Multinational production vs trade in an endogenous growth model with heterogeneous firms

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Following the seminal work of Melitz (2003), a number of scholars have incorporated firm heterogeneity into trade models.

But, static steady-state models - abstract from the long-run economic growth effect.

Main question: Would this increase in productivity through reallocation lead to an increase in the long-run growth rate?
Motivation

- The seminal open-economy endogenous growth models - assume away firm-level differences within sector.
- More recently, models with endogenous growth with firm heterogeneity
- But, all these models focus one a single foreign market entry mode i.e. export.
Empirical evidence suggest instead that FDI grows faster than trade and it is an important conduit of international technology spillovers.

This paper:
- Constructs a model of endogenous growth with international trade and multinational production, with firm heterogeneity.
- Endogenous international technology spillover.
- Generates endogenous and semi-endogenous growth without scale-effect.
Primitives

- The setting is a symmetric two-country framework.
- Each country consists of two sectors.
- Final goods produced by competitive firms according to:

\[ Y_t = A L_{Y_t}^{1-\alpha} \sum_{c=H,F} \int_{\Omega^c} q_t^c(\phi)^\alpha dG^c(\phi) \]  

(1)
Intermediate goods sector

- Firms engage in R&D to discover new varieties of good as in Romer (1990).
- The main departure is that firms draw their ex-post productivity from a distribution in the spirit of Melitz (2003)
- A firm needs to incur additional fixed costs to adapt to domestic and foreign market conditions: domestic ($f_d$), export ($f_x$) and set-up foreign subsidiary ($f_m$).
- These costs are interpreted as involving units of 'knowledge'.

$$\xi_t = \frac{L_t^\gamma}{(1 + \Theta)\gamma N_{dt}^\gamma L_{It}^{\lambda-1}}$$  \hspace{1cm} (2)
Productivity cutoffs

- A firm that has already sunk its start-up cost \( f_e \) will enter a particular market if the benefit of doing so exceeds the cost.
- The minimum levels of \( \phi \) for which firms choose to sell at home, export, and produce abroad.

\[
v_j(\phi) = w\xi f_j \text{ where } j = d, x, m
\]  

- Multinational cutoff

\[
v_m(\phi^*_m) - w\xi f_m = v_x(\phi^*_m) - w\xi f_x
\]
Productivity cutoffs

$$pHfL$$

**Figure**: Domestic, Export and FDI cut-off
Free entry condition

- Having solved for when firms choose to sell in the domestic market, export or serve through FDI, solving the model backward- to determine the incentives to entry.

- Firms are ex-ante identical - decision to create new varieties depends on the ex-ante expected value of entry to the expected fixed cost of entry.

\[
\int_{\phi_d^*}^{\infty} (v_d(\phi) - w\xi f_d)g(\phi)d\phi + \int_{\phi_x^*}^{\phi_m} (v_x(\phi) - w\xi f_x)g(\phi)d\phi \\
+ \int_{\phi_m^*}^{\infty} (v_m(\phi) - w\xi f_m)g(\phi)d\phi = w\xi f_e
\]  

(4)
Flow of new varieties

- The growth rate of new varieties is dictated by the free-entry condition.
- The aggregate flow of new intermediate varieties produced

\[ \dot{N}_d = \frac{(1 + \Theta)\gamma N_d^\gamma L^\lambda}{F} \frac{L^\nu}{L^\nu} \]  

where

\[ F = \frac{f_e}{1 - G(\phi^*_d)} + f_d + \eta_x f_x + \eta_m f_m \]  

\[ \eta_x \equiv \frac{G(\phi^*_m) - G(\phi^*_x)}{1 - G(\phi_d)} \quad \text{and} \quad \eta_m \equiv \frac{1 - G(\phi^*_m)}{1 - G(\phi^*_d)} \]
Closed form solution with Pareto distribution

- Assume firm productivity follow a Pareto distribution with CDF
  \[ G(\phi) = 1 - \left( \frac{\phi}{\phi^*} \right)^k \]
  and the corresponding PDF
  \[ k\phi^k \phi^{-(k+1)} \]

Assumption 1

\[ \beta = \frac{k}{\sigma - 1} > 1 \]

- Solving the model yields the domestic productivity cutoff

\[ \phi^*_d = \phi \left[ \frac{f_d}{f_e (\beta - 1)} \{1 + \Lambda_x + \Lambda_m\} \right]^{\frac{1}{k}} \tag{7} \]

where,

\[ \Lambda_x = h^\beta \left( \frac{f_x}{f_d} \right)^{1 - \beta}, \quad \Lambda_m = \left( \frac{f_m - f_x}{f_d} \right)^{1 - \beta} (1 - h)^\beta. \]
Aggregate Productivity

- The aggregate productivity:

\[ y = A^\sigma \alpha^{2(\sigma-1)} N_d \Phi (1 - s_1) \]  

(8)

- Weighted average productivity

\[ \Phi = \beta \frac{f_e}{f_d} \left( \frac{\phi^*_d}{\phi} \right)^k \phi^*_d \sigma^{-1} \]  

(9)
Reallocating Effect

Proposition 1

Given assumption (1): (a) Freer trade \((dh > 0 \text{ and/or } df_x < 0)\) leads to a decrease in export cutoff \((d\phi_x^* < 0)\) and increase in FDI cutoff \((d\phi_m^* > 0)\). The domestic productivity cutoff and the weighted average productivity \(\Phi\) increases for parameter values \(fx/fm < h\). The productivity gain from trade cost reduction, however, is strictly lower than trade-only model; (b) Openness to MP in the form of reduction in \(fm\) lead to an increase in export cutoff \(d\phi_x^* > 0\), a decrease FDI cutoff \(d\phi_m^* < 0\). This will unambiguously lead to an increase in domestic productivity cutoff \(d\phi_d^* > 0\) and weighted average productivity \(\Phi\).
Reallocation effect

- Firms Exit
- Produce for domestic market
- Serve foreign via export
- Horizontal FDI
- New export cutoff
- New FDI cutoff

\[ \phi_d^{\sigma-1}, \phi_s^{\sigma-1}, \phi_m^{\sigma-1}, \phi^{\sigma-1} \]
Growth Effect

- No long-run growth effects but has level effects
- The steady-state number of varieties:
  \[ N_d^* = \left\{ L^{\lambda - v} \frac{s^*}{g^*} \left[ \frac{(1 + \Theta) \gamma}{F} \right] \right\}^{\frac{1}{1 - \gamma}} \] (10)
- The expected fixed cost of developing a new variety:
  \[ F = \beta f_e \left( \frac{\phi^*_d}{\phi} \right)^k \] (11)
- International technology spillovers:
  \[ \Theta = 1 - \left( \frac{1}{(\beta - 1) \frac{f_e}{f_d} \left( \frac{\phi^*_d}{\phi} \right)^k} \right) \] (12)
Proposition 2

When the return to knowledge is weak in the spirit of Jones(1995) in which $\gamma < 1$ and if assumption (1) is satisfied: (a) a fall in trade cost reduces the steady-state level of domestic varieties for $f_x/f_m < h < 1$. But the elasticity of steady-state number of varieties with respect to trade cost is lower than the trade-only model; (b) the stronger the degree of inter-temporal spillover (high $\gamma$) implies a larger elasticity of the steady-state number of varieties with respect to a reduction in trade costs.

- Both $F$ and $\Theta$ increases in response to $h(\tau^{1-\sigma})$. But the negative resource cost effect dominate the spillover effect under this specification.
Steady-state Welfare

**Proposition 3**

If $\gamma < 1$ in the spirit of, if Assumption (1) holds:

1. **Exogenous spillover - a reduction in trade cost** ($\uparrow h$ and/or $\downarrow f_x$) lead to a
   increase in long-run per-capita output iff $k < (\sigma - 1) \left( \frac{1}{\gamma} - 1 \right)$ for
   $f_x/f_m < h < 1$. But in the presence of MP the elasticity of steady-state
   per-capita output with respect to trade cost reduction is lower.

2. **Exogenous spillover - welfare improves with freer trade** iff
   $\gamma < \frac{\sigma - 1}{\sigma - 1 + k \left( \frac{1}{1 + 2\Lambda_x + 2\Lambda_m} \right)} \equiv \nabla$ for $f_x/f_m < h < 1$. 
Proposition 4 (Heterogeneity and welfare)

If productivity of firms in the intermediate goods sector follow a Pareto distribution with shape parameter $k > \sigma - 1$ and assuming endogenous selection for firms into domestic and foreign markets i.e. $\epsilon > 1$ and $\ell > 1$, the greater the dispersion of firm productivity (smaller $k$), (a) the larger the welfare if and only if $k < (\sigma - 1) \left( \frac{1}{\gamma} - 1 \right)$, (b) the larger the gains from a reduction in trade costs due to reallocation effect, (c) the larger the welfare loss from a reduction in variable trade costs due to variety effect.
Calibration

Panel A: Weighted Average Productivity
- With FDI
- No FDI

Panel B: Variety
- With FDI
- Without FDI

Panel C: Welfare Gain
- With FDI
- Without FDI

Panel D: Growth rate
- With FDI
- Without FDI
Conclusion

- Implication of change in trade and FDI costs in dynamic general equilibrium mode with firm-level productivity differences.
- Trade cost change can have substantial reallocation effect, but this is partly offset by a decrease in variety.
- The aggregate welfare effects turn out to depend critically on the degree of firm heterogeneity and the magnitude of technology spillover parameters.
- For wide range of parameters - openness lead to higher welfare.