Knowledge Interactions and Travel Behavior

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Industrial Society

based on
mass production of commodities
(homogeneity)

Brain Power Society (L. Thurow)

or

C-Society (Å. Andersson)

based on
brain power
or
creativity
(heterogeneity)

a comprehensive theory of
spatial economics
in the Brain Power Society

↑ incorporating

dual linkages

E-linkages: linkages through the production and transaction of (traditional) goods and services (the New Economic Geography)

K-linkages: linkages through the creation and transfer of knowledge · ideas · information

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weak microfoundation

Today's my presentation

a simple model of knowledge interactions

(=human interactions for the creation and transfer / learning of knowledge)

↓

preliminary implications for travel behavior in knowledge interactions

↓

future research tasks

Knowledge interactions

(human interactions for creation and transfer / learning of knowledge)

<u>fundamental characteristics</u>

1. The basic unit = the Brain of each person
   (Brain ≡ the State of Knowledge of a person)

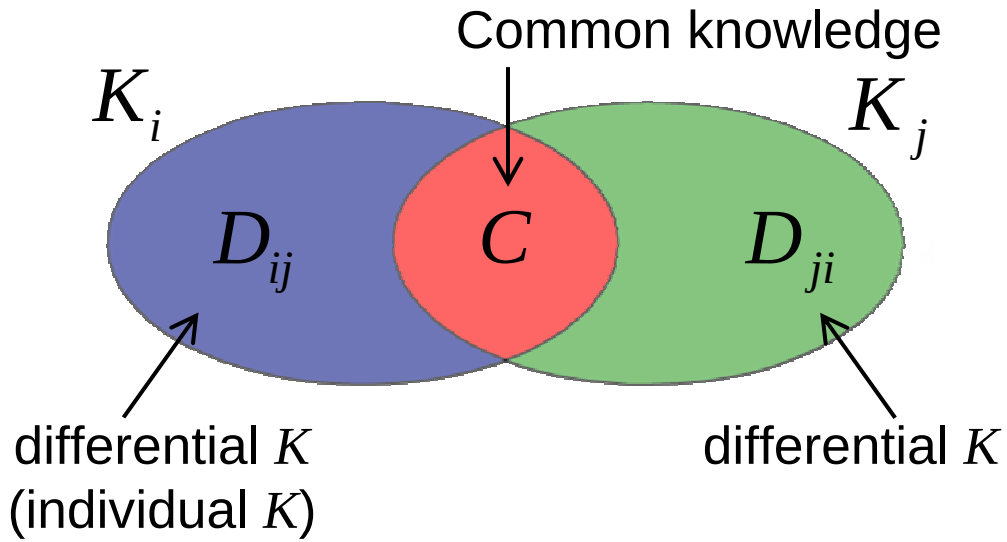
2. Heterogeneity of Brains (= Diversity of People)
   → necessity / motivation of interactions
   → synergy through interactions

3. Heterogeneity is endogenous: It necessarily changes through interactions.

“**The Bad News:** The brain is the only natural resource in the Øresund Region.
The Good News: The brain is the only natural resource that expands with use.”
Håkan Pettersson
Ph.D Biochemistry, Lund

in the cooperative process of K-creation
the key factor:

the heterogeneity of people



new ideas through the encounter of heterogeneous people

> “Heterogeneity is a tonic: it adds an energy of unexpected combinations.”

Joe Klein
The Guardian, June 12, 2002

“How the Solidarity dream turned sour”

“三 个 臭 皮 匠、

抵 个 渚 葛 亮”

“三人寄れば、文殊の知恵”

With three ordinary persons together, splendid ideas will come out.

But,

Question: Is it true in the long-run?

antinomy

"With three ordinary persons together, splendid ideas will come out."

↓

But, after three ordinary persons meeting for three years, no splendid ideas will come out.

"Heterogeneity is a tonic: it adds an energy of unexpected combinations." (Joe Klein)

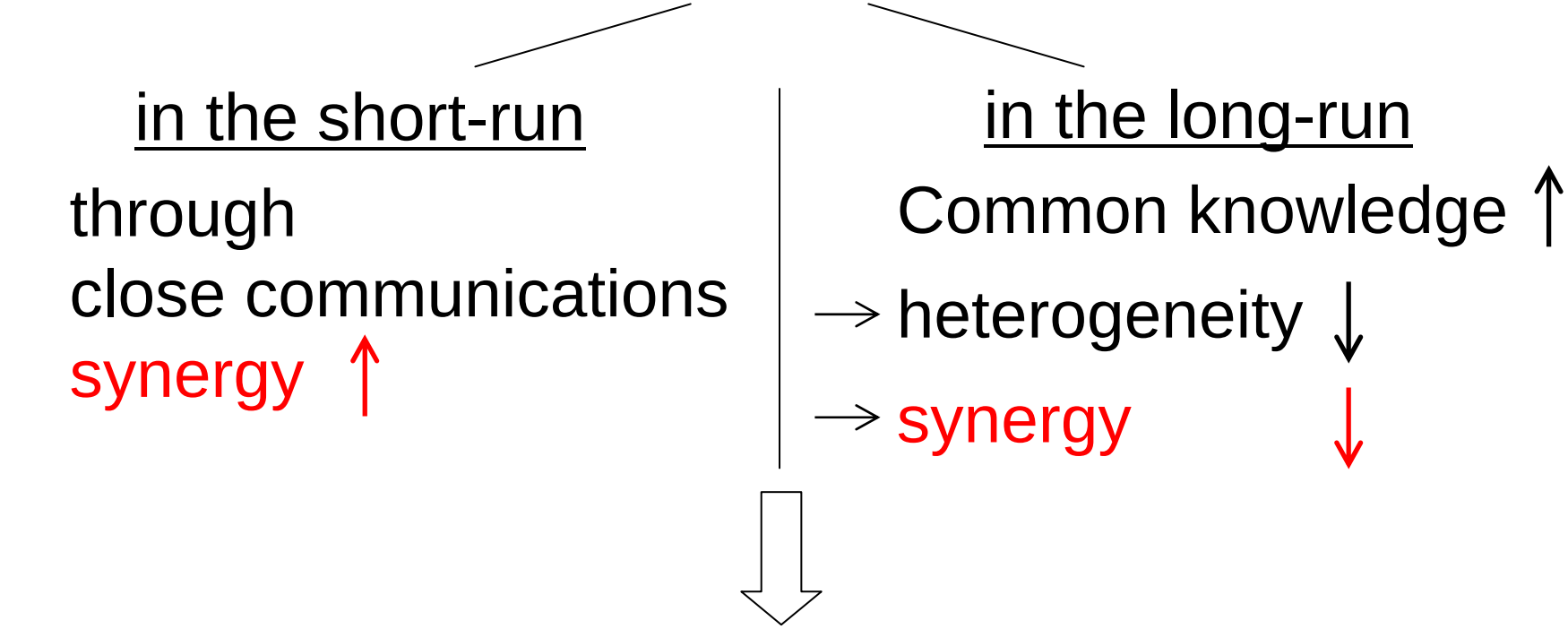
↓

But, after three glasses of tonic, it will taste just like plain water.

close cooperation of
heterogeneous K-workers

↓

antinomy



⇩

heterogeneity of K-workers = an endogenous variable changing over time

e.g. “nominication” in Japan

In the rest of presentation

A simple model of knowledge interactions

(without explicitly considering “space”)

introducing
location / distance

implications for travel behavior

Marcus Berliant and Masahisa Fujita, 4 June 2006

1. “Knowledge Creation as a Square Dance on the Hilbert Cube” ‥‥ N-person case without K-transfer

2. “Dynamics of Knowledge Creation and Transfer: The Two Person Case” ‥‥ 2-person case both { K-creation, K-transfer }

modeling the **dynamic process of knowledge creation** as a square dance ①
on the Hilbert Cube ②

→ How does the heterogeneity (among the given set of members) change over time?

→ How is the productivity in knowledge creation affected?

① “Square Dance”

- very popular in the mid USA

- 8 members

  each pair: partner dancing

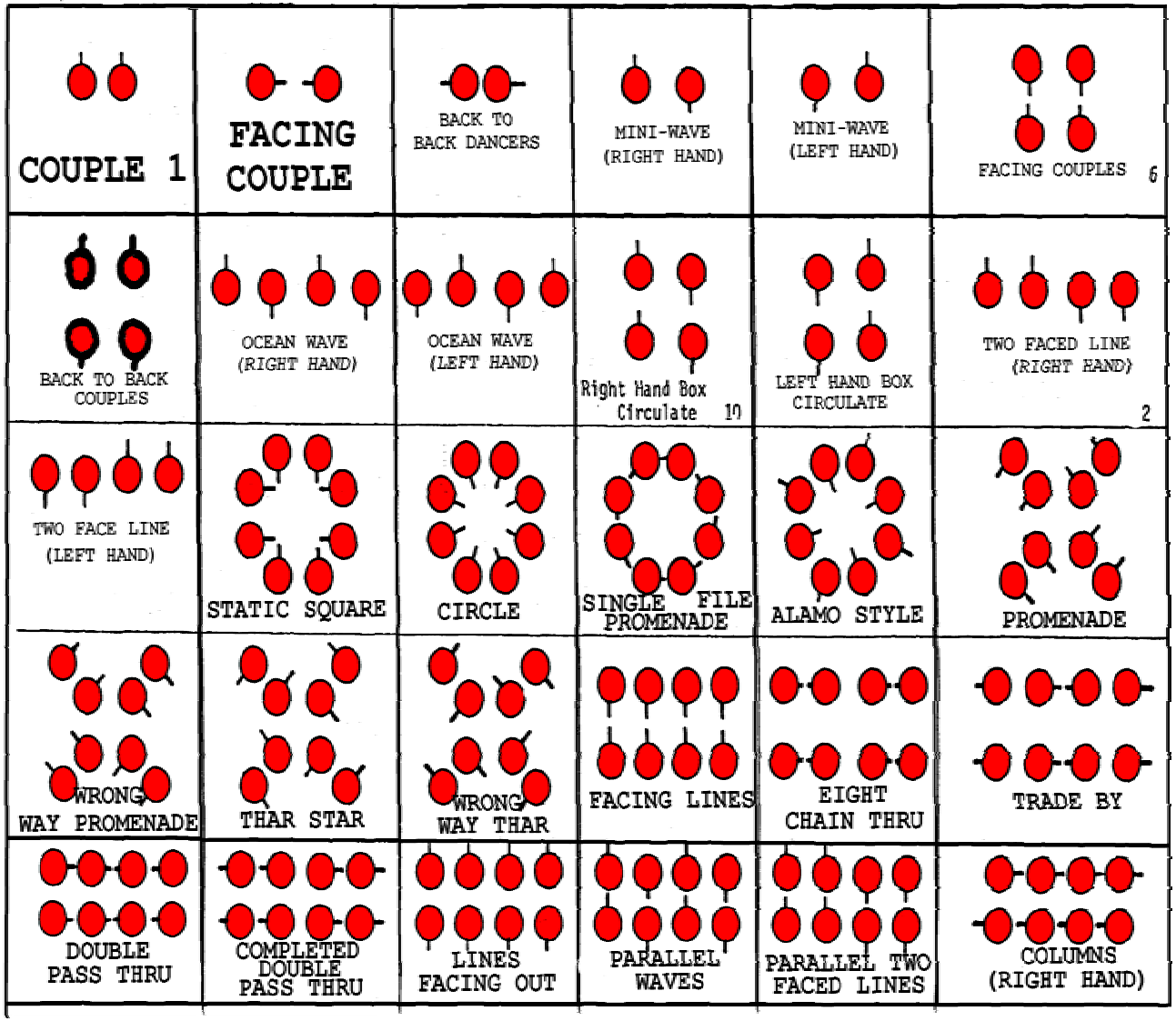
  ⟶ sequentially changing partners

FORMATION

Names & Pictograms of selected formation arrangements (callerab 1980)

CALLERLAB

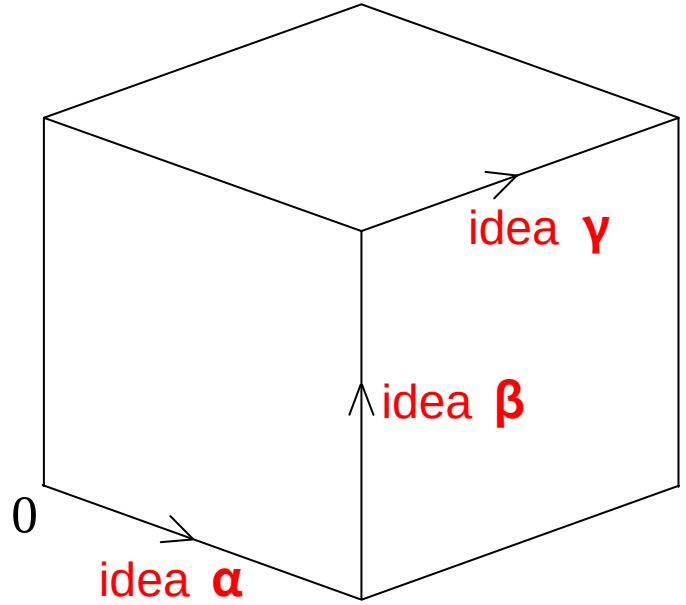
CALLERLAB APPROVED 1980



http://www.penrod-sq-dancing.com/fasr1.html

② “Hilbert Cube” (infinite dimensional)

$n = 3$: (the cube in the three-dimensional space)



$n = 4$

$n = 5$

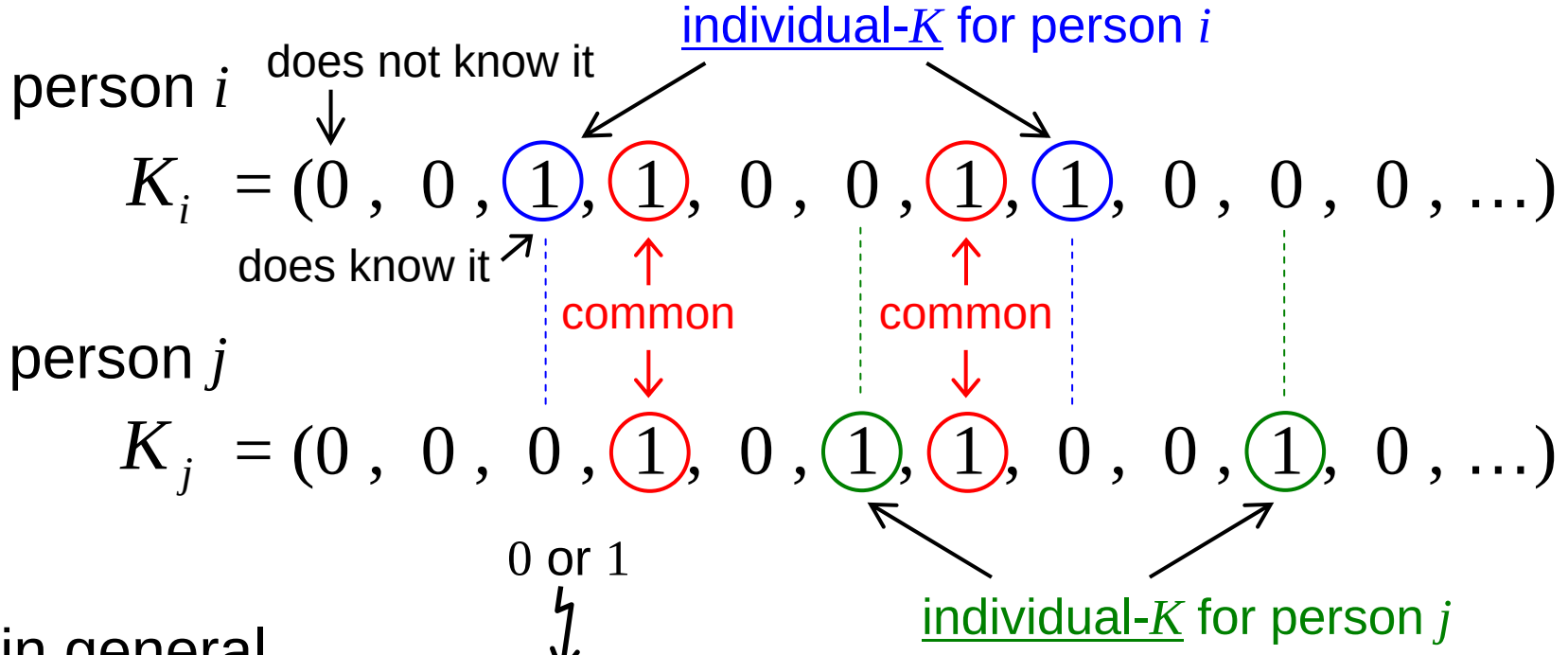
$n \vdots = \infty$: the (infinite dimensional) Hilbert space

$\updownarrow$

new ideas are limitless

potential ideas : $1,2,3,\ldots k,\ldots\ldots\ldots\ldots\ldots\infty$

<u>sate of knowledge</u> (at a given moment of time)



<u>in general</u>

$$K_i = (x_i^1, x_i^2, x_i^3, \ldots\ldots, x_i^k, \ldots\ldots)$$

$$K_j = (x_j^1, x_j^2, x_j^3, \ldots\ldots, x_j^k, \ldots\ldots)$$

over time, each K_j changes through some creation / transfer of ideas: $x_i^k : 0 \to 1$

At each moment of time,
Knowledge creation can take place

either { ① in meeting of two persons (only 2 at a time)
or
② in isolation }

chosen voluntarily by each person so as to:

$\max \dot{y}_i(t) = \dot{n}_i(t) =$ new ideas created at t
+
ideas transferred from others at t

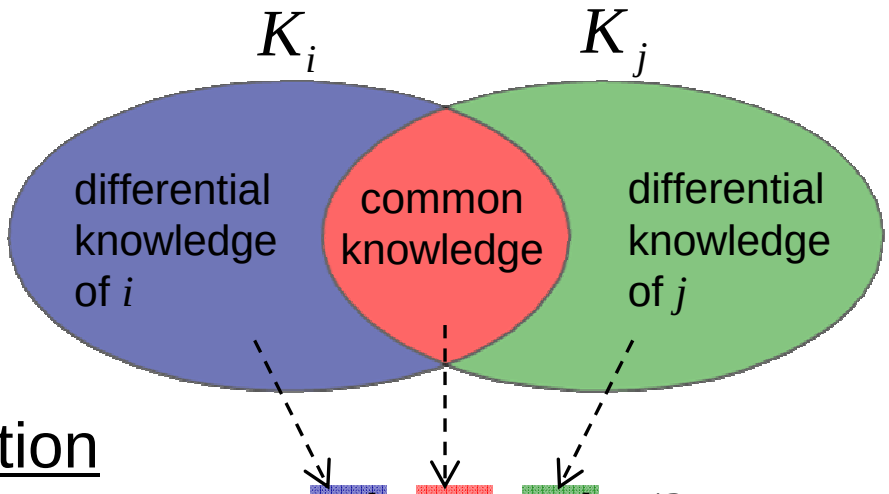
($\max$ growth rate of i's income)

{ income of person i at time t :
$y_i(t) = n_i(t)$

the size of $K_i(t) \equiv$ the level of H-capital

① in meeting of two persons, i and j

Creation and transfer of knowledge / ideas



K-creation

$$a_{ij} = \beta[n_{ij}^{d} \cdot n_{ij}^{c} \cdot n_{ji}^{d}]^{1/3}$$

K-transfer

$$i \rightarrow j: \; b_{ij} = \gamma[n_{ij}^{d} \cdot n_{ij}^{c}]^{1/2}$$

$$j \rightarrow i: \; b_{ji} = \gamma[n_{ij}^{c} \cdot n_{ji}^{d}]^{1/2}$$

② in isolation

K-creation

the rate of growth of K_i in isolation

$$a_i = \alpha n_i$$

Index for meeting / not meeting

at each time t:

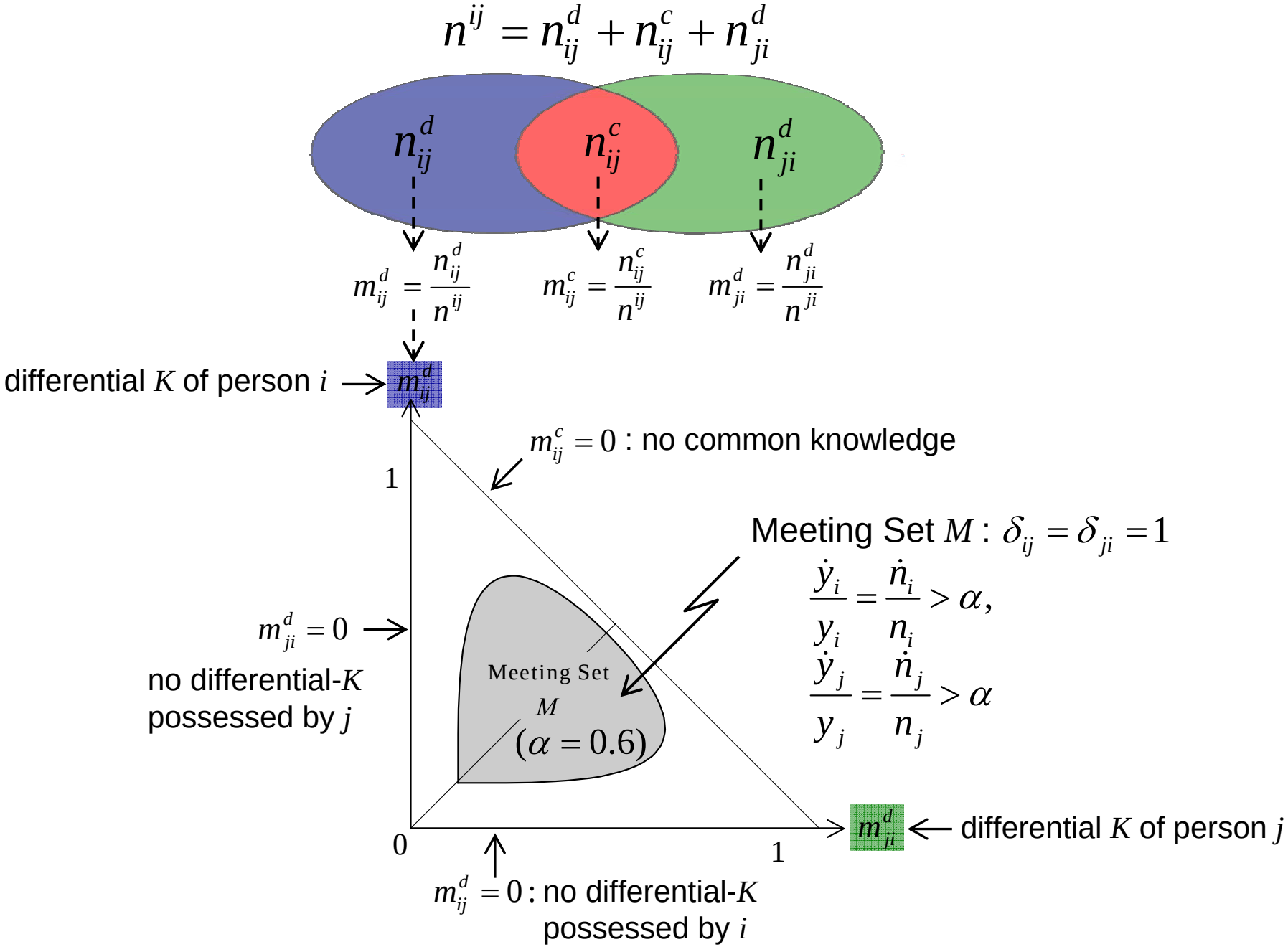
$$\delta_{ij}(t) = \begin{cases} 1 & \text{if person } i \text{ wants to meet person } j \\ 0 & \text{otherwise} \end{cases}$$

$$\delta_{ji}(t) = \begin{cases} 1 & \text{if person } j \text{ wants to meet person } i \\ 0 & \text{otherwise} \end{cases}$$

when the meeting of i and j occurs at time t,

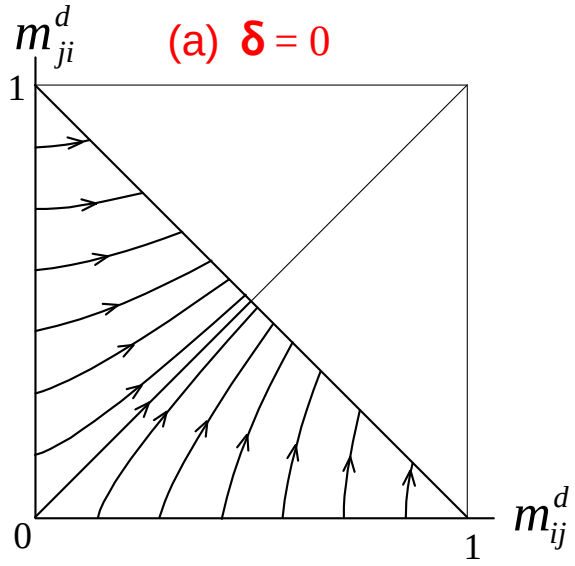
$$\delta_{ij}(t) = \delta_{ji}(t) = 1$$

When does the meeting by i and j take place?

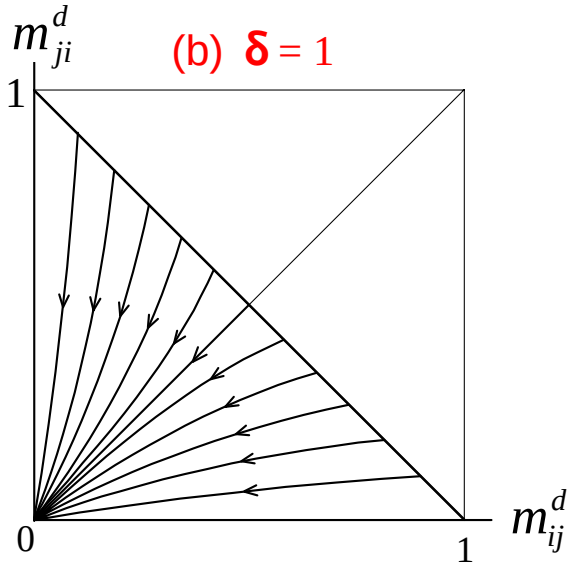


dynamics

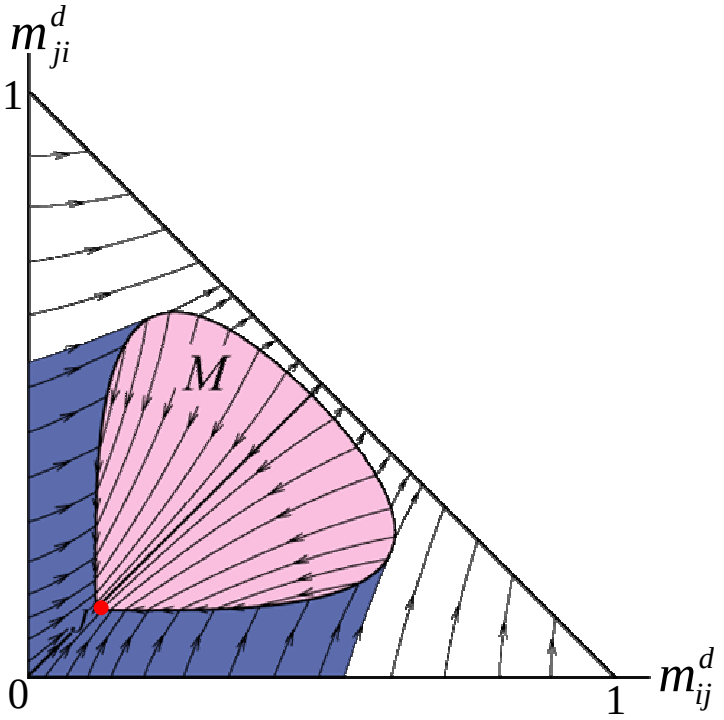
① each in isolation



② in meeting

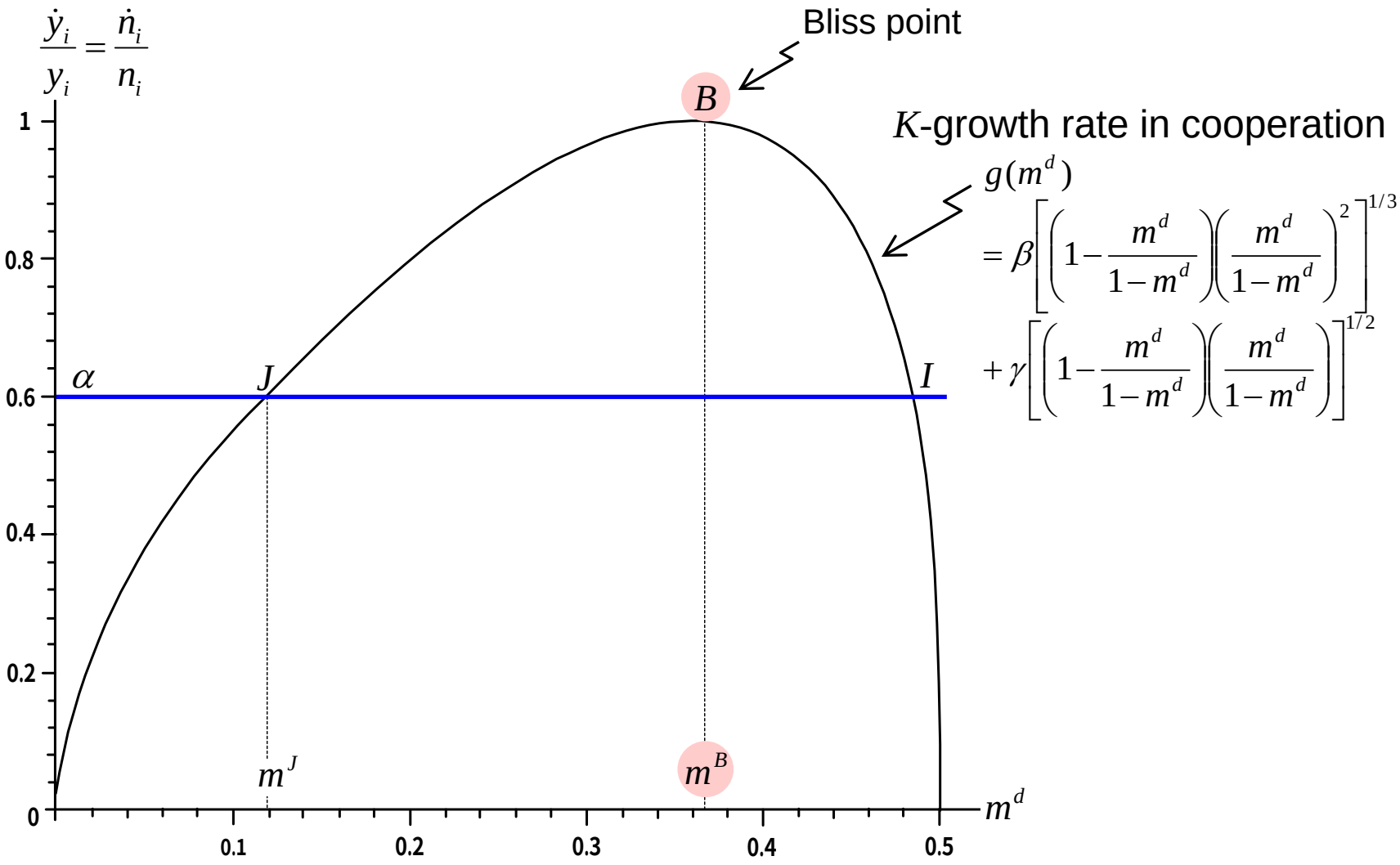


③ Knowledge dynamics with δ endogenous



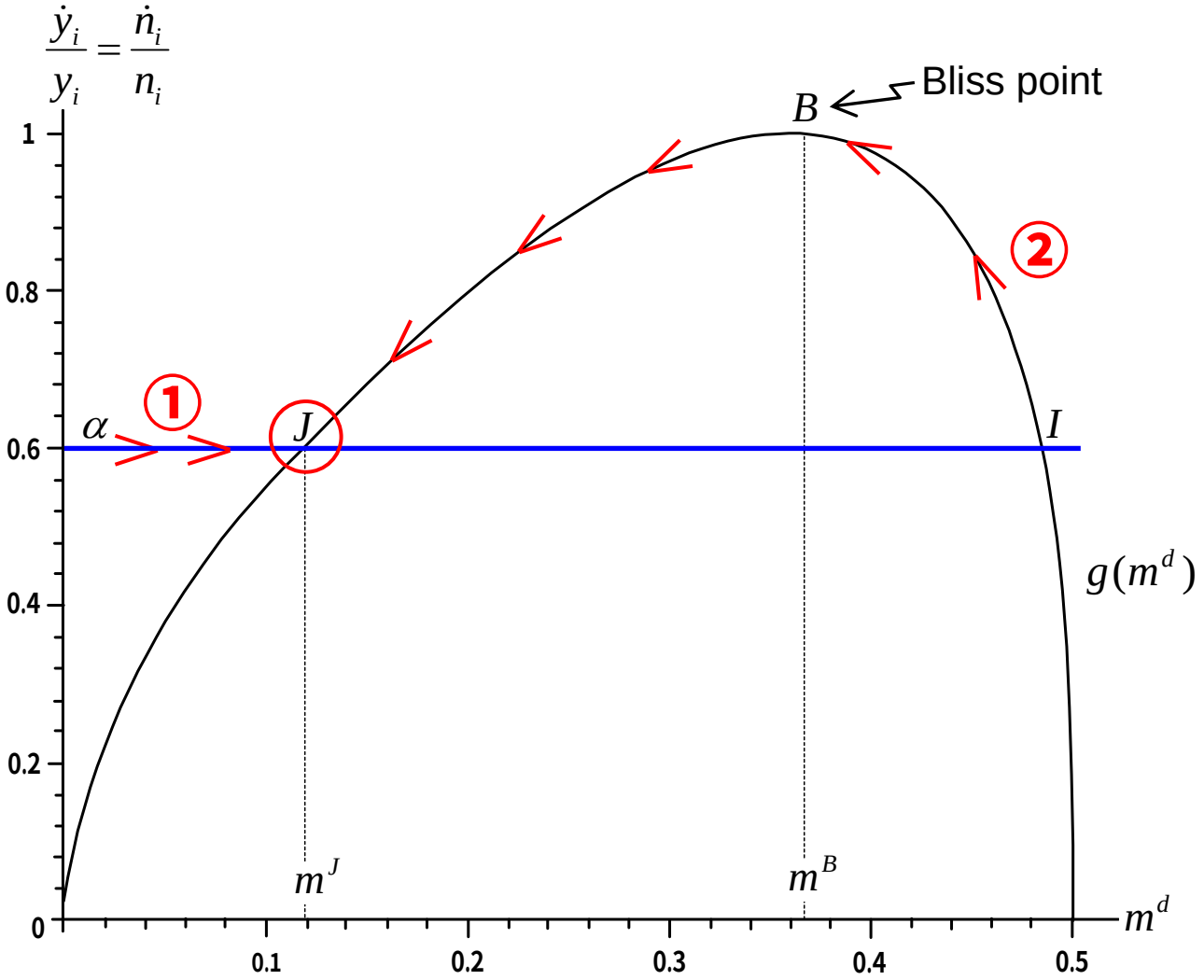
Efficiency and the bliss point on the diagonal

(symmetric case: $m_{ij}^d = m_{ji}^d \equiv m^d$)



equilibrium dynamics on the diagonal

the 2-person case



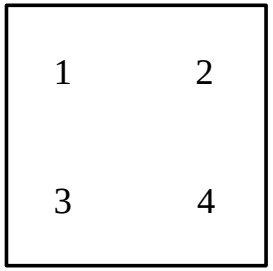
The two-person case

→ tendency for the accumulation of too much common knowledge

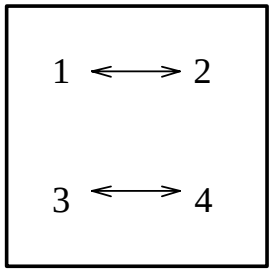
the 4-person case

possible equilibrium configurations with four dancers

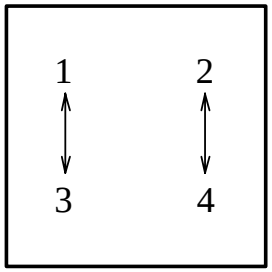
(a) solos



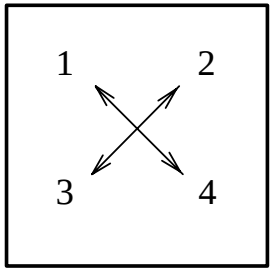
(b−1)



(b−2)

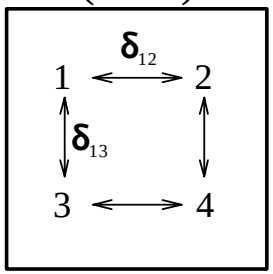


(b−3)

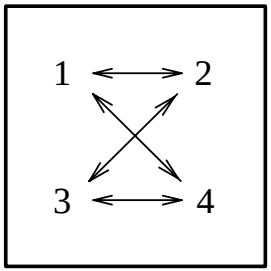


quick rotation

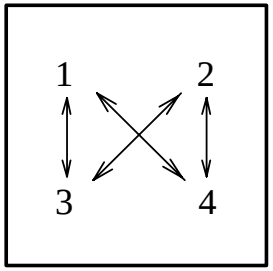
(c−1)



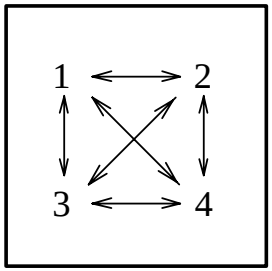
(c−2)

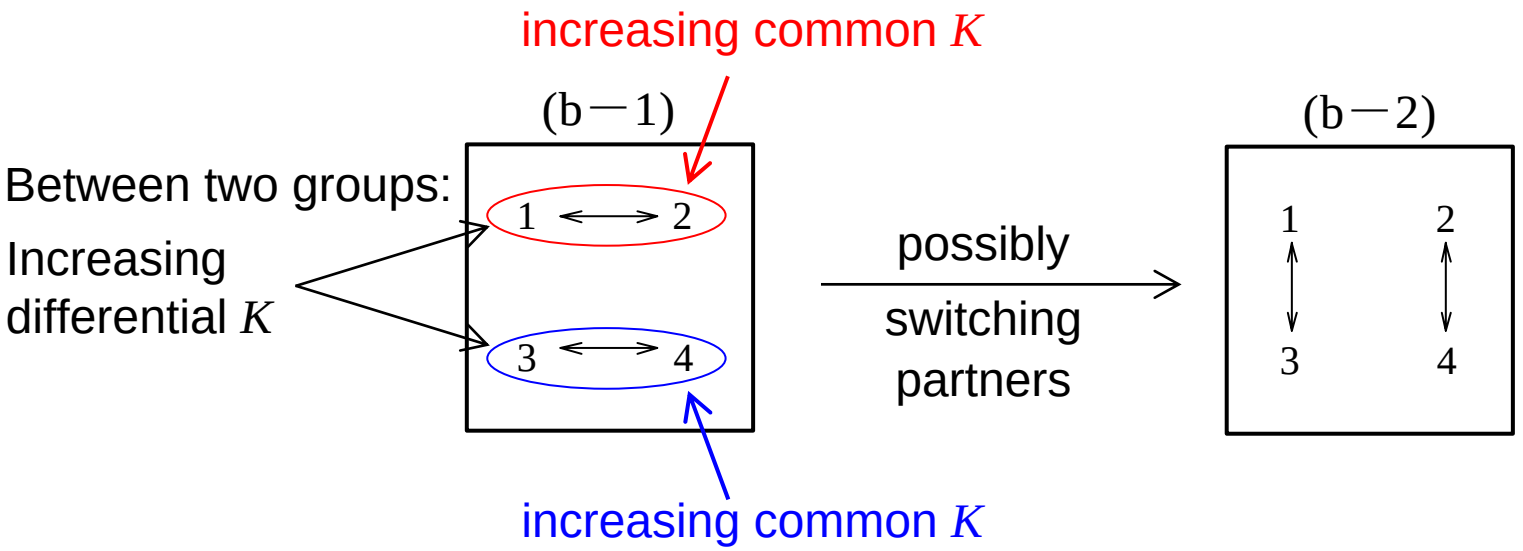


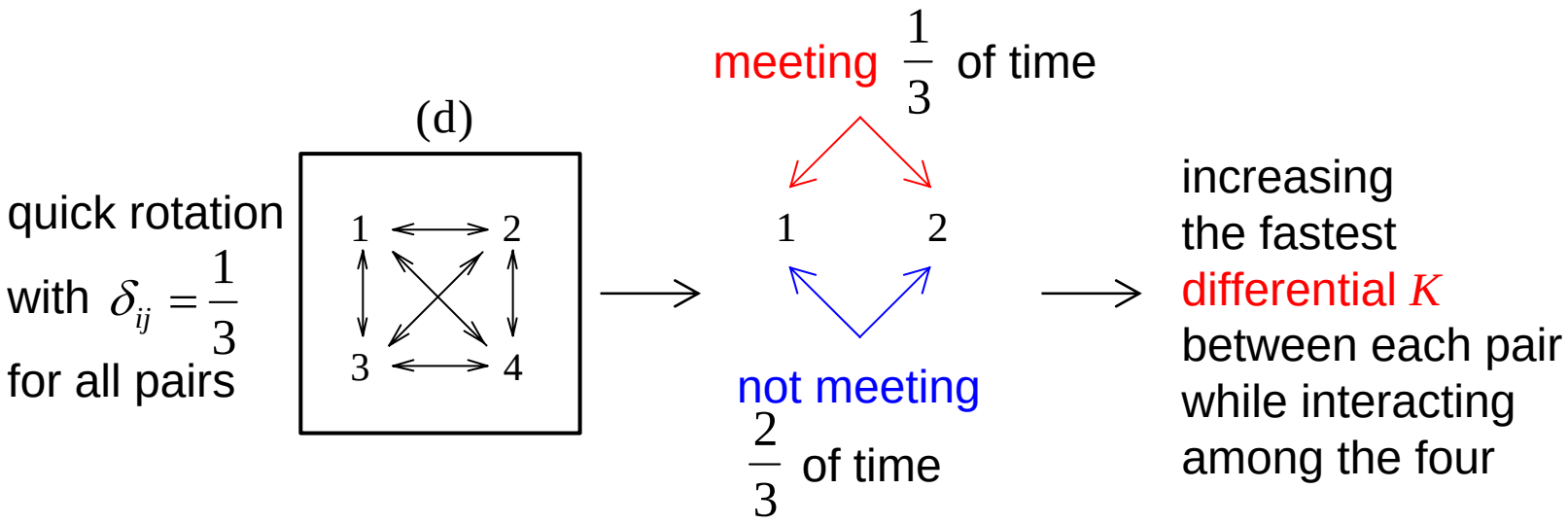
(c−3)



(d)




increasing common K
(b−1)
Between two groups:
Increasing
differential K
1
2
3
4
possibly
switching
partners
(b−2)
1
2
3
4
increasing common K


meeting $\frac{1}{3}$ of time
(d)
quick rotation
with $\delta_{ij} = \frac{1}{3}$
for all pairs
1
2
3
4
1
2
not meeting
$\frac{2}{3}$ of time
increasing
the fastest
differential K
between each pair
while interacting
among the four

the 4-person case

a simple case when

$\gamma = 0$

K-transfer:

$$b_{ij} = \gamma[n_{ij}^{d} \cdot n_{ij}^{c}]^{1/2}$$

$$b_{ij} \equiv 0 : \text{ no } K\text{-transfer}$$

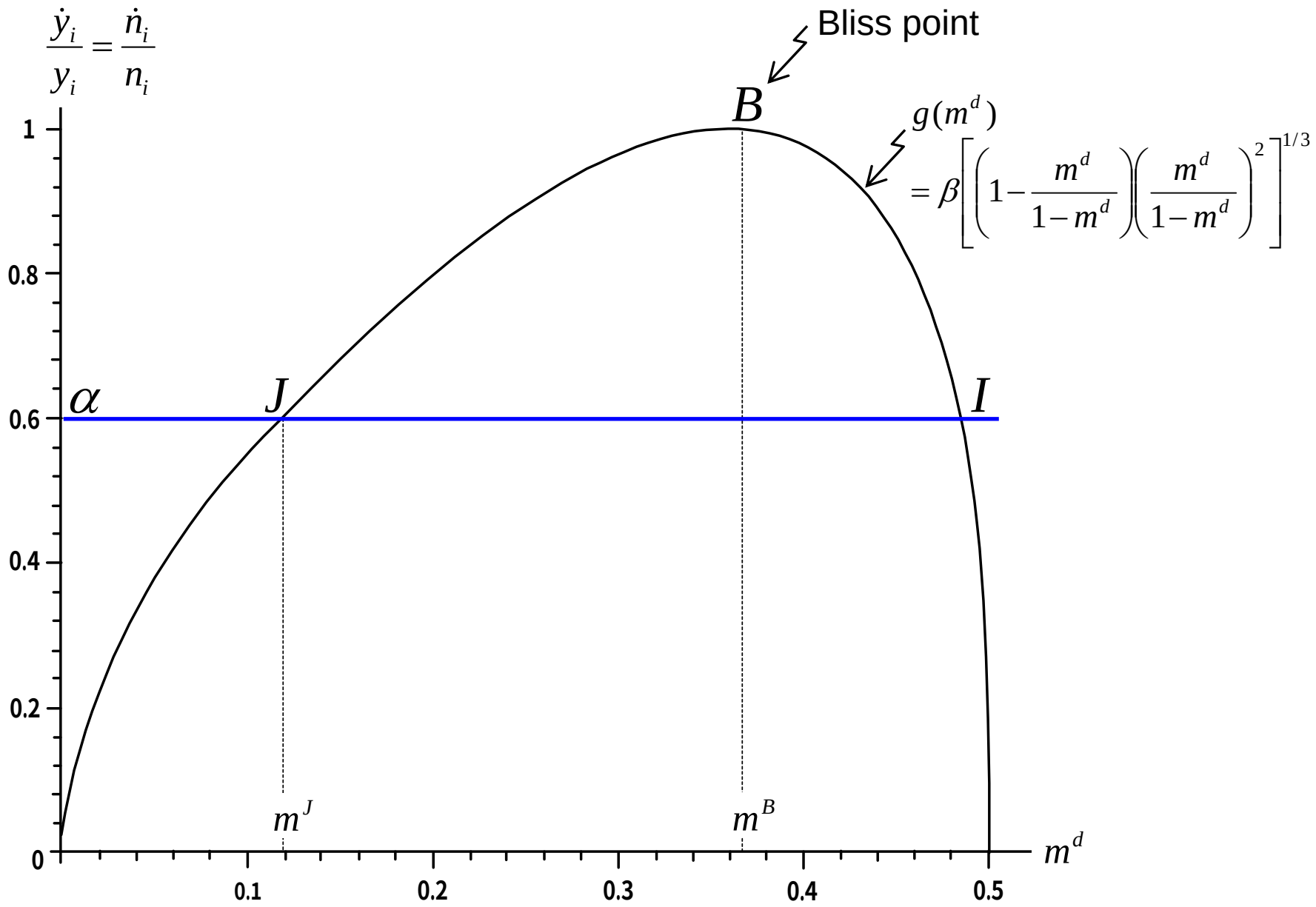
The case with very sticky (tacit) knowledge
(only sharing the new ideas created jointly)

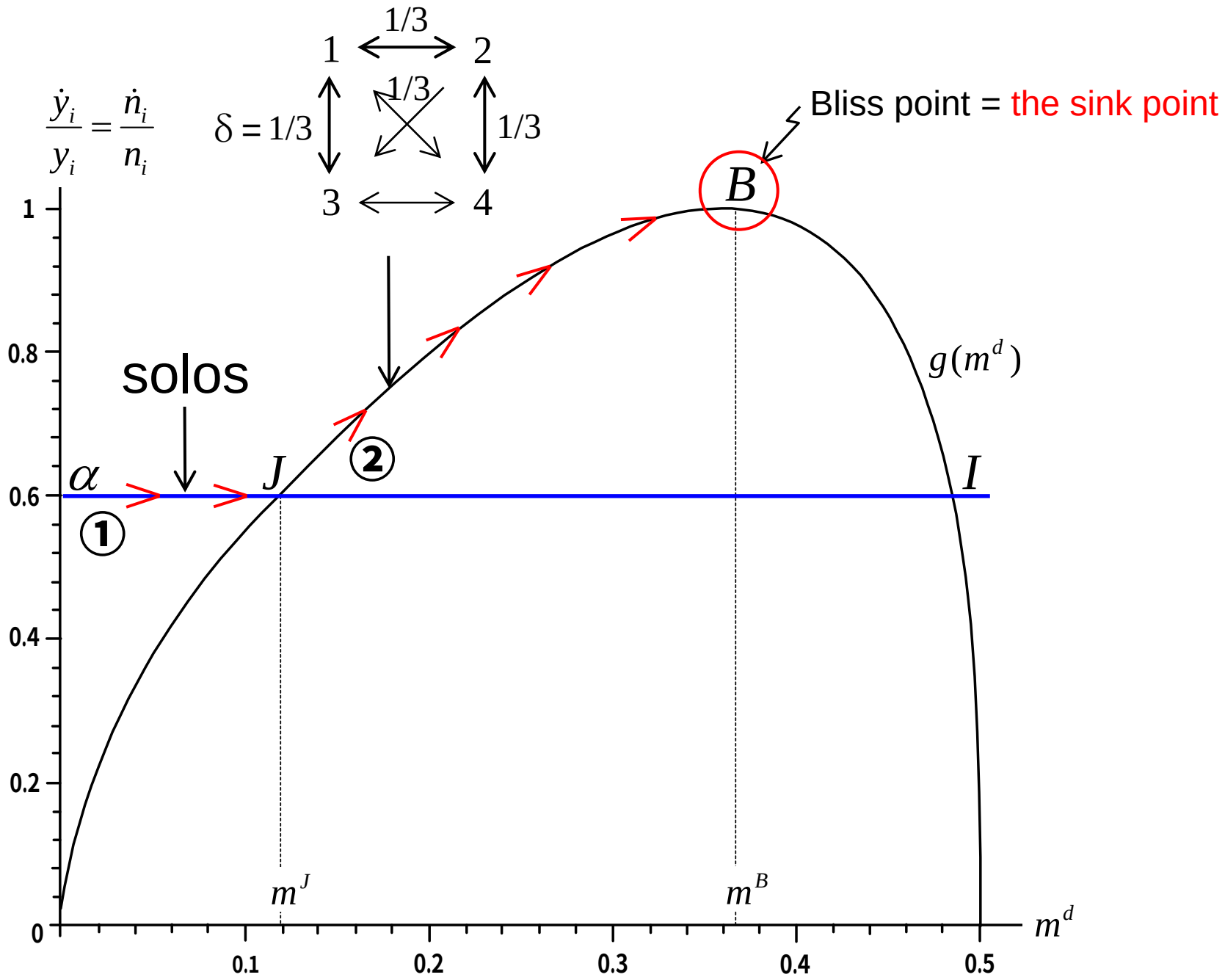
Example 1: Tokyo Osaka

many small firms (each with several workers)
each specialized in very specific manufacturing services

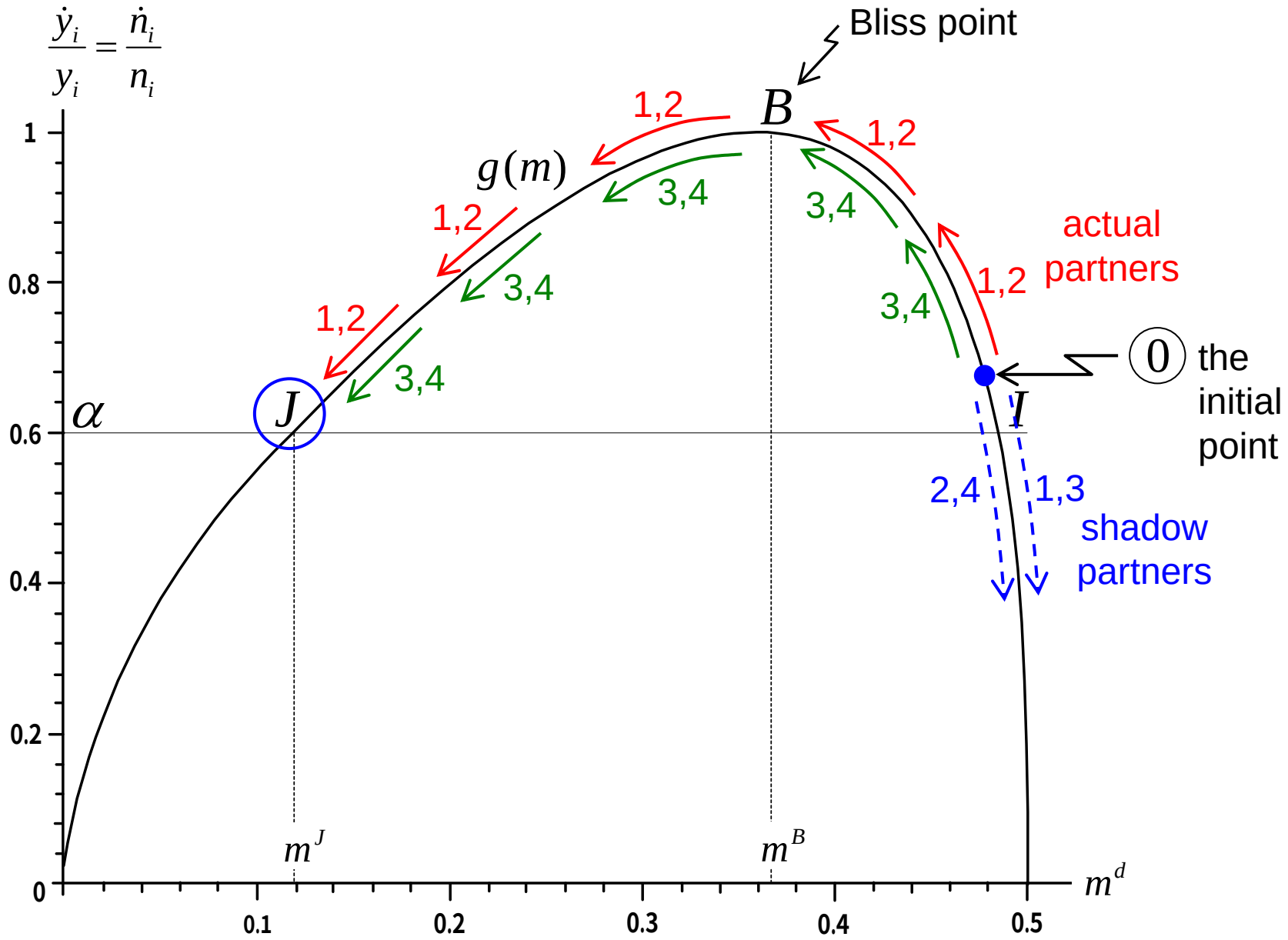
Example 2: The third Italy

Equilibrium dynamics with symmetric initial $m_{ij}^{d}(0) = m^{d}(0)$ **for all** $i \neq j$

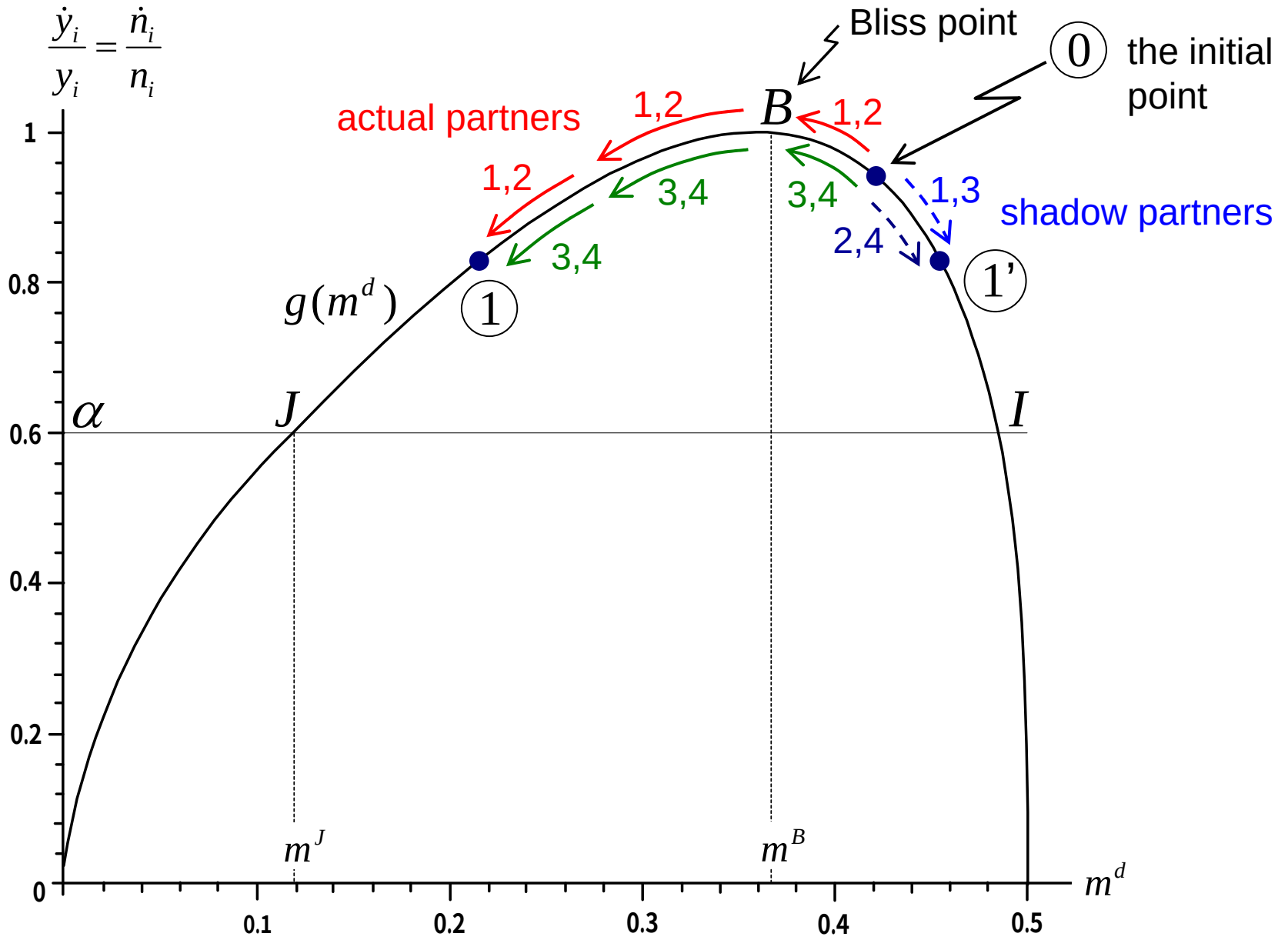


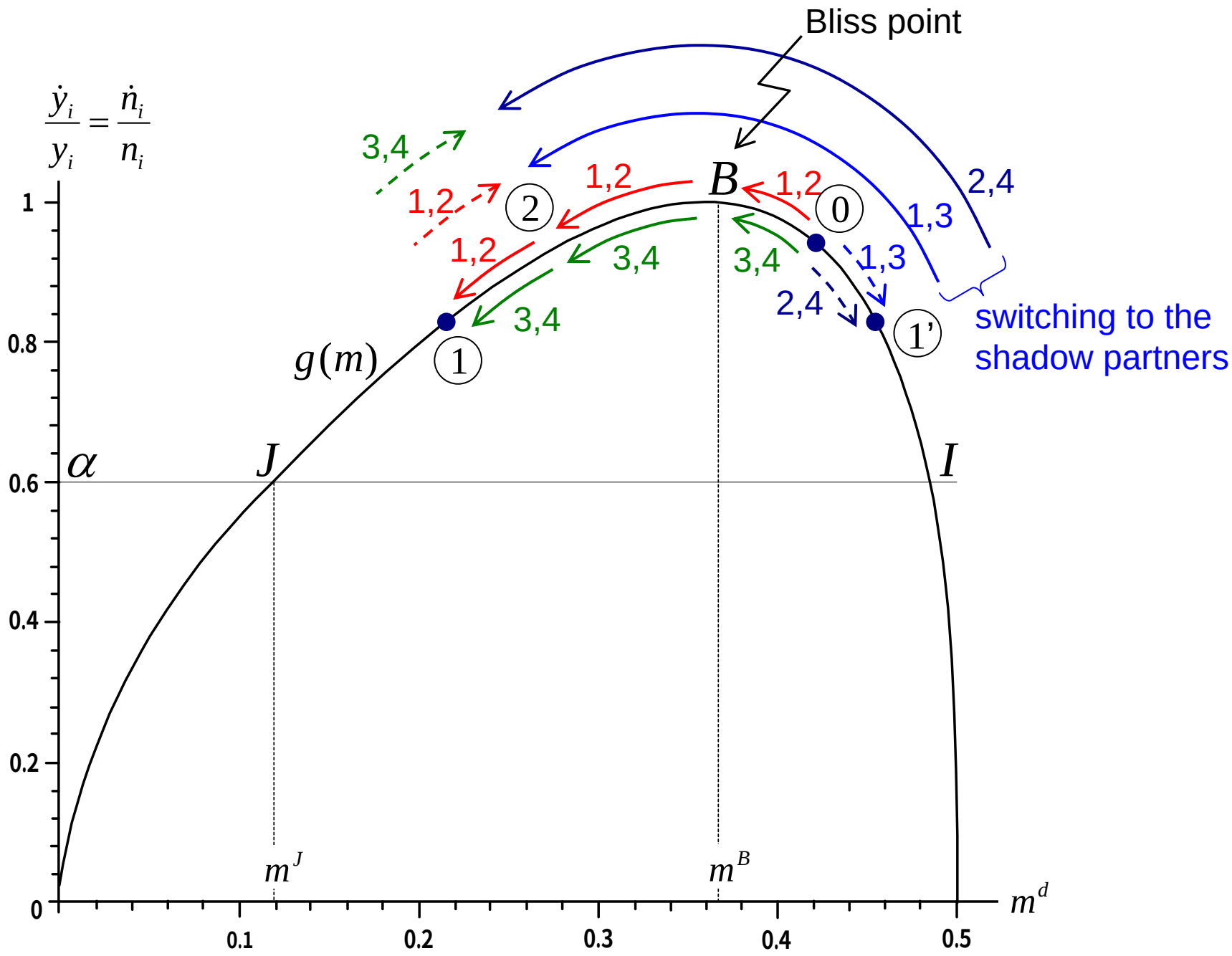


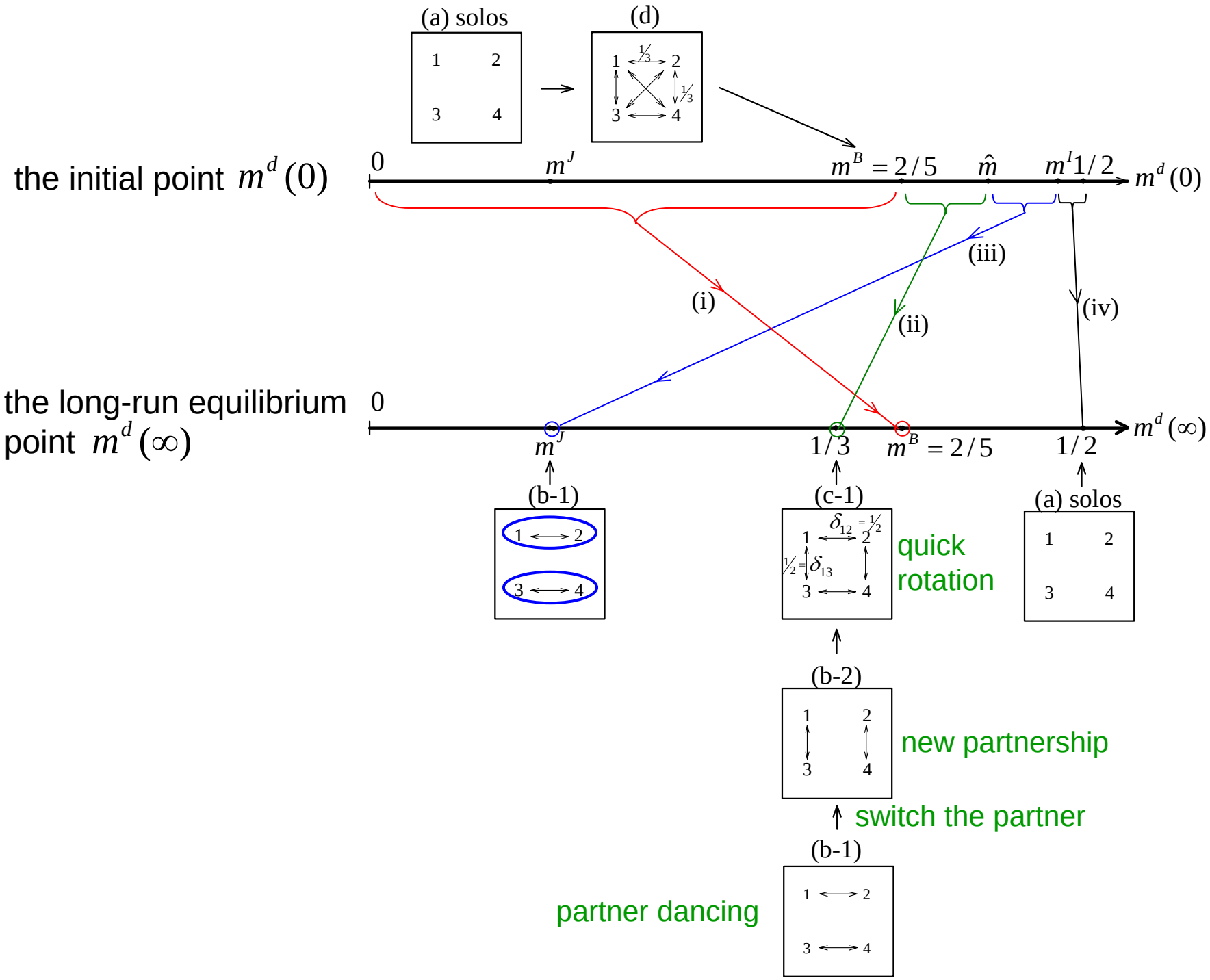
Equilibrium dynamics with $m^d(0) < m^B$



too heterogeneous initial state ➞ dividing into two distinct groups

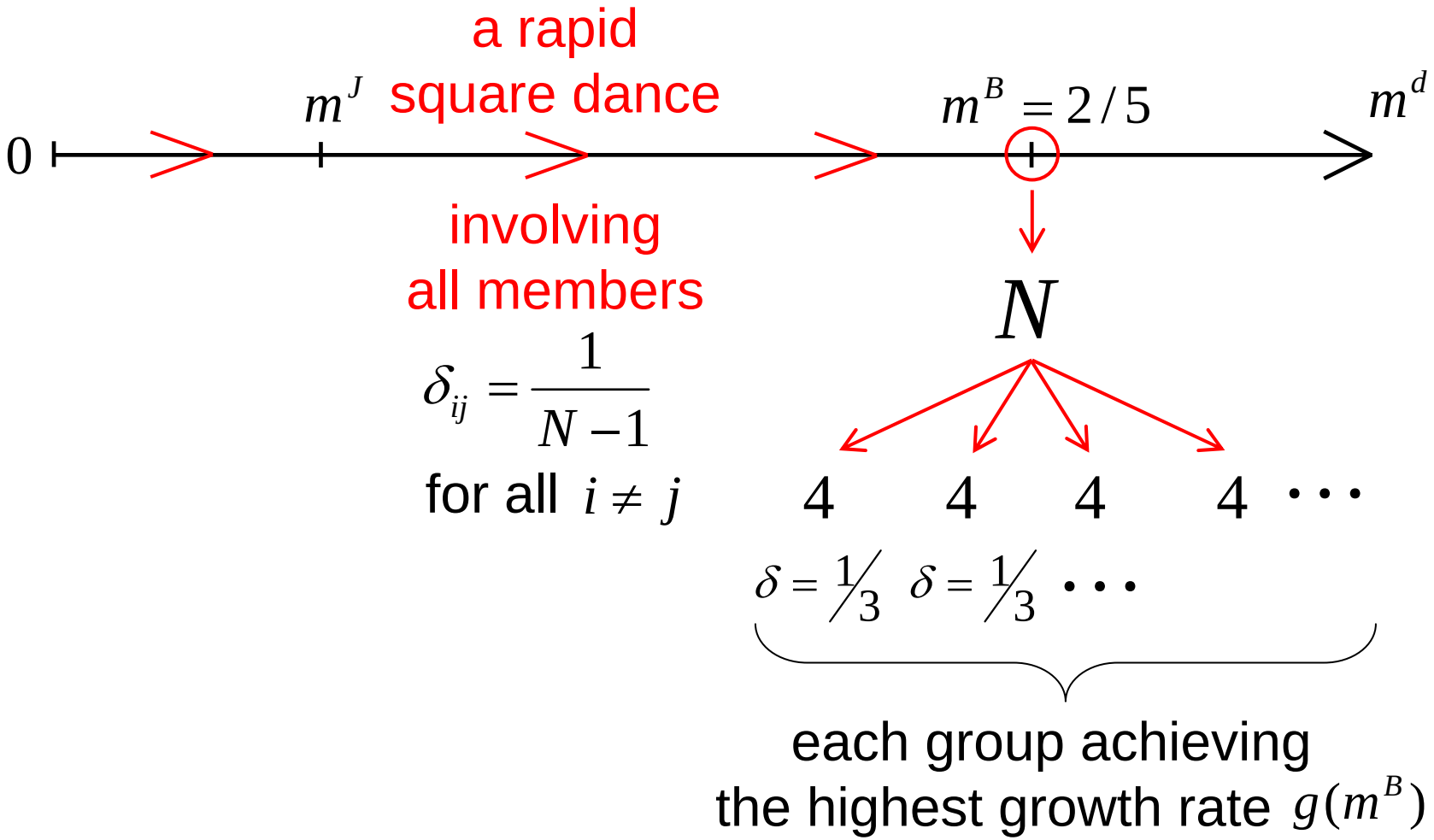

$\frac{\dot{y}_i}{y_i} = \frac{\dot{n}_i}{n_i}$
Bliss point
0
the initial point
actual partners
1,2
1,2
1,2
3,4
3,4
3,4
1,3
2,4
shadow partners
B
1
1'
$g(m^d)$
α
J
I
m^J
m^B
m^d
1
0.8
0.6
0.4
0.2
0
0.1
0.2
0.3
0.4
0.5


Bliss point
$\frac{\dot{y}_i}{y_i} = \frac{\dot{n}_i}{n_i}$
3,4
1,2
1,2
B
1,2
2
0
2,4
1,3
1,2
3,4
3,4
1,3
2,4
3,4
1'
switching to the
shadow partners
$g(m)$
1
α
J
I
1
0.8
0.6
0.4
0.2
0
m^J
m^B
m^d
0.1
0.2
0.3
0.4
0.5


(a) solos
(d)
1
2
3
4
1/3
the initial point $m^d(0)$
0
m^J
$m^B = 2/5$
$\hat{m}$
$m^I 1/2$
$m^d(0)$
(i)
(ii)
(iii)
(iv)
the long-run equilibrium point $m^d(\infty)$
0
m^J
1/3
$m^B = 2/5$
1/2
$m^d(\infty)$
(b-1)
(c-1)
(a) solos
$\delta_{12} = 1/2$
$1/2 = \delta_{13}$
quick rotation
(b-2)
new partnership
switch the partner
(b-1)
partner dancing

any N = a multiple of 4

essentially the same as 4-person case



why 4 ?

Bliss point

dividing into $N = 4$ at $m^B = \frac{2}{5}$

↓

the fastest growth rate of K

Where does this magic number come from?

so far : $a_{ij} = \beta[n_{ij}^c \cdot n_{ij}^d \cdot n_{ji}^d]^{1/3}$

↓

the weight on the common knowledge

generalization : $a_{ij} = \beta(n_{ij}^c)^{\theta}(n_{ij}^d \cdot n_{ji}^d)^{\frac{1-\theta}{2}}$

↓

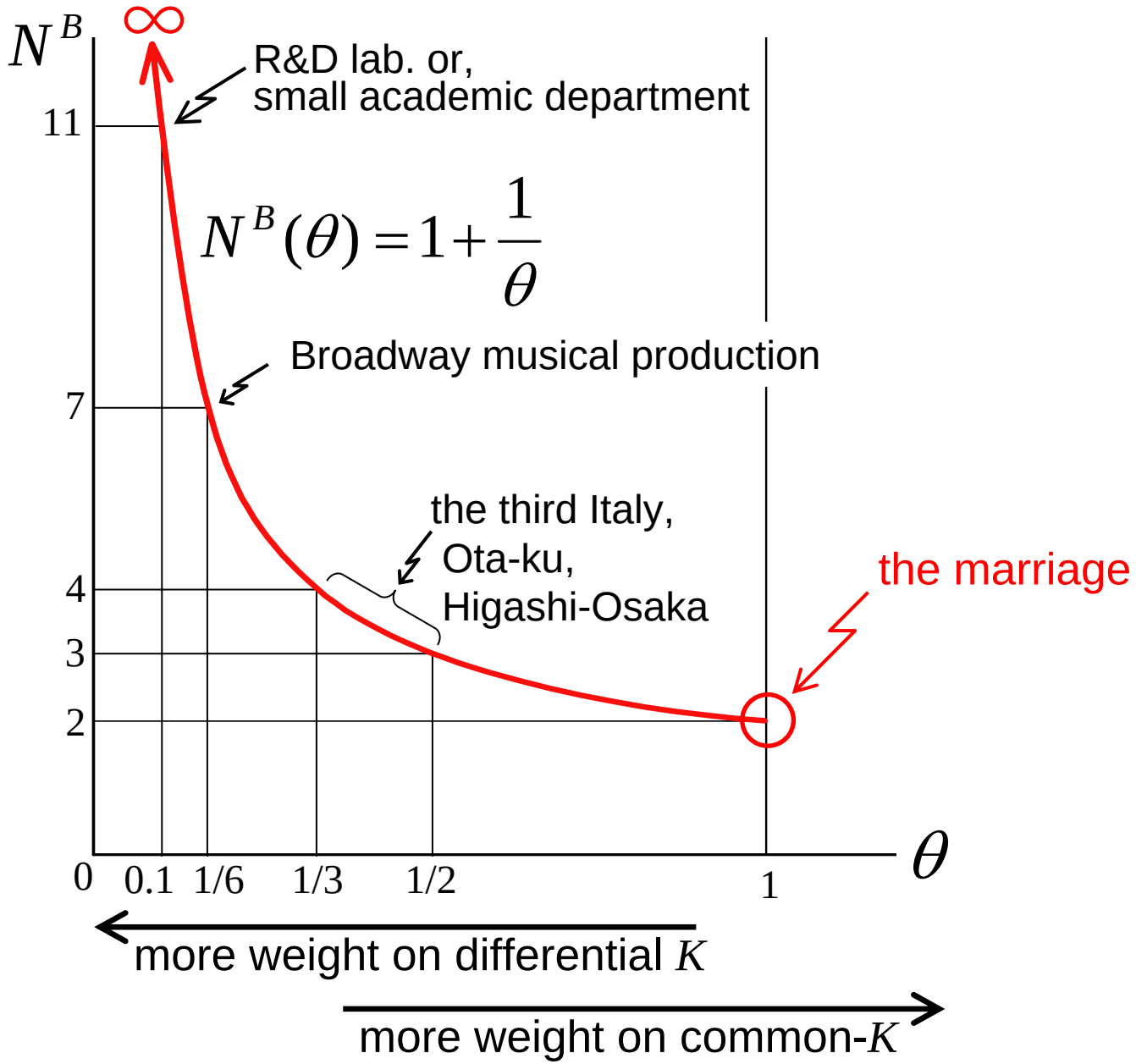
$$N^B = 1 + \frac{1}{\theta} \quad \text{at} \quad m^B = \frac{1-\theta}{2-\theta}$$

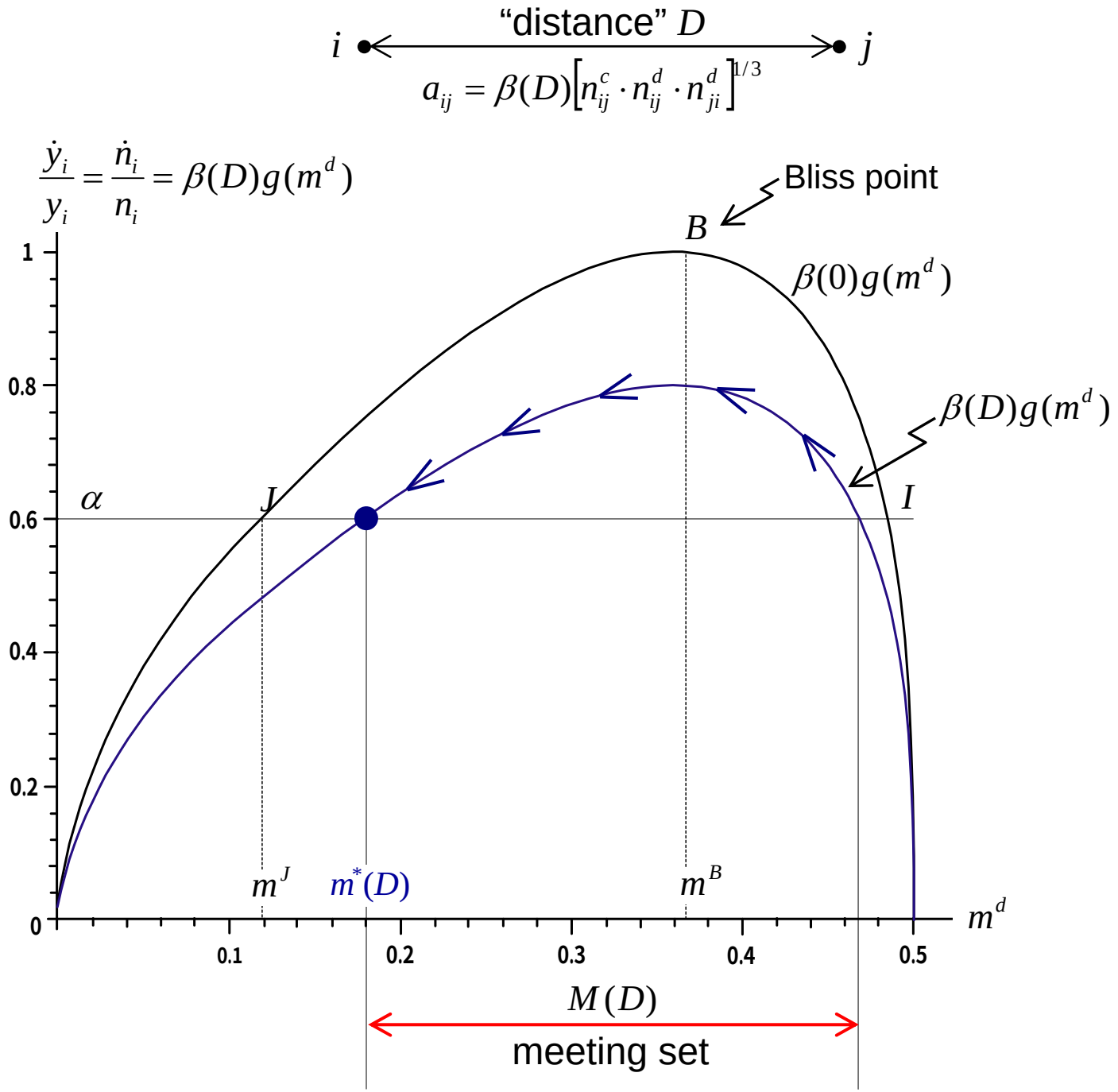
↑

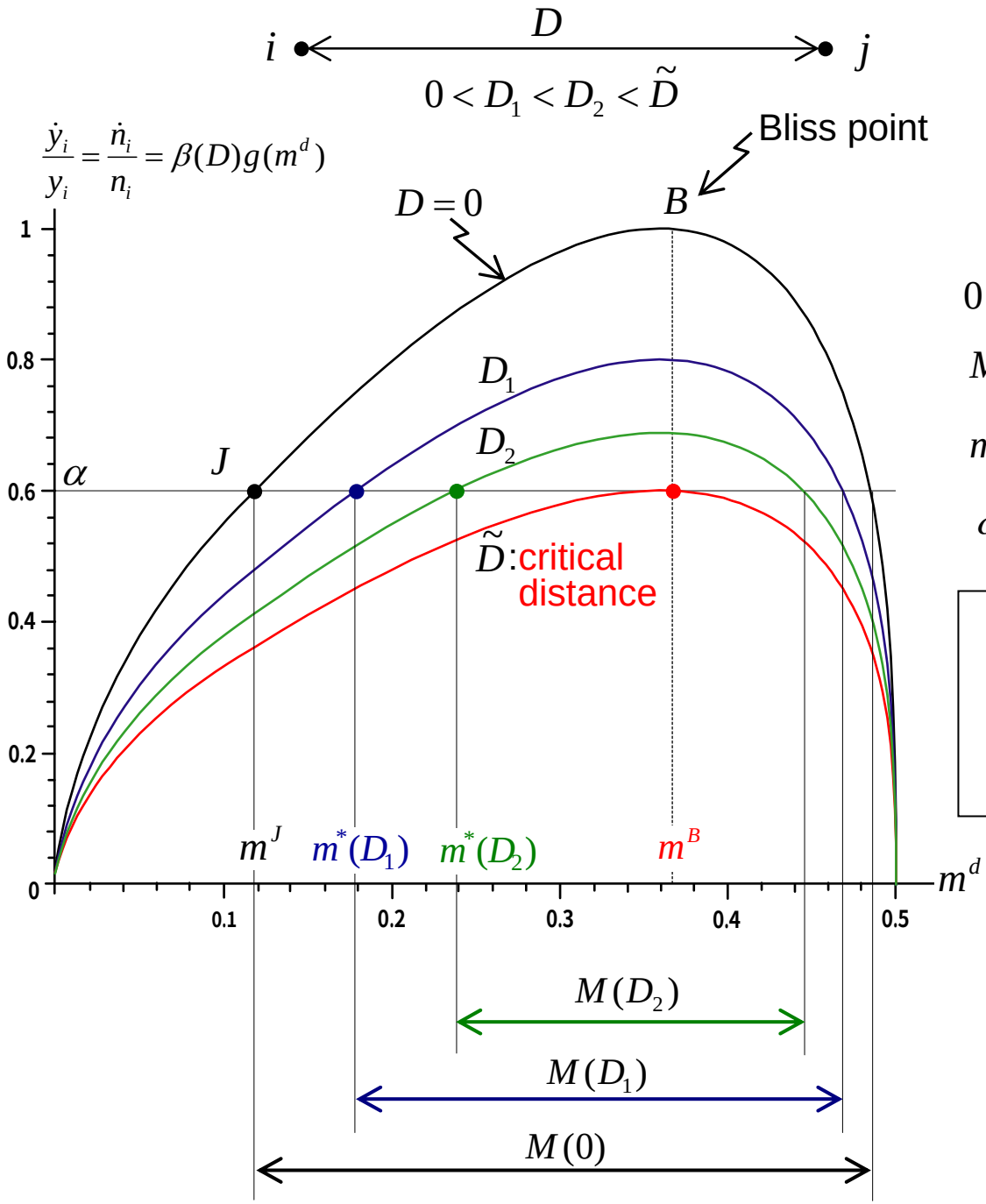
the size of partnership, achieving the fastest growth rate of K

$$a_{ij} = \beta (n_{ij}^{c})^{\theta} (n_{ij}^{d} \cdot n_{ji}^{d})^{\frac{1-\theta}{2}}$$

optimal group size $N^{B}(\theta)$




"distance" D
i
j
$a_{ij} = \beta(D)\left[n_{ij}^{c} \cdot n_{ij}^{d} \cdot n_{ji}^{d}\right]^{1/3}$
$\frac{\dot{y}_i}{y_i} = \frac{\dot{n}_i}{n_i} = \beta(D)g(m^d)$
Bliss point
B
$\beta(0)g(m^d)$
$\beta(D)g(m^d)$
α
J
I
1
0.8
0.6
0.4
0.2
0
0.1
0.2
0.3
0.4
0.5
m^J
$m^*(D)$
m^B
m^d
$M(D)$
meeting set



$$0 < D_1 < D_2 < \tilde{D} \Rightarrow$$

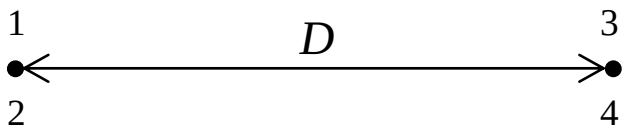
$$M(0) \supset M(D_1) \supset M(D_2) \supset M(\tilde{D}) = \{m^B\}$$

$$m^*(0) < m^*(D_1) < m^*(D_2) < m^*(\tilde{D}) = m^B$$

$$\delta_{ij}^*(0) > \delta_{ij}^*(D_1) > \delta_{ij}^*(D_2) > \delta_{ij}^*(\tilde{D})$$

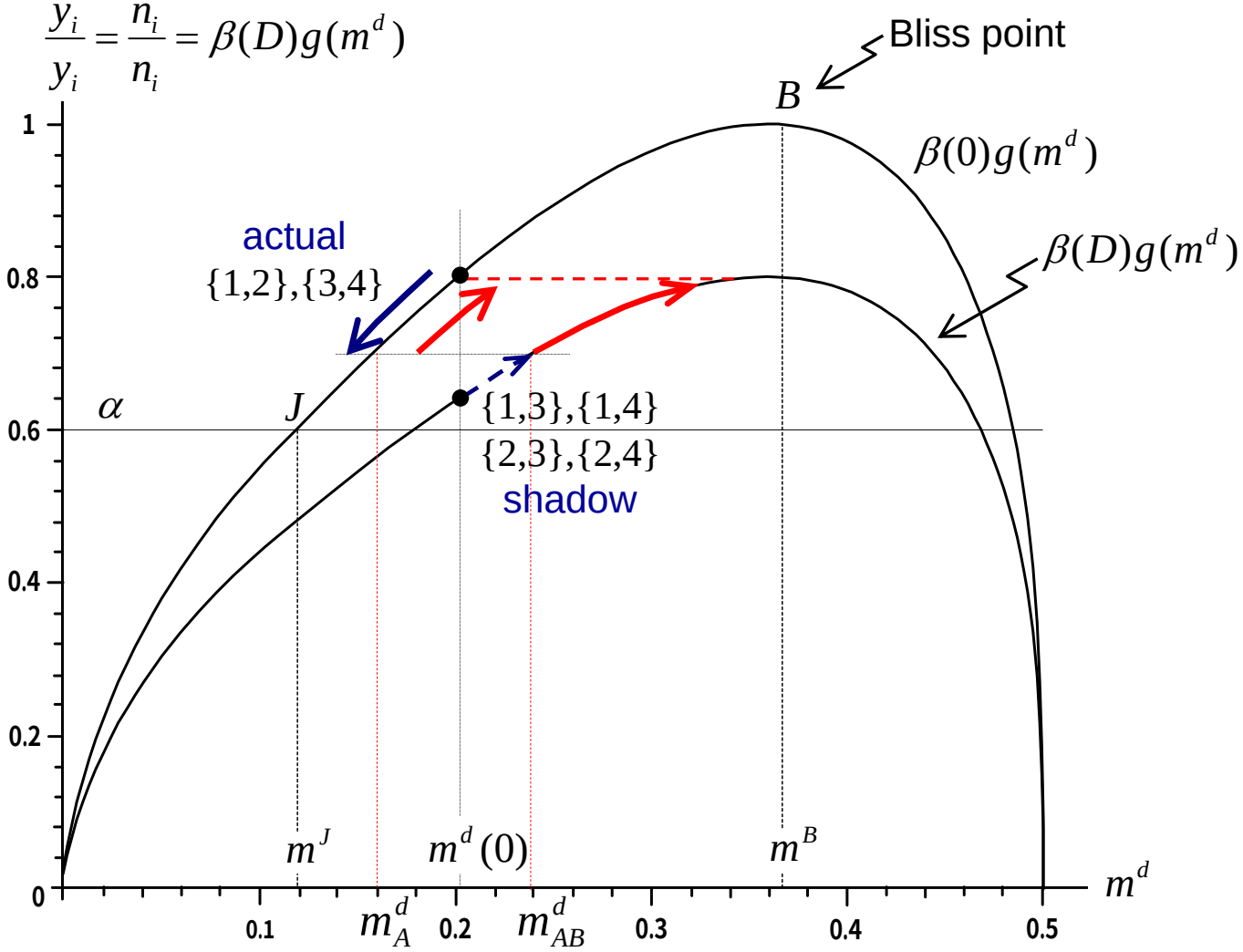
greater distance
⇒ more selective for a partner
with a greater K-heterogeneity

4-person case with distance

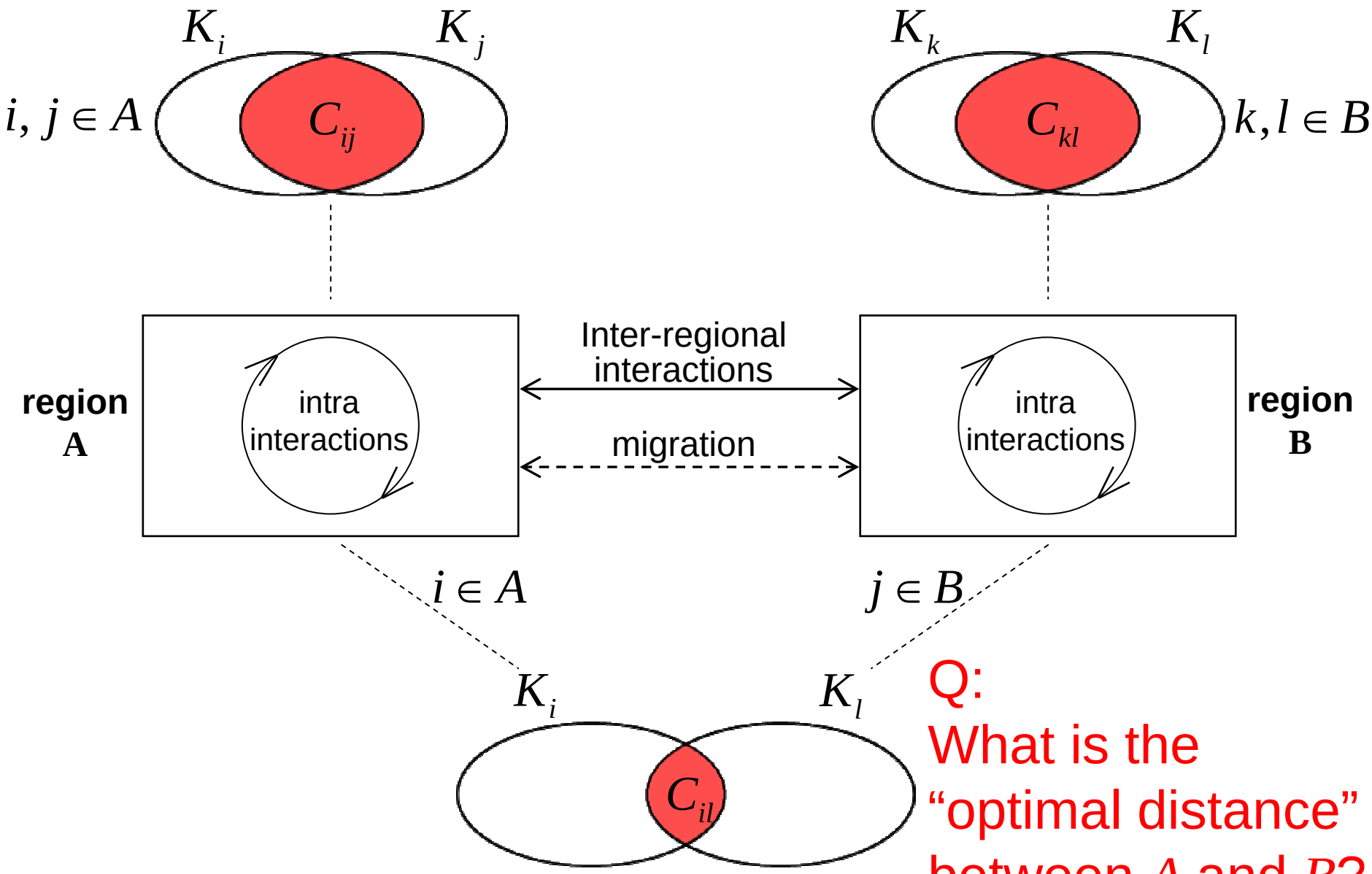


$m_{ij}^d(0) = m^d(0)$ for all $i \neq j$

$$\frac{\dot{y}_i}{y_i} = \frac{\dot{n}_i}{n_i} = \beta(D)g(m^d)$$



Two-region case with many persons



Q:
What is the "optimal distance" between A and B?

Possible Extensions / Tasks

1. multiple modes of K-transfer

2. multiple types of meeting

3. types of traveling
   - short-run: periodical
   - short-run: irregular
   - ⋮
   - migration

4. knowledge structure

5. searching and stochastic modeling

⋮

X. Unifying the E-linkages and K-linkages in the spatial economy

Thanks
and
Sorry for overtime