}(1-\delta)\omega\bar{K}_t} + \overbrace{r_t^k \omega \bar{K}_t} - B_{t-1}\frac{Z_{t-1}}{\pi_t}$$

An entrepreneur who bought capital in *t-1* experienced an idiosyncratic shock, ω.

This log-normal shock has mean unity across all entrepreneurs, $\omega \sim F(\omega, \sigma_t)$.

Time Line


Period *t*
Period *t+1*
Entrepreneur pays off debt to bank, determines current net worth.
End of period *t*: Using net worth and loans, entrepreneur purchases new, end-of-period stock of capital from capital goods producers. Entrepreneur observes idiosyncratic disturbance to its newly purchased capital.
After realization of period *t+1* shocks, entrepreneur supplies capital services to rental market
Entrepreneur sells undepreciated capital to capital producers
Entrepreneur goes to bank for another loan.

Accelerator and Debt Deflation Effects

- Net worth, averaged across entrepreneurs:

$$N_t = \underbrace{P_{k',t}(1-\delta)\bar{K}_t + r_t^k \bar{K}_t}_{\text{Source of standard 'accelerator effects'}} - \underbrace{B_{t-1}\frac{Z_{t-1}}{\pi_t}}_{\text{source of 'Fisher deflation effects'}}$$

- Shocks that raise output tend to be amplified if the shock also raises capital values and entrepreneurial income ('accelerator effects')

- Shocks that reduce the price level hurt entrepreneurial net worth and depress output ('Fisher deflation effect')

- Finding based on estimated model of US and EA (CMR):
  - Financial frictions magnify output effect of shocks that raise *Y* and *P*.
  - Financial frictions have little impact on shocks that move *Y* and *P* in opposite directions.

Five Adjustments to Standard DSGE Model for CSV Financial Frictions

- Drop: household intertemporal equation for capital.
- Add: characterization of the loan contracts that can be offered in equilibrium (zero profit condition for banks).
- Add: efficiency condition associated with entrepreneurial choice of contract.
- Add: Law of motion for entrepreneurial net worth (source of accelerator and Fisher debt-deflation effects).
- Introduce: bankruptcy costs in the resource constraint.

Risk Shock and News

- Assume

$$\hat{\sigma}_t = \rho_1 \hat{\sigma}_{t-1} + \overbrace{u_t}^{\text{iid, univariate innovation to } \hat{\sigma}_t}$$

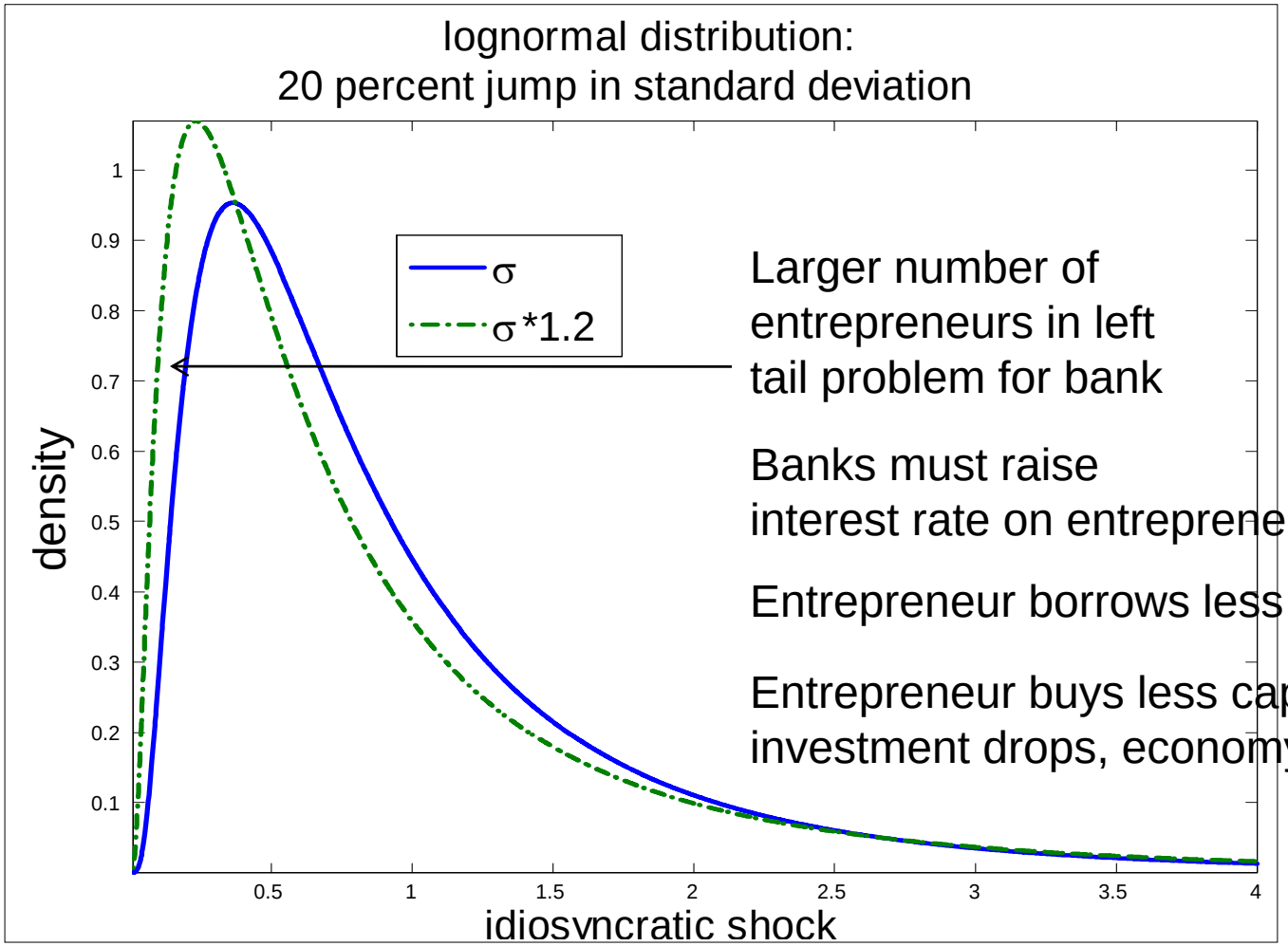
- Agents have advance information about pieces of u_t

$$u_t = \xi_t^0 + \xi_{t-1}^1 + \ldots + \xi_{t-8}^8$$

$$\xi_{t-i}^i \sim \text{iid}, E(\xi_{t-i}^i)^2 = \sigma_i^2$$

$$\xi_{t-i}^i \sim \text{piece of } u_t \text{ observed at time } t - i$$

Economic Impact of Risk Shock



Larger number of entrepreneurs in left tail problem for bank

Banks must raise interest rate on entrepreneur

Entrepreneur borrows less

Entrepreneur buys less capital, investment drops, economy tanks

Monetary Policy

- Nominal rate of interest function of:
  - Anticipated level of inflation.
  - Slowly moving inflation target.
  - Deviation of output growth from ss path.
  - Monetary policy shock.

Estimation

- Use standard macro data: consumption, investment, employment, inflation, GDP, price of investment goods, wages, Federal Funds Rate.
- Also some financial variables: BAA - 10 yr Tbond spreads, value of DOW, credit to nonfinancial business.
- Data: 1985Q1-2010Q2

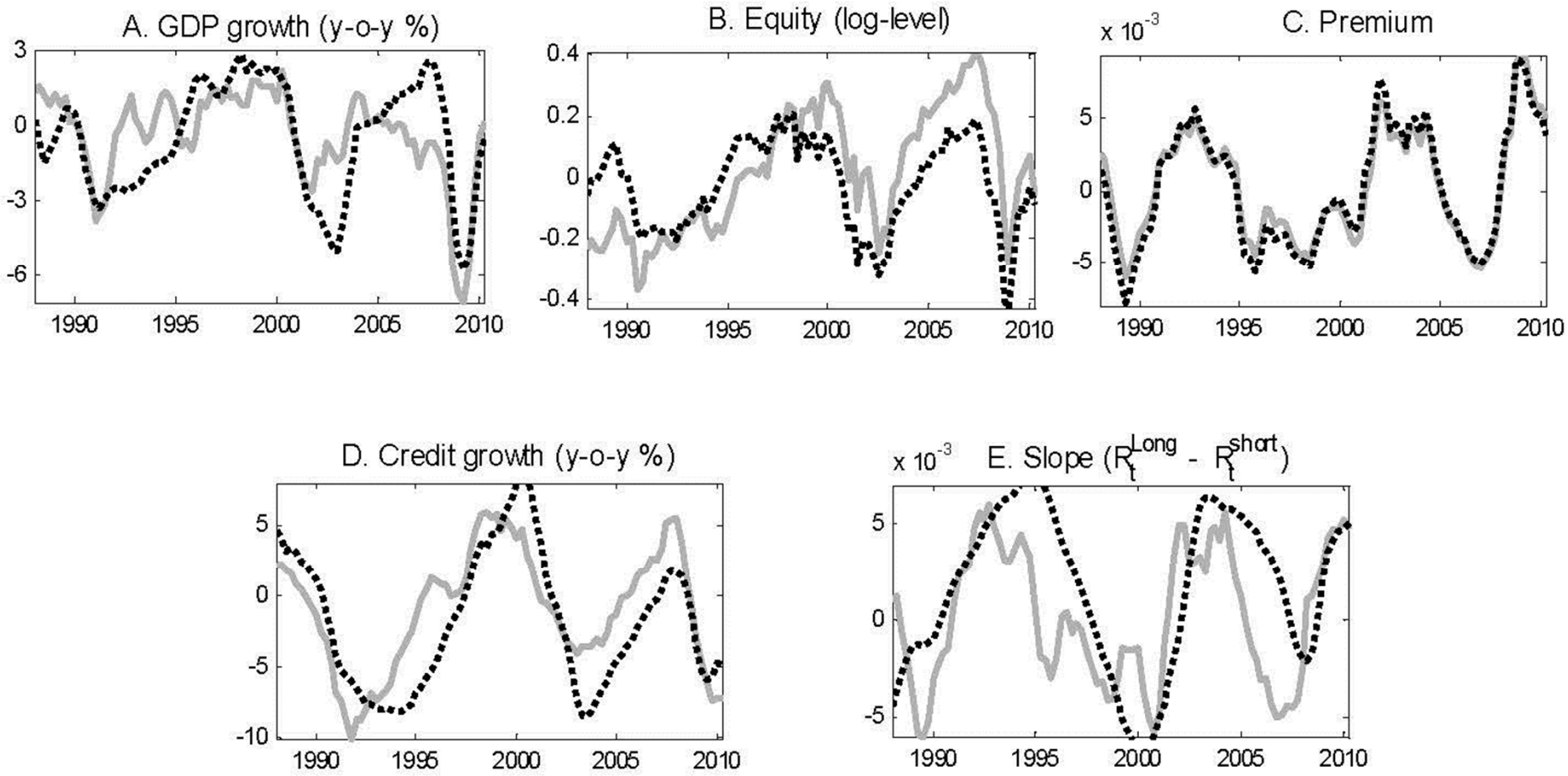
Key Result

- Risk shocks:
  - important source of fluctuations.
- Out-of-Sample evidence suggests the model deserves to be taken seriously.

Risk Shocks

- Important
- Why are they important?
- What shock do they displace, and why?

Role of the Risk Shock in Macro and Financial Variables



Notes: The grey solid line represents the (two-sided) fitted data. The dotted black line is the model simulations.

Percent Variance in Business Cycle Frequencies Accounted for by Risk Shock	
variable	*Risk*, σ_t
GDP	62
Investment	73
Consumption	16
Credit	64
Premium $(\mathbf{Z} - \mathbf{R})$	95
Equity	69
$R^{10 \text{ year}} - R^{1 \text{ quarter}}$	56

Note: 'business cycle frequencies means' Hodrick-Prescott filtered data.

Why Risk Shock is so Important

- A. Our econometric estimator ‘thinks’

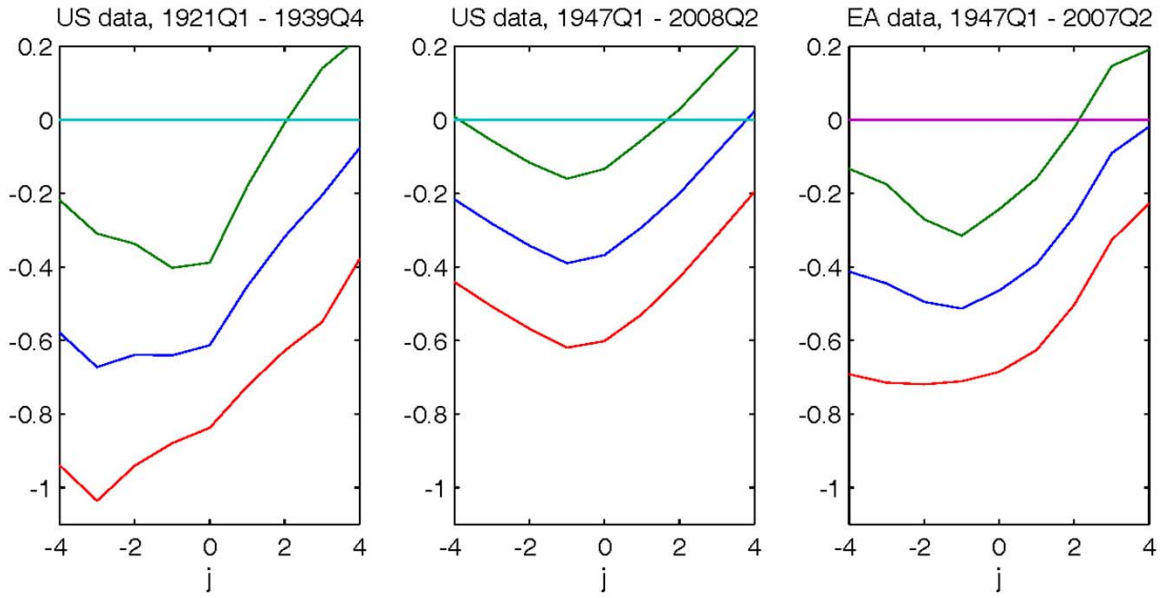
  risk spread ~ risk shock.

- B. In the data: the risk spread is strongly negatively correlated with output.

- C. In the model: bad risk shock generates a response that resembles a recession

- A+B+C suggests risk shock important.

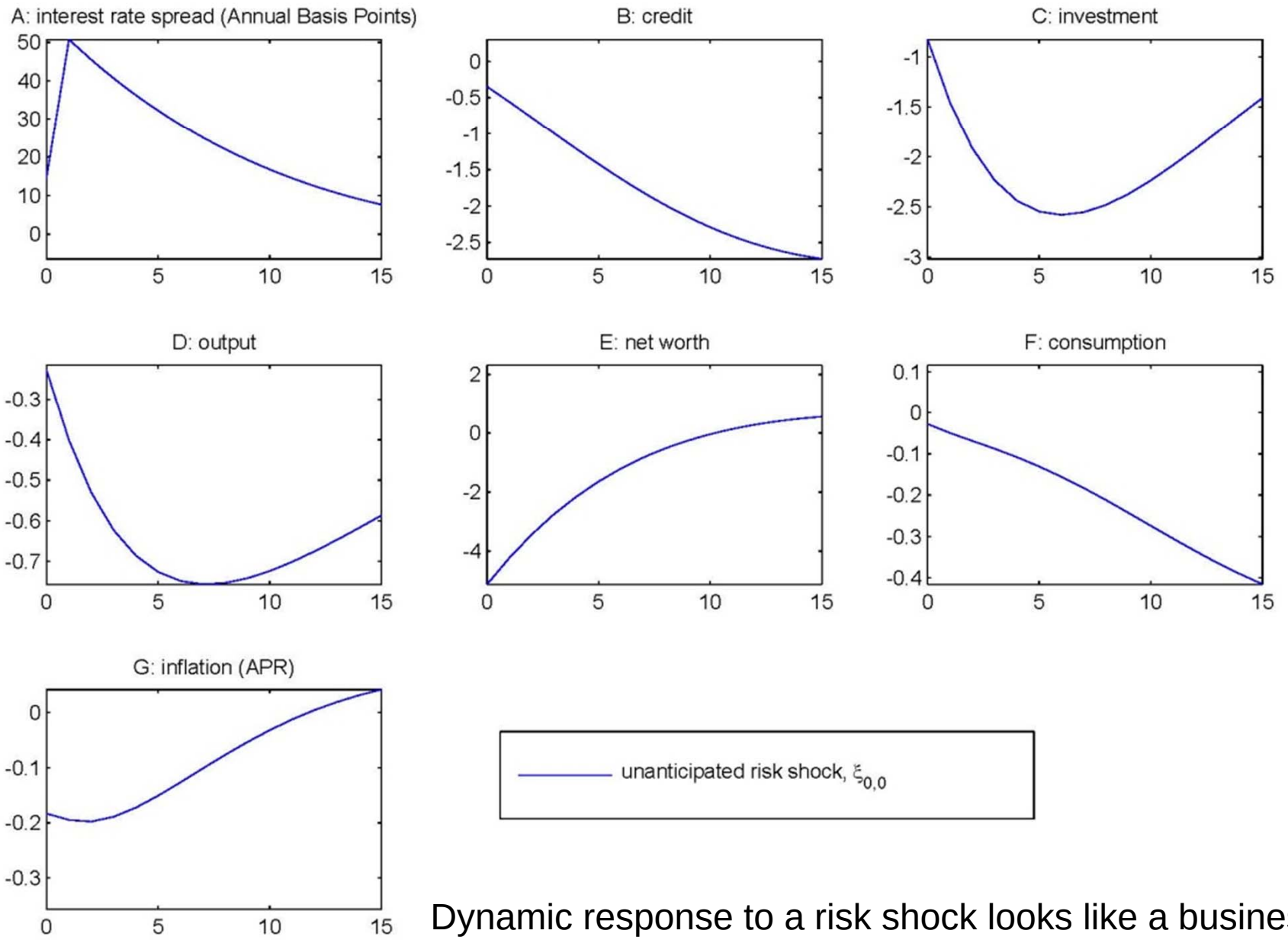
Correlation (risk spread(t),output(t-j)), HP filtered data, 95% Confidence Interval



The risk spread is significantly negatively correlated with output and leads a little.

Notes: Risk spread is measured by the difference between the yield on the lowest rated corporate bond (Baa) and the highest rated corporate bond (Aaa). Bond data were obtained from the St. Louis Fed website. GDP data were obtained from Balke and Gordon (1986). Filtered output data were scaled so that their standard deviation coincide with that of the spread data.

Figure 6: Dynamic Responses



Dynamic response to a risk shock looks like a business cy

What Shock Does the Risk Shock Displace, and why?

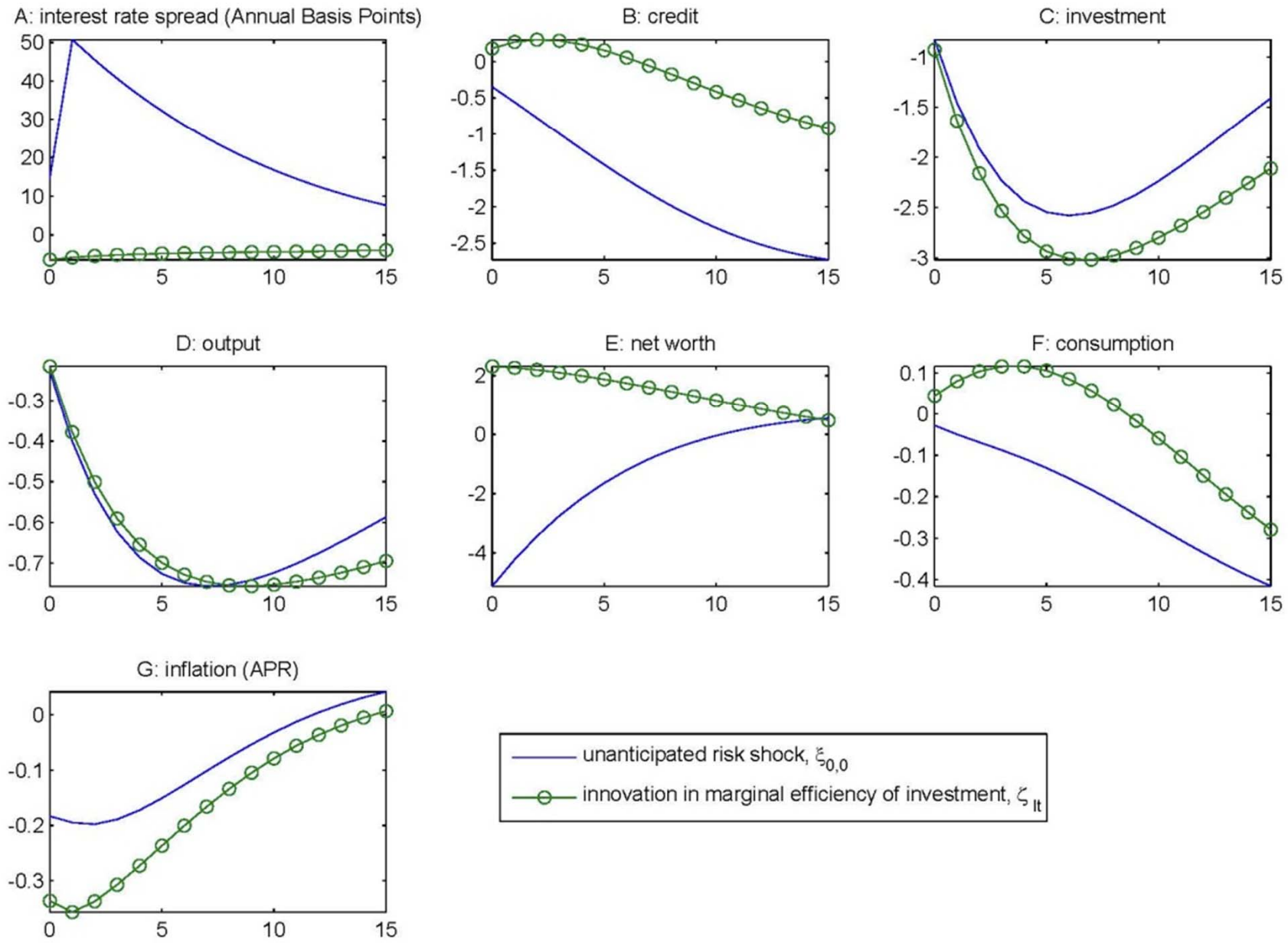
- The risk shock mainly crowds out the marginal efficiency of investment.
  - But, it also crowds out other shocks.

- Compare estimation results between our model and model with no financial frictions or financial shocks (CEE).

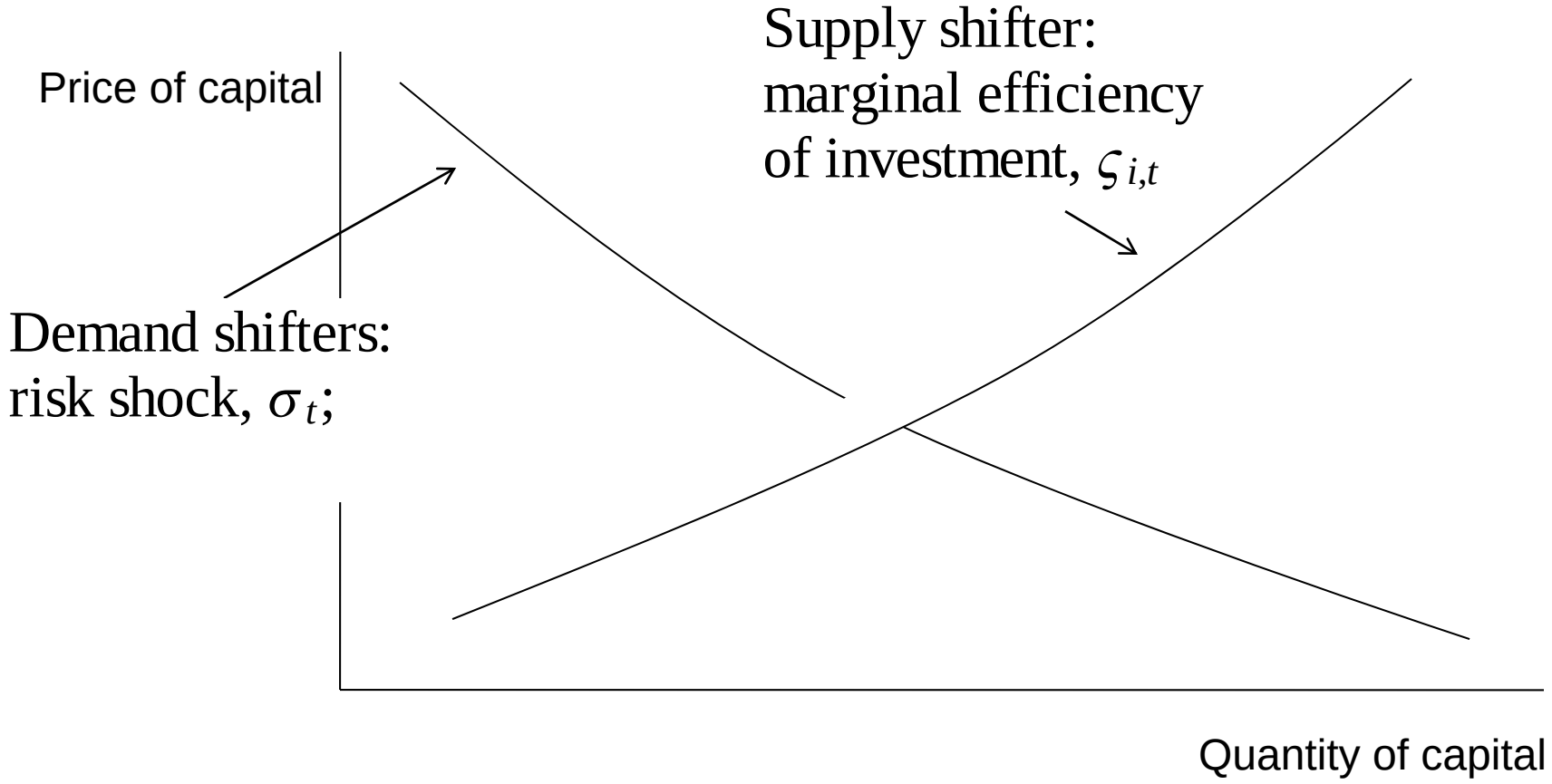
- Baseline model mostly ‘steals’ explanatory power from m.e.i., but also from other shocks:

Variance Decomposition of GDP at Business Cycle Frequency (in percent)									
shock	*Risk* σ_t	*Equity* γ_t	*M.E.I.* $\zeta_{I,t}$	*Technol.* $\varepsilon_t,\ \mu_{z,t},$	*Markup* $\lambda_{f,t},$	*M.P.* ϵ_t	*Demand* $\zeta_{c,t}$	*Exog.Spend.* g_t	*Term*
Baseline model	62	0	13	2	12	2	4	3	0
CEE	[–]	[–]	[39]	[18]	[31]	[4]	[3]	[5]	[-]

Figure 6: Dynamic Responses to Two Shocks



Why does Risk Crowd out Marginal Efficiency of Investment?



- Marginal efficiency of investment shock can account well for the surge in investment and output in the 1990s, *as long as the stock market is not included in the analysis.*

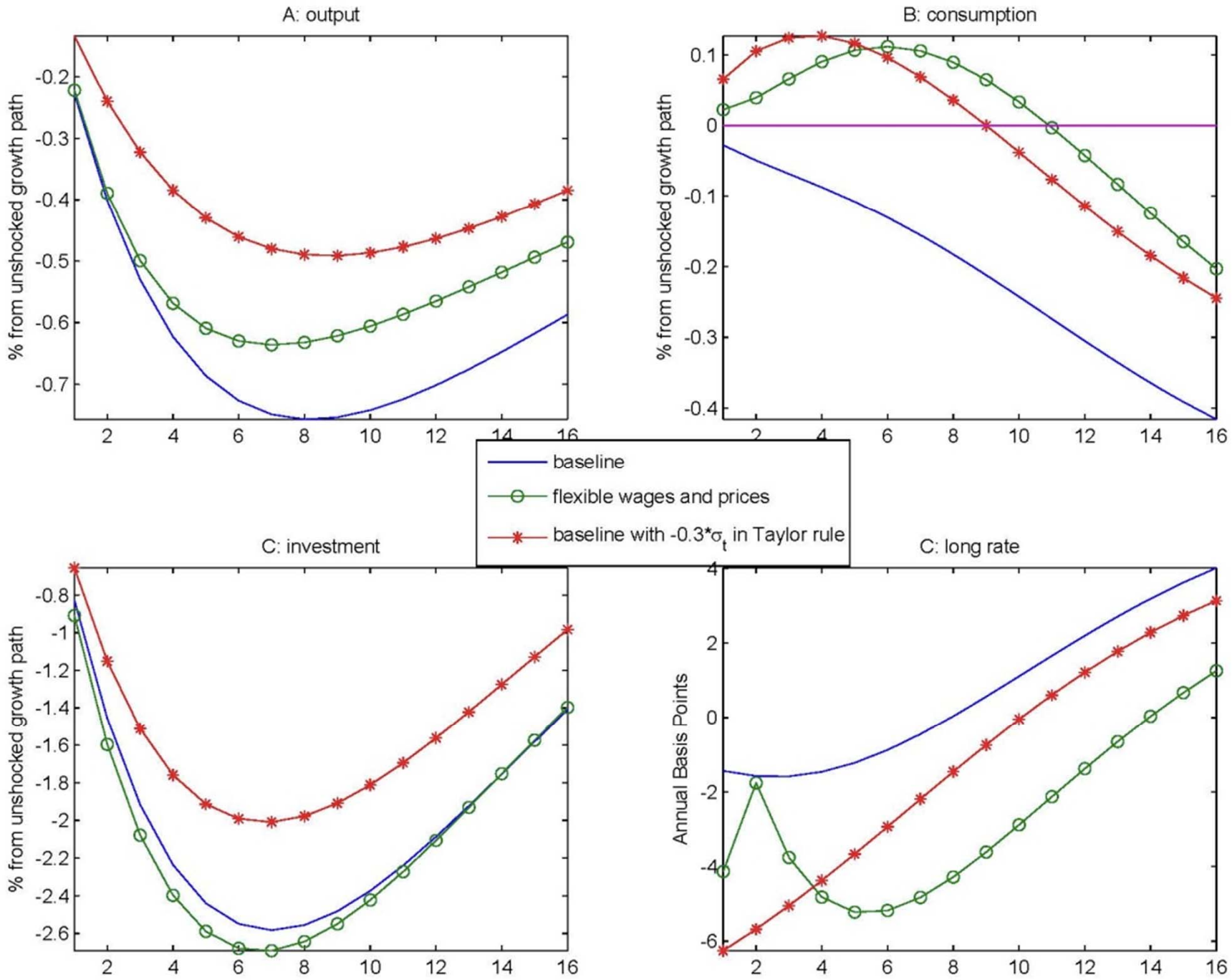
- When the stock market is included, then explanatory power shifts to financial market shocks.

CKM Challenge

- CKM argue that risk shocks (actually, any intertemporal shock) cannot be important in business cycles.
- Idea: a shock that hurts the intertemporal margin will induce substitution away from investment and to other margins, such as consumption and leisure.
- CKM argument probably right in RBC model.
- Not valid in New Keynesian models.

Failure of Comovement Between C & I in RBC Models With Risk Shocks

- In RBC model, jump in risk discourages investment.
- Reduction in demand leads to reduction of price of current goods relative to future goods, i.e., real interest rate.
- Real interest rate decline induces surge in demand, partially offsetting drop in investment.
- This Mechanism does not necessarily work in NK model because real rate not fully market determined there.


A: output
% from unshocked growth path
B: consumption
% from unshocked growth path
baseline
flexible wages and prices
baseline with -0.3*σt in Taylor rule
C: investment
% from unshocked growth path
C: long rate
Annual Basis Points

‘Out of Sample Evidence’

- Out of sample forecasting performance good.
- Predictions for aggregate bankruptcy rate good.
- Correlates well with Bloom evidence on cross-sectional uncertainty.

A Policy Experiment….

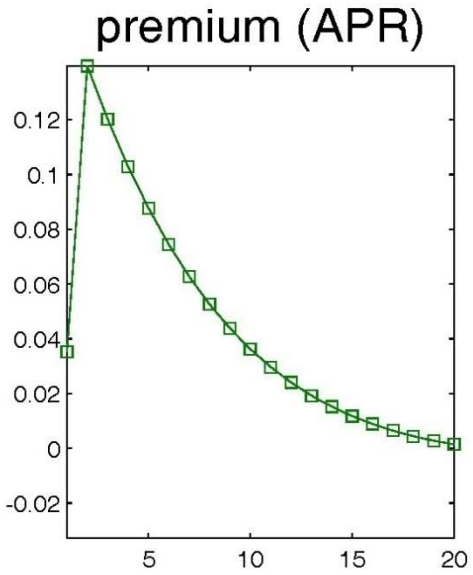
How Should Policy Respond to the Risk Spread?

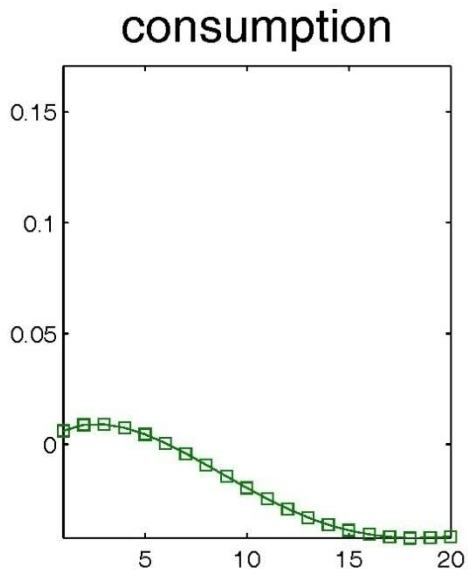
- Taylor's recommendation:

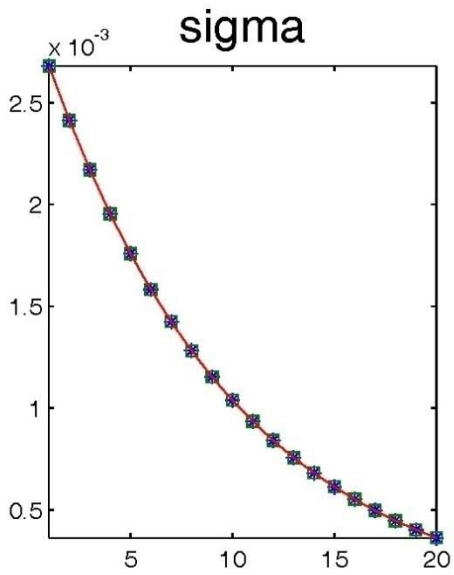
$$R_t = \alpha \pi_t^e + \beta y_t - \gamma(\text{Risky rate}_t - \text{Risk free rate}_t)$$

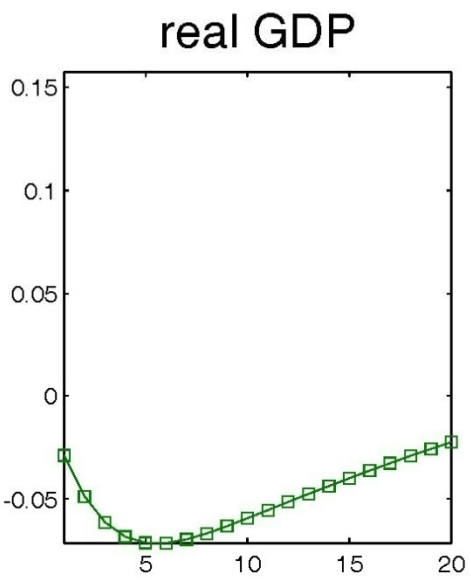
$$\gamma = 1$$

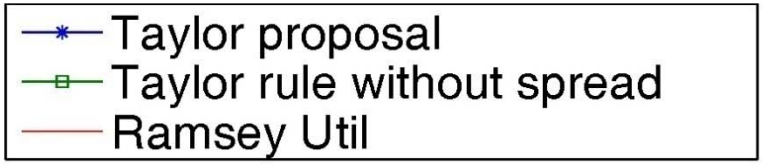
- Evaluate this proposal by comparing performance of economy with $\gamma = 1$ and $\gamma = 0$ against Ramsey-optimal benchmark.



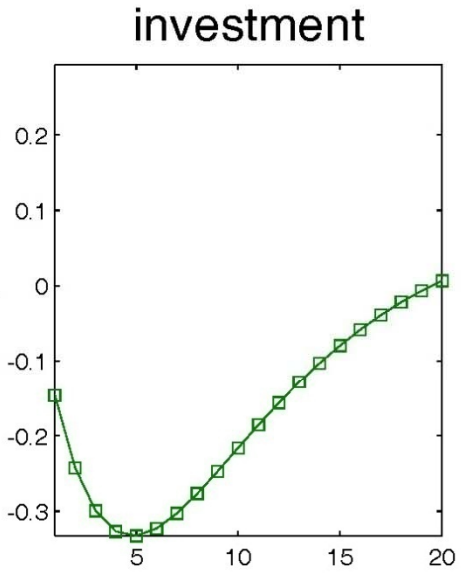




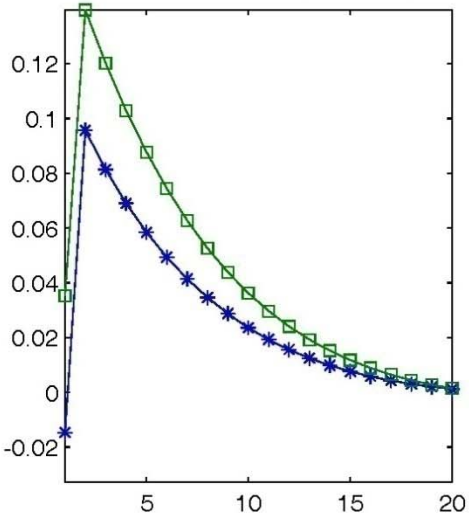




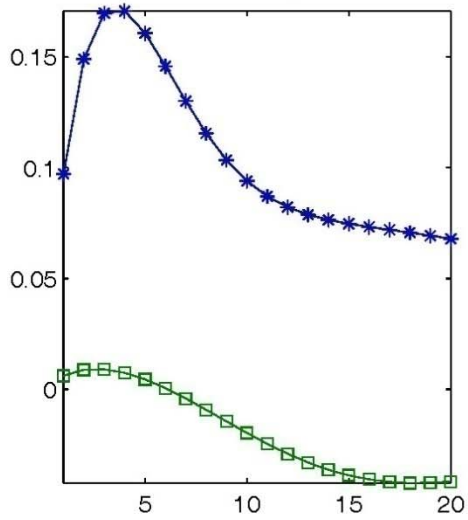
Get a recession, just like in earlier graph



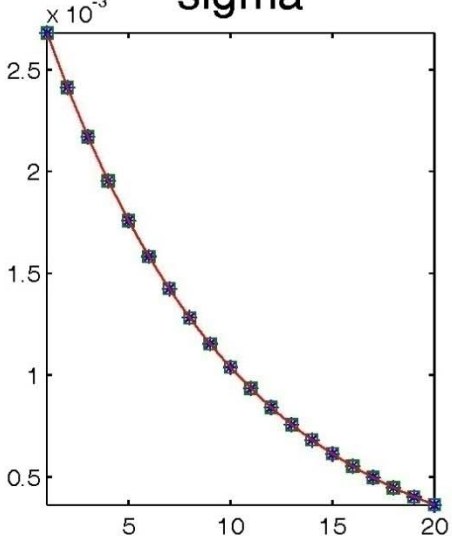
premium (APR)



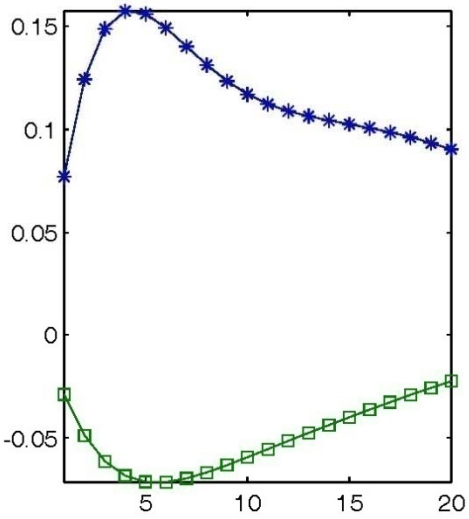
consumption



sigma



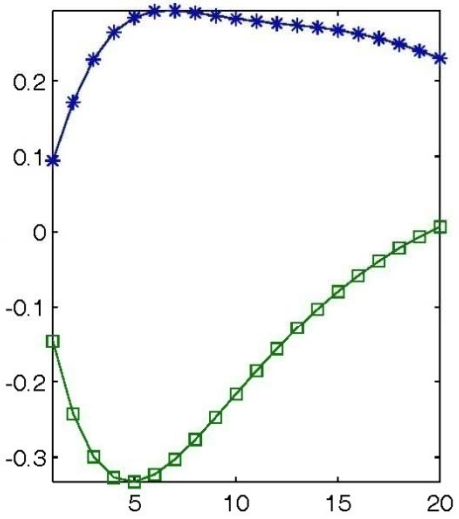
real GDP

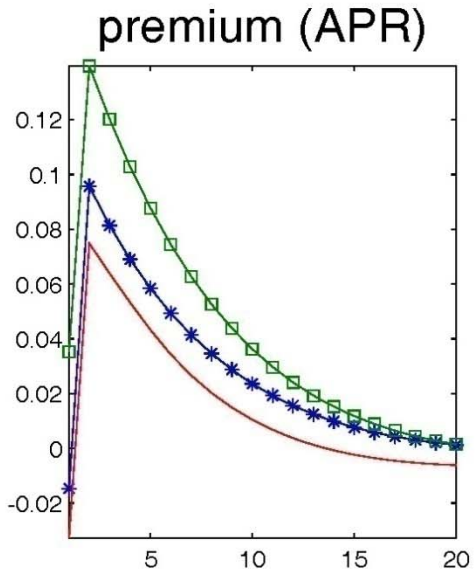


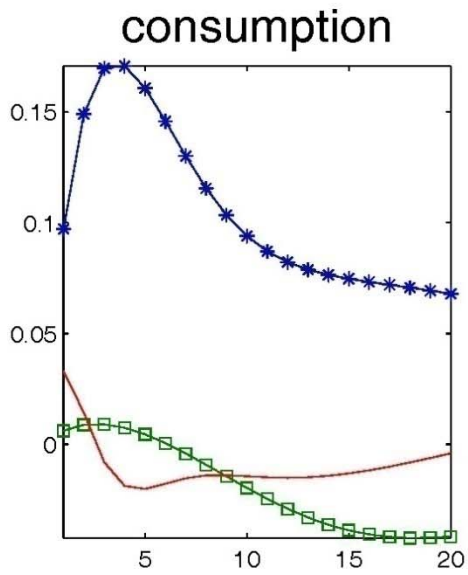
Taylor proposal
Taylor rule without spread
Ramsey

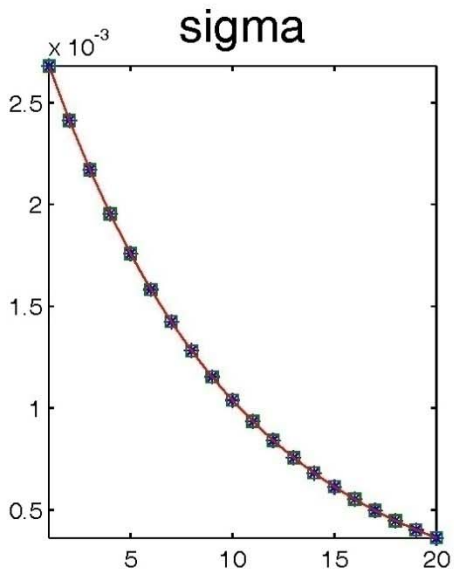
Taylor suggestion creates a boom
Is it too much?

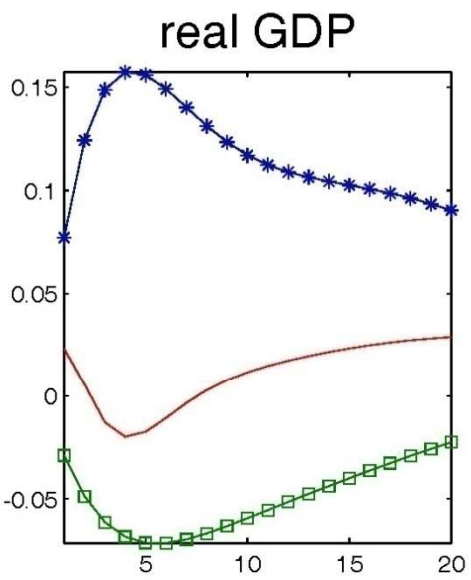
investment



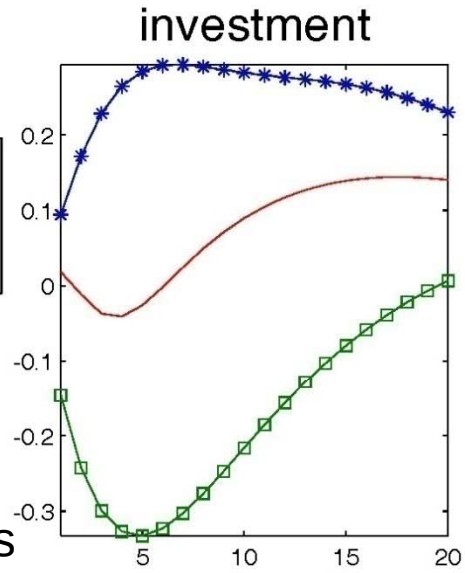








Taylor proposal
Taylor rule without spread
Ramsey Util



Taylor's suggestion overstimulates

Conclusion

- Incorporating financial frictions changes inference about the sources of shocks:
  - risk shock.
- Interesting to Explore Mechanisms that Make Risk Shock Endogenous.
- Models with financial frictions can be used to ask interesting policy questions:
  - When there is an increase in risk spreads, how should monetary policy respond?
  - How should monetary policy be structured to avoid excess asset market volatility?
  - What are the pro's and con's of 'unconventional monetary policy'?