Trade and growth

In this lecture we shall adopt the Ricardian view point on the determinants of the pattern of specialization in trade.

According to the Ricardian theory, specialization reflects the comparative advantage produced by differences in technology

According to the Heckscher-Ohlin theory, instead, technological possibilities are uniform, and specialization reflects differences in relative factor endowments.

We shall adopt the Ricardian view-point to address the following questions:

1. what are the gains from trade in innovation goods?
2. Are these gains equally shared by all countries, or there may be losers and winners?
3. Is trade in innovation goods beneficial to technological change?

Empirical evidence on the relation between trade and growth

Macro evidence:

- Dollar (1992) and Sachs and Warner (1995): positive correlation between openness and growth.

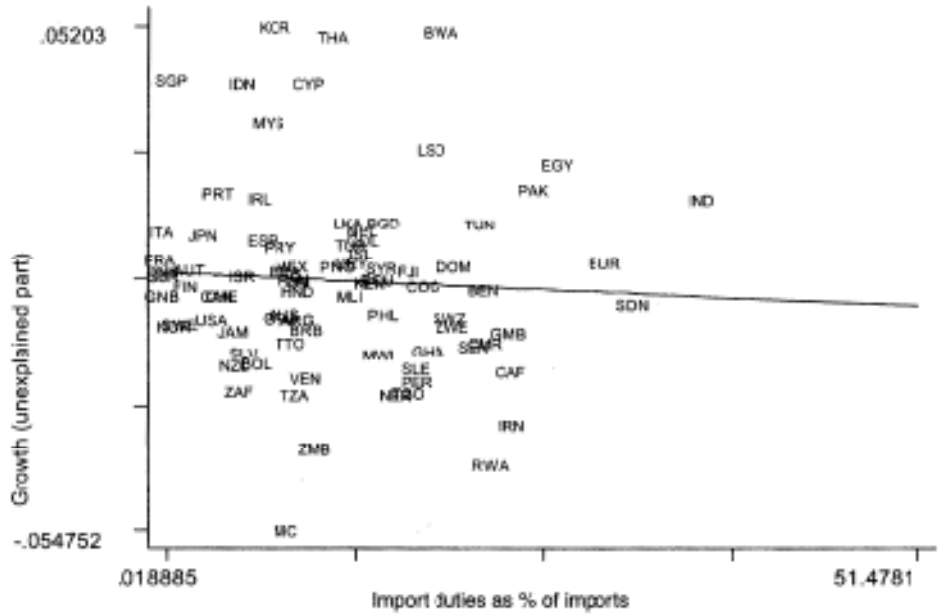
The problem with this evidence is that the direction of causality is unclear because 'openness' may be endogenous:

Openness → productivity growth

Openness ← productivity growth

Growth versus duties

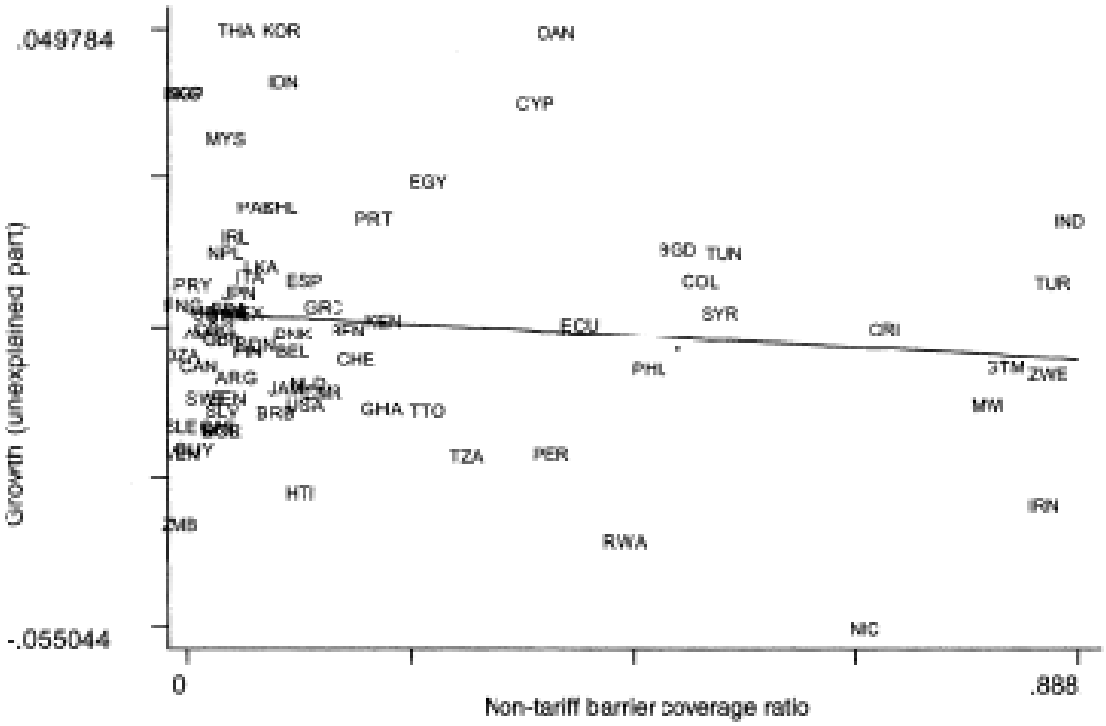
Figure 1 PARTIAL ASSOCIATION BETWEEN GROWTH AND DIRECT MEASURES OF TRADE RESTRICTIONS



- growth differences unexplained by initial per-capita GDP + secondary education regressed against duties as % of imports (Rodriguez and Rodrik, 2001)

- Regression coefficient weakly negative and not statistically significant

Growth versus non-tariff barriers



- growth differences unexplained by initial per-capita GDP + secondary education regressed against measure of non-tariff barriers (Rodriguez and Rodrik, 2001)

- Regression coefficient weakly negative and not statistically significant

1. Country specific growth-gains from trade:

- access to international markets makes internal-demand constraints less binding for sectors that are *net exporters*.

  Larger demand → higher specialization and productivity (deeper division of labor) → higher competitiveness → faster growth.

2. World-wide growth-gains from trade must lie elsewhere
   These type of gains are often justified by micro-arguments based on 'learning by exporting', but we shall see that there are also other arguments in this direction.

Micro evidence:

Standard explanation of micro-based effects of trade on productivity is learning by exporting…

- Bernard and Jensen (1997), Bernard, Eaton, Jensen and Kortum (2004): firms that engage in exporting are typically more productive, might be "learning by exporting" but could be selection (Melitz, 2003).

Learning by exporting (Salomon and Shaver, 2005): trade enables knowledge spillovers to materialize

The mechanism through which learning by exporting is argued to occur is by exporting firms accessing information to which they would otherwise not be privy. Grossman and Helpman (1991, 1993) argue that trade facilitates a bidirectional exchange of knowledge across borders.

Evidence suggests…

that exporters, compared to nonexporters, tend to be more productive (e.g., Aw and Huang, 1995; Clerides et al., 1998; Bernard and Jensen, 1999; Delgado et al., 2002). Finding the temporal sequencing that drives this relationship is vital in order to draw conclusions with respect to firm strategy. Namely, is the relationship driven by productive firms becoming exporters or exporting enhancing firms' productivity or both?

- productivity → exports
- exports → productivity

Evidence of leaning by exporting is mixed

Salomon and Shaver (2005):

> To date, the evidence suggests that productive firms become exporters and that exporting does not increase productivity. Hence, the conclusion has been that there is little learning by exporting.

Salomon and Shaver (2005) obtain more favorable evidence of 'learning by exporting' by using firm patent, rather than firm productivity data.

There is also evidence of 'trade dependent technology transfer':

- Firms in developing countries that import machinery from advanced economies more productive (e.g., Goldberg and Pavnik, 2007).

Correlation between exports and productivity is partly from selection effects

Melitz (2003) clarifies working of 'selection effects'

- Trade may not cause higher firm-level productivity
- Trade promotes *faster (export-led) growth of high productivity firms*
- Trade induces inter-firm *reallocations towards high productivity firms*
- *Low productivity firms are forced exit the market*

- → **industry wide productivity effects**

A world with trade in innovation goods

Consistently with the evidence showing that learning by exporting is not that strong, in what follows we assume:

because of non-codifiable knowledge, the leader preserves a knowledge advantage over the follower, even after the leader's patent is printed, and/or the leader's innovation good is traded.

Does trade promote growth and higher income in all countries?

Two countries with identical production function

$$Y_i = L^{1-\alpha} \int_0^1 A_{ij}^{1-\alpha} x_{ij}^{\alpha} di, \qquad 0 < \alpha < 1$$

Substituting x_i with its equilibrium value we get:

$$Y_i = \varphi A_t L$$

where A_t is the average productivity parameter across all sectors

$$A_t = \int_0^1 A_{it} di$$

and $\varphi = \alpha^{\frac{2\alpha}{1-\alpha}}$.

Profit maximizing output of intermediate 'machines' in sector *i*

$$x_{i,t} = A_{it} L \alpha^{2/(1-\alpha)}$$

Aggregate intermediate input of 'machines' $\int_{i=0}^{1} x_{i,t} di = A_t L \alpha^2 \varphi = \alpha^2 Y_t$

Aggregate value of intermediates is: $\int_{i=0}^{1} p_{i,t} x_{i,t} di = \alpha Y_t$

Total wage income is:

$$W_t = L \times \partial Y_t / \partial L = (1-\alpha) Y_t$$

Total profit income is:

$$\Pi_t = \int_0^1 (p_{it} - 1)\, x_{it}\, di$$

Recalling $p_{i,t} = \frac{1}{\alpha}$ $\quad \Pi_t = \frac{1-\alpha}{\alpha} \int_{i=0}^{1} x_{i,t} di = \frac{1-\alpha}{\alpha} \alpha^2 Y_t$

$$\Pi_t = (1-\alpha)\alpha Y_t$$

N_t = National income at t

$$N_t = W_t + \Pi_t = (1-\alpha)Y_t + (1-\alpha)\alpha Y_t = (1-\alpha)(1+\alpha)Y_t$$

$$N_t = (1-\alpha^2)\varphi A_t L$$

This implies: national income N_t = $GDP_t = Y_t - \int_{i=0}^{1} x_{i,t} di =$ Gross output – output used to producing intermediates

Innovation

To innovate with probability μ the innovator faces R&D expenditure:

$$c_{it}(\mu) = (1-\tau)\cdot\phi(\mu)\cdot A_{i,t-1}$$

- τ is a proportional innovation subsidy by the government
- If knowledge is higher, R&D is more costly

$$\phi(0) = 0$$

and

$$\phi'(\mu) > 0, \quad \phi''(\mu) > 0 \quad \text{for all } \mu > 0$$

- **Entry barriers: no R&D by outsiders within a country**
- **One incumbent monopolist in each sector, investing in R&D**

- if monopolist does not innovate, she gets previous period profit
- if she innovates, she gets a profit which is γ times higher ($\gamma>1$).

Monopolist's R&D increases with:

- innovation step $\gamma - 1$
- scale effect L and other factors affecting monopoly profit
- R&D subsidy τ

In equilibrium,

$$g = \hat{\mu}(\gamma - 1)$$

$\hat{\mu}$

Depends positively on τ, on L, and on profit per unit of efficiency π

Open up Trade:

- **Two countries: home (no star) and foreign (*)**
- Identical intermediate products
- Trade in intermediates and in final output
- In each sector, output monopolized by least-cost producer

$$Y_t = \int_0^1 Y_{it} di = L^{1-\alpha} \int_0^1 \hat{A}_{it}^{1-\alpha} x_{it}^{\alpha} di, \qquad 0 < \alpha < 1$$

$$\hat{A}_{it} = \max\{A_{it}, A_{it}^*\}$$

Wage income

$$W_t = (1-\alpha)Y_t = (1-\alpha)\zeta \hat{A}_t L$$

$$W_t^* = (1-\alpha)Y_t^* = (1-\alpha)\zeta \hat{A}_t L^*$$

Profits

Profit income in each country depends on the fraction of the intermediate monopolies that resides in that country. Define

$$\lambda_{it} = \begin{cases} 1 & \text{if } A_{it} > A_{it}^* \\ 0 & \text{otherwise} \end{cases}$$

$$\Pi_t = \pi(L + L^*) \int_0^1 \lambda_{it} \hat{A}_{it} di$$

$$\Pi_t^* = \pi(L + L^*) \int_0^1 (1 - \lambda_{it}) \hat{A}_{it} di$$

Selection effect on world income

$$N_t + N_t^* = (1-\alpha)(Y_t + Y_t^*) + \alpha(1-\alpha)(Y_t + Y_t^*)$$
$$= (1-\alpha^2)\varphi(L\hat{A}_t + L^*\hat{A}_t)$$

whereas when the world economy was closed it was[7]

$$N_t + N_t^* = (1-\alpha^2)\varphi(LA_t + L^*A_t^*)$$

World income larger after trade opening

Scale effect:

- gains from openness depend on ‘market size’, hence employment
- If the home country is ‘small’ and the foreign country is ‘large’, and they prevail in an equal number of sectors, the home country has more to gain from openness, because it gets access to larger markets.

Advantage from backwardness is not guaranteed

abstract from innovation … and assume L = L* (country-size is the same)

- Wage income is increased by openness, because workers in final output sector use more advanced machines,
  difference is greater if the productivity gap is greater.

- Profit income may not grow with openness, because home sectors may be monopolized by foreign producers, with a loss of profit

- After openness, national income may not increase in a country losing many sectors to foreign competition
- More complex effects would follow if machines are produced with labor, because there would be a displacement of the workers producing these machines, with implications on the wage rate

Introduce innovation

Case A: home sector leading

Case B: home and foreign sector neck and neck

Case C: foreign sector is leading

case A

- If the home leader innovates, she preserves leadership and the whole market L + L*. This happens with prob. μ_A.
- If she fails to innovate, and the foreign follower innovates (this occurs with prob. $(1 - \mu_A)\ \mu_A^*$), they become neck and neck; in this case we may assume that home and foreign producers monopolize their own market (L and L*, respectively).
- If she fails to innovate, and the foreign follower fails too (this occurs with prob. $(1 - \mu_A)\ (1 - \mu_A^*)$, the home producer preserves leadership.

Case C is symmetric with respect to case A

Case B (level sector)

- Home producer becomes world leader if she innovates and the foreign producer does not. This occurs with probability $\mu_B (1 - \mu_B^*)$.
- If she fails to innovates and the foreign producer succeeds (which occurs with prob $(1 - \mu_B) \mu_B^*$), the home producer looses the home market L, and becomes a follower.
- If home and foreign producers both succeed or fail [prob. is $\mu_B \mu_B^* + (1 - \mu_B)(1 - \mu_B^*)$], each preserves her market.

Scale effect of trade:

- In case A and C, the successful innovator preserves the entire world market L + L*. In the closed economy, market size is just L or L*.
- In case B this effect amounts to an 'escape competition effect', that is not present in the closed economy.
- **The scale effect of trade provides stronger innovation incentives than in the closed economy case.**
- **The scale effect of trade is larger if L/L* is smaller**

Question: would the 'scale effect of trade' vanish, if we remove the scale effect at the country level, by replacing L and L*, with L/m and L*/m, respectively?

Answer: No, because if we replace total employment L with sector employment L/m it would still be true that world-wide sector employment is larger than country sector employment. World market size is higher!

Escape entry effect

- The leader who is unsuccessful at innovation may lose the foreign market to the foreign rival.
- The neck and neck producer, who is unsuccessful at innovation, is losing the home market to the foreign rival.
- **These effects are not present in the closed economy**
- **The escape entry effect provides stronger innovation incentives in the open than in the closed economy.**

Scale + escape-entry effects suggest that trade has a positive effect on innovation in the following cases:

$\mu_A > \mu$ innovation in the leading home sector is higher under trade

$\mu_C^* > \mu^*$ innovation in the leading foreign sector is higher under trade

$\mu_B > \mu$ innovation in the home neck-neck sector is higher under trade

$\mu_B^* > \mu^*$ innovation in the foreign neck-neck sector is higher under trade

There is however a relevant exception to the conclusion that trade is beneficial to innovation activity. It may be the case that:

$\mu_C < \mu$ innovation in the home backward sector is lower under trade

Discouragement effect of foreign entry

- In the closed economy the backward sector is not facing the threat of entry by the foreign leading sector.
- The catching-up probability from any given μ_C by the home follower is lower, if μ_C^* of the leading sector is higher.
- If μ_C^* is large enough, innovation is higher with no trade than with trade in backward home sector.
- If μ_C^* is large, $\mu_C < \mu$
- **If the catching up probability (that depends on μ_C^*) is too low, the expected benefit from R&D is lower than the cost:**
  no innovation in the backward sector $\mu_C = 0 < \mu$

Remark

- $\mu_C = 0$ does not affect steady state productivity growth in this sector, that depends on the growth rate of

$$\hat{A}_{it} = \max\{A_{it}, A_{it}^*\}$$

  This depends on μ_C^*.

- $\mu_C = 0$ will affect the **steady state number** of sectors that are in states A, B, C.

Steady state growth

Average productivity level in home sectors that are leaders (state A):

$$\hat{A}_{At}$$

Average world-wide productivity level

$$\hat{A}_t = q_A \hat{A}_{At} + q_B \hat{A}_{Bt} + q_C \hat{A}_{Ct}$$

q_A, q_B, q_C = steady state fraction of sectors in state A, B, C

$q_A + q_B + q_C = 1$

$$\hat{A}_t = q_A \hat{A}_{At} + q_B \hat{A}_{Bt} + q_C \hat{A}_{Ct}$$

$$g = \eta_A g_A + \eta_B g_B + \eta_C g_C$$

where $\eta_A = q_A \frac{\hat{A}_{A,t}}{\hat{A}_t}$, $\eta_B = q_B \frac{\hat{A}_{B,t}}{\hat{A}_t}$, $\eta_C = q_C \frac{\hat{A}_{C,t}}{\hat{A}_t}$

$$\eta_A + \eta_B + \eta_C = 1$$

Steady state growth

$$g = \eta_A g_A + \eta_B g_B + \eta_C g_C$$

$$g_A = (\gamma - 1)\mu_A$$

$$g_B = (\gamma - 1)(\mu_B + \mu_B^* - \mu_B \mu_B^*)$$

$$g_C = (\gamma - 1)\mu_C^*$$

$\mu_B + \mu_B^* - \mu_B \mu_B^*$ = probability of technology improvement in B sector

Notice there is a duplication growth-effect of trade on g_B

Faster growth in all countries

Compare closed economy growth rates $g = (\gamma - 1)\mu$, $g^* = (\gamma - 1)\mu^*$ with:

$$g_A = (\gamma - 1)\mu_A$$

$$g_B = (\gamma - 1)(\mu_B + \mu_B^* - \mu_B\mu_B^*)$$

$$g_C = (\gamma - 1)\mu_C^*$$

Because, $\mu_A > \mu$, $\mu_C^* > \mu^*$, $\mu_B > \mu$, $\mu_B^* > \mu^*$

We have $g_A > g$, $g_C > g^*$, $g_B > g$, $g_B > g^*$

Trade opening in a backward country

- Consider a closed home country that at time t is backward in every sector, that is,

$$A_{i,\,t} < A^*_{i,t} \qquad \text{all i}$$

- Suppose that, just before time, t economic reform produces

$$\mu >> \mu^*$$

- Suppose the country decides to open trade at t:
- ⇒ all home sectors are monopolized by foreign sectors
- After trade opening, technology level in each sector is $A^*_{i,t}$

Lower income level after trade?

- Because production of each intermediate x_i is monopolized by foreign leader, profit income in home country is wiped out.
- Wage income will rise because home workers use more productive foreign machines
- Overall effect is uncertain

Lower growth rate after trade?

If $\mu - \mu^* >> 0$ and large enough (which is a strong assumption), it may be the case that after trade the growth rate is lower in the home country… This is more likely to be the case if the size L of the home country is small.

If the home country is small:

- Scale effect on μ_C^* is small because L is small
- Escape entry effect on μ_C^* is small, because L is small, and moreover, the backward sectors are not innovating at all. Therefore …

$\mu_C^* - \mu^*$ is small

$\mathbf{g_C - g^* = (\gamma - 1)(\mu_C^* - \mu^*)}$ is small

from $\mu^* << \mu$ we conclude:

$\mu_C^* < \mu$ $\mathbf{g_C < g}$

Product innovations in final output

Situation will be worse for the ‘backward country’ if we remove the assumption that production of final output remains within the country and exploits the progress of frontier technology.

- Suppose (as realism requires) that some innovation goods are final goods. In this case, some final good markets will be lost by the ‘backward country’ to the foreign competitor.
- In this case the home production of final goods may specialize in traditional (mature) output varieties. The world demand for traditional varieties has a relatively low elasticity with respect to world output. These may negatively affect the exports of the backward country and its terms of trade.