Macroeconomics A

Lecture 6: Credit Frictions

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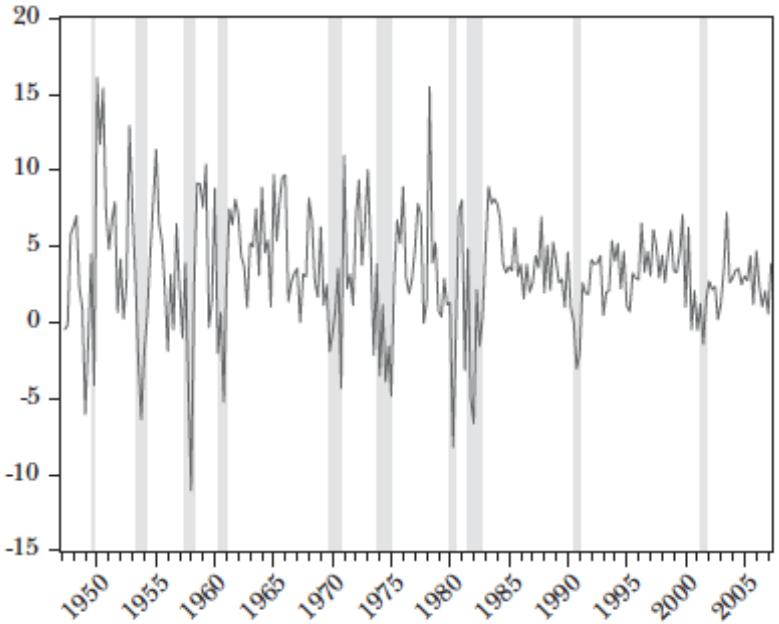
The "Great Moderation", 1980 – 2007

- Macroeconomic volatility during 1980 – 2007 much lower than before
- Lucas (2003): "[...] macroeconomics in this original sense has succeeded: its central problem of depression prevention has been solved, for all practical purposes, and has in fact been solved for many decades."
- Why? Commonly given reasons:
  - Independent CBs and good MP
  - Structural change from manufacturing (volatile) to services (believed to be less volatile)
  - More information available (IT revolution)
  - Luck

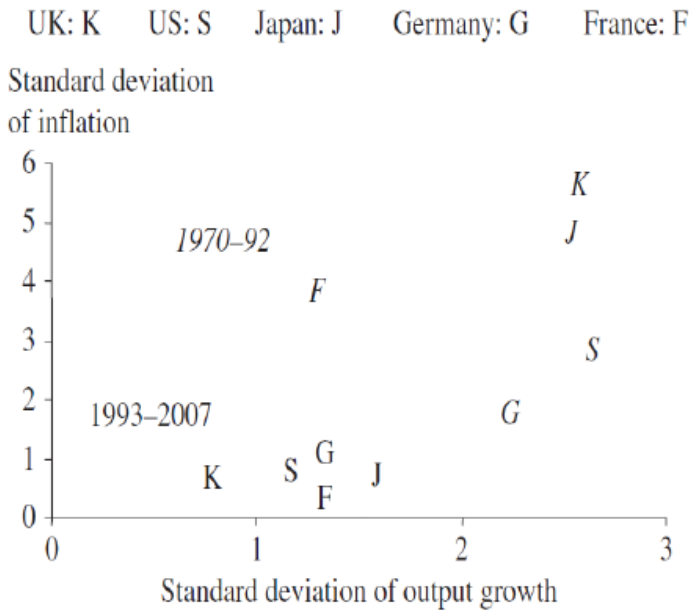
The "Great Moderation", 1980 – 2007

GDP Growth, 1947–2007
(quarterly, annual rate in percent)

(US)

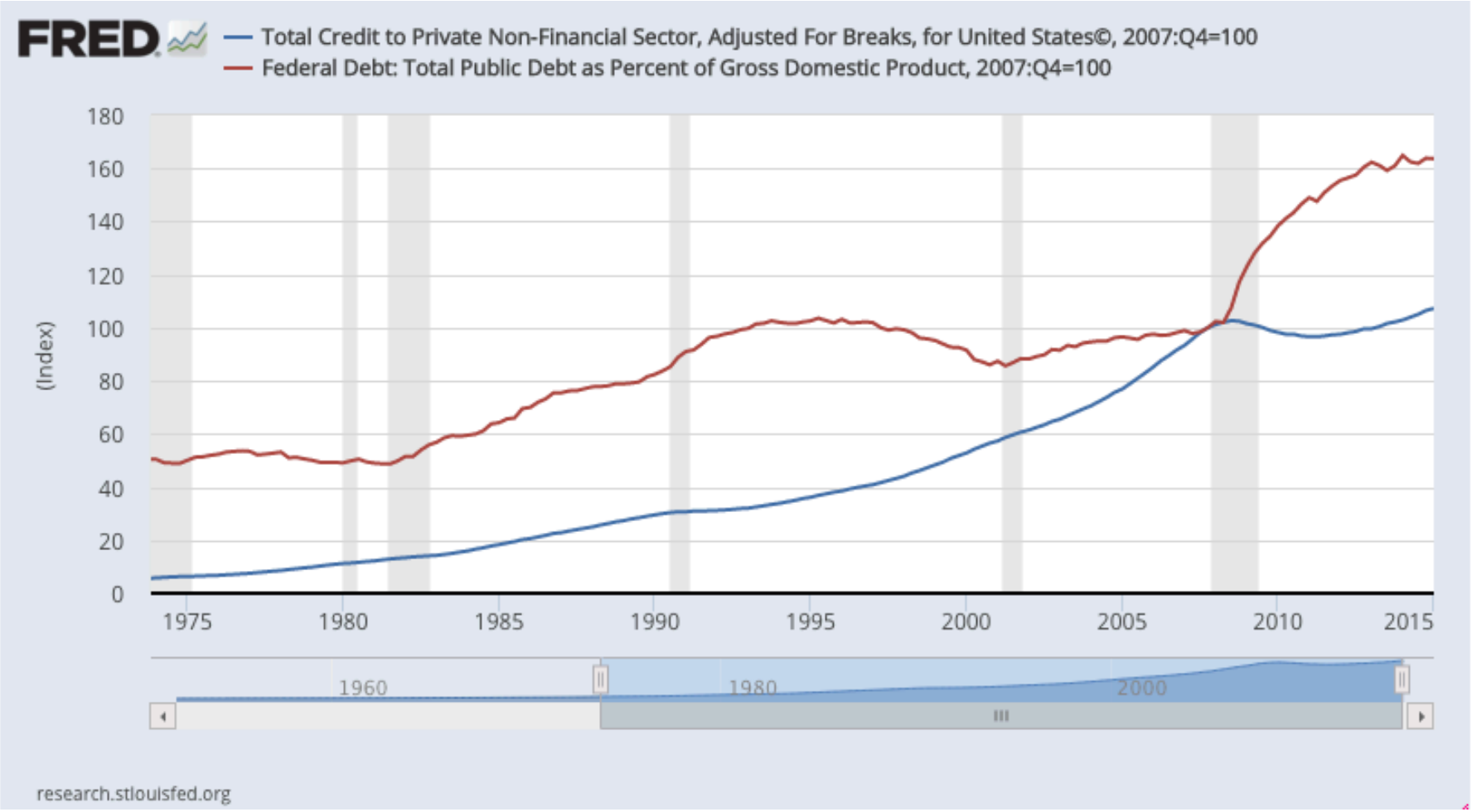


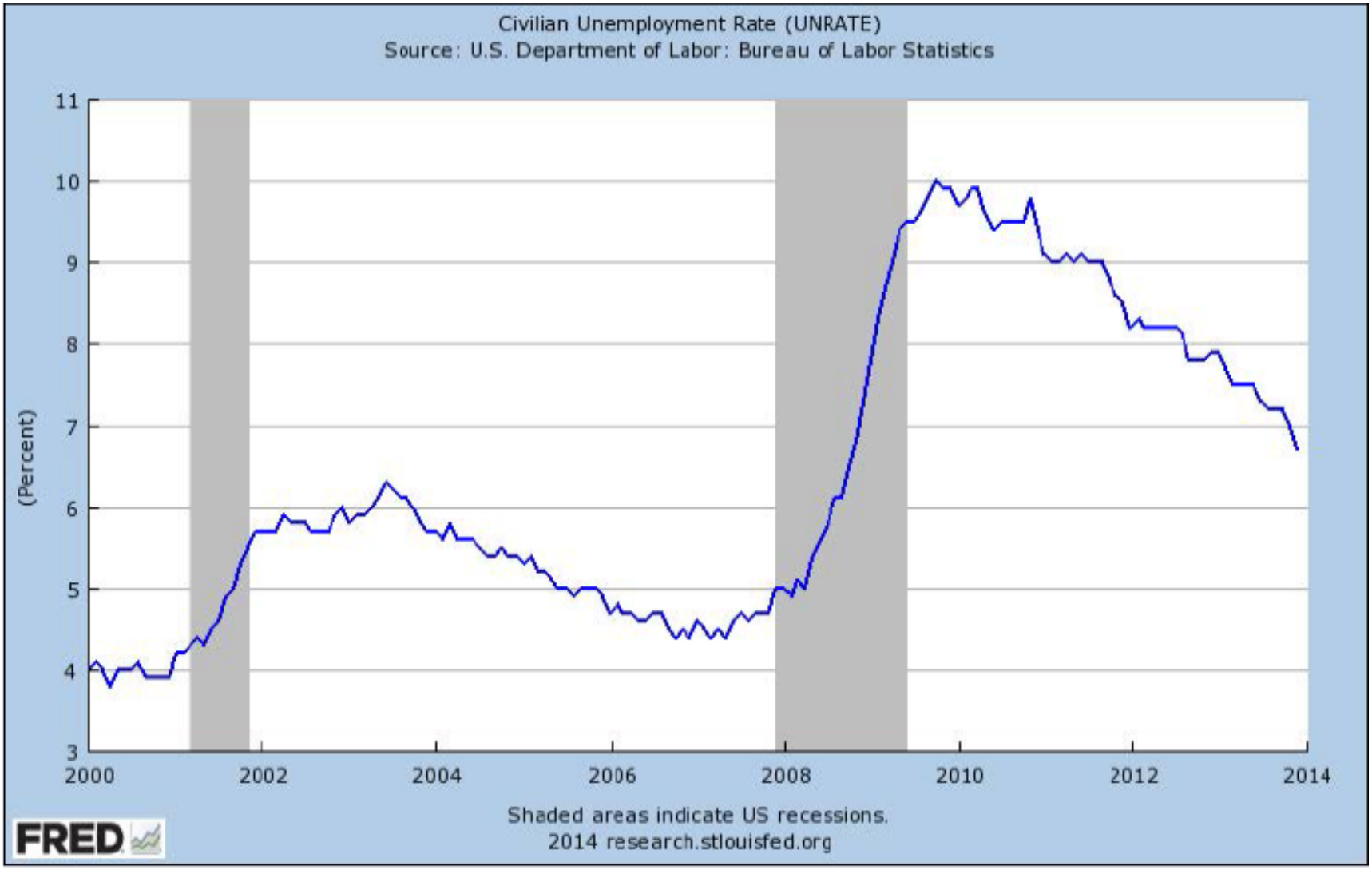
Source: National Income and Product Accounts.
Note: Shaded periods represent NBER-designated recessions



Source: Bean, *EJ*, 2009.

Increase in debt




Civilian Unemployment Rate (UNRATE)
Source: U.S. Department of Labor: Bureau of Labor Statistics
(Percent)
11
10
9
8
7
6
5
4
3
2000
2002
2004
2006
2008
2010
2012
2014
Shaded areas indicate US recessions.
2014 research.stlouisfed.org
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Credit frictions

No role for financial sector and asset prices in the models so far. Recent experience (financial crisis 2008-2010) says there must be a link between finance and macro.

- The financial crisis can be analysed from many different angles (labor: banker's pay and incentives, intl macro: savings glut, micro: coordination failures/bank runs, political economy).
- We are going to model one mechanism that gives a role for asset prices in the transmission of shocks. This is by far not the only explanation for what happened!
- This mechanism gives an answer to the question: why were the real effects of the bursting of the housing bubble so big?

Quantitative model of the financial accelerator

- Original model of financial accelerator due to Kiyotaki and Moore (1998).
- Study a simplified version of Bernanke, Gertler, Gilchrist (1999), which is closer to NK and aims to be quantitative model.
- Three types of agents: households, entrepreneurs, retailers
- Households: Supply labor, save, and consume goods. Standard.
- Entrepreneurs: Borrow to invest, accumulate net worth, supply some labor,
- Retailers: Buy the homogenous good produced by entrepreneurs and differentiate them before selling on to households. Retail prices are sticky.

Credit markets and asymmetric information

- Fundamental problem that borrowers have more information about (and more control over) the projects they undertake than the lenders who finance them.
- Assume lender cannot verify the outcome of an investment project without some monitoring cost.
- Known as costly state verification (CSV) problem.
- Leads to a positive *external finance premium* (= cost of financing from outside the firm relative to opportunity cost)
- Ability to borrow is constrained by net worth

Entrepreneurs

- Risk-neutral (otherwise very hard)
- Die with probability $1 - \gamma$ (so that they never accumulate enough net worth to become self-financing)
- Borrow money (in addition to using their net worth) to acquire capital
- Also supply some labor to the general labor market

Idiosyncratic risk for entrepreneurs

Let's first look at the entrepreneur's problem and financing frictions in a simplified setting.

- Entrepreneurs can do a "project" in every period, which yields a total nominal payoff of

$$\omega R^k Q K$$

  if K units of capital are used. Q is the price of one unit of capital. Hence, ωR^k is the gross nominal return on capital. R^k is the aggregate component (common for all firms) and ω is the firm-specific component.
- ω drawn from a continuous distribution with CDF $F(x)$, PDF $f(x)$, an expectation $\mathbb{E}(\omega) = 1$.
- Ex ante, neither the entrepreneur nor the lender observe ω prior to undertaking project
- Ex post, the entrepreneur observes ω. The lender would have to incur a monitoring cost, which is a fraction μ of the ex post project payoff, in order to see ω.

Borrowing decision and contract offered by lender

- Suppose an entrepreneur has net worth N at the beginning of the period.
- The price of capital goods is Q.
- For the entrepreneur to acquire K units of capital, an amount $QK - N$ must be borrowed once net worth has been used.
- If the entrepreneur's idiosyncratic shock is ω, the total project payoff is $\omega R^k QK$
- The financial contract we consider specifies a threshold $\overline{\omega}$.
  - if $\omega \geq \overline{\omega}$ then a fixed amount $\overline{\omega} R^k QK$ is repaid
  - if $\omega < \overline{\omega}$ then the borrower defaults, and after the lender has inspected the project and determined ω, an amount $(1 - \mu)\omega R^k QK$ can be seized.
- This type of contract is known as *risky debt* and can be shown to contain a contract that is optimal from the borrower's pespective (see micro/mechanism design class).

Lender's return

- Suppose the lender is able to diversify lending across a large representative sample of entrepreneurs with net worth N.
- As entrepreneurs' idiosyncratic draws are independent, the law of large numbers applies and the actual return on lending amount $QK - N$ is:

$$\left(\overline{\omega}(1 - F(\overline{\omega})) + (1 - \mu)\int_0^{\overline{\omega}} \omega f(\omega) d\omega\right) R^k QK$$

- Suppose the lender's outside option for lending is to earn a risk-free interest R. Assuming perfect competition between lenders, we get that the above must equal $R(QK - N)$.

Division of gross profits

- Define the lender's gross share of aggregate revenues (before monitoring costs) as

$$\Gamma(\overline{\omega}) \equiv \int_0^{\overline{\omega}} \omega f(\omega) d\omega + \overline{\omega} \int_{\overline{\omega}}^{\infty} f(\omega) d\omega$$

and

$$G(\overline{\omega}) \equiv \int_0^{\overline{\omega}} \omega f(\omega) d\omega$$

- Then the monitoring costs are $\mu G(\overline{\omega})$.
- Lender's net share of revenues $= \Gamma(\overline{\omega}) - \mu G(\overline{\omega})$
- Borrower's net share of revenues $= 1 - \Gamma(\overline{\omega})$

Optimal contracting problem

- Maximize borrower's payoff in the aggregate (or expectation of individual's payoff: is the same because of LLN) subject to lender wanting to participate (gets at least his outside option)
- Choice variables: terms of the loan: default threshold $\overline{\omega}$ and amount lent $B \equiv QK - N$. For given Q and N, maximizing over K is equivalent to maximizing over B.
- Formally:

$$\max_{K,\overline{\omega}} (1 - \Gamma(\overline{\omega}))R^k QK \tag{1}$$

$$\text{s.t.} \quad (\Gamma(\overline{\omega}) - \mu G(\overline{\omega}))R^k QK = R(QK - N) \tag{2}$$

- Define the external finance premiunm $s \equiv R^k/R$ and $k \equiv QK/N$ and rewrite the problem as

$$\max_{k,\overline{\omega}} (1 - \Gamma(\overline{\omega}))sk \tag{3}$$

$$\text{s.t.} \quad (\Gamma(\overline{\omega}) - \mu G(\overline{\omega}))sk = k - 1 \tag{4}$$

Solving this

- First-order conditions from the Lagrangian:

$$\Gamma'(\overline{\omega}) = \lambda(\Gamma'(\overline{\omega}) - \mu G'(\overline{\omega}))$$
$$((1 - \Gamma(\overline{\omega})) + \lambda(\Gamma(\overline{\omega}) - \mu G(\overline{\omega})))\, s = \lambda$$

  and the constraint must bind:

$$(\Gamma(\overline{\omega}) - \mu G(\overline{\omega}))sk = k - 1$$

- Under some regularity conditions, you can show that these equations imply a solution of the form

$$k = \psi(s)$$

  where $\psi(s)$ is increasing in s.

Interpretation

Rewrite as

$$QK = \psi(s)N.$$

The borrower can raise more capital K when

- the average return on project R^k increases compared to lender's outside option R (i.e. increase in s):
- the borrower's net worth N increases: higher collateral
- when the price of capital Q_t decreases

The full model makes R^k stochastic, and allows for contracts contingent on R^k. Result very similar, with $s = \mathbb{E}(R^k/R)$.

Putting this into general equilibrium

- Entrepreneurs' aggregate production function is

$$Y_t = A_t K_t^{\alpha} L_t^{1-\alpha}$$

(Individual production function includes idiosyncratic ω component)

- Expected gross return to holding one more unit of capital is

$$\mathbb{E}(R_{t+1}^k) = \mathbb{E}\left(\frac{MPK_{t+1} + Q_{t+1}(1-\delta)}{Q_t}\right)$$

which is the supply curve for capital.

- Demand curve for capital is found by inverting the result from the optimal contract:

$$\mathbb{E}(R_{t+1}^k) = s\left(\frac{N_{t+1}}{Q_t K_{t+1}}\right) R_{t+1}$$

- Note: in "standard" RBC model: supply of capital from households consumption-saving decision, demand from firms. Here: households lend to banks, who then lend to entrepreneurs.

Putting this into general equilibrium

- Entrepreneur's net worth:

$$N_{t+1} = \gamma \int (\text{Entrep.}i\text{'s profits})_t di + W_t^e$$

  where W_t^e is the entrepreneurs' labor income, and γ is the probability of not dying.
- Households: like in standard RBC, with capital (return R_{t+1})
- Entrepreneurs' output Y_t is sold to the retail sector firms, which are like the monopolistically competitive firms in the NK model (with Calvo prices etc) and who turn this into a the households' consumption goods $c(i)$. Households as in NK model.

What do we get from all this?

Financial accelerator mechanism:

- Consider a negative demand shock to the economy
- Reduces the quantity (or price) of output that can be sold
- This reduces the MPK, and hence the asset value of capital used to produce output
- This reduces the net worth of entrepreneurs who hold capital
- This reduces the amount of capital that they can take in future investments, external finance premium s increases
- This reduces investment, and aggregate demand
- ...

Note: all this requires entrepreneurs to be constrained in their financing!

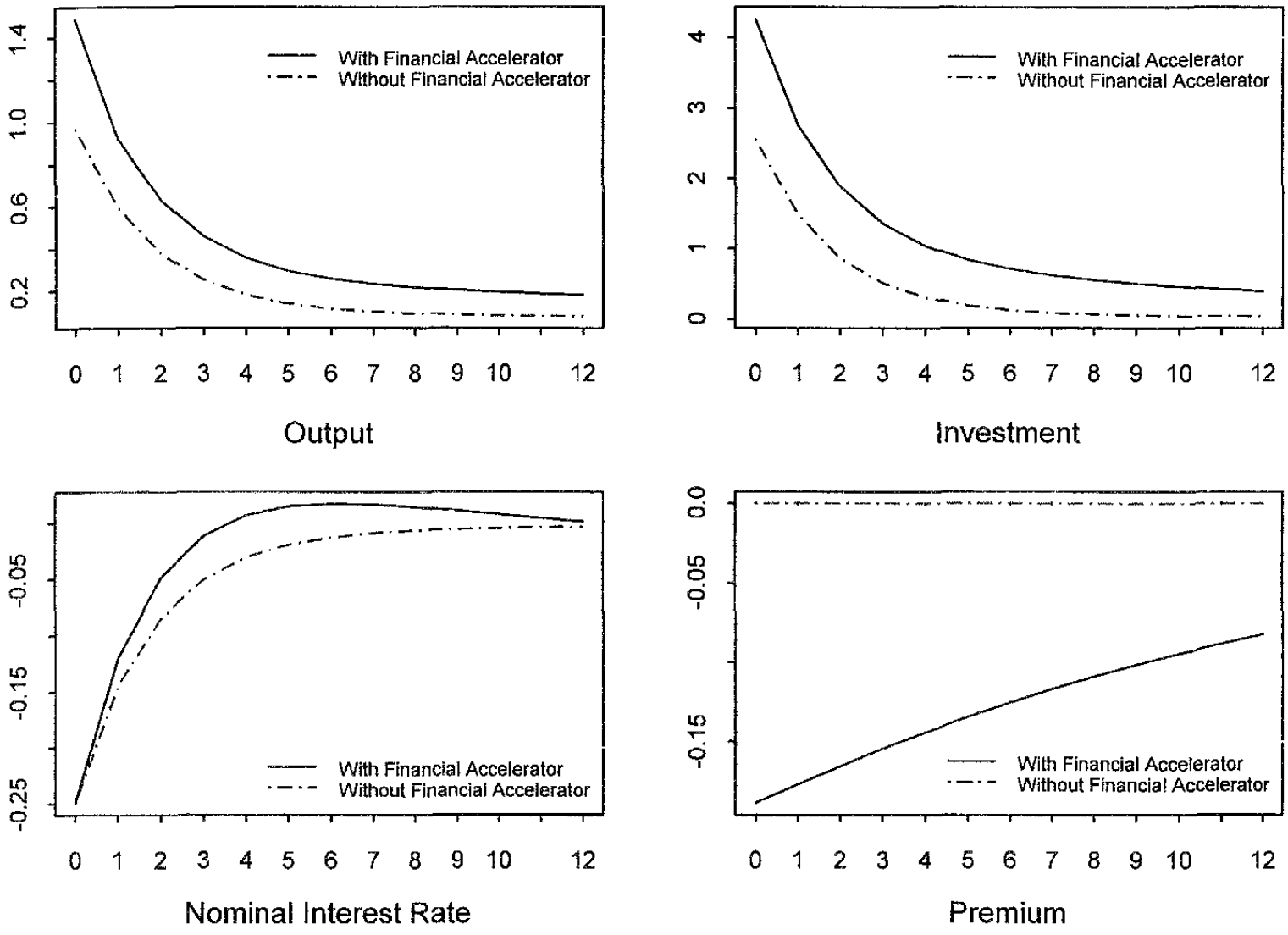
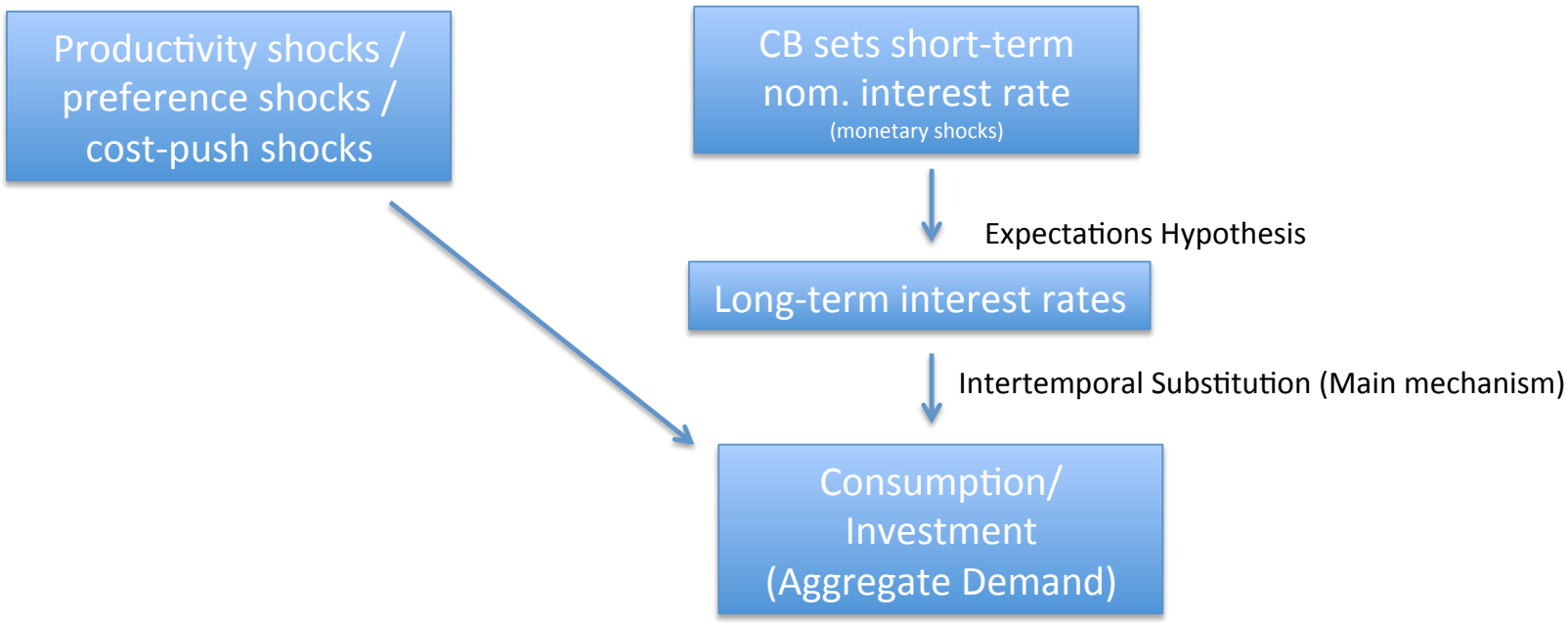
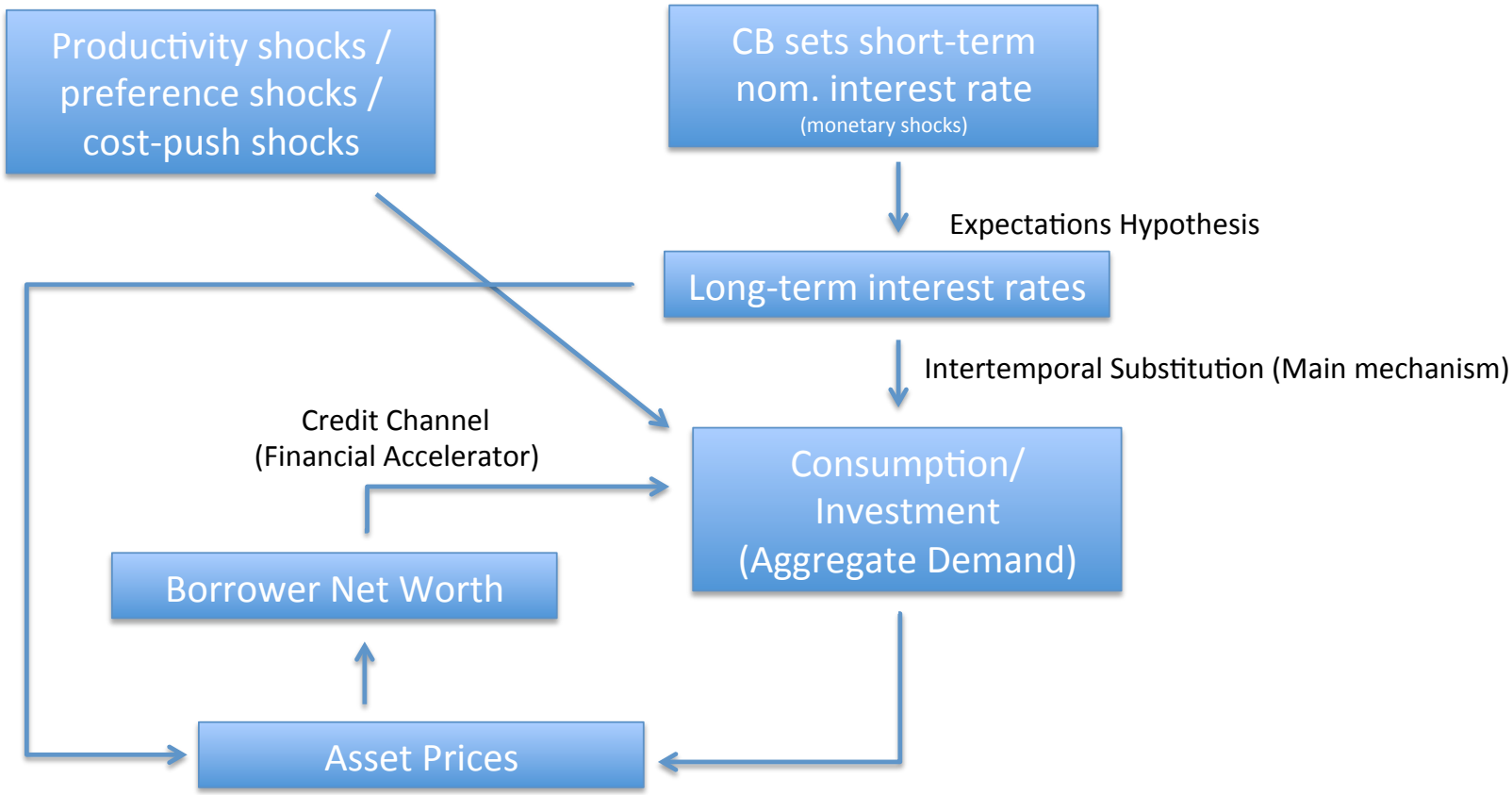


Fig. 3. Monetary shock – no investment delay. All panels: time horizon in quarters.

Overview


Productivity shocks / preference shocks / cost-push shocks
CB sets short-term nom. interest rate
(monetary shocks)
Expectations Hypothesis
Long-term interest rates
Intertemporal Substitution (Main mechanism)
Consumption/ Investment (Aggregate Demand)

Overview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(Financial Accelerator)
Consumption/ Investment (Aggregate Demand)
Borrower Net Worth
Asset Prices

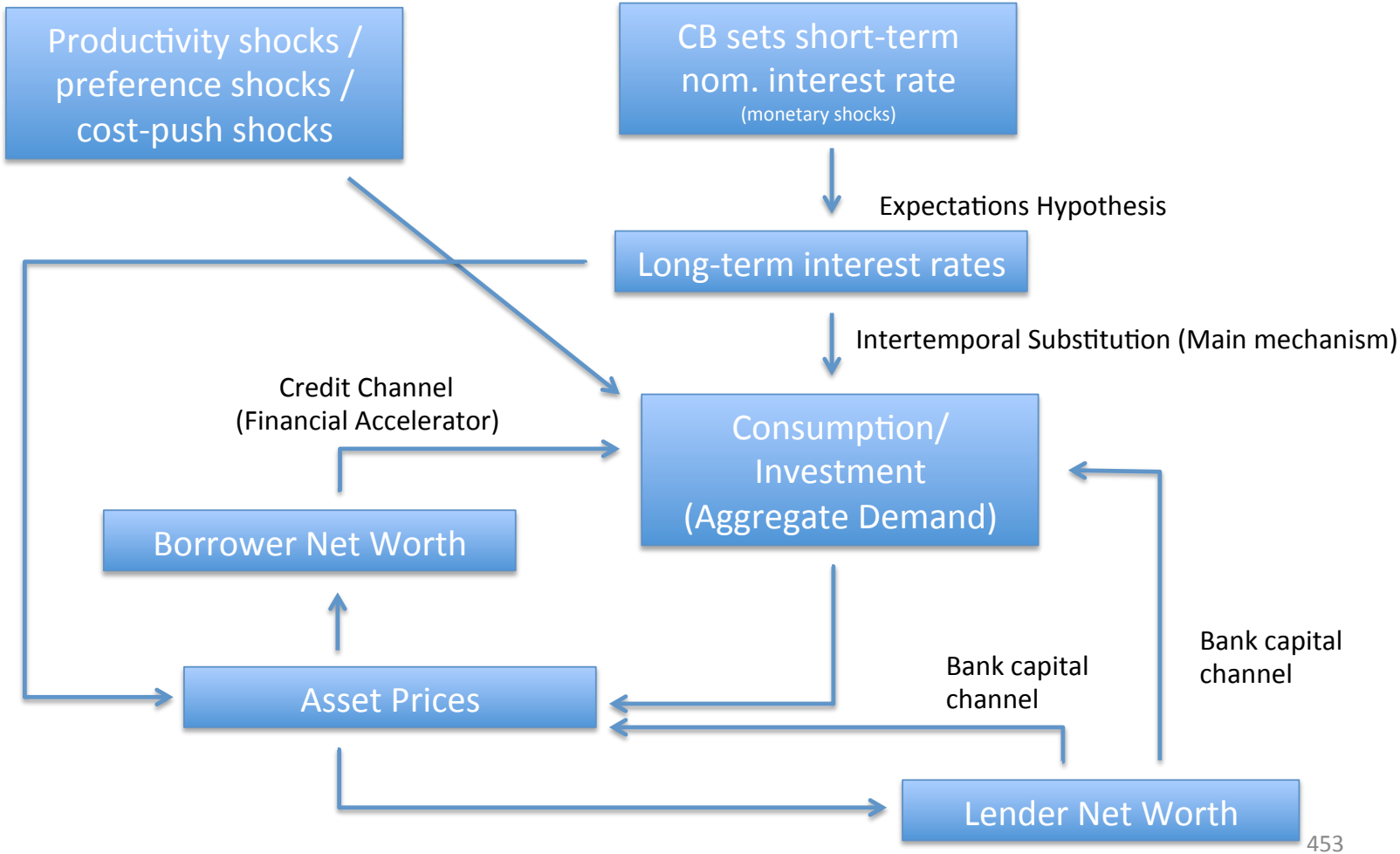
You can play this even further

If you have a channel of how an asset price shock will be amplified, you get even more of a kick

- Bank capital channel: Banks have to maintain a particular maximum leverage ratio (size of the balance sheet vs. core capital)
- If the value of your assets decrease, you have to write it off; capital requirements will not be met anymore
- You have to sell off assets. This, in turn, reduces asset prices (pecuniary externality)
- Then the value of your assets decreases again...

Margin/Haircut spiral: in times of crisis, banks increase 'haircuts', i.e. value assets as a collateral less $\Rightarrow$ tightens borrowing constraint further

Overview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