Strategic Fertility, Education Choices, and Conflicts in Deeply Divided Societies

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Fertility / Education trade-off

Demographic transition and rise in education: key elements of economic take-off

1. Individual incentives:
   - Opportunity cost (Becker and Lewis 1973, de la Croix and Doepke 2003 etc.)
   - Returns to education (Galor and Weil 2000)
   - Cost of contraception (Bhattacharya and Chakraborty 2017)
   - Changing gender-specific opportunities (Voigtlaender and Voth 2013)
2. Cultural diffusion of low fertility norms (Spolaore & Wacziarg 2014, Daudin, Franck & Rapoport 2018)

Norms, conflict and strategic behaviour

1. Group-based norms of behaviour $\Longrightarrow$ scope for strategic interactions
2. Weak property rights $\Longrightarrow$ resource appropriation game, in a society divided along ethnic or religious lines

- Strategic fertility
  - "People as Power" (Yuval-Davis 1996)
  - Population race backfires (de la Croix & Dottori 2008) with a Beckerian Q-Q tradeoff (Doepke, 2015)
- Strategic education?

Research questions

1. What happens when education becomes a strategic decision in a resource appropriation game?
2. Do we find empirical support for these predictions in societies with weak property rights and ethnic/religious fragmentation?

What we do

1. Build a model featuring a trade-off between production and appropriation
   - Output increases with human capital with decreasing returns
   - Appropriation decided through a contest where power depends on the relative size and human capital of groups
2. Establish a theoretical link between group size and investment in fertility / education
3. Investigate this link empirically in the context of Indonesia + external validity

Preferences and budget constraints

Continuum of identical agents divided in 2 groups, a and b, of respective size N^a and N^b

$$\text{Indiv. j in group i} \qquad U_t^{ij} = c_t^{ij} + \beta d_{t+1}^{ij} - \frac{\lambda}{2}\left(n_t^{ij}\right)^2 \tag{1}$$

$$\text{Adult b.c.:} \qquad c_t^{ij} = 1 - \tau y_t^i - \gamma\, n_t^{ij} e_t^{ij} \tag{2}$$

$$\text{Elderdely b.c.:} \qquad d_{t+1}^{ij} = \tau n_t^{ij}\, y_{t+1}^i. \tag{3}$$

Technology

$$\text{h.c. formation:} \quad h^{ij}_{t+1} = \left(e^{ij}_t\right)^{\rho}, \quad \rho \in [0,1] \tag{4}$$

$$\text{h.c. agg:} \quad H_{t+1} = h^a_{t+1} N^a_{t+1} + h^b_{t+1} N^b_{t+1}. \tag{5}$$

$$\text{Pop. growth:} \quad N^i_{t+1} = n^i_t N^i_t \tag{6}$$

$$\text{Output} \quad Y_{t+1} = (H_{t+1})^{(1-\alpha)}, \quad \alpha \in [0,1]. \tag{7}$$

$$\text{Indiv. income} \quad y^i_{t+1} = (1-\alpha) H^{-\alpha}_{t+1} h^i_{t+1} + \Pi^i_{t+1} \frac{\alpha Y_{t+1}}{N^i_{t+1}} \tag{8}$$

Contest function

"Winner-takes-all contest" à la Garfinkel and Skaperdas 2007b revisited

$$\Pi^a = \begin{cases} \dfrac{(h^a)^\mu N^a}{(h^a)^\mu N^a + (h^b)^\mu N^b}, \text{ if } h^i_t \neq 0 \text{ and } N^i_t \neq 0 \ \forall i \in \{a, b\}, \\ \dfrac{N^a}{N^a + N^b}, \quad \text{if } \ h^i = 0 \ \text{ and } \ N^i \neq 0 \quad \forall i \in \{a, b\}, \\ \dfrac{(h^a)^\mu}{(h^a)^\mu + (h^b)^\mu}, \quad \text{if } \ h^i \neq 0 \ \text{ and } \ N^i = 0 \quad \forall i \in \{a, b\}, \\ \frac{1}{2}, \quad \text{if } \ h^i = 0 \ \text{ and } \ N^i = 0 \quad \forall i \in \{a, b\}, \end{cases} \tag{9}$$

Equilibrium without norms

Proposition 1

When norms on fertility and education are absent, at the Nash equilibrium, fertility and education choices are not affected by a change in group size.

Intuition: individual agents do not internalise the effect of their fertility and education choices on aggregate human capital.

Equilibrium with norms

- Key element: elasticity of power to human capital μ

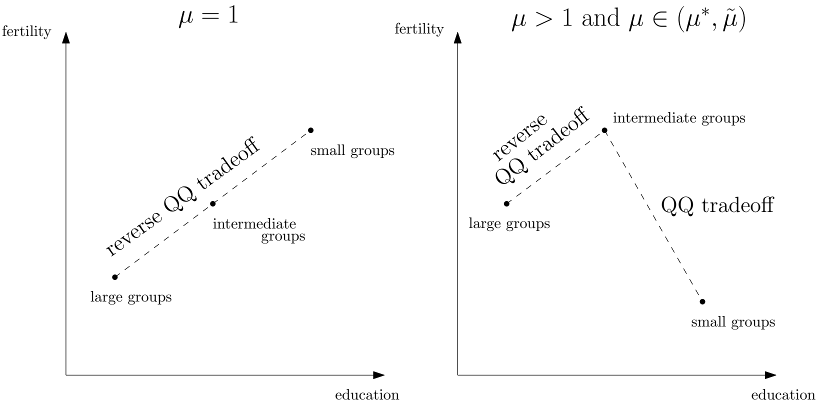


Figure 1: Propositions 2 (left panel) and 3 (right panel)

Intuition

Change in group size has three distinct effects on fertility and education:

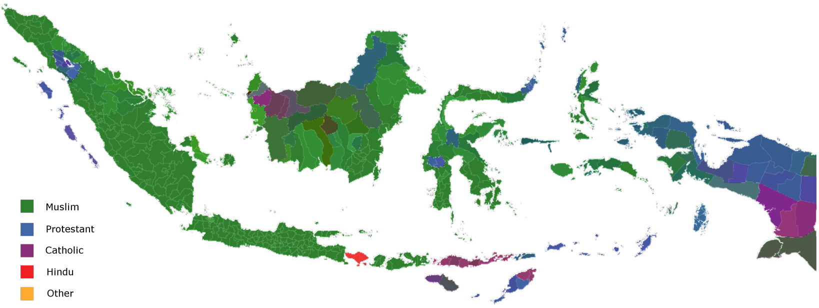
1. Direct group size effect: – b/c marginal return of approp. ↘
2. Indirect strategic effect: + or – b/c fert & educ can be either subs or comp in contest function
3. Indirect substitution effect: Beckerian effect pushing for subs between fert & educ

- (1) outweighs (2), so negative overall
- (3) outweighs (1) and (2) only for high enough values of μ

Endogenous norm formation

- Intermediate value of coordination cost $\implies$ asymmetric equilibrium
- Only small groups coordinate to strategically increase both fertility and education
- Relaxes assumption on μ, which just needs to be not too low

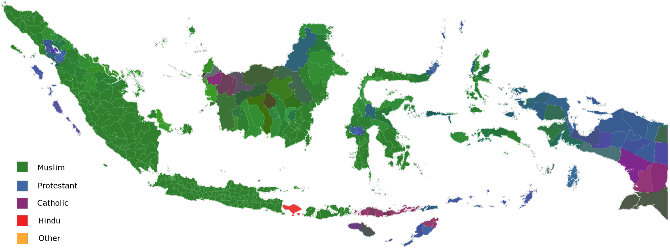
Context: Indonesia



Source : *Data Sensus Penduduk 2010 Badan Pusat Statistik*

Figure 2: Religious Affiliations in the Indonesian 2010 Census

Religious divisions and politics in Indonesia



Source : *Data Sensus Penduduk 2010 Badan Pusat Statistik*

1. Fragmented along religious lines (Chen 2006, 2010, Gaduh 2012, Bazzi et al. 2018a)
2. Widespread corruption: Korupsi, Kolusi, Nepotism (Pisani 2014)
3. Education seen as a means to access administrative or elected positions, that come with rents (pension, bribes etc.)

Data and summary stats

Variable	Mean	(Std. Dev.)
Fertility sample		
Children ever born	3.92	(2.64)
Children surviving	3.42	(2.17)
Currently married (%)	77.57	(41.71)
Age	50.79	(4.22)
Urban status (%)	41.78	(49.32)
Years of schooling	4.77	(4.22)
Average years of schooling in regency	7.41	(2.04)
Child mortality in regency (%)	5.51	(4.48)
Residing in province of birth (%)	88.36	(32.08)
Number of observations	3,187,482	
Education sample		
Years of schooling	8.25	(4.11)
Age	28.96	(1.94)
Urban status (%)	47.12	(49.92)
Average years of schooling in regency	7.5	(2.06)
Residing in province of birth (%)	85.09	(35.62)
Number of observations	6,211,129	

Source: Census data from 1971, 1980, 1990, 2000, 2010 downloaded from IPUMS International

Estimating equation - fertility

$$E(y_i) = f(\beta_0 + \sum_{k=1}^{11} \beta_{1,k} 1(G_i = k) + \beta_2 X_r + \beta_3 Z_i)$$

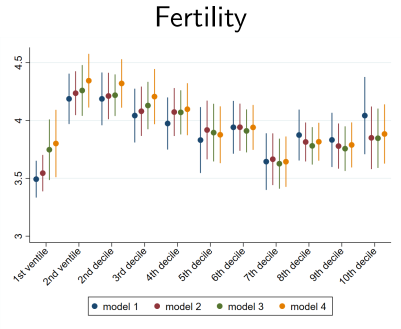
Variable	**(1)**	**(2)**	**(3)**	**(4)**
type of model	Poisson			
Outcome	Children every born			
	Surviving children			
Year of birth f.e.	x	x	x	x
Census year * urban status	x	x	x	x
Average years of schooling in regency		x	x	x
Child mortality in regency		x	x	x
Own years of schooling			x	x
Marital status			x	x
Religion			x	x
Sample excluding migrants				x

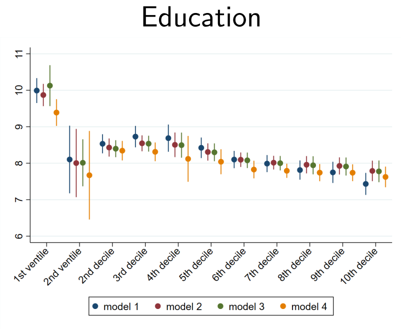
Estimating equation - education

$$E(y_i) = f(\beta_0 + \sum_{k=1}^{11} \beta_{1,k} 1(G_i = k) + \beta_2 X_r + \beta_3 Z_i)$$

Variable	**(1)**	**(2)**	**(3)**	**(4)**
Fertility equation				
type of model	OLS			
Outcome	Years of schooling			
Year of birth f.e.	x	x	x	x
Census year * urban status	x	x	x	x
Child mortality in regency		x	x	x
Sex			x	x
Religion			x	x
Sample excluding migrants				x

Empirical results - Indonesia

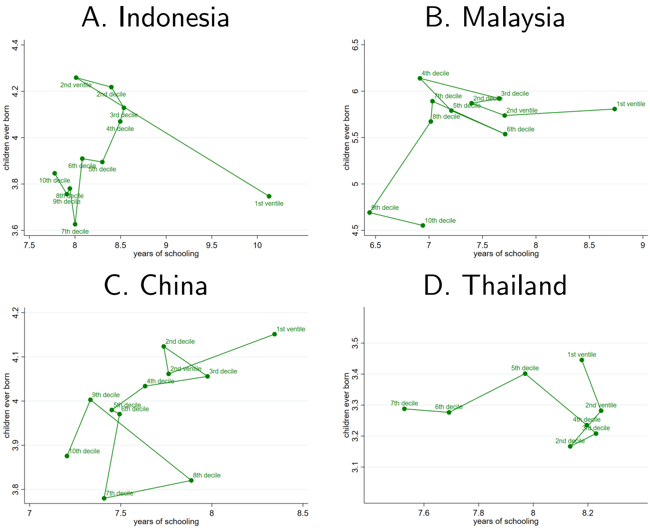




Source: Indonesian Census, waves 1971-2010

- Very small minorities limit fertility to invest massively in education: Usual Q-Q trade-off
- Medium-sized groups invest more than majority groups in both education and fertility: Reverse Q-Q trade-off

Empirical results - External validity

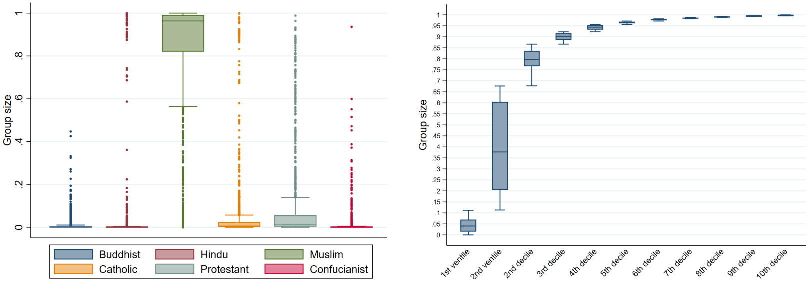


Source: Indonesian Census, waves 1971-2010, Malaysian Census, waves 1970-2000, Chinese Census, waves 1982-2000, Thai Census, waves 1990-2000

Contribution

1. Family macro and development:
   - Introduce nuances to the usual quality-quantity trade-offs
   - Link institutional failure to demographics
2. Economics of conflict: introduce fertility and education as choice variables in the appropriation process
3. Economics of cultural norms: provide a narrative for norm formation as the result of strategic interactions between groups

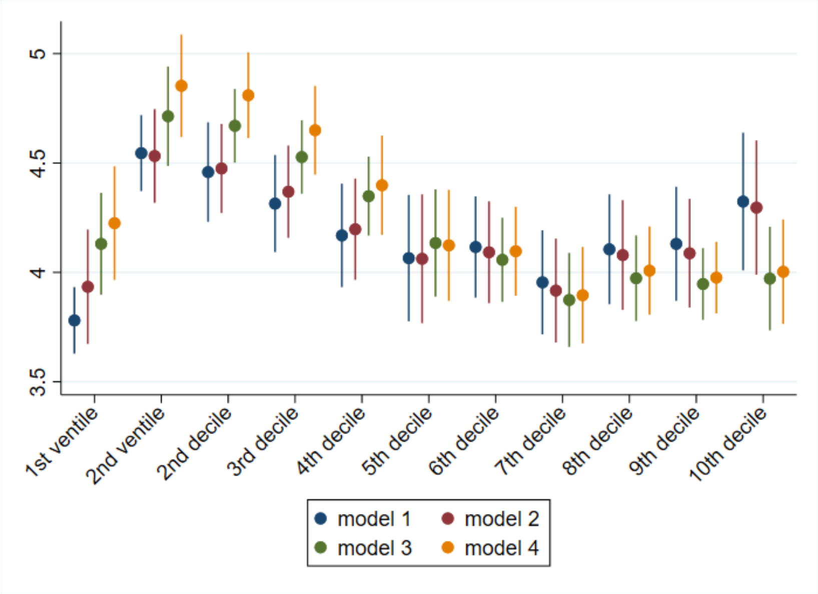
Group size



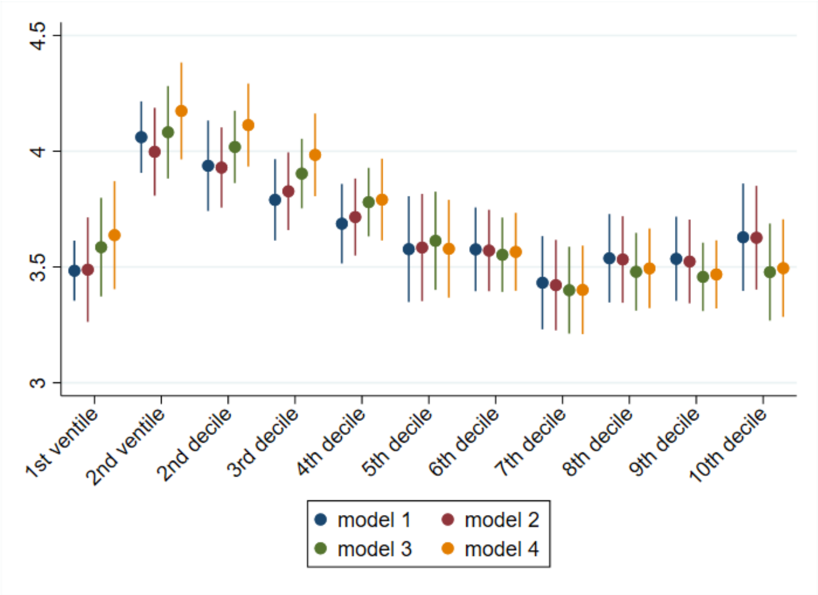
Source: Indonesian Census, waves 1971-2010

Figure 3: Distribution of size of religious group by religion and deciles

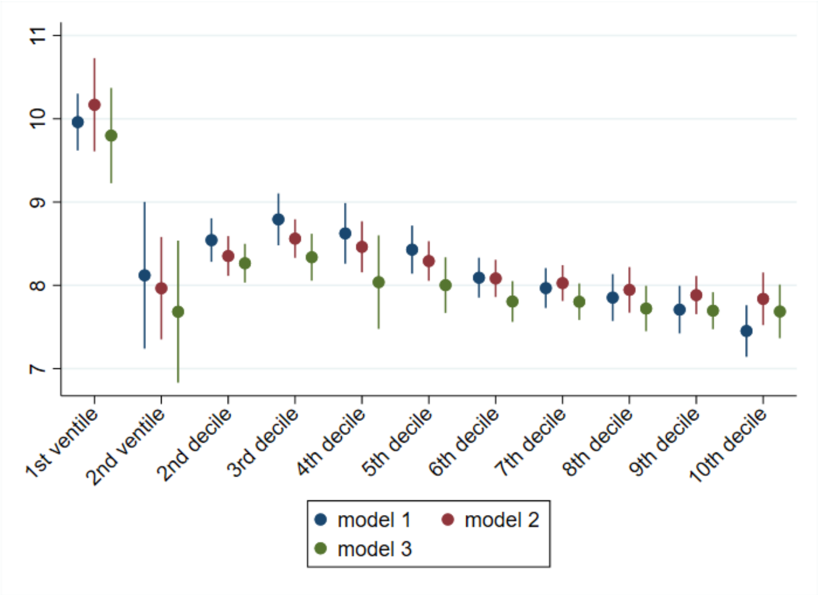
Children ever born



Surviving children



Education


11
10
9
8
7
1st ventile
2nd ventile
2nd decile
3rd decile
4th decile
5th decile
6th decile
7th decile
8th decile
9th decile
10th decile
model 1
model 2
model 3

Roadmap

1. Set up of the problem
2. Equilibrium without norms
3. Equilibrium when $\mu = 1$
4. Equilibrium when $\mu > 1$
5. Endogenous coordination

Group a's payoff function

$$\max_{(n_t^{aj}, e_t^{aj}) \in \mathcal{X}} W_t(n_t^{aj}, n_t^a, n_t^b, e_t^a, e_t^a, e_t^b, x_t^a). \tag{10}$$

$$W_t(n_t^{aj}, n_t^a, n_t^b, e_t^{aj}, e_t^a, e_t^b, x_t^a) =$$
$$\beta\tau n_t^{aj}\left((1-\alpha)H_{t+1}^{-\alpha}(e_t^{aj})^\rho + \Pi_{t+1}^a \frac{\alpha Y_{t+1}}{N_{t+1}^a}\right) - \gamma\, n_t^{aj} e_t^{aj} - \frac{\lambda}{2}\left(n_t^{aj}\right)^2 \tag{11}$$

Problem with norms - social planner

$$V_t(n_t^a, n_t^b, e_t^a, e_t^b, x_t^a) = W_t(n_t^{aj}, n_t^a, n_t^b, e_t^{aj}, e_t^a, e_t^b, x_t^a),$$

where

$$n_t^{aj} = n_t^a \quad \forall j \in [0, N_t^a], \qquad e_t^{aj} = e_t^a \quad \forall j \in [0, N_t^a].$$

Definition (Nash equilibrium of period t)

For all $x_t \in [0,1]$, a pure-strategy Nash equilibrium of period t is a strategy profile $(n_t^{a\star}, n_t^{b\star}, e_t^{a\star}, e_t^{b\star}) = (n^a(x_t), n^b(x_t), e^a(x_t), e^b(x_t))$ with $n^i : [0,1] \to [0, \bar{n}]$ and $e^i : [0,1] \to [0, \bar{e}]$ such that for all $i \in \{a, b\}$,

$$V_t(n_t^{i\star}, n_t^{-i\star}, e_t^{i\star}, e_t^{-i\star}, x_t^i) \geq V_t(n_t^i, n_t^{-i\star}, e_t^i, e_t^{-i\star}, x_t^i) \quad \forall (n_t^i, e_t^i) \in \mathcal{X}.$$

Case with $\mu = 1$

Proposition 2: Reverse quality-quantity trade-off

For $\mu = 1$, both the fertility and education of group *i* are decreasing with the share of group *i* in the population at the Nash equilibrium.

Case with $\mu > 1$

Proposition 3

There exist $\mu^* > 1$ and $\tilde{\mu} > 1$ such that for any $\mu \in (\mu^*, \tilde{\mu})$,

$$e^{a0} > e^{a1/2} > e^{a1} \quad \text{and} \quad n^{a1/2} > n^{a1} > n^{a0}.$$

Endogenous coordination

Definition (Stackelberg-Nash equilibrium of period t)

A Stackelberg-Nash equilibrium of period t is a strategy profile

$$(d_t^{a\star}, d_t^{b\star}, n_t^{a\star}, n_t^{b\star}, e_t^{a\star}, e_t^{b\star}) =$$

$$(d^a(x_t), d^b(x_t), n^a(x_t), n^b(x_t), e^a(x_t), e^b(x_t))$$

with $d^{i\star} \in \underset{d^i \in \{0,1\}}{\operatorname{argmax}} V(n^{i\star}, n^{-i\star}, e^{i\star}, e^{-i\star}, x^i) - \kappa\, d^i$

such that $(n^{i\star}, e^{i\star}) \in \underset{(n^{ji}, e^{ji}) \in \mathcal{X}}{\operatorname{argmax}} W(n^{ji}, n^{i\star}, n^{-i\star}, e^{ji}, e^{i\star}, e^{-i\star}, x^i)$

$$\forall j \in [0, Nx^i], \quad \forall x^i \in [0,1] \quad \text{if } d^i = 0,$$

$$(n^{i\star}, e^{i\star}) \in \underset{(n^i, e^i) \in \mathcal{X}}{\operatorname{argmax}} V(n^i, n^{-i\star}, e^i, e^{-i\star}, x^i)$$

$$\forall x^i \in [0,1] \quad \text{if } d^i = 1.$$

Equilibrium with endogenous coordination

Proposition 5

Suppose that $x_t^a = 0$. There exist $\tilde{\kappa}_1$, $\tilde{\kappa}_2$, $\tilde{\kappa}_3$ such that if $\tilde{\kappa}_2 < \min\{\tilde{\kappa}_1, \tilde{\kappa}_3\}$, $\tilde{\kappa}_1 \neq \tilde{\kappa}_3$, there exists a unique Stackelberg-Nash equilibrium given by

$(d_t^{a\star}, d_t^{b\star}, n_t^{a\star}, n_t^{b\star}, e_t^{a\star}, e_t^{b\star}) =$
$(1, 1, \hat{n}^a(1,1), \hat{n}^b(1,1), \hat{e}^a(1,1), \hat{e}^b(1,1)) \ \forall \kappa < \tilde{\kappa}_2$,

$(d_t^{a\star}, d_t^{b\star}, n_t^{a\star}, n_t^{b\star}, e_t^{a\star}, e_t^{b\star}) =$
$(1, 0, \hat{n}^a(1,0), \hat{n}^b(0,1), \hat{e}^a(1,0), \hat{e}^b(0,1)) \ \forall \kappa \in (\tilde{\kappa}_2, \tilde{\kappa}_3)$,

$(d_t^{a\star}, d_t^{b\star}, n_t^{a\star}, n_t^{b\star}, e_t^{a\star}, e_t^{b\star}) =$
$(0, 0, \hat{n}^a(0,0), \hat{n}^b(0,0), \hat{e}^a(0,0), \hat{e}^b(0,0)) \ \forall \kappa > \max\{\tilde{\kappa}_1, \tilde{\kappa}_3\}$

Equilibrium with endogenous coordination

A Asymmetric equilibrium occurs for intermediate values of κ
- Low $\kappa \rightarrow$ back to case with exogenous coordination
- High $\kappa \rightarrow$ back to case without coordination

B1 *Free-riding of the small group*: always makes small group win from coordination

B2 *Changes in aggregate outcomes*: ambiguous effect of large group coordination
- higher output vs higher appropriation effort

$\rightarrow$ Latter effect dominates when μ not too low

high μ	B1 and B2 favor coordination
intermediate μ	B1 favors, B2 against, but $B1 > B2$
low μ	B1 favors, B2 against, but $B1 < B2$