THE FINANCIAL ACCELERATOR: FINANCIAL MARKETS AND THE MACROECONOMY

APRIL 16, 2012

FINANCIAL ACCELERATOR

- "Financial accelerator" framework
  - The most widely-used and applied framework in macroeconomic theory and policy for thinking about financial markets
  - Developed in series of studies by Bernanke and Gertler in late 1980's and early 1990's
- Popular-press language
  - "Financial accelerator"
  - "Financial feedback loops"
  - "Loan spirals"
- Describes well many of the financial-macroeconomic linkages underpinning the dynamics of
  - The Great Depression
  - Current macroeconomic conditions

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- Describes well many of the financial-macroeconomic linkages underpinning the dynamics of
  - The Great Depression
  - Current macroeconomic conditions
- Will develop idea in context of firm theory
- Can also develop idea in context of consumer theory
  - Recall "credit constraint" analysis of consumption/savings decisions

OUTLINE OF FRAMEWORK

Major ideas underlying Financial Accelerator Framework

1. Firms' financial assets (i.e., stocks and bonds) matter for their ability to purchase physical assets (i.e., machines and equipment)
2. Market prices of financial assets matter for firm financing constraints
3. Government regulation affects the linkage between financial markets and real (i.e., goods and physical capital) markets ***through*** financing constraints

OUTLINE OF FRAMEWORK

Four Building Blocks of the Financial Accelerator Framework

1. **Two-Period Model of Firm Profit Maximization**
   - **Based on Chapter 6**
   - **Enriched to allow for both physical assets (machines and equipment) and financial assets (stocks and bonds)**

2. **Financing Constraint – conceptually the key building block**
   - **Quantity of physical capital firms can purchase depends on the market value of their financial assets**
   - **Reflects market and regulatory structures designed to mitigate informational asymmetries**
   - **(Recall basic Chapter 6 theory of firms featured no constraints on firm profit maximization)**

Introduction

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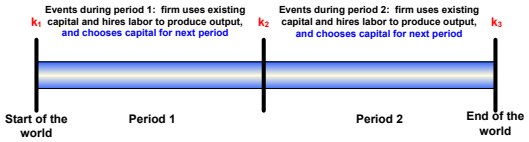
   - (Recall basic Chapter 6 theory of firms featured no constraints on firm profit maximization)

3. **Government Regulation/Oversight of Financial Relationships**

4. **Relationship between Firm Profits and Dividends**

BASIC FIRM THEORY

- **Timeline of events**



- **Notation**
  - k_1: capital used for production in period 1 (decided upon in "period 0")
  - n_1: labor used for production in period 1
  - w_1: real wage rate for labor in period 1 ($w_1 = W_1/P_1$)
  - i: nominal interest rate (between period 1 and period 2)
  - P_1: nominal price of output produced and sold by firm in period 1
    AND nominal price of one unit of capital bought by the firm in period 1 for use in period 2

ENRICHING THE BASIC FIRM THEORY

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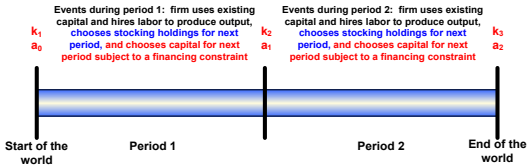

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  - a_0: real wealth (stock) holdings at beginning of period 1/end of period 0

The "defining features" of stock

  - S_1: nominal price of a unit of stock in period 1
  - D_1: nominal dividend paid in period 1 by each unit of stock held at the start of period 1

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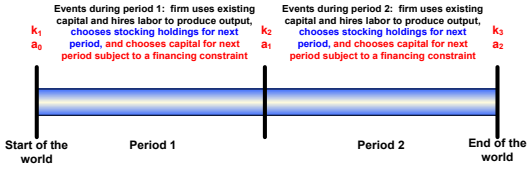

- **Notation**
  - k_2: capital used for production in period 2 (decided upon in period 1)
  - n_2: labor used for production in period 2
  - w_2: real wage rate for labor in period 2 ($w_2 = W_2/P_2$)
  - i: nominal interest rate (between period 1 and period 2)
  - P_2: nominal price of output produced and sold by firm in period 2 AND nominal price of one unit of capital bought by the firm in period 2 for use in period 3
  - a_1: real wealth (stock) holdings at beginning of period 2/end of period 1

The "defining features" of stock

  - S_2: nominal price of a unit of stock in period 2
  - D_2: nominal dividend paid in period 2 by each unit of stock held at the start of period 2

  - n_2: net inflation rate between period 1 and period 2 (recall: $n_2 = P_2/P_1 - 1$)

RATES OF RETURN

- "Interest rates" can be defined for any type of asset
  - There is no ***single*** interest rate in the economy

- Interpret/understand the ***two*** types of "interest rates" that co-exist in this richer framework of firm profit maximization
  - i: nominal interest rate on bonds
    - Recall from Chapter 14

$$1 + i = \frac{1}{P_1^b}$$

    - Thus can think of bonds (one ***type*** of financial asset) as being in the background of the analysis

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  - i^{STOCK}: nominal return on stock – i.e., "interest rate on stock" (though bad terminology)
    - Define according to

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    - Measures the net dollar return (in period 2) on one share of stock (whose purchase price was S_1 in period 1)

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REAL INTEREST RATE ON GOVERNMENT BONDS: A "RISKLESS" ASSET

$$1+i=\frac{1}{P_1^b} \quad \xleftrightarrow[\text{as}]{\text{can rewrite}} \quad i=\frac{1}{P_1^b}-1 \quad \xleftrightarrow{\text{express as } \textit{real} \text{ interest rate}} \quad 1+r=\frac{1+i}{1+\pi}$$

    - Thus can think of bonds (one ***type*** of financial asset) as being in the background of the analysis
  - i^{STOCK}: nominal return on stock – i.e., "interest rate on stock" (though bad terminology)
    - Define according to

REAL INTEREST RATE ON STOCKS: A "RISKY" ASSET

$$1+i^{STOCK}=\frac{S_2+D_2}{S_1} \quad \xleftrightarrow[\text{as}]{\text{can rewrite}} \quad i^{STOCK}=\frac{S_2+D_2}{S_1}-1 \quad \xleftrightarrow{\text{express as } \textit{real} \text{ interest rate}} \quad 1+r^{STOCK}=\frac{1+i^{STOCK}}{1+\pi}$$

    - Measures the net dollar return (in period 2) on one share of stock (whose purchase price was S_1 in period 1)
- Can distinguish two measures of real interest rates in this framework

FIRM PROFIT FUNCTION

- A ***dynamic*** profit maximization problem
  - Because firm exists for both periods
  - All analysis conducted from the perspective of the very beginning of period 1
  - → Must consider present-discounted-value (PDV) of lifetime (i.e., two-period) profits
- Dynamic profit function
  - (specified in nominal terms – could specify in real terms…)

Period-1 profits

$$\underbrace{P_1 f(k_1,n_1)}_{\text{Total revenue in period 1 (price x output)}}+\underbrace{P_1 k_1}_{\text{Value of pre-existing physical capital (an asset for firms)}}+(S_1+D_1)a_0-\underbrace{P_1 w_1 n_1}_{\text{Total labor cost in period 1}}-\underbrace{P_1 k_2}_{\text{Total cost of buying physical capital for period 2 (time to build → must purchase period-2 capital in period 1)}}-S_1 a_1$$

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Period-1 profits

$$P_1 f(k_1, n_1) + P_1 k_1 + (S_1 + D_1) a_0 - P_1 w_1 n_1 - P_1 k_2 - S_1 a_1$$

- Total revenue in period 1 (price x output)
- Value of pre-existing physical capital (an asset for firms)
- Value (inclusive of dividends) of pre-existing financial assets (i.e., stock-holdings in *other* firms)
- Total labor cost in period 1
- Total cost of buying physical capital for period 2 (time to build → must purchase period-2 capital in period 1)
- Total cost of buying financial assets (i.e., stock-holdings in *other* firms) for period 2

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As usual: no physical or financial assets needed for "period 3"

= 0 = 0

Period-1 profits (PDV of) period-2 profits

$$P_1 f(k_1, n_1) + P_1 k_1 + (S_1 + D_1) a_0 - P_1 w_1 n_1 - P_1 k_2 - S_1 a_1 + \frac{P_2 f(k_2, n_2)}{1+i} + \frac{P_2 k_2}{1+i} + \frac{(S_2 + D_2) a_1}{1+i} - \frac{P_2 w_2 n_2}{1+i} - \frac{P_2 k_3}{1+i} - \frac{S_2 a_2}{1+i}$$

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- Total labor cost in period 2
- Total cost of buying physical capital for period 3 (time to build → must purchase period-3 capital in period 2)
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INFORMATIONAL ASYMMETRIES

- "Informational asymmetries" pervasive in borrowing/lending relationships
- Borrower (whether consumer, firm, or financial institution) ***much*** more likely to know his own ability/willingness to repay a loan
  - Lenders only know little about the "quality" or "trustworthiness" of a borrower
  - Asymmetry of information – cannot be eliminated
- To mitigate consequences of informational asymmetries, lenders often require borrower to have a stake in "succeeding" in the project/purpose for which funds are being borrowed
  - Consumers
    - e.g., down payment on house purchase
    - e.g., down payment on car purchase
    - If stop making payments on house or car
      - Borrower loses down payment (in addition to the car or house…)…
      - Affects individual's incentives ***before*** borrowing

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  - Consumers
    - e.g., down payment on house purchase
    - e.g., down payment on car purchase
    - Total amount of loan (typically) depends on individual's collateral
  - Firms
    - Capital investment (factories, technology upgrades, etc) outlays
    - Payroll outlays
    - Financing inventories
    - Total amount of loan (typically) depends on firm's collateral

"Working capital"

  - Financial institutions: borrow in order to make (big) loans
    - By raising "small" quantities of funds from many different sources

FINANCING CONSTRAINT

- Capture this idea through a financing constraint on firm's ability to purchase capital between period 1 and period 2
- Financing constraint
  - Total expenditures on period-1 physical investment must be equal to market value of firm's financial (stock) holdings
  - (Technically, smaller than or equal to, so an inequality constraint…but will formally analyze constraint with equality)

$$P_1 \cdot inv_1 = S_1 \cdot a_1$$

$inv_1 = k_2 - k_1$ (investment is *change in* quantity of physical capital)

$$P_1 \cdot (k_2 - k_1) = S_1 \cdot a_1$$

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  - Important: a_1 appears in the financing constraint, *not* a_0
    - Idea this assumption captures: firm might try to strategically manipulate the value of *financial* assets it holds in order to affect the quantity of *physical* investment it can engage in
    - (From the perspective of beginning of period 1, a_1 has not yet been chosen, whereas a_0 is pre-determined)

GOVERNMENT OVERSIGHT OF FINANCIAL MARKETS

- Government oversight of informational asymmetries in borrower/ lender relationships
  - Filing of proper documentation
  - Full disclosure ("truth-in-lending") laws
  - Direct lending in some markets
  - …
- Capture government Regulation of financial dealings in our framework in very simple way
  - Firm can only borrow up to a multiple *R* of the market value of its financial assets for physical investment purposes
  - e.g., if government regulates that expenditures on investment cannot be larger than 5 times market value of financial assets, *R* = 5

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  - e.g., if government regulates that expenditures on investment cannot be larger than 5 times market value of financial assets, *R* = 5
- Terminology: *R* is leverage ratio
  - Will think of it as government regulation…
  - …but can and does also reflect market and institutional arrangements

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Government regulation of leverage *R*

$$P_1 \cdot (k_2 - k_1) = R \cdot S_1 \cdot a_1$$

Impose this financing constraint on firm profit maximization problem

FINANCIAL ACCELERATOR FRAMEWORK

- Four Building Blocks of the Financial Accelerator Framework

1. Firm Profit Function

= 0 = 0

$$P_1 f(k_1, n_1) + P_1 k_1 + (S_1 + D_1) a_0 - P_1 w_1 n_1 - P_1 k_2 - S_1 a_1 + \frac{P_2 f(k_2, n_2)}{1+i} + \frac{P_2 k_2}{1+i} + \frac{(S_2 + D_2) a_1}{1+i} - \frac{P_2 w_2 n_2}{1+i} - \frac{P_2 k_3}{1+i} - \frac{S_2 a_2}{1+i}$$

2. Financing Constraint

$$P_1 \cdot (k_2 - k_1) = S_1 \cdot a_1$$

3. Government Regulation of Financial Relationships (imposition of *R* on financing constraint)

$$P_1 \cdot (k_2 - k_1) = R \cdot S_1 \cdot a_1$$

4. Relationship between firm profits and dividends

LATER

FIRM PROFIT MAXIMIZATION

Maximize two-period profits

$$P_1 f(k_1, n_1) + P_1 k_1 + (S_1 + D_1)a_0 - P_1 w_1 n_1 - P_1 k_2 - S_1 a_1 + \frac{P_2 f(k_2, n_2)}{1+i} + \frac{P_2 k_2}{1+i} + \frac{(S_2 + D_2)a_1}{1+i} - \frac{P_2 w_2 n_2}{1+i} - \frac{P_2 k_3}{1+i} - \frac{S_2 a_2}{1+i}$$

= 0 = 0

Subject to financing constraint

$$P_1 \cdot (k_2 - k_1) = R \cdot S_1 \cdot a_1$$

Construct Lagrangian

$$P_1 f(k_1, n_1) + P_1 k_1 + (S_1 + D_1)a_0 - P_1 w_1 n_1 - P_1 k_2 - S_1 a_1 + \frac{P_2 f(k_2, n_2)}{1+i} + \frac{P_2 k_2}{1+i} + \frac{(S_2 + D_2)a_1}{1+i} - \frac{P_2 w_2 n_2}{1+i}$$
$$+ \lambda \left[R \cdot S_1 \cdot a_1 - P_1 \cdot (k_2 - k_1) \right]$$

Lagrange multiplier on financing constraint

CRUCIAL OBSERVATION: in basic firm theory (i.e., Chapter 6), value of this multiplier was....

FIRM PROFIT MAXIMIZATION

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Lagrange multiplier on financing constraint

CRUCIAL OBSERVATION: in basic firm theory (i.e., Chapter 6), value of this multiplier was....

λ = 0 i.e., there was no financing constraint!

LATER: will study which regulatory and/or market features make the financing constraint effectively "disappear" (i.e., cause λ = 0)

FIRM PROFIT MAXIMIZATION

$$P_1 f(k_1, n_1) + P_1 k_1 + (S_1 + D_1)a_0 - P_1 w_1 n_1 - P_1 k_2 - S_1 a_1 + \frac{P_2 f(k_2, n_2)}{1+i} + \frac{P_2 k_2}{1+i} + \frac{(S_2 + D_2)a_1}{1+i} - \frac{P_2 w_2 n_2}{1+i} + \lambda\left[R \cdot S_1 \cdot a_1 - P_1 \cdot (k_2 - k_1)\right]$$

- **FOCs with respect to n_1, n_2**

Identical except for time subscripts

with respect to n_1: $P_1 f_n(k_1, n_1) - P_1 w_1 = 0$ — Equation 1

with respect to n_2: $\frac{P_2 f_n(k_2, n_2)}{1+i} - \frac{P_2 w_2}{1+i} = 0$ — Equation 2

  - Financing constraint does not affect profit-maximizing choices of labor hiring…
  - …thus same analysis from Chapter 6 of labor demand curve, etc, applies

- **FOCs with respect to k_2, a_1**
  - The interesting aspects of the framework
  - The heart of the financial accelerator framework

FIRM PROFIT MAXIMIZATION

$$P_1 f(k_1, n_1) + P_1 k_1 + (S_1 + D_1)a_0 - P_1 w_1 n_1 - P_1 k_2 - S_1 a_1 + \frac{P_2 f(k_2, n_2)}{1+i} + \frac{P_2 k_2}{1+i} + \frac{(S_2 + D_2)a_1}{1+i} - \frac{P_2 w_2 n_2}{1+i} + \lambda\left[R \cdot S_1 \cdot a_1 - P_1 \cdot (k_2 - k_1)\right]$$

- **FOCs with respect to k_2, a_1**

with respect to k_2:

with respect to a_1:

FIRM PROFIT MAXIMIZATION

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- **FOCs with respect to k_2, a_1**

  with respect to k_2: $-P_1 + \frac{P_2 f_k(k_2, n_2)}{1+i} + \frac{P_2}{1+i} - \lambda P_1 = 0$ **Equation 3**

  with respect to a_1: $-S_1 + \frac{S_2 + D_2}{1+i} + \lambda \cdot R \cdot S_1 = 0$ **Equation 4**

FIRM PROFIT MAXIMIZATION

$$P_1 f(k_1, n_1) + P_1 k_1 + (S_1 + D_1)a_0 - P_1 w_1 n_1 - P_1 k_2 - S_1 a_1 + \frac{P_2 f(k_2, n_2)}{1+i} + \frac{P_2 k_2}{1+i} + \frac{(S_2 + D_2)a_1}{1+i} - \frac{P_2 w_2 n_2}{1+i} + \lambda\left[R \cdot S_1 \cdot a_1 - P_1 \cdot (k_2 - k_1)\right]$$

- **FOCs with respect to k_2, a_1**

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  with respect to a_1: $-S_1 + \frac{S_2 + D_2}{1+i} + \lambda \cdot R \cdot S_1 = 0$ **Equation 4**

- **Analysis of Equation 4 in isolation**
  - **Answers the central question: under what conditions does $\lambda = 0$?**
  - **Reveals how stock market returns affect financing constraints**
  - **Reveals how government regulation affects financing constraints**
- **Analysis of Equation 3 and Equation 4 jointly**
  - **Demonstrates how/why financial market prices (i.e., stock prices/returns) matter for macroeconomic activity**
  - **The financial accelerator effect**

WHY IS FINANCING A *CONSTRAINT*?

$$-S_1 + \frac{S_2 + D_2}{1+i} + \lambda \cdot R \cdot S_1 = 0$$

Equation 4

↓ Solve for λ

$$\lambda = \left[S_1 - \frac{S_2 + D_2}{1+i} \right] \cdot \frac{1}{R \cdot S_1}$$

↓ Pull $1/S_1$ term inside

$$\lambda = \left[1 - \frac{S_2 + D_2}{S_1} \cdot \frac{1}{1+i} \right] \cdot \frac{1}{R}$$

↓ Multiply *and* divide second term in parentheses by P_1 *and* P_2

$$\lambda = \left[1 - \frac{S_2 + D_2}{S_1} \cdot \frac{P_1}{P_2} \cdot \frac{P_2}{P_1} \cdot \frac{1}{1+i} \right] \cdot \frac{1}{R}$$

↓ Use definition of inflation, $1 + \pi_2 = P_2 / P_1$, and regroup terms

$$\lambda = \left[1 - \frac{S_2 + D_2}{S_1} \cdot \frac{P_1}{P_2} \cdot \frac{1+\pi_2}{1+i} \right] \cdot \frac{1}{R}$$

WHY IS FINANCING A *CONSTRAINT*?

$$\lambda = \left[1 - \frac{S_2 + D_2}{S_1} \cdot \frac{P_1}{P_2} \cdot \frac{1+\pi_2}{1+i} \right] \cdot \frac{1}{R}$$

(from previous page)

↓ Use definition of "nominal interest rate on stock", $1 + i^{STOCK} = (S_2 + D_2) / S_1$
Use definition of inflation, $1 + \pi_2 = P_2 / P_1$

$$\lambda = \left[1 - \frac{1+i^{STOCK}}{1+\pi_2} \cdot \frac{1+\pi_2}{1+i} \right] \cdot \frac{1}{R}$$

↓ Fisher equation for stock: $1 + r^{STOCK} = (1 + i^{STOCK}) / (1 + \pi_2)$
Fisher equation for bonds: $1 + r = (1 + i) / (1 + \pi_2)$

$$\lambda = \left[1 - \frac{1+r^{STOCK}}{1+r} \right] \cdot \frac{1}{R}$$

↓ Final rewrite!

$$\lambda = \left[\frac{r - r^{STOCK}}{1+r} \right] \cdot \frac{1}{R}$$

The Lagrange multiplier on firm's financing constraint

WHY IS FINANCING A *CONSTRAINT*?

$$\lambda = \left[\frac{r - r^{STOCK}}{1+r}\right] \cdot \frac{1}{R}$$

The Lagrange multiplier on firm's financing constraint

- **Basic firm theory (Chapter 6)**
  - **No financing constraint**
  - **Can interpret basic firm theory analysis as featuring $\lambda = 0$**
    - **Interpretation: under "normal market conditions," financing constraints don't matter (much…)**
    - **Identify "normal market conditions" as *TYPE OF* "steady state"**

$$P_1 f(k_1, n_1) + P_1 k_1 + (S_1 + D_1)a_0 - P_1 w_1 n_1 - P_1 k_2 - S_1 a_1 + \frac{P_2 f(k_2, n_2)}{1+i} + \frac{P_2 k_2}{1+i} + \frac{(S_2 + D_2)a_1}{1+i} - \frac{P_2 w_2 n_2}{1+i}$$
$$+ \lambda \left[R \cdot S_1 \cdot a_1 - P_1 \cdot (k_2 - k_1)\right]$$

$= 0$

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$$+ \lambda \left[R \cdot S_1 \cdot a_1 - P_1 \cdot (k_2 - k_1)\right]$$

$= 0$

  - **If $\lambda = 0$ (i.e., "normal market conditions," aka "steady state")**
    - **Labor demand decisions unaffected by financial market conditions**
    - **Capital demand decisions unaffected by financial market conditions**

- **Key question: what causes $\lambda = 0$?**

WHY IS FINANCING A *CONSTRAINT*?

$$\lambda = \left[\frac{r - r^{STOCK}}{1+r}\right] \cdot \frac{1}{R}$$

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- **Two conditions for $\lambda = 0$**
  - **Market returns on risky assets equal returns on riskless assets**
    - **Risky assets: stocks**
    - **Riskless assets**
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Can think of both government bonds (financial assets) and machines & equipment (physical assets) as "riskless": you (pretty much…) know what you're going to get from them.

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Interpretation: if returns on financial assets are aligned with returns on physical assets, financing constraints "don't matter"

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  - **Government oversight of borrowing/lending relationships very lax**
    - **The larger is *R*, the lower is *λ***
    - **Financing constraint:** $P_1 \cdot (k_2 - k_1) = R \cdot S_1 \cdot a_1$

Market value of financial assets

      - **Holding constant market value of financial assets, higher *R* allows higher k_2**

Finance Fundamentals

WHY IS FINANCING A *CONSTRAINT*?

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In practice, not literally infinity…

$$R = \infty \longrightarrow \lambda = 0$$

Interpretation: if government regulations allow high borrowing with little assets, financing constraints "don't matter"

FINANCING CONSTRAINT AND CAPITAL DEMAND

- **Suppose R = 1 in "steady state" (but keep R in rest of analysis)**
  - **R > 1 is "lax regulation" (because it lowers λ, all else constant)**
  - **R < 1 is "tight regulation" (because it increases λ, all else constant)**
  - **→ Whether or not financing constraint matters (i.e., whether or not λ = 0) all depends on whether or not $r^{STOCK} = r$ or not**

KEY IDEA: if returns on riskless assets = returns on risky assets → financing constraints "don't matter" for firm production decisions

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$$-P_1 + \frac{P_2 f_k(k_2, n_2)}{1+i} + \frac{P_2}{1+i} - \lambda P_1 = 0$$ **Equation 3 (FOC on k_2)**

$$\lambda = \left[\frac{r - r^{STOCK}}{1+r}\right] \cdot \frac{1}{R}$$ **Equation 4 (FOC on a_1)**

- **Basic firm theory (Chapter 6)**
  - **Capital demand function derived from Equation 3**
  - **Idea same as in Chapter 6…but now complicated by the financing constraint**

Substitute λ from Equation 4 into Equation 3

$$-P_1 + \frac{P_2 f_k(k_2, n_2)}{1+i} + \frac{P_2}{1+i} - \left[\frac{r - r^{STOCK}}{1+r}\right]\frac{1}{R} P_1 = 0$$

Rearrange

FINANCING CONSTRAINT AND CAPITAL DEMAND

$$-P_1+\frac{P_2 f_k(k_2,n_2)}{1+i}+\frac{P_2}{1+i}-\left[\frac{r-r^{STOCK}}{1+r}\right]\frac{1}{R}P_1=0$$ (from previous page)

Divide by P_1

$$\frac{P_2 f_k(k_2,n_2)}{P_1(1+i)}+\frac{P_2}{P_1(1+i)}-\left[\frac{r-r^{STOCK}}{1+r}\right]\frac{1}{R}=1$$

Use definition of inflation, $1+\pi_2 = P_2 / P_1$

$$\left(\frac{1+\pi_2}{1+i}\right)f_k(k_2,n_2)+\frac{1+\pi_2}{1+i}-\left[\frac{r-r^{STOCK}}{1+r}\right]\frac{1}{R}=1$$

Apply Fisher relation for "riskless" assets

$$\frac{f_k(k_2,n_2)}{1+r}+\frac{1}{1+r}-\left[\frac{r-r^{STOCK}}{1+r}\right]\frac{1}{R}=1$$

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$$\frac{f_k(k_2,n_2)}{1+r}+\frac{1}{1+r}-\left[\frac{r-r^{STOCK}}{1+r}\right]\frac{1}{R}=1$$

Multiply by (1+r)

Marginal product of capital, *mpk*

$$f_k(k_2,n_2)+1-\frac{r-r^{STOCK}}{R}=1+r$$

Suppose $R = 1$ in "steady state" but keep R in the analysis

COBB-DOUGLAS PRODUCTION FUNCTION

- **Commonly-used functional form in quantitative macroeconomic analysis**

$$f(k,n) = k^{\alpha} n^{1-\alpha}$$

- **Describes the empirical relationship between aggregate GDP, aggregate capital, and aggregate labor quite well**
- $\alpha \in (0,1)$ **measures capital's share of output**
  - **Hence** $(1-\alpha) \in (0,1)$ **measures labor's share of output**
  - **Interpretation**
    - **The relative importance of (either) capital (or labor) in the production process**
  - **Estimates for U.S. economy:** $\alpha \approx 0.3$
  - **Estimates for Chinese economy:** $\alpha \approx 0.15$ **(not (yet) a very capital-rich economy)**
- **Cobb-Douglas form useful for illustrating factor demands**
  - $mpn = f_n(k,n) = (1-\alpha)k^{\alpha} n^{-\alpha}$
  - $mpk = f_k(k,n) = \alpha k^{\alpha-1} n^{1-\alpha}$

FINANCING CONSTRAINT AND CAPITAL DEMAND

- **Firm-level demand for capital defined by the relation**

$$r = \alpha k^{\alpha-1} n^{1-\alpha} - \left[\frac{r - r^{STOCK}}{R}\right] \left(= mpk - \left[\frac{r - r^{STOCK}}{R}\right]\right)$$

$$\downarrow$$

$$r = \alpha k^{\alpha-1} n^{1-\alpha} - \frac{r}{R} + \frac{r^{STOCK}}{R}$$

$$\downarrow$$

$$\left[1 + \frac{1}{R}\right] r = \alpha k^{\alpha-1} n^{1-\alpha} + \frac{r^{STOCK}}{R}$$

$$\downarrow$$

$$\left[\frac{R+1}{R}\right] r = \alpha k^{\alpha-1} n^{1-\alpha} + \frac{r^{STOCK}}{R}$$

$$\downarrow$$

$$r = \left(\frac{R}{R+1}\right) \alpha k^{\alpha-1} n^{1-\alpha} + \frac{r^{STOCK}}{R+1}$$

Solve for *r* (return on "riskless" physical assets)

FINANCING CONSTRAINT AND CAPITAL DEMAND

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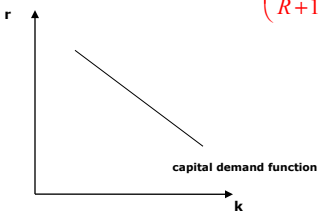
$$r = \left(\frac{R}{R+1}\right)\alpha k^{\alpha-1} n^{1-\alpha} + \frac{r^{STOCK}}{R+1}$$

Because exponent ($\alpha - 1$) is a negative number, can move to denominator

$$r = \left(\frac{R}{R+1}\right)\alpha \left(\frac{n_t}{k_t}\right)^{1-\alpha} + \frac{r^{STOCK}}{R+1}$$

CHAPTER 6: NEGATIVE RELATIONSHIP BETWEEN *r* AND *k*



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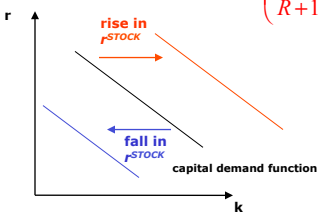
Rise (fall) in return on stock leads to shift out (in) of capital demand function



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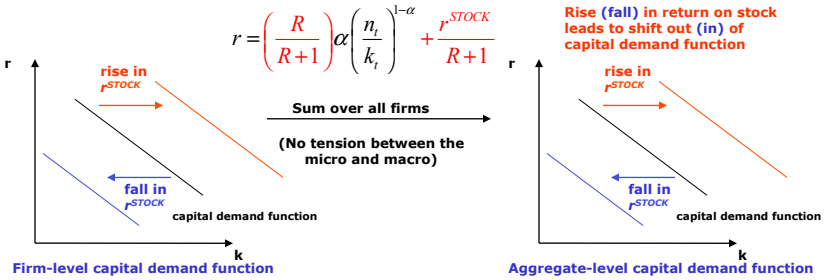

Firm-level capital demand function

Aggregate-level capital demand function

- **IMPORTANT**: changes in financial market returns shift capital demand (and hence investment demand – recall $inv_t = k_{t+1} - k_t$)

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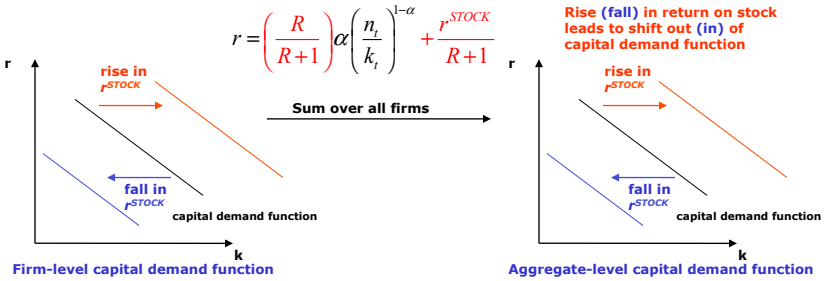

Firm-level capital demand function

Aggregate-level capital demand function

- **Basis for the financial accelerator effect**
- **Basis for understanding the role of financial oversight**

FINANCIAL ACCELERATOR FRAMEWORK

- **Four Building Blocks of the Financial Accelerator Framework**

1. **Firm Profit Function**

$$P_1 f(k_1,n_1)+P_1k_1+(S_1+D_1)a_0-P_1w_1n_1-P_1k_2-S_1a_1+\frac{P_2f(k_2,n_2)}{1+i}+\frac{P_2k_2}{1+i}+\frac{(S_2+D_2)a_1}{1+i}-\frac{P_2w_2n_2}{1+i}-\frac{P_2k_3}{1+i}-\frac{S_2a_2}{1+i}$$

= 0 = 0

2. **Financing Constraint**

$$P_1\cdot(k_2-k_1)= \quad S_1\cdot a_1$$

3. **Government Regulation of Financial Relationships (imposition of *R* on financing constraint)**

$$P_1\cdot(k_2-k_1)=R\cdot S_1\cdot a_1$$

4. **Relationship between firm profits and dividends**

NOW

DIVIDENDS AND PROFITS

- **Dividend: payment made by a corporation to its shareholders; the portion of corporate profits paid out to stockholders (Wikipedia definition)**

- **Corporate dividend policies differ widely across industries and companies**
  - **Some companies retain most of their profits (to re-invest in ongoing projects)**
  - **Some industries' dividend policies subject to government regulation**
    - **Recently: financial companies receiving government support had dividend payments limited to $0.01 per share**

- **Recent average: ≈35 percent of profits disbursed as dividends**
  - **Based on recent data collected by U.S. Bureau of Economic Analysis for corporations listed on S&P 500**

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- **Recent average: ≈35 percent of profits disbursed as dividends**
  - **Based on recent data collected by U.S. Bureau of Economic Analysis for corporations listed on S&P 500**
- **Simplifying assumption for our analytical framework**
  - **All (100 percent) firm profits distributed as dividends**
  - **In period *t*, D_t = nominal profits$_t$**
- **Building Block 4: Relationship between firm profits and dividends**

$$D_t = P_t \cdot profit_t$$ ← REAL profits of firm in period *t*

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($P_2 k_3$ = 0; $S_2 a_2$ = 0)

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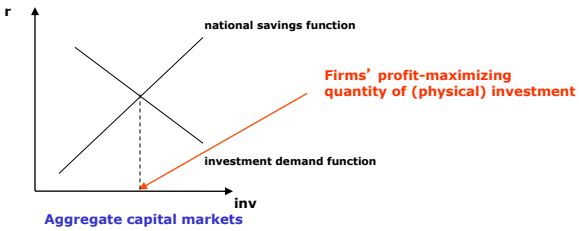
FINANCIAL ACCELERATOR IN ACTION

- Suppose economy is in a "steady-state" in which $r = r^{STOCK}$...
- ...then a shock causes r^{STOCK} to decline
  - i.e., broad range of financial asset returns suddenly fall...
  - ...perhaps because of problems stemming from one or a few classes of financial assets (i.e., mortgage-backed bonds)



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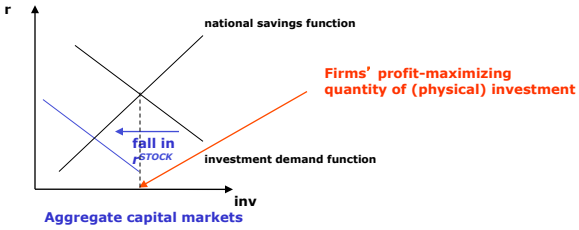

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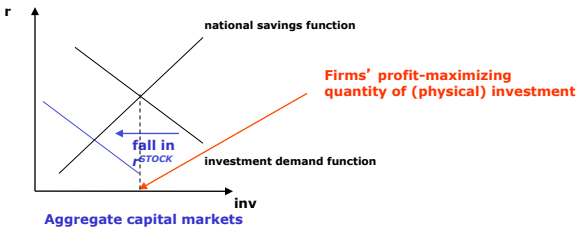

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- Firm profits *fall* (i.e., investment no longer at profit-maximizing choice)
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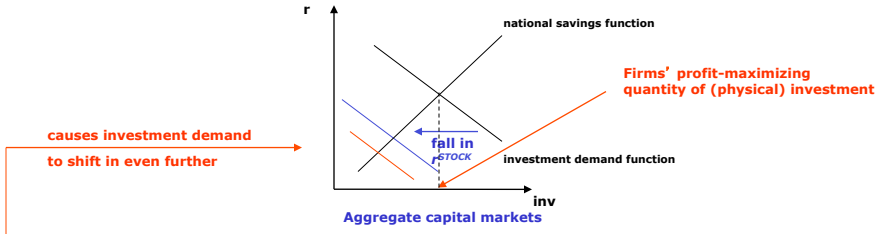

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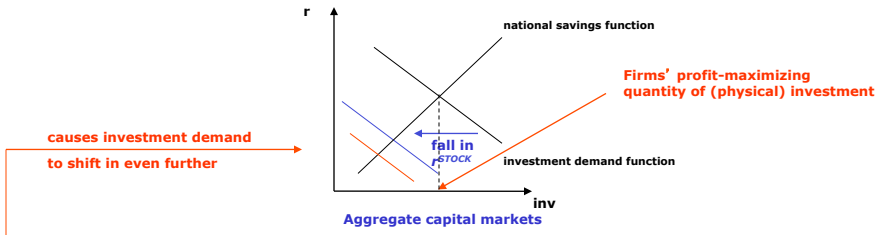

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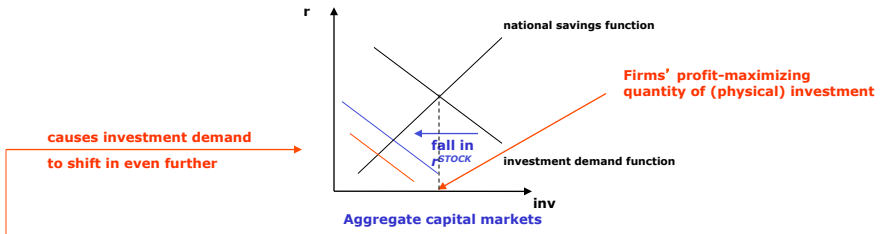

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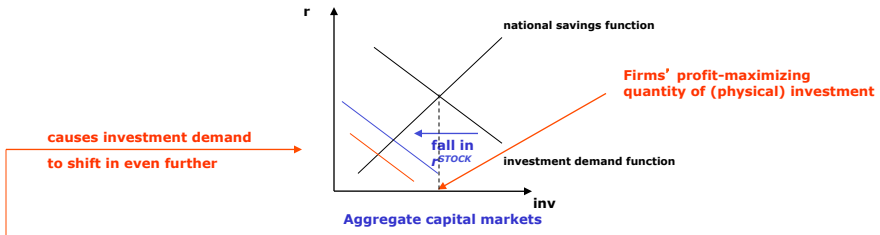

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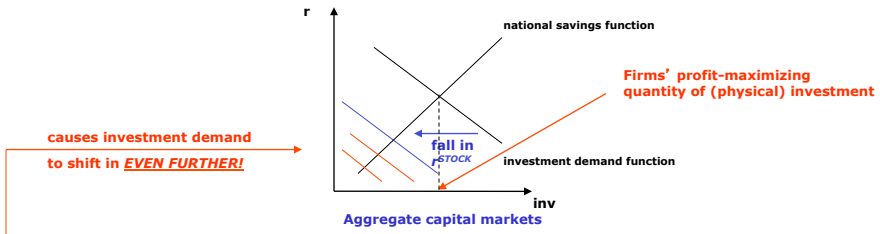

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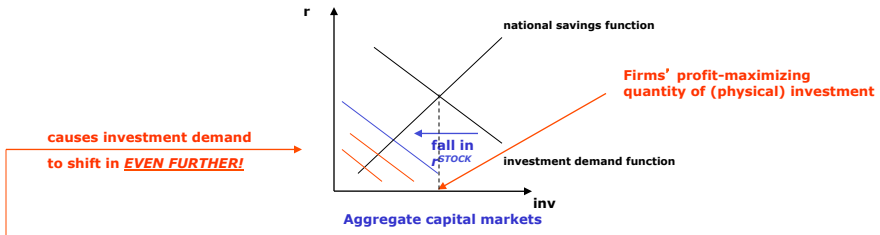

AND ON AND ON...

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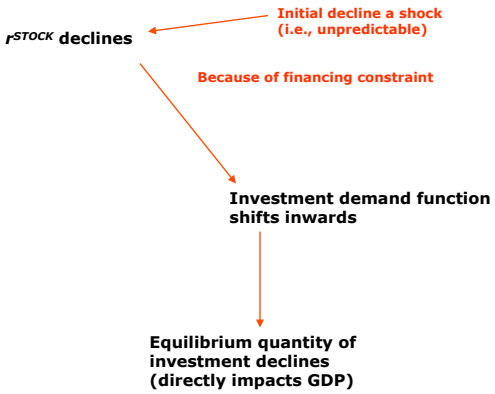

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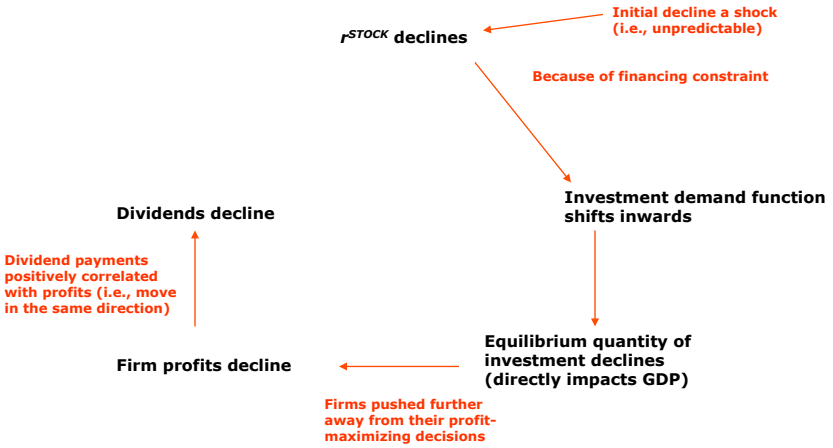

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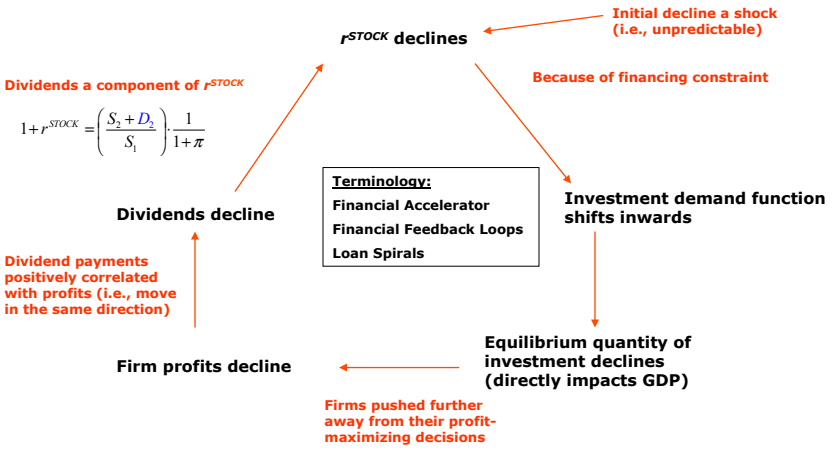

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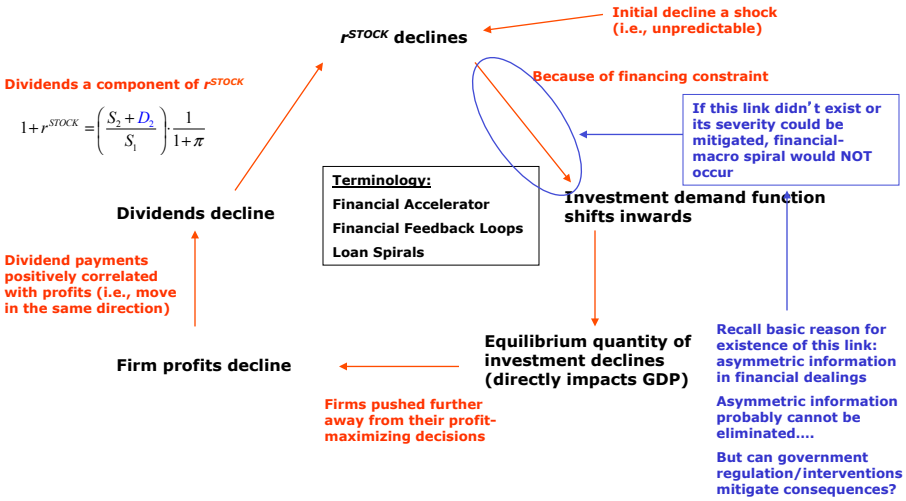

POLICY AND REGULATORY RESPONSES

- Entire accelerator mechanism due to financing constraint

$$P_1 \cdot (k_2 - k_1) = R \cdot S_1 \cdot a_1$$

- Lagrange multiplier related to asset returns and government regulation by

$$\lambda = \left[\frac{r - r^{STOCK}}{1+r}\right] \cdot \frac{1}{R}$$

- If r^{STOCK} falls below r (which causes accelerator mechanism to begin)
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- Interpretation of rise in R
  - For a given market value of financial assets, $S_1 a_1$, a higher R allows firms to borrow more from private lenders, in turn allowing them to purchase more (physical) capital
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- Changes in R can be time-consuming to implement
  - Simultaneously controlled by Federal Reserve, Treasury, Securities and Exchange Commission (SEC), Comptroller of the Currency, and several other regulatory agencies – huge coordination delays!
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  - Exactly the intention of U.S. Troubled Asset Relief Program (TARP)
    - Direct purchases by Treasury of a wide variety of financial assets
    - The increased demand for these assets would lift their price
  - Exactly the intention of Federal Reserve's programs to buy a wide variety of financial assets – increased demand would lift prices

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- ***r* often reflects rate of consumption growth between periods**
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- **Now: *r* *also* measures price/return of risky assets (i.e., stock) in "steady state"**
  - **If $r = r^{STOCK}$, financing issues don't affect (very much) macroeconomic outcomes**
  - **If *r* and r^{STOCK} deviate significantly**
    - **Financial conditions of firms matter for investment/output**
    - **And can matter very importantly!**

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Macro-Finance Fundamentals

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- Other ways of understanding *r*....will study in more advanced courses in macroeconomics and finance