In Support of the TRIPs Agreement

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8 September, 2011
DEGIT-XVI, St Petersburg
Introduction

- Intellectual property rights (IPR) protection in developing countries has been a topic of debate for many years.
- The Agreement of Trade-Related Aspects of Intellectual Property Rights (TRIPs) (Uruguay Round 1994) required reforms of systems for patent rights, copyrights, as well as enforcement mechanisms and dispute settlements of IPR. (Applied mainly to developing countries.)
- Criticism of the TRIPs:
  - generates income transfers from developing countries to patent-holding multinational firms
  - slows down technological progress (local firms cannot build on imitation of foreign technologies).
Gustafsson and Segerstrom (2010, IER), model with endogenous imitation, costless trade.

Grossman and Lai (2004, AER)

Glass and Saggi (2002, JIE)

Deardorff (1992, Economica), Deardorff (1990, World Economy)

McCalman (2001, JIE)

Chin and Grossman (1991, NBER WP)

Helpman (1993, Econometrica)

Lai (1998, J Dev Econ)

Branstetter and Saggi (2009, forthcoming Econ Journal)
Global economy, 2 regions: North and South.
Increasing product variety: innovation (which occurs in the North) is modeled as developing new product varieties.
Labor is the only factor of production. Mobile across sectors but not across regions. $w_N > w_S$.
$L_{Nt} = L_{N0}e^{gLt}$ and $L_{St} = L_{S0}e^{gLt}$.
$g_L$ is the population growth rate.
Innovation, FDI and imitation are all costly activities
Innovation, FDI and imitation rates are endogenously determined
Decreasing returns to innovative, adaptive and imitative R&D.
Iceberg trade costs
Innovation at rate $g$

Production by Northern Firms $n_N$ varieties

FDI at rate $\phi$

Production by Foreign Affiliates $n_F$ varieties

Imitation at rate $t_S$

Production by Southern Firms $n_I$ varieties

Imitation at rate $t_N$

Production by Southern Firms $n_C$ varieties
Households

- Households share identical preferences and consist of infinitely lived individuals endowed with 1 unit of labor, inelastically supplied.
- Each household is modeled as a dynastic family that maximizes discounted lifetime utility

\[ U = \int_0^\infty e^{-(\rho - g_L)t} \ln(u_t) dt \]

where

\[ u_t = \left[ \int_0^{n_t} x_t(\omega)^{\alpha} d\omega \right]^{\frac{1}{\alpha}}, \quad 0 < \alpha < 1 \]

\[ \sigma \equiv \frac{1}{1-\alpha} \text{ is the elasticity of substitution, } \alpha \text{ the degree of product differentiation} \]

- \( \rho > g_L \)
Static consumer optimization yields the familiar CES demand function

\[ x_t(\omega) = \frac{p_t(\omega)^{-\sigma} c_t}{P_t^{1-\sigma}} \]

\( c_t \) is individual consumer expenditure at time \( t \), \( p_t(\omega) \) the price of variety \( \omega \) at time \( t \), the aggregate price index is

\[ P_t = \left[ \int_0^n p_t(\omega)^{1-\sigma} d\omega \right]^{\frac{1}{1-\sigma}} \]

Dynamic consumer optimization yields

\[ \frac{\dot{c}_t}{c_t} = r_t - \rho \]

where \( r_t \) is the market interest rate and \( \rho \) the subjective discount rate.

In any steady-state equilibrium \( \frac{\dot{c}_t}{c_t} = 0 \) and \( r_t = \rho \ \forall t \).
FDI rate and imitation rates

\[ \phi \equiv \frac{\dot{n}_{It} + \dot{n}_{lt}}{n_{Nt}} : \text{FDI rate} \]

\[ \iota_{S} \equiv \frac{\dot{n}_{lt}}{n_{Nt}} : \text{Imitation rate of foreign affiliate varieties} \]

\[ \iota_{N} \equiv \frac{\dot{n}_{lt}}{n_{Nt}} : \text{Imitation rate of northern varieties} \]
Firms choose prices to maximize profits.
Firms choose R&D to optimize the value of the firm.
Constant returns to scale in production of output.
Production of 1 unit of output requires 1 unit of labor for a northern firm and for a foreign affiliate, but only $\zeta \in (0, 1)$ units of labor for a southern firm.

Iceberg trade costs: $\tau > 1$ units of a good must be produced and shipped in order for 1 unit of the good to arrive at its destination. $\implies$ A firm’s MC for serving its domestic market will differ from the MC for serving the export market.
Free entry into innovative R&D activities in North
All northern firms have access to the same technology
To innovate and develop a new product variety, a northern firm $i$ must devote $\frac{a_N g^\beta}{n_t^\theta}$ units of labor to innovative R&D.

- $a_N$: innovative R&D productivity parameter
- $n_t$: the disembodied stock of knowledge at time $t$
- $\theta$: intertemporal knowledge spillover parameter
- $\beta > 0$: externality parameter

$\theta < 1$ as in Jones (1995) - Weak intertemporal knowledge spillovers. Key assumption in ruling out strong scale effects.
Innovation-generated flow of products

- The aggregate flow of new products is
  \[ \dot{n}_t = \frac{n_t^\theta L_{Rt}}{a_N g^\beta} \]
  where \( L_{Rt} = \sum_i l_{Rit} \) is the total amount of (northern) labor employed in innovative R&D activities.

- It follows that
  \[ g \equiv \frac{\dot{n}_t}{n_t} = \frac{g_L}{1-\theta} \]

- Economic growth rate (real wage growth) is proportional to \( g \) and pinned down by parameters of the model. "Semi-endogenous" growth
Relative R&D difficulty

\[ \delta \equiv \frac{n_t^{-\theta}}{L_t/n_t} = \frac{n_t^{1-\theta}}{L_t} \]

- \( n_t^{-\theta} \) measures absolute R&D difficulty in \( \frac{a_N g^\beta}{n_t^{\theta}} \), decreases over time if \( \theta \in (0, 1) \), increases over time if \( \theta < 0 \).

- \( L_{Nt}/n_t \): market size term
Aggregate product flows

- The aggregate flow to the South through FDI is
  \[ \dot{n}_{Ft} + \dot{n}_{It} = \frac{n_t^\theta L_{Ft}}{a_F \phi^\beta} \]  
  (1)

- The aggregate flow of foreign affiliate varieties that have been imitated by southern firms is
  \[ \dot{n}_{It} = \frac{n_t^\theta L_{It}}{a_I (\eta S)^\beta} \]  
  (2)

- The aggregate flow of northern varieties that firms in the South imitate is
  \[ \dot{n}_{Ct} = \frac{n_t^\theta L_{Ct}}{a_I d (\eta S)^\beta} \]  
  (3)

- \(a_F\) and \(a_I\) are adaptive and imitative R&D productivity parameters and \(d > 1\) is a "distance" parameter.

- \(a_I\) is our measure of the strength of IPR protection in the South.
R&D incentives

- Free entry into innovative, adaptive and imitative R&D activities
- There is a stock market in each region that channels household savings to firms that engage in R&D and helps households diversify the risk of holding stocks issued by these firms.
- Ruling out any arbitrage opportunities implies that the total return on equity must equal the opportunity cost of invested capital, given by the risk-free market interest rate $\rho$. 

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No-arbitrage conditions

- No-arbitrage condition for a northern firm:
  \[ \nu_{Nt} = \frac{\pi_{Nt}}{\theta g + \iota_N + \rho} = \frac{w_N a_N g^\beta}{n_t^\theta} \]

  \[ \Rightarrow \]

  \[ \frac{X_N + \tau X_N^*}{(\sigma-1)\gamma_N} = \frac{a_N g^\beta}{\rho + \theta g + \iota_N} \left( \frac{n_t^{1-\theta}}{L_t} \right) \]

- No-arbitrage condition for a foreign affiliate:
  \[ \nu_{Ft} - \nu_{Nt} = \frac{\pi_{Ft}}{\theta g + \iota_S + \rho} - \frac{w_N a_N g^\beta}{n_t^\theta} = \frac{w_S a_F \phi^\beta}{n_t^\theta} \]

  \[ \Rightarrow \]

  \[ \frac{X_F + \tau X_F^*}{(\sigma-1)\gamma_F} - wa_N \delta g^\beta = a_F \delta \phi^\beta \]
No-arbitrage conditions cont’d

No-arbitrage condition for a southern firm that has imitated a foreign affiliate:

\[ U_{lt} = \frac{\pi_{lt}}{\theta g + \rho} = \frac{w_{S} a_{l}(\nu_{S})^{\beta}}{n_{l}^{\theta}} \]

\[ \Rightarrow \]

\[ \frac{(1 - \zeta)(x_{l} + \tau x_{l}^{*})}{\gamma_{l} \rho + \theta g} = a_{l} \delta_{l}^{\beta} \]
No-arbitrage condition for a southern firm that has imitated a northern firm:

\[ U_C t = \frac{\pi_C t}{\theta g + \rho} = \frac{w_S a l d l^B}{n_t} \]

\[ \implies \]

In the small trade costs case

\[ \frac{\zeta \left( X_C + \tau X^*_C \right)}{(\sigma - 1)\gamma_C} \frac{\gamma_C}{\rho + \theta g} = a_l d \delta l^B_N \quad \text{if} \quad \frac{w_N}{w_S} > \frac{\tau \zeta}{\alpha} \]

and, in the large trade costs case

\[ \frac{\zeta X_C}{(\sigma - 1)\gamma_C} + \frac{(w - \tau \zeta) X^*_C}{\gamma_C} \frac{\gamma_C}{\rho + \theta g} = a_l d \delta l^B_N \quad \text{if} \quad \frac{w_N}{w_S} < \frac{\tau \zeta}{\alpha} \]
Steady-state full employment of labor condition for the North:

\[ L_{N0} = [a_N \delta g^{1+\beta} + X_N + \tau X_N^*] L_0 \]

Steady-state full employment of labor condition for the South:

\[ L_{S0} = \left[ \left( a_F \phi^{1+\beta} \gamma_N + a_I \nu_S^{1+\beta} \gamma_F + a_I d_1^{1+\beta} \right) \delta + X_F + \tau X_F^* + \zeta \left( X_I + \tau X_I^* + X_C + \tau X_C^* \right) \right] L_0 \]
R&D done in the North is financed by northern savings and R&D done in the South by southern savings.

Steady-state asset condition:

\[
\frac{X_F^*}{X_F} = \left( \frac{p_F}{p_F^*} \right)^\sigma \frac{c_N}{c_S} \frac{L_{N_0}}{L_{S_0}} \frac{P_{St}^{1-\sigma}}{P_{Nt}^{1-\sigma}}
\]
We solve for a steady-state equilibrium where wages, nominal prices and consumer expenditure are constant over time.

The whole model reduces to 7 equations (2 labor market conditions, 4 R&D conditions, 1 asset condition) in 7 unknowns \( (w, \delta, \phi, \nu_N, \nu_S, X_F, X_F^*) \).
The model is calibrated to fit the world prior to the adoption and implementation of the TRIPs Agreement (1990) and after the TRIPs (2005).

- $\rho = 0.07$ real interest rate (avg real return on US stock market during 20th century, Mehra and Prescott 1985)
- $\alpha = 0.714 \implies (\text{markup } 1/\alpha \text{ of } 40\%, \text{ Basu 1996, Norrbin 1993})$
- $\theta = 0.72 \implies 2$ percent rate of economic growth 1950-1994 from Jones (1995)
- $g_L = 0.014$ average population growth rate 1990s (World Bank Development Indicators, 2011).
\( L_{N0} = 1 \) and \( L_{S0} = 2 \), to fit the ratio of the working age population in middle-income countries to that in high income countries.

\( \beta = 1 \implies 1 / (1 + \beta) = 0.5 \) (patent literature estimates range from 0.1 and 0.6, Kortum 1993)

\( \zeta = 0.9 \implies \) Southern firms have 10% lower production costs than foreign affiliates.

Fact 1: 10X increase in FDI inflow to developing countries from 1990 to 2005 (UNCTAD 2011). 6X increase after adjustment for inflation and population growth.


Fact 3: Large observed North-South wage difference.

\( a_N = 1 \) normalization.

\( a_F = 35 \) (costly FDI) and \( d = 250 \) (costly imitation of northern firms) needed to generate high \( w_N/w_S \).

\( a_I = 2 \) in 1990, \( a_I = 6.15 \) in 2005 \( \implies \) little FDI inflow in 1990, 6X increase by 2005.
### Numerical results

<table>
<thead>
<tr>
<th></th>
<th>1990</th>
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<th>(B)</th>
<th>(C)</th>
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<td>$= 1.33$</td>
<td>$= 1.54$</td>
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<td>$= 6.15$</td>
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<td>0.002</td>
<td>0.006</td>
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<td>0.002</td>
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<td>$\gamma_N$</td>
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<td>0.925</td>
<td>0.892</td>
<td>0.822</td>
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<td>$\gamma_F$</td>
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<td>0.055</td>
<td>0.036</td>
<td>0.055</td>
<td>0.003</td>
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<td>0.007</td>
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<td>$L_{F0}$</td>
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<td>0.070</td>
<td>0.012</td>
<td>0.069</td>
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<td>$u_{S0}$</td>
<td>151.1</td>
<td>187.3</td>
<td>158.6</td>
<td>179.2</td>
<td>208.4</td>
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</table>
1990 and 2005 benchmarks: stronger IPR protection and trade liberalization enhances welfare in North and South, proportionally more so in the South. FDI rate $\phi \uparrow$, imitation rates $\iota_N \downarrow$ and $\iota_S \downarrow$, more varieties transferred to foreign affiliates ($\gamma_N \downarrow$ and $\gamma_F \uparrow$), corresponding increase in southern firms that have imitated foreign affiliates ($\gamma_I \uparrow$).

Column A: Trade liberalization alone generates a small increase in $u_N$ and $u_S$.

Column B: Stronger IPR protection alone generates large increase in both $u_N$ and $u_S$.

Column C: Strengthening IPR protection beyond the TRIPs level further enhances welfare in both regions, despite fewer southern firms (also $\gamma_I \downarrow$ in comparison to 1990 benchmark).
Less costly and costless FDI

- Previous models such as Helpman (1993), Lai (1998) and Branstetter and Saggi (2009) assume costless FDI.
- Costless FDI corresponds to $a_F = 0$ in our model.
- Lowering $a_F$ from our benchmark $a_F = 35$ substantially decreases the relative wage ratio $w_N/w_S$. We set the standard assumption of free trade $\tau = 1$ and lower the cost of FDI towards 0.
- For the standard assumptions of free trade and costless FDI, northern wage rate is only 2.7 percent higher than southern wage rate.
- Our model suggests that costly FDI can help explain the large North-South wage differences observed in the data. It also suggests that the commonly used assumption of costless FDI is a rather strong assumption.
### Numerical results - Costless FDI

<table>
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<tr>
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<td>(\tau = 1)</td>
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<tr>
<td>(a_F = 35)</td>
<td>(a_F = 35)</td>
<td>(a_F = 10)</td>
<td>(a_F = 0.5)</td>
<td>(a_F = 0)</td>
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<td>(w_N/w_S)</td>
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<td>1.885</td>
<td>1.610</td>
<td>1.200</td>
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<tr>
<td>(\delta)</td>
<td>23.23</td>
<td>23.24</td>
<td>25.30</td>
<td>36.44</td>
<td>51.79</td>
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<td>(\phi)</td>
<td>.006</td>
<td>.006</td>
<td>.012</td>
<td>.050</td>
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<tr>
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<td>.061</td>
<td>.035</td>
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<td>.007</td>
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<tr>
<td>(\nu_N)</td>
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<td>.000</td>
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<td>.000</td>
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<tr>
<td>(\gamma_N)</td>
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<td>.892</td>
<td>.805</td>
<td>.502</td>
<td>.297</td>
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<tr>
<td>(\gamma_F)</td>
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<td>.046</td>
<td>.113</td>
<td>.398</td>
<td>.614</td>
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<td>(\gamma_I)</td>
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<td>.055</td>
<td>.079</td>
<td>.099</td>
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<td>(\gamma_C)</td>
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<td>(c_N/c_S)</td>
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<td>(L_{F0})</td>
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<td>.070</td>
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<td>(u_{N0})</td>
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<td>211.7</td>
<td>280.1</td>
<td>586.9</td>
<td>1017.3</td>
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</table>

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Small $d$: Imitation vs FDI as source of technology transfer

- The distance parameter $d$ determines how much more difficult imitation of northern imported varieties is compared to imitation of foreign affiliate varieties (where production already takes place in the South).

- As shown in the Gustafsson and Segerstrom (2010) model, for small values of $d$, i.e. when the imitation channel is sufficiently important relative to the FDI channel as a source of technology transfer, stronger IPR protection is welfare improving for the North but worsens welfare in the South.

- With small $d$, there is too much northern imitation, resulting in too low $w_N/w_S$. 

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$d = 25$, technology transfer through imitation vs. FDI

<table>
<thead>
<tr>
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<th>1990</th>
<th>2005</th>
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<td>$\tau = 1.54, a_I = 2$</td>
<td>$\tau = 1.33, a_I = 6.15$</td>
<td>$\tau = 1.33, a_I = 2$</td>
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<td>$w_N / w_S$</td>
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<td>1.80</td>
<td>1.70</td>
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<tr>
<td>$\delta$</td>
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<td>$\phi$</td>
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<tr>
<td>$\iota_S$</td>
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<td>$\iota_N$</td>
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<td>$\gamma_N$</td>
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<td>$c_N / c_S$</td>
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<td>$u_{S0}$</td>
<td>205.0</td>
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</table>

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Conclusions

- Dynamic general equilibrium model that can account for large wage differences between the North and the South due to the assumption of costly FDI.
- Our model indicates that the assumption of costless FDI that is used in many previous North-South models with IPR protection is a strong assumption.
- The model can account for the large (6X) observed increase in FDI going to developing countries from 1990 to 2005.
- For plausible parameter values, stronger IPR protection in developing countries (TRIPs) leads to large welfare gains for both developing and developed countries.