Country- and sector-specific trade liberalization, directed technical change, and long-run growth

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What and why to do

- does trade liberalization raise economic growth?
- empirically, Yes[1]
- theoretically, Yes (but sometimes No), w/ monopolistic competition:[2]
  - most assume symmetric countries
  - all consider trade costs in a single differentiated good sector
- in reality, trade costs are different across countries AND sectors:

ad valorem eqv 2018	agriculture	manufacturing	services
lower-income	260%	190%	360%
high-income	230%	170%	290%

Source: WTO (2021) trade cost index

- Q: how does country- AND sector-specific liberalization affect growth?

[1]Wacziarg and Welch (2008), Estevadeordal and Taylor (2013), Irwin (2019)

[2]homogeneous firms: Rivera-Batiz–Romer (1991a, b), Baldwin–Forslid (1999); heterogeneous firms: Baldwin–Robert-Nicoud (2008), Sampson (2016), Naito (2017, 2019, 2021), Impullitti–Licandro (2018), Perla et al. (2021), Akcigit et al. (2021), etc.

How to do

- directed technical change (DTC) model of Acemoglu (2002, RES)
  - growth $\rightleftarrows$ skill premium (relative wage of skilled to unskilled labor)
- literature on two-country DTC models:[3]
  - all assume specialized R&D (innovation by North, imitation by South)
  - this paper: innovation by asymmetric countries

[3] Acemoglu (2002, 2003), Gancia and Bonfiglioli (2008), Chu et al. (2015), Acemoglu et al. (2015)

What I got

around a symmetric BGP, country- and sector-specific liberalization:

- may not raise skill premium for some country-sector pairs
  - in contrast to static quantitative trade models[4]
- raises the balanced growth rate for any country-sector pair
  - stronger support for "liberalization is good for growth"

[4] Epifani and Gancia (2008), Parro (2013), Burstein and Vogel (2017), Cravino and Sotelo (2019)

The model

two-country DTC model of Acemoglu (2002, RES):

- two countries: $j, k = 1, 2$ (developing and developed)
- two factors: $i = S, L$ (skilled and unskilled labor)
- two machine sectors: $i = S, L$
  - final good $\rightarrow$ i-augmenting machines
  - CES, monopolistic competition, Krugman (extendable to Melitz)
  - the only tradable, subject to iceberg trade cost factor $\tau^i_{jk}(\geq 1)$
- two intermediate good sectors: $i = S, L$
  - factor $S \times S$-aug machines $\rightarrow$ S-intensive intermediate (services)[5]
  - factor $L \times L$-aug machines $\rightarrow$ L-intensive intermediate (manufacturing)
- one final good sector: Y
  - two intermediate goods $\rightarrow$ final good

[5] Cravino and Sotelo (2019, AEJ Macro)

Technology market clearing condition

$$\kappa_j = s_j(\omega_j^*/\nu_j^*)\delta_j^*; \tag{13}$$
$$\kappa_j \equiv \kappa_j^S/\kappa_j^L, s_j \equiv S_j/L_j, \omega_j \equiv w_j^S/w_j^L, \nu_j \equiv n_j^S/n_j^L,$$
$$\delta_j^* \equiv \frac{\zeta_{jj}^{S*} + (1-\zeta_{kk}^{S*})(L_k/L_j)(w_k^{L*}/w_j^{L*})(s_k/s_j)(\omega_k^*/\omega_j^*)}{\zeta_{jj}^{L*} + (1-\zeta_{kk}^{L*})(L_k/L_j)(w_k^{L*}/w_j^{L*})}, k \neq j,$$
$$\zeta_{kj}^i \equiv E_{kj}^i/\sum_l E_{lj}^i; \sum_k \zeta_{kj}^i = 1.$$

- relative R&D cost = relative firm value, of S- to L-aug machine
- δ_j: relative profitability in machine sector S to L
- ζ_{kj}^i: expenditure share of i-aug machines j buys from k
- in autarky, $\delta_j = 1 \to$ same as Acemoglu (2002)
- $\zeta_{jj}^S \uparrow$, $\zeta_{kk}^S \downarrow \to \delta_j \uparrow \to \nu_j \uparrow$

Relative factor market clearing condition

$$s_j = [\alpha/(1-\alpha)]^{\varepsilon} \omega_j^{-\psi} \nu_j^{\psi-1} (m_j^S / m_j^L)^{(1-\sigma)(\psi-1)}; \qquad (14)$$
$$\psi \equiv 1 + (\varepsilon - 1)/\sigma > 1 - 1/\sigma > 0,$$
$$\zeta_{jj}^i = (m_j^i)^{\sigma-1}.$$

- relative supply = relative demand, of S to L
- $\varepsilon (> 0)$: elasticity of substitution across intermediate goods
- $\sigma (> 1)$: elasticity of substitution across machines
- $\psi (> 0)$: elasticity of substitution across factors
- $m_j^i (\leq 1)$: j's "autarkiness" in machine sector i
- in autarky, $m_j^i = 1 \rightarrow$ same as Acemoglu (2002)
- $\psi > 1$: $\nu_j \uparrow \rightarrow \omega_j \uparrow$

Growth equation

$$\gamma_j^* = (1 - 1/\sigma)^\sigma [(s_j\omega_j^* + 1)/(s_j\omega_j^*\delta_j^* + 1)] R_j^* (m_j^{L*})^{1-\sigma} - \rho; \tag{18}$$

$$R_j^* \equiv \left[\alpha^\varepsilon \left(\frac{S_j}{\kappa_j^S}\right)^{\psi-1} \left(\frac{m_j^{S*}}{m_j^{L*}}\right)^{(1-\sigma)(\psi-1)} \delta_j^{*\psi-1} + (1-\alpha)^\varepsilon \left(\frac{L_j}{\kappa_j^L}\right)^{\psi-1}\right]^{1/(\psi-1)}.$$

- γ_j: growth rate of n_j^i (equalized across i)
- ρ: subjective discout rate
- R_j: "resource function" (aggregating $\frac{S_j}{\kappa_j^S}, \frac{L_j}{\kappa_j^L}$, adjusting for $\frac{m_j^S}{m_j^L}, \delta_j$)
- in autarky, $m_j^i = 1, \delta_j = 1 \rightarrow$ same as Acemoglu (2002):

$$\gamma_j^* = (1 - 1/\sigma)^\sigma [\alpha^\varepsilon (S_j/\kappa_j^S)^{\psi-1} + (1-\alpha)^\varepsilon (L_j/\kappa_j^L)^{\psi-1}]^{1/(\psi-1)} - \rho.$$

Hat algebra around a symmetric BGP

Assumption 1

At an old BGP, all exogenous variables are the same across countries, and τ^i_{jk}, κ^i_j are the same across machine sectors:

$$S_j = S, L_j = L \Rightarrow s_j = S/L \equiv s \forall j,$$
$$\tau^i_{jk} = \tau \in (1, \infty) \forall i \forall j, k, k \neq j,$$
$$\kappa^i_j = \kappa \forall i \forall j \Rightarrow \kappa_j = \kappa/\kappa = 1 \forall j.$$

- analytically examine the effects of changes in $\tau^S_{21}, \tau^L_{21}, \tau^S_{12}, \tau^L_{12}$
- (local) hat algebra: $\widehat{x} \equiv d \ln x \equiv dx/x$

Skill premium

Proposition

Around the symmetric old BGP:
- δ_j, R_j, ν_j are increasing in τ^S_{kj}/τ^L_{kj} but decreasing in τ^S_{jk}/τ^L_{jk}, $k \neq j$.
- ω_j is increasing in τ^S_{kj}/τ^L_{kj} but decreasing in τ^S_{jk}/τ^L_{jk}, $k \neq j \Leftrightarrow \psi > 1$.

- $\tau^S_{21} \uparrow \rightarrow \zeta^S_{11} \uparrow \rightarrow \delta_1 \uparrow \rightarrow \nu_1 \uparrow (\because (13)) \rightarrow \omega_1 \uparrow$ iff $\psi > 1$ $(\because (14))$
- $\omega_1 \uparrow$ w/ liberalization in τ^L_{21}, τ^S_{12}, but $\downarrow$ w/ liberalization in τ^S_{21}, τ^L_{12}

Balanced growth rate

Proposition

Around the symmetric old BGP,
$\partial\gamma/\partial \ln \tau^i_{jk} < 0 \; \forall i = S, L \; \forall j, k = 1, 2, k \neq j.$

- (18):

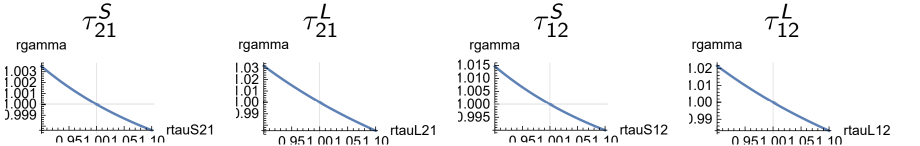
$$\begin{aligned} d\gamma_j &= (\rho+\gamma)[\beta\widehat{\omega}_j - \beta(\widehat{\omega}_j + \widehat{\delta}_j) + \widehat{R}_j + (1-\sigma)\widehat{m}^L_j] \\ &= (\rho+\gamma)\{-\beta\widehat{\delta}_j + \beta[(1-\sigma)(\widehat{m}^S_j - \widehat{m}^L_j) + \widehat{\delta}_j] + (1-\sigma)\widehat{m}^L_j\} \\ &= -(\sigma-1)(\rho+\gamma)[\beta\widehat{m}^S_j + (1-\beta)\widehat{m}^L_j]. \end{aligned}$$

- $\chi \equiv n^L_1/n^L_2 \uparrow \rightarrow \gamma_1 \downarrow, \gamma_2 \uparrow$ ($\because$ 1 imports less, 2 imports more)
- $\tau^i_{21} \uparrow \rightarrow m^i_1 \uparrow \rightarrow \gamma_1 \downarrow \rightarrow \chi \downarrow \rightarrow \gamma_2 \downarrow$
- $\tau^i_{12} \uparrow \rightarrow m^i_2 \uparrow \rightarrow \gamma_2 \downarrow \rightarrow \chi \uparrow \rightarrow \gamma_1 \downarrow$
- $\gamma \uparrow$ w/ any country- and sector-specific liberalization, whether $\psi \gtreqless 1$

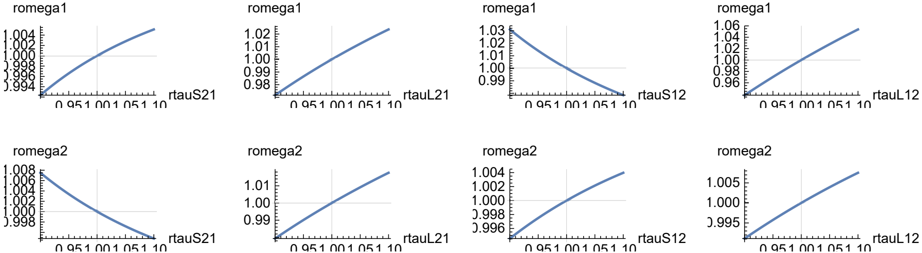
Exact hat algebra around a factual BGP

- express the model in relative changes: $\widetilde{x} \equiv x'/x$
- parameters:
  - $\rho = 0.02$ (Acemoglu, 2009)
  - $\sigma = 3.8$ (Bernard et al., 2003)
  - $\psi = 1.7$ (Acemoglu, 2009)
  - $\Rightarrow \varepsilon = 1 + 3.8(1.7 - 1) = 3.66$
- data on a factual BGP: ann avg 2010–2019, WDI
  - intermediate sectors: $i = S$ (services), $i = L$ (agriculture and industry)
  - countries: $j = 1$ (low & middle income), $j = 2$ (high income)
  - services share: $\beta_1 = 0.515948, \beta_2 = 0.693663$
  - domestic expenditure shares in machine sectors: $\zeta_{11}^S = 0.968899, \zeta_{22}^S = 0.963665, \zeta_{11}^L = 0.826309, \zeta_{22}^L = 0.64393$
  - relative GDP and growth rate: $y_1 = 0.537046, \gamma = 0.0174589$
- counterfactual relative changes in iceberg trade costs:
  - $\widetilde{\tau}_{jk}^i = 0.9$ (decreased by 10%); $\widetilde{\tau}_{jk}^i = 1.1$ (increased by 10%)

Effects of relative changes in τ^i_{jk} around a factual BGP

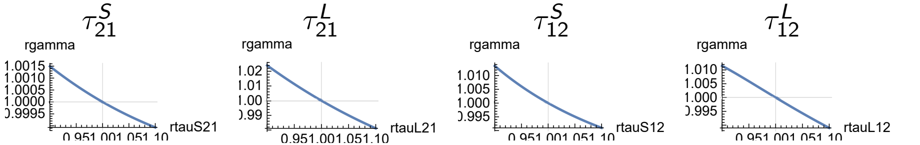


(a) relative changes in the balanced growth rate γ

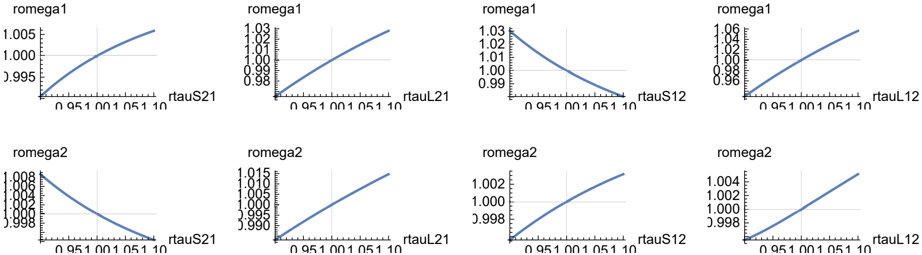


(b) relative changes in countries' skill premiums ω_1 (top), ω_2 (bottom)

Melitz (Pareto shape $\theta = 3.4$ from Ghironi–Melitz (2005))

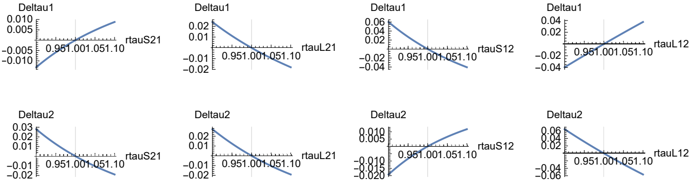


(a) relative changes in the balanced growth rate γ

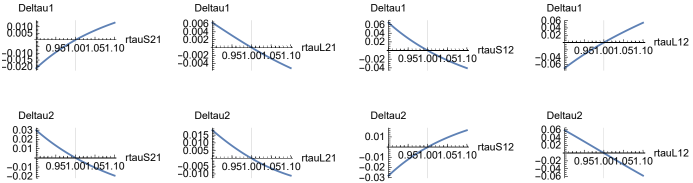


(b) relative changes in countries' skill premiums ω_1 (top), ω_2 (bottom)

Welfare around a factual BGP



(a) changes in countries' long-run welfare Δu_1 (top), Δu_2 (bottom), Krugman



(b) changes in countries' long-run welfare Δu_1 (top), Δu_2 (bottom), Melitz

- j's welfare tends to move in the same direction as j's skill premium
- j's liberalization may not raise j's welfare

Summary

- around a symmetric BGP:
  - 1's skill premium $\uparrow$ w/ $\tau_{21}^{L}\downarrow$, $\tau_{12}^{S}\downarrow$, but $\downarrow$ w/ $\tau_{21}^{S}\downarrow$, $\tau_{12}^{L}\downarrow \Leftrightarrow \psi > 1$
  - balanced growth rate $\uparrow$ w/ $\tau_{jk}^{i}\downarrow \forall i, j, k \; \forall\psi$
- the above is mostly valid:
  - around a factual BGP
  - w/ heterogeneous firms