Resource-Based Regions, the Dutch Disease and City Development

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Natural resources

- Resource cities, countries
  - Oil, Gas, Coal, Gold, Fish, Forest ...
- Resource industry
  - Gazprom
  - LUKoil
- Siberia: various resources
- China had about 666 cities in 1996, among which 126 were classified as resource-type cities
- Naura, phosphate bearing minerals

Blessing or curse?

- Nauru
  - A small island situated in the South Pacific between Hawaii and Australia
  - Grow rapidly in the 1980s when the country began mining for guano, the excrement of cave dwelling animals that is used as an ingredient in fertilizer, gunpowder and exotic dishes served in France. It is a prosperous island, for the phosphate deposits
  - They changed food

$\Longrightarrow$

Blessing or curse? (cont.)

- The fattest nation on earth
- Average life of Nauru people: 49 of male and 55 of female

Blessing or curse? (cont.)

- Some resource countries are suffering from wars

Blessing or curse? (cont.)

- About 10%–20% Chinese resource-type cities were classified as “hopeless” due to resource depletion
- Japanese city Yubari reached its highest population of 116,908 in 1960 but lost 90% of its residents after the mines closed in the 1990s
- Dutch disease
  - decline of the manufacturing sector in the Netherlands after the discovery of a large natural gas field in 1959
  - happens even without resource depletion
- Some cities (Daqing, Tangshan in China) are good enough
- Why?

Related literature

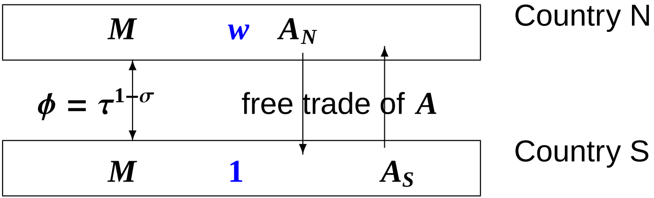
- Focus on the economic issues
- small open economy
  - Corden and Neary (1982), Corden (1984)
  - prices of manufactured goods are fixed
  - no impacts of globalization
- learning by doing in the manufacturing sector
  - Matsuyama (1992): comparison of closed and open economies. Productivity of A

Our aims

- By use of NEG/NTT, we investigate the Dutch disease
  - in terms of industry shares
  - in terms of welfare
- Conclusions: Successful region/city development depends on
  - How are resources used?
  - How manufacturing goods are freely transported?
- The Dutch disease occurs even if resource is not depleted

Basic setup

- Two regions N and S of symmetric size
  - immobile labor, to be lifted later
- Two sectors: manufacturing M and resource sector A



- Consumer: 1 labor with utility $U = M^{1-\mu-\eta} A_N^{\mu} A_S^{\eta}$
  - $M = \left(\int_0^{n^T} m(i)^{\frac{\sigma-1}{\sigma}} di \right)^{\frac{\sigma}{\sigma-1}}$

Basic setup (cont.)

- differentiated resource goods, region specified due to climate, geography, natural endowment ...
- Iceland and Norway import tropical fruits and wine, Luxemburg imports seafood
- $\mu, \eta > 0;\ \mu + \eta < 1$

- Transport cost τ for M, $\phi = \tau^{1-\sigma}$. Free trade of A, to be lifted later
- A_N and A_S: CRS. Marginal: One unit of labor
  - choose A_S as the numéraire
  - wage in N is w and wage in S is 1

composite $l^{\alpha} A_N^{\beta} A_S^{\gamma}$

Basic setup (cont.)

- M: IRS. Fixed: f units, Marginal: $(\sigma - 1)/\sigma$ units of composite input of labor and two resource goods.
  - $f + \frac{\sigma - 1}{\sigma} x = l^\alpha A_N^\beta A_S^\gamma$
  - $\alpha, \beta, \gamma \geq 0$, $\alpha + \beta + \gamma = 1$
- $\hat{\mu} = \mu + \beta(1 - \mu - \eta)$ and $\hat{\eta} = \eta + \gamma(1 - \mu - \eta)$
  - direct and indirect expenditure shares of A_N and A_S
  - $\alpha \in [1/(2\sigma), 1]$, $\beta, \gamma \in [0, 1)$

    Resource advantage in N $\quad \hat{\eta} < \hat{\mu} < 1/2$

    (to avoid corner, to be discussed later)
- $\Phi \equiv w - \hat{\mu}(1 + w), \quad \Psi \equiv 1 - \hat{\eta}(1 + w), \quad \bar{w} \equiv \frac{\hat{\mu}}{\hat{\eta}} \ (> 1)$
  - $L\Phi$ is the total labor cost for the M sector in N
  - $L\Psi$ is the total labor cost for the M sector in S
  - $\bar{w}$ is the relative resource advantage of A_N over A_S

Basic setup (cont.)

- both Φ and Ψ are positive

- By cost minimization, to produce one unit of a variety, we need
  - $\alpha\Gamma w_k^{\alpha-1}\left(p_N^A\right)^{\beta}\left(p_S^A\right)^{\gamma}$ units of labor
  - $\beta\Gamma w_k^{\alpha}\left(p_N^A\right)^{\beta-1}\left(p_S^A\right)^{\gamma}$ units of A_N
  - $\gamma\Gamma w_k^{\alpha}\left(p_N^A\right)^{\beta}\left(p_S^A\right)^{\gamma-1}$ units of A_S
  - $k = N, S$, $\Gamma \equiv \alpha^{-\alpha}\beta^{-\beta}\gamma^{-\gamma}$

Equilibrium

- firm share in N is $\theta = \dfrac{\Phi}{\Phi + w^{\alpha}\Psi}$
  - labor is the only production factor
  - determined by direct and indirect labor input
- total number of firms: $n^T = \dfrac{Lw^{-\alpha-\beta}}{\sigma f \alpha \Gamma}(\Phi + w^{\alpha}\Psi)$
- wage w is determined by
  $\mathcal{F}(w, \phi) \equiv \mathcal{A}(w) + \mathcal{B}(w)\phi + \mathcal{C}(w)\phi^2 = 0$
  - $\mathcal{A}(w) \equiv -\Psi + \alpha(1 - \mu - \eta)$
  - $\mathcal{B}(w) \equiv w^{\alpha\sigma}\Psi - w^{-\alpha\sigma}\Phi$
  - $\mathcal{C}(w) \equiv \Phi - \alpha(1 - \mu - \eta)$
- Proposition 1 $\forall \phi \in [0, 1]$
  - $\exists$ a unique equilibrium wage $w \in [1, \overline{w}]$
  - equilibrium wage $w \downarrow$ in ϕ

Equilibrium (cont.)

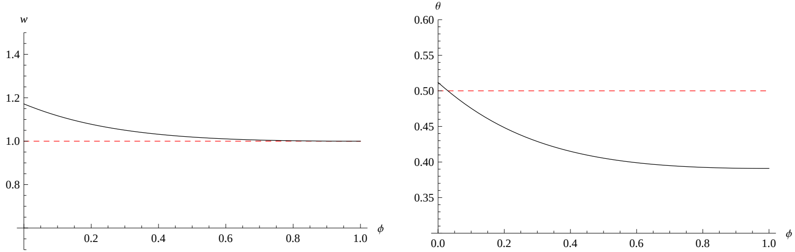
- the number of firms in N ↓ in ϕ
- the number of firms in S ↑ in ϕ

- Economics inside
  - Wage in the resource advantageous country is higher $(w \geq 1)$
  - Wage advantage ↓ with trade integration
  - A higher wage increases the demand for M by the income effect, decreases the demand for M by raising the price
  - industrial location is determined by the production-cost effect and the market-access effect
  - More firms move to the resource disadvantageous country
  - Dutch disease in terms of industry shares

- $\bar{\theta} \equiv \dfrac{1}{1+\bar{w}^{\alpha-1}} \in [1/2, 1), \quad \underline{\theta} \equiv \dfrac{1-2\hat{\mu}}{2\alpha(1-\mu-\eta)} \in (0, \dfrac{1}{2})$

Equilibrium (cont.)

- The firm share θ in N $\downarrow$ in ϕ, $\quad \theta \in [\underline{\theta}, \overline{\theta}]$



(a) Wage w (b) Firm share θ

Equilibrium: Resource booms

- What are booms?
  - A boom of resource good as a final good
  - A boom of resource good as an intermediate good
- Modeling
  - No closed form of θ. Check $\overline{\theta} = \theta(0)$, $\underline{\theta} = \theta(1)$ and $\hat{\phi}$ defined by $\theta(\hat{\phi}) = 1/2$
  - $\alpha + \beta + \gamma = 1$. A small change in β (resp. γ) does not alter γ (resp. β) but changes only
- Proposition 2
  - $\frac{\partial \overline{\theta}}{\partial \mu} > 0$ (relative wage ↑ in μ, market-size effect dominant)
  - $\frac{\partial \underline{\theta}}{\partial \mu} < 0$ (production-cost effect dominant)

Equilibrium: Resource booms (cont.)

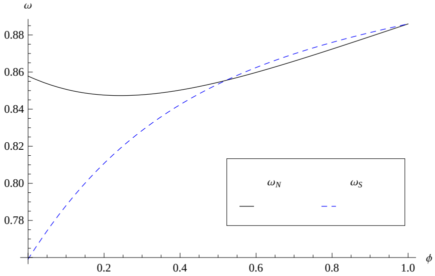
- $\dfrac{\partial \hat{\phi}}{\partial \mu} < 0$ (boom weakens M)
- $\dfrac{\partial \bar{\theta}}{\partial \beta} > 0, \quad \dfrac{\partial \underline{\theta}}{\partial \beta} < 0 \quad \dfrac{\partial \hat{\phi}}{\partial \beta}$ is indeterminate
  - $\beta \uparrow \longrightarrow w \uparrow \longrightarrow \text{labor input} \downarrow \begin{cases} \text{small } \hat{\mu} - \hat{\eta} \longrightarrow \frac{\partial \hat{\phi}}{\partial \beta} < 0 \\ \text{large } \hat{\mu} - \hat{\eta} \longrightarrow \frac{\partial \hat{\phi}}{\partial \beta} > 0 \end{cases}$

Welfare

- Do not compare optimal with equilibrium
- Examine welfare in equilibrium path
  - How residents in two countries benefit from globalization?
  - Which country is better off?
- Definition: real wages
  - $\omega_N = \omega_N(\phi) \equiv w \cdot P_N^{-(1-\mu-\eta)} \left(p_N^A\right)^{-\mu} \left(p_S^A\right)^{-\eta}$
  - $\omega_S = \omega_S(\phi) \equiv 1 \cdot P_S^{-(1-\mu-\eta)} \left(p_N^A\right)^{-\mu} \left(p_S^A\right)^{-\eta}$
- Facts when $\phi \uparrow$
  - Firms move from N to S
  - Nominal wage in N decreases
  - Prices decrease

Welfare (cont.)

- Results
  - $\omega_S \uparrow$ if $\sigma > 1 + \mu - \eta$
  - $\omega'_N(1) > 0$ always holds while $\omega'_N(0) < 0$ when σ is large enough
  - $\omega_S/\omega_N < 1$ at $\phi = 0$
  - $\omega_S/\omega_N > 1$ for a sufficiently large $\phi \neq 1$
  - $\omega_S/\omega_N = 1$ at $\phi = 1$.



Welfare (cont.)

- Economics inside
  - For small ϕ, although the price index can be higher in N, a higher income makes the residents there better off
  - For large ϕ, the opposite is true. More firms choose to locate in S, which makes the price index there lower than in N, and thus the income differential $w - 1 \downarrow$
  - When $\phi = 1$, same real wage!
  - Dutch disease in terms of welfare

Generalization: Costly Transportation of A

- Iceberg transport cost: τ_A
- $\theta = \dfrac{\Phi}{\Phi + w^{\alpha}\Psi\tau_a^{\gamma-\beta}}, \quad n^T = \dfrac{Lw^{-\alpha-\beta}\tau_a^{-\gamma}}{\sigma f \alpha \Gamma}(\Phi + w^{\alpha}\Psi\tau_a^{\gamma-\beta})$
- Wage equation
  $\mathcal{F}_a(w,\phi) = \mathcal{A}(w) + \mathcal{B}_a(w)\phi + \mathcal{C}(w)\phi^2 = 0$
  - $\mathcal{B}_a(w) = w^{\alpha\sigma}\Psi\tau_a^{(\gamma-\beta)\sigma} - w^{-\alpha\sigma}\Phi\tau_a^{(\beta-\gamma)\sigma}$
- Results
  - $w(0) = \bar{w} > 1, \quad w(1) = \tau_a^{\frac{\beta-\gamma}{\alpha}}$
  - $\theta(0) = \frac{1}{1+\bar{w}^{\alpha-1}\tau_a^{\gamma-\beta}}$

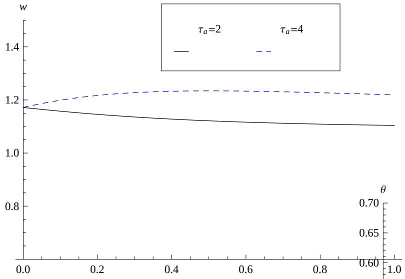
Generalization: Costly Transportation of A (cont.)

- $\theta(1) = \max\{\min\{\theta^0(1), 1\}, 0\}$ where

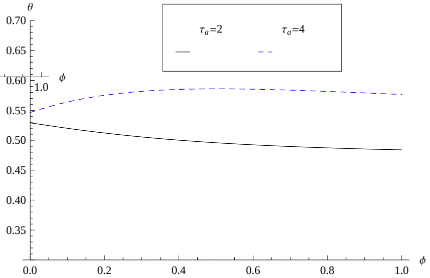
$$\theta^0(1) = \frac{\Phi}{\Phi + \Psi}\bigg|_{w=w(1)} = \frac{1 - \hat{\mu}(1 + \tau_a^{\frac{\gamma-\beta}{\alpha}})}{(1 - \hat{\mu} - \hat{\eta})(1 + \tau_a^{\frac{\gamma-\beta}{\alpha}})}.$$

- Economics inside
  - A full agglomeration may arise
  - $w(1) \neq 1$ if $\beta \neq \gamma$ and $\tau_a > 1$.
  - When manufactured goods are freely transported but resource goods are costly transported, the wage is lower (resp. higher) in S than in N if $\beta > \gamma$ (resp. $\beta < \gamma$)
  - Firms find it more profitable to locate in the region producing more important resource good
  - Dutch disease is more difficult to occur for a larger τ_a

Generalization: Costly Transportation of A (cont.)



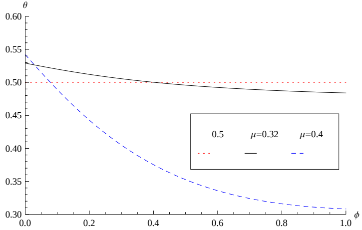
(a) Wage w



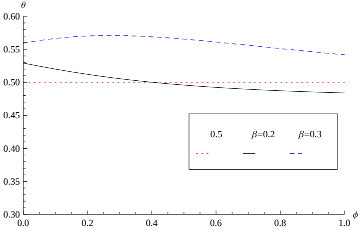
(b) Firm share θ

Generalization: Costly Transportation of A (cont.)

- Two resource booms generate different impacts
  - The resource boom in final goods: $\Delta\bar{\theta} > 0$, $\Delta\underline{\theta} < 0$, and $\Delta\hat{\phi} < 0$ are true again
  - The impact of the resource boom in intermediate goods on firm location is positive for any ϕ
  - Accessibility to the input market is more important for firms, especially when τ_A is positive



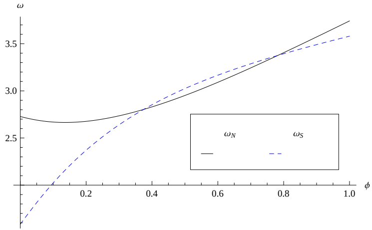
(a) Resource boom in F.G.



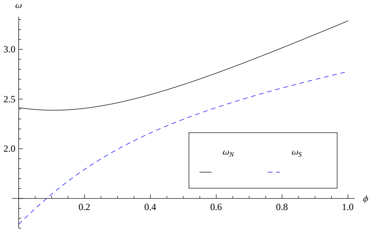
(b) resource booms in I.G.

Generalization: Costly Transportation of A (cont.)

- Welfare. The Dutch disease in terms of welfare
  - Occurs when τ_a is small
  - Disappears for a large τ_a



(a) The case for a small τ_a



(b) The case of a large τ_a

Labor Migration

- Footloose entrepreneur model
- Immobile unskilled workers and mobile skilled workers
- M production: Fixed 1 skilled worker Marginal $(\sigma - 1)/\sigma$ composite good: unskilled worker and two resource goods as before
- nominal wages of skilled workers

$$R_N = \frac{L}{K} \frac{(\sigma - 1)[(1 - \hat{\mu})w - \hat{\mu}] - \mu + \eta w}{\theta\alpha(\sigma - 1)(\sigma - 1 + \mu + \eta)},$$

$$R_S = \frac{L}{K} \frac{(\sigma - 1)[(1 - \hat{\eta}) - \hat{\eta}w] + \mu - \eta w}{(1 - \theta)\alpha(\sigma - 1)(\sigma - 1 + \mu + \eta)}.$$

Labor Migration (cont.)

- real wages

$$\omega_k^{\text{skill}} = R_k \cdot P_k^{-(1-\mu-\eta)} \left(p_N^A\right)^{-\mu} \left(p_S^A\right)^{-\eta},$$
$$\omega_k^{\text{unskill}} = w_k \cdot P_k^{-(1-\mu-\eta)} \left(p_N^A\right)^{-\mu} \left(p_S^A\right)^{-\eta}.$$

- standard replicator dynamics for skilled labor migration

$$\frac{d\theta}{dt} = (\omega_N^{\text{skill}} - \omega_S^{\text{skill}})\theta(1-\theta).$$

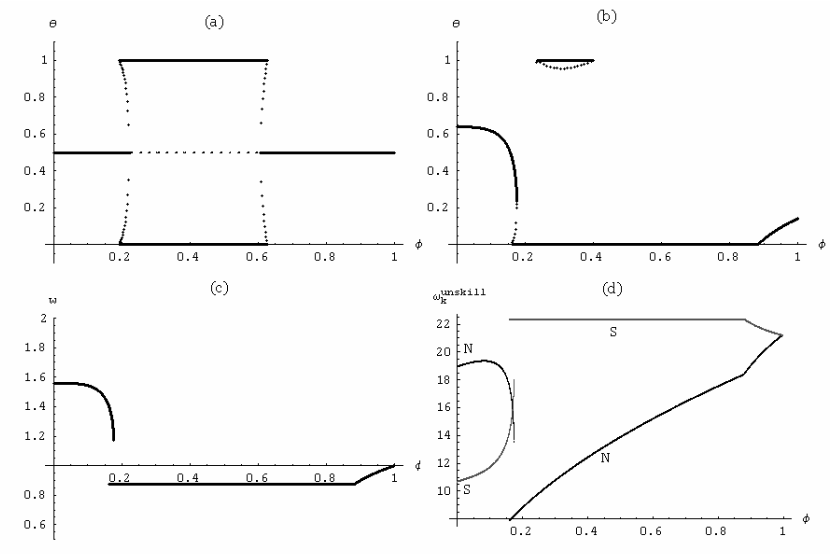
Simulation examples

- (a): two symmetric regions: $\sigma = 2$, $\mu = \eta = 0.25$, $\beta = \gamma = 0.15$, $L = K = 1000$
  - The solid and dotted lines: stable and unstable equilibria
  - A re-dispersion of firms when ϕ is sufficiently large
  - When ϕ is large, the unskilled-labor wage in the core region is higher, which forms a strong dispersion force when ϕ is large.
- (b): asymmetric regions: $\sigma = 2$, $\mu = 0.3$, $\eta = 0.2$, $\alpha = 0.7$, $\beta = 0.2$, $\gamma = 0.1$, $L = K = 1000$
  - Lifting trade barriers drives firms to relocate to the region with resource disadvantage
  - Multiple equilibria are possible and full agglomeration in N is another stable equilibrium for $\phi \in (0.24, 0.40)$.
  - Agglomeration is more unlikely to occur in N than in S

Simulation examples (cont.)

- (c): the equilibrium wage in N of unskilled worker
  - w becomes lower (resp. higher) when firms relocate to S (resp. N)
- (d): the welfare in both regions
  - $\omega_N^{\text{unskill}} > \omega_S^{\text{unskill}}$ holds when ϕ is small; The reverse holds when ϕ is large.
- In summary, we still obtain the Dutch disease in terms of both industry shares and welfare when transportation costs fall in the mobile-labor case.

Simulation examples (cont.)



Conclusion

- two factors for a Dutch disease
  - transport cost τ_M
  - resource goods as M inputs
- Policy implication
  - Yunnan province of China is abundant in forest resource
  - Introduce paper pulp industry