The Q-Theory of Mergers

Jovanovic and Rousseau

Presented By Ding Dong
Department of Economics, HKUST

HKUST Macro Group

Introduction

- Two types of capital accumulation
  - Direct investment (internal accumulation, new capital)
  - M&As (external acquisition, used capital[1])
- Nature of cost
  - Investment: high marginal adjustment cost, low fixed cost
  - M&As: high fixed cost, low marginal adjustment cost
- Q-theory of (direct) investment
  - Higher Q, higher investment rate
  - Does this apply to M&A investment?
- Highlights of this paper
  - Q-theory applies to M&A investment as well, and
  - M&As respond to Q more than direct investment
  - M&As waves are reallocative waves
  - High-Q firms by low-Q firms
  - Capital flows to better projects and management

[1] In reality, there are two distinct used capital market, one for equipment transactions only, the other for transactions with restructures. In the paper doesn't differentiate between these two markets, as they move together.

Model

Production:

- Production function:

$$f(K_t, N_t) = z_t K_t^{\alpha} N_t^{1-\alpha} \tag{1}$$

- z: idiosyncratic technology
  - Markov chain process: $Pr(z_{t+1} = z' | z_t = z) = F(z', z)$
  - positive correlated: $F_2(z', z) < 0$
- K: capital
  - law of motion:

$$K' = (1 - \delta)K + X + Y \tag{2}$$

  - new or disassembled capital investment (X): price = 1
  - used capital market - salvage : price = s
  - used capital market- M&As: price = q
  - used capital investment (Y): q = s (no arbitrage condition[2])
  - investment rate (intensity): $x = X/K$
  - merger rate (intensity): $y = Y/K$
  - law of motion:

$$K' = (1 - \delta + x + y)K \tag{3}$$

[2] This is not generally true, adding credit frictions may distort this result.

Model

Bellman Equation:

$$V(z,K) = \max_{x,y,N} zK^{\alpha}N^{1-\alpha} - wN - C(x,y)K - xK - qyK + \frac{1}{1+r}E_z\{V(z',K')\} \tag{4}$$

- adjustment cost

$$C(x,y) = \begin{cases} c(x,y) + \phi, & if \quad y \neq 0 \\ c(x,y) + 0, & if \quad y = 0 \end{cases} \tag{5}$$

- static labor choice:
  - w taken as given:

$$(1-\alpha)z(K/N)^{\alpha} = w \tag{6}$$

  - labor demand linear in capital

$$N = [\frac{w}{(1-\alpha)z}]^{1/\alpha}K \tag{7}$$

- AK technology:

$$A \equiv zK^{\alpha}N^{1-\alpha} - wN = a(z)K \tag{8}$$

Model

- Bellman Equation:

$$V(z,K) = \max_{x,y} a(z)K - C(x,y)K - xK - qyK + \frac{1}{1+r} E_z\{V(z',K')\} \tag{9}$$

- Tobin's Q ($\equiv \frac{V(z,K)}{K}$):

$$Q(z) = \max_{x,y} a(z) - C(x,y) - x - qy + \frac{1-\delta+x+y}{1+r}\{Q^*(z)\} \tag{10}$$

where

$$Q^*(z) = E(\frac{V(z',K')}{K'}|z) = \int \max\{q, Q(z')\}F(z',z) \tag{11}$$

Model

Without fixed cost:

$$Q(z) = \max_{x,y} a(z) - C(x,y) - x - qy + \frac{1-\delta+x+y}{1+r} Q^*(z) \qquad (12)$$

- f.o.c (at interior maximum)
  - $c_1(x,y) + 1 = \frac{1}{1+r} Q^*(z)$
  - $c_2(x,y) + q = \frac{1}{1+r} Q^*(z)$
- $Q^*(z)$ increases with z
  - z is positively auto-correlated
  - high-z firms will grow faster
- without fixed cost,
  - all firms: x & y
  - no difference b/w large and small firms
  - no optimal firm size (only optimal growth)

Model

$$Q(z) = \max_{x;y} a(z) - c(x,y) - \phi 1_{\{y>0\}} - x - qy + \frac{1-\delta+x+y}{1+r} Q^*(z) \quad (13)$$

- gross investment rate: i=x+y
- with fixed cost,
  - low-i firms: x (avoid fixed cost ϕ: y=0)
  - high-i firms: x & y
- participation in merger
  - cut-off value of i^* [3]

$$i^* + c(i^*, 0) = \phi + \min_y \{(i^* - y) + qy + c(i^* - y, y)\} \quad (14)$$

  - cut-off value of z^*
- intensity of merger (vs. investment)
  - cut-off value of i_o
  - cut-off value of z_o

[3] existence: LHS increases with i, while RHS decreases with i.

Model

Continuation Problem:

- If continue,
  - value of K: Q(z)K
  - internal value of capital
- If quit
  - value of K: qK
  - outside value of capital
- Cut-off value of z_e: participation in production
  - $Q(z_e) = q$

Cut-off values of z:

$$z_e < z^* < z_o \tag{15}$$

Distribution of firms

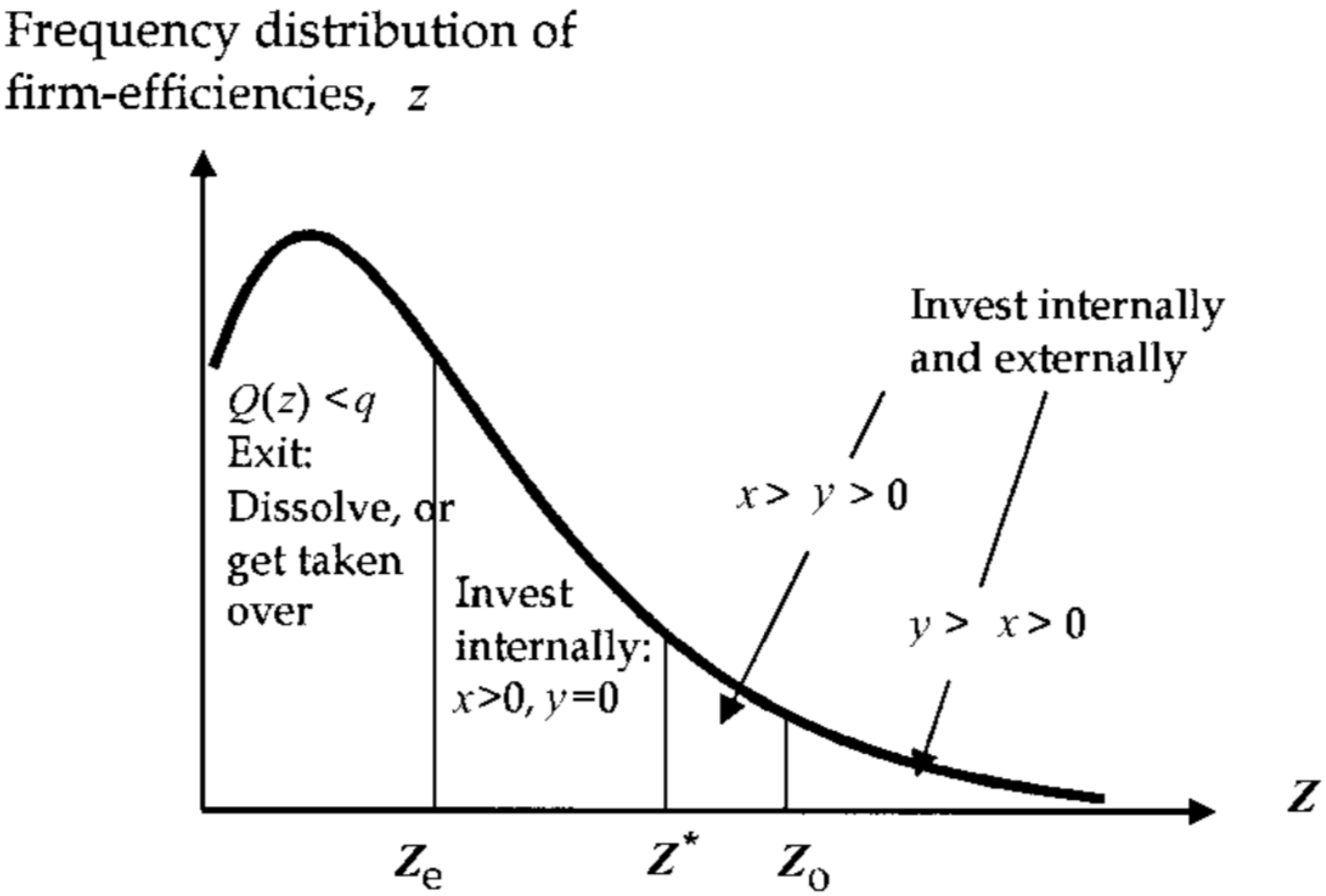

Figure: The Cut-off Values of z ($z_e < z^* < z_o$)

Investment Strategy

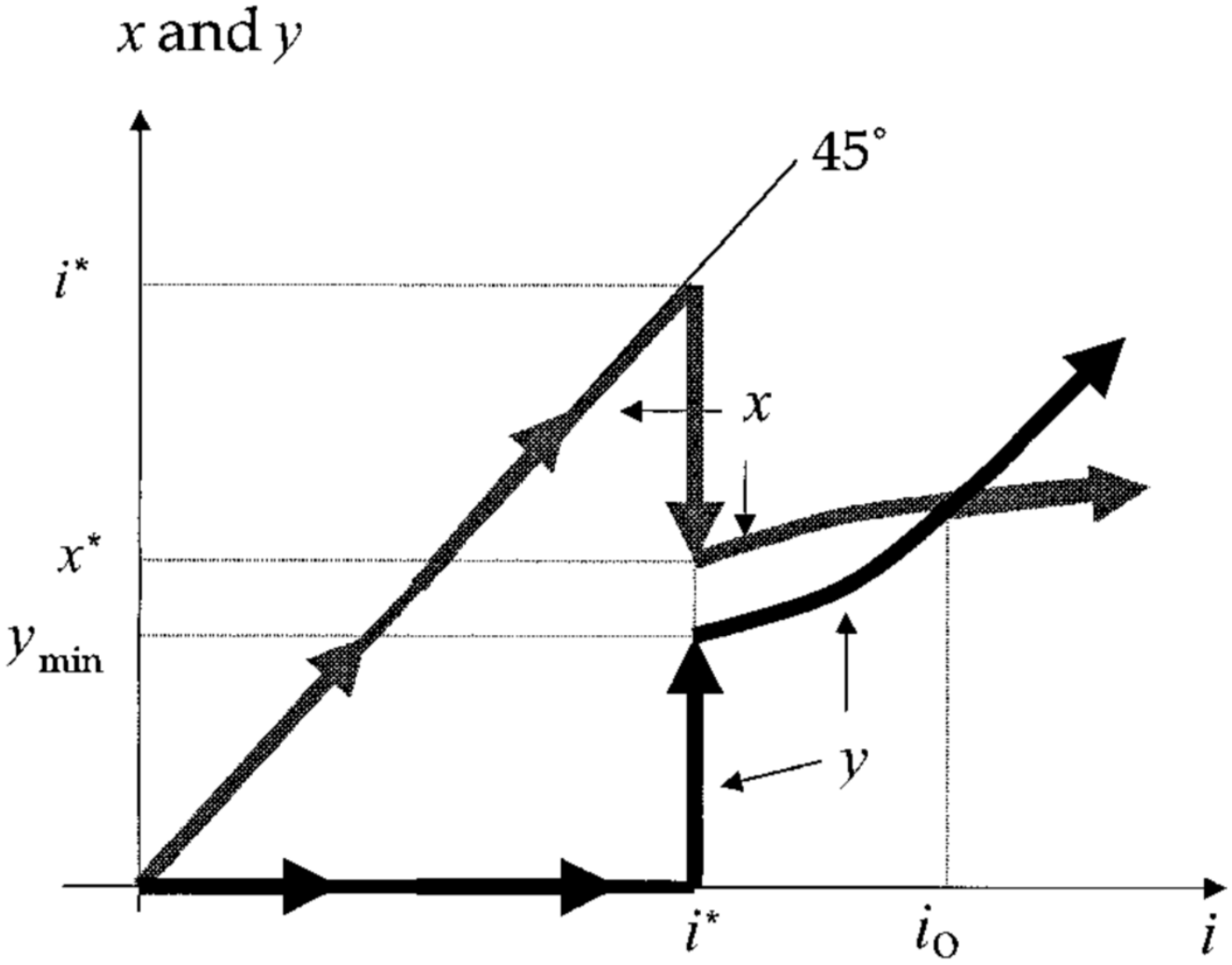

Figure: The Expansion Path of x and y (Model)

Investment Strategy

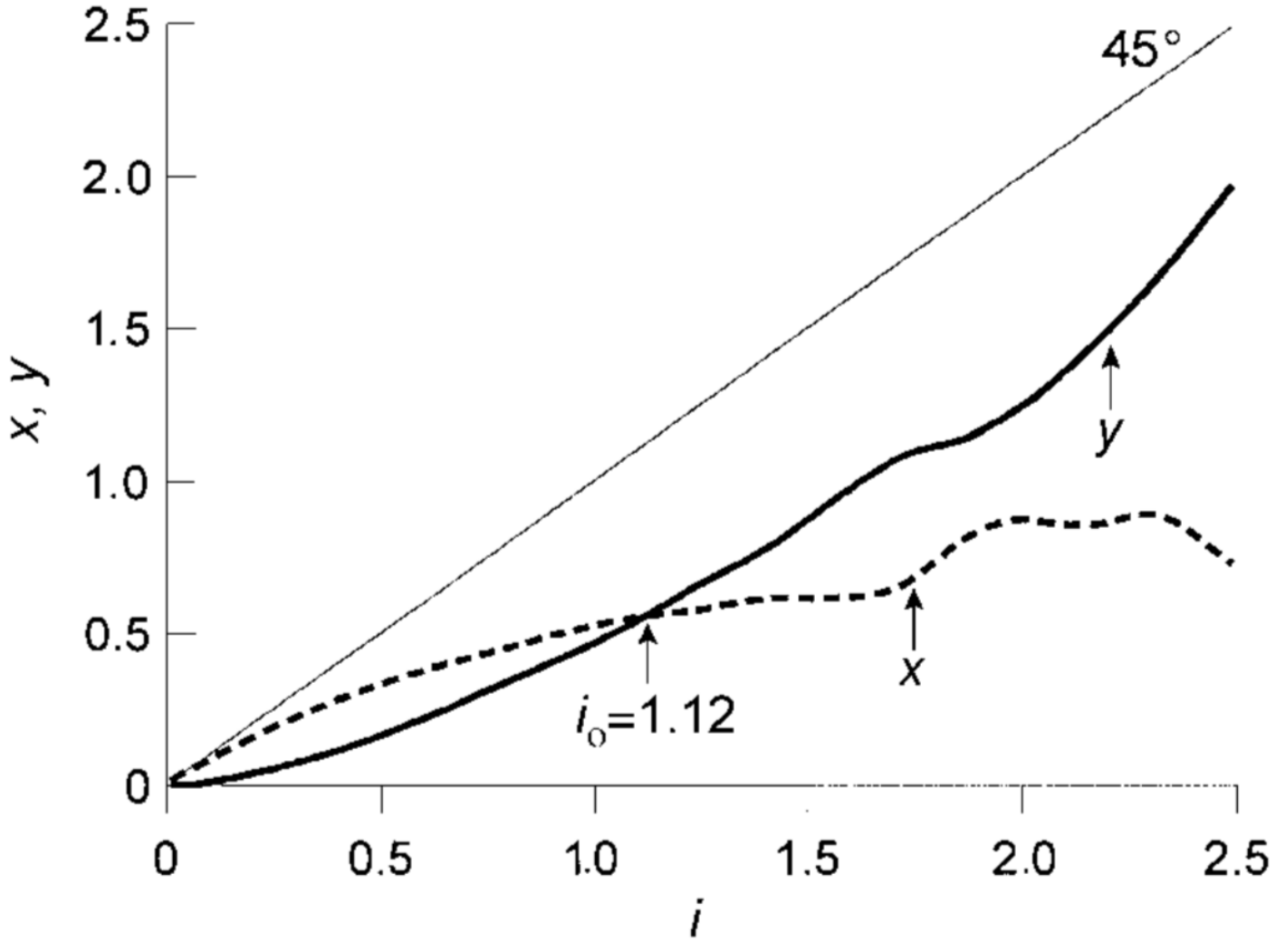

Figure: The Expansion Path of x and y (Data: 1971-2001)

Q-theory

- Recall F.O.Cs
  - $c_1(x, y) = Q^*(z) - 1$
  - $c_2(x, y) = Q^*(z) - q$
- Assume c(x,y) is additively separable.
  - $x = g(Q^*)$
  - $y = h(Q^* - q)$
- Linearized equations for estimation
  - $x_{j,t} = \alpha_0^x + \alpha_1^x Q_{j,t-1} + \alpha_2^x t$
  - $y_{j,t} = \alpha_0^y + \alpha_1^y [Q_{j,t-1} - \bar{q}] + \alpha_2^y t$
  - same as Hayashi(1982)
- Prediction
  - $\alpha_1^x > 0$
  - $\alpha_1^y > 0$

Q-theory

TABLE 1—INVESTMENT REGRESSIONS

	Dependent variable	
Independent variable	$100x_{j,t}$	$100y_{j,t}$
$Q_{j,t-1}$	0.746	
	(35.71)	
$Q_{j,t-1} - \bar{q}_{t-1}$		2.220
		(18.42)
Time trend	−0.120	0.0308
	(13.29)	(7.32)
R^2:	0.0479	0.0206
N:	111,039	26,383

Notes: The table presents estimates for equation (10) with t statistics in parentheses. The regressions include dummy variables for two-digit SIC's (not reported).

Table: Investment Regressions

Merger Waves

- If all firms have the same z
  - Q=q
  - no M&As
- M&As should rise when dispersion of Q is high
  - Was Q more dispersed during merger waves?
- 1900, 1920, 1980, 1990: Yes!
  - reallocation waves.
- 1960: No

Discussion

- A seminal work on M&As:
  - high-buys-low pattern
    - "q-theory of mergers"
    - resources transferred from low to high productivity firms
    - merger waves as reallocation waves
    - challenged by Rhodes-Kropf and Robinson (2008): "like-by-like"
  - merger more sensitive to firm's q than direct investment
    - by a factor of 2.6
- Limitation:
  - no size effect
  - constant resale price of capital
  - a-cyclical merger
  - no general equilibrium effect