



ECON 314

Wednesday, April 29

Dynamics of the q Model and Other Investment Topics

Readings: Romer 9.4 through rest of Chapter 9

Class notes: 158 - 165



Today's Far Side offering



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Timely ...



Context and overview

- Building on the last class, we examine the dynamics of the q theory as a saddle-point equilibrium
- Adjustment dynamics bring us back to $q = 1$ as a long-run equilibrium
- Irreversibility of investment may reduce the incentive to invest, depending on how much new information is gained by waiting
- In a simple environment, the Modigliani-Miller theorem asserts that the optimal amount of investment does not depend on whether it is financed by bonds (borrowing), new stock issuance, or retained earnings
- Empirical evidence on investment models is fraught with difficulty: it is very difficult to demonstrate that changes in the cost of capital (interest rate) affect aggregate investment

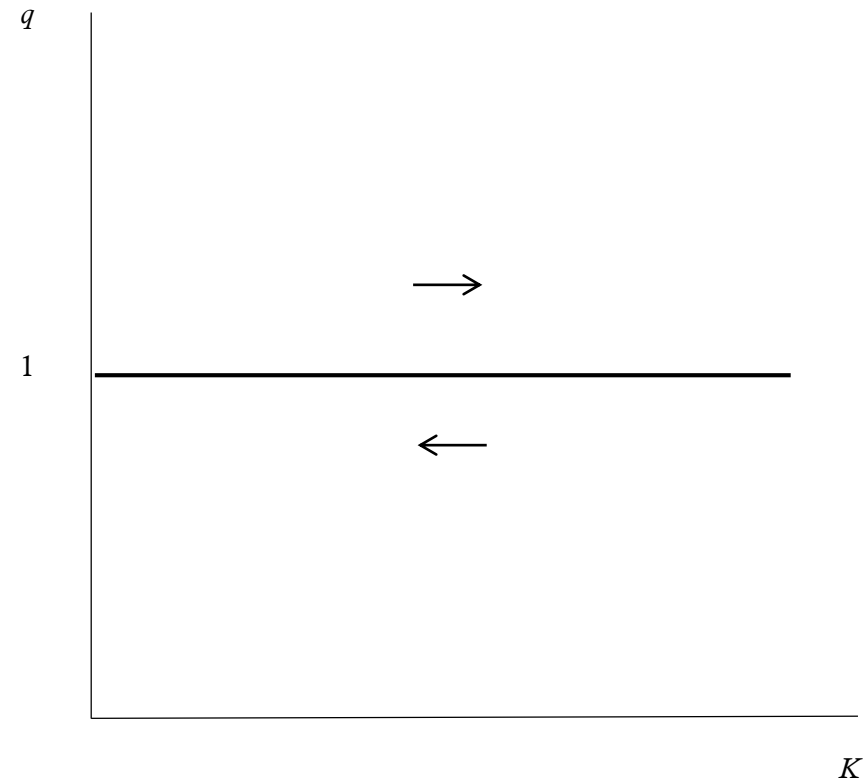


Dynamics of K

- Recall that there are N firms and that each firm has $\kappa(t)$ units of capital at time t
- Aggregate capital: $K(t) = N \kappa(t)$
- Aggregate investment:

$$\dot{K}(t) = \frac{N}{a} [q(t) - 1] \equiv f[q(t)]$$

$$f(1) = 0, f' > 0$$



Dynamics of q

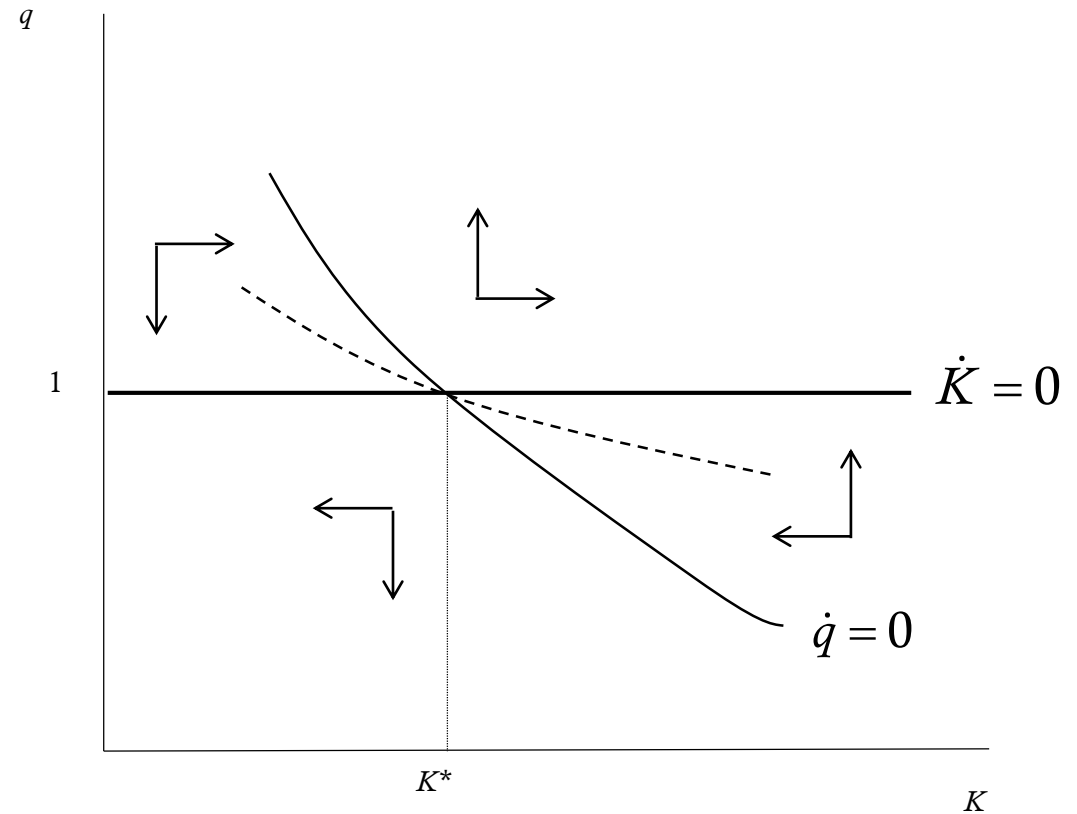
- From Euler equation:

$$\dot{q}(t) = rq(t) - \pi[K(t)]$$

- The stationary values of q are

$$\dot{q}(t) = 0 \Rightarrow q(t) = \frac{\pi[K(t)]}{r}$$

- Slopes downward because $\pi' < 0$
- Saddle path slopes down through stable quadrants
- q jumps to saddle path, K converges slowly along path to K^*





Effects of changes

- Increase in π function
 - Shifts $\dot{q} = 0$ curve upward
 - q jumps up (stock prices rise)
 - With $q > 1$, investment becomes positive and K rises
 - Eventually $q = 1$ again
 - Each unit of stock now \sim more capital, so shares are worth more, but $q = 1$
- Decrease in r has same effect as above
- Can anything shift $\dot{K} = 0$
 - It's usually pegged at $q = 1$
 - Tax or tax credit on investment would change after-tax return vs. before-tax return
 - $\dot{K} = 0$ would shift up (for tax) or down (for credit) to $q = 1 + \tau$, where τ is the tax rate (negative for credit)



Irreversible investment

- Uncertainty is central to investment, but we have ignored
- Dixit and Pindyck model based on three assumptions
 - We get better information about return to capital in period $t + s$ as s gets smaller
 - Reed will know more about future dorm demand next year than it does now
 - Investment is at least partially irreversible
 - Reed can't get all costs back by “unbuilding” a dorm that has been built
 - Investment can be postponed
 - Reed can build a dorm either now or next year
- All of these assumptions are pretty obviously true



Option value of postponement

- Investing now forfeits the option of not investing
 - This option has value because it may avoid investment that turns out to be unnecessary
- To invest now, benefits must cover standard investment costs PLUS the option value of waiting
- Actual optimal K^* may be less than the certainty-based prediction of the q model
- Degree of uncertainty has important impact on investment
- See *Investment under Uncertainty* by Dixit and Pindyck (Chapters 1 and 2 are recommended) for more details and examples



Financing: The Modigliani-Miller theorem

- Three methods firms can use to finance new capital
 - Retained earnings (internal finance)
 - Borrowing (issuing bonds = “leverage”)
 - New equity (new ownership shares)
- Does it matter which one the firm uses?
 - Maybe
 - Under assumptions of Modigliani-Miller theorem, it doesn't matter
- Coursebook example of three firms with different leveraging
 - \$1000 in capital, shares cost \$1, $r = 10\%$
 - Good years: profit = \$150 (15% ROR)
 - Bad years: profit = \$50 (5% ROR)
 - Equally likely



Table of outcomes

	Low Leverage	High Leverage	Ridiculous Leverage
Shares	1000	500	1
Debt	\$0	\$500	\$999
Debt service	\$0	\$50	\$99.90
Profits in good year	\$150	\$100	\$50.10
Profits in bad year	\$50	\$0	\$-49.90
Profits/share: good	\$0.15	\$0.20	\$50.10
Profits/share: bad	\$0.05	\$0.00	\$-49.90
Profits/share: ave	\$0.10	\$0.10	\$0.10

Analysis

- Risk *looks* different by profits/share
- Investor alternatives
 - Buy 10 shares of LL, get \$1.50 or \$0.50
 - Buy 5 shares of HL & \$5 of bonds, get \$1.50 or \$0.50
 - Buy 0.1 share of RL & \$9.99 of bonds, get \$1.50 or \$0.50
- These are exactly the menu of assets offered by the 3 firms
- Funding mechanism does not matter to diversified investor!

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Some empirical evidence

- Very difficult to detect empirical relationship between investment and cost of capital
 - Dynamics are problematic
 - Measurement of cost is hard
 - $E(MPK)$ variation may swamp cost effects
 - Causality is ambiguous
- Look for special cases to study
 - Cummins, Hassett, and Hubbard: Tax reforms change cost of capital
 - Fazzari, Hubbard, and Peterson: Role of cash flow
 - More examples in coursebook chapter



Review and summary

- The q model of investment predicts saddle-path convergence to a state where $q = 1$, so there is no longer incentive to add capital
- Optimal capital stock is determined by MPK/r
 - Any change causes immediate jump in q and gradual change in K
- Irreversibility may provide an additional obstacle to investment because firms must forgo option of delaying investment
- Modigliani-Miller theorem provides benchmark conditions under which the desirability of investment is independent of the method of finance
- Empirical studies have struggled to support the q model because investment does not seem responsive to cost of capital



One, last bad economist joke ...

There is a story about the last May Day parade in the Soviet Union. After the tanks and the troops and the planes and the missiles rolled by, there came ten people dressed in black.

"Are they spies?" asked the Russian Premier.

"They are economists," replied the KGB director. "Imagine the havoc they will wreak when we set them loose on the Americans."

--Taken from Jeff Thredgold, *On the One Hand: The Economist's Joke Book*



What's next?

- Nothing!
- We have finished our basic study of macroeconomics!
- Friday's class will be devoted to a broad discussion of the macroeconomics of the coronavirus pandemic
 - No recorded lecture
 - Just discussion in Zoom conference, which will be recorded for those unable to participate at class time