Developmental and welfare implications of free trade without transfer of knowledge in economies with learning by doing: Slower global growth and greater global inequality?

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Motivation: trade, knowledge, and production

- The relationship between trade and knowledge is at the center of the global debate in the current crisis of the WTO rules

- Displacement of “trade and growth” by “trade and knowledge” in current policy discourses acknowledges the dynamic consequences of trade policies

- Our paper: Macroeconomic approach in a global dynamic general equilibrium perspective
  - It differs from static general equilibrium analysis
  - And differs from dynamic analyses that focus on partial equilibrium

Trade and learning

- Two different learning processes associated with trade:
  1. Social interactions
  2. Production and investment (learning by doing, learning by investing, learning by learning)

- Over time, with the development of the institutional structures for learning, 1 has become relatively less relevant
  - Tacit knowledge still of critical importance (example: ASML)

- Classical theories of trade focus on learning by repetition
  - Specialization that leads to more repetition of tasks improves efficiency
  - The recognition that there is learning through social interactions would have reinforced free-trade theorems (and did play a role in popular policy discourse and some analytical work)

Free trade in classical theory (no learning by doing)

- Since Ricardo and Smith, free trade has been a basic tenet of economics—taking advantage of economies of scale and (static) comparative advantage is the recipe for *increasing the wealth of nations*

- In a certain class of models, it was possible to show that everyone *could* be made better off
  - Though without government redistribution, not everyone would be better off
  - And the necessary redistributions seldom occurred

- It is well known from Arrow-Debreu and subsequent work (Greenwald-Stiglitz 1986, 2006, Newbery-Stiglitz 1984) that the assumptions needed for those results to hold are highly restrictive
  - In absence of a full set of risk markets, free trade could even make everyone worse off

Free trade in classical theory (no learning by doing)

- Smith and Ricardo focused their attention on a static economy (with pin factories and trade in traditional products like port and wool), not the dynamic, innovative economies of the 21st century, where countries worry about their dynamic comparative advantage
    - They wrote in the late 18th or early 19th century, before or just at the beginning of the industrial revolution
- The question of who will dominate in the production of the fastest chips or the green technologies has risen to the top of the policy agenda around the world
    - Even the US, a traditional free trade advocate (putting aside the point that the practice often differed markedly from the rhetoric), has embraced trade-distorting industrial policy, worried that it will lose its dynamic comparative advantage to China, which has long embraced similar policies

Our paper: Trade with learning in production

- A central assumption in the Arrow-Debreu competitive model was that technology was fixed, or at least that it was not endogenous

- Our paper shows that even in a simple variant of the Ricardian model, with labor the only input into production, and a simple dynamic process of learning by doing, free trade without transfer of knowledge can have negative global dynamic efficiency effects as well as large distributional effects

Key ingredients of the theory

1. There is learning by doing
   - Learning in the production of goods, although only in one sector of the economy

2. Learning spillovers are larger within a country than between countries
   - Knowledge moves more easily within a country than it does across borders, and this may be especially so in a world with strong intellectual property regimes, where countries and firms work hard not to have their knowledge shared
   - Much of knowledge is embedded in individuals and these move across sectors within a country, spreading tacit knowledge from one sector to another, and gets reflected in institutional arrangements, again resulting in knowledge and the benefits of that knowledge being shared more within a country than between countries (institutional transplants by and large don't work)

Main results

- Under certain parameters, in a simple two country model free trade will lead to an increase in welfare in one country—the country with a ever so slight comparative advantage in the learning sector-- and a decrease of welfare in the other country, which specializes in the production of goods that involve no learning and thus it experiences stagnation in its levels of productivity
    - The country with current comparative advantage in the sector in the sector where learning occurs learns more
    - In practice, it is also in a position to enhance its comparative advantage over time, but we do not include this effect in our analysis; doing so would strengthen our results.
- Over the long run, free trade can both lower *aggregate (global)* output and increase inequality (compared to autarky), an outcome which would lower global social welfare with any inequality averse global social welfare function (provided the discount rate is not too high)
    - The architecture of knowledge creation and transmission matters, and trade affects both
    - Implicit: Free trade rules (including those related to IPR) preserve and exacerbate (neo)colonial trade patterns and knowledge disparities

Mechanisms

- When knowledge is not transferred from one country to the other but it is transferred within a country, the specialization of one country in the sector in which knowledge is created and of the other in the sector in which no knowledge is created will lead to an “impoverishment” of the latter country in terms of knowledge, with respect to the counterfactual of no trade, in the disadvantaged country
  - Because of cross-sector spillovers, the country with an initial comparative advantage in the knowledge producing sector will be more knowledgeable in all its productive sectors

- In an initially almost symmetric equilibrium with two countries and two sectors (agriculture, manufacturing), with an inelastic aggregate supply of the factor of production (labor), over time free trade leads to half of the global labor supply being less productive both in the production of manufactures and agriculture with respect to the no trade counterfactual, while the other half is more productive at everything

- If the increase in learning in the advantaged country is not sufficiently large, global GDP will eventually be lower than what it would have been in the no free trade scenario
  - The lack of growth in the disadvantaged country more than offsets the higher growth in the advantaged country
  - The disadvantaged country will converge to a zero measure in the global economy

- Once the disadvantaged country “disappears”, the advantaged is effectively back in autarky but it has a population with more knowledge than in the counterfactual with no trade
  - Free trade has advantaged the country that is (slightly) ahead

A two-period model

- Two countries (alpha, beta), two commodities (Manufactures, M; Agriculture, A), two periods (0,1)

- Output per worker in period 1 is a function of size of manufacturing within the country in period 0

- Full spillovers of knowledge within a country, no spillovers across countries

- Output per worker in both sectors is initially $P_0 = 1$, and output of manufacturing and agriculture in the second period is given by $P_0[\ 1 + f(l_{M0})]$
  - f is the learning function, f(0)= 0, f'> 0, l_M is the input into sector M in a particular country in time 0
  - Special case: f takes on a linear form, $f(l_{M0}) = kl_{M0}$.

A two-period model

- The labor supply in both countries is unity in every period, and utility functions are Cobb-Douglas and symmetric in the two commodities:

$$U = A^{1/2}M^{1/2}$$

- For simplicity, we (initially) assume no discounting
- In autarky, given the fully symmetric preferences, the first period U= ½
- The output of (each) economy in the second period is $1 + f(1/2)$ and, with linear learning, utility is (for k=1)

$$1 + f(1/2) = 3/2$$

A two-period model: autarky with slight differences in comparative advantage

- Consider now a world where one country (alpha) has an ever so light comparative advantage in manufacturing, so small as to be negligible:
  - Output per worker in country alpha in manufacturing is (1 + Δ) and in agriculture is (1 - Δ), and conversely in country beta

- In the absence of trade, the relative price p for food (taking manufacturing as our numeraire) will be

  $1 + \Delta / (1 - \Delta)$ and the reciprocal, respectively

- Then $l_{M1}(1 + \Delta) = p l_{A1}(1- \Delta)$, i.e. half of labor is devoted to each sector 1 as before

- Utility in the first period is

$$U_0 = (1 + \Delta)^{1/2}(1 - \Delta)^{1/2}$$

in both countries

A two-period model: autarky

- To the first order of approximation, there is no change in utility, with the increased productivity in one sector being offset by losses in productivity in the other
- So too in the next period, in autarky, in both countries productivity in both sectors has increased, though from a lower base in country beta, but by the same proportion (1 + f(1/2))
  - In each country relative prices remain unchanged and utility has become

$$U_1 = (1 + f(\tfrac{1}{2}))U_o = (1 + \Delta)^{1/2}(1 - \Delta)^{1/2}[1 + f(\tfrac{1}{2})]$$

- The two countries grow in parallel, one consuming a little more food, the other a little more manufactured goods, but both allocating ½ of their labor to manufacturing, and thus they both experience the same growth

A two period model: free trade

- With free trade alpha specializes in manufacturing, beta in agriculture
- Given the symmetry, we can easily calculate utility the zeroth period, where the global supply of the two goods is now $1 + \Delta$, so the relative price is unity, and thus each country's GDP is $1 + \Delta$, divided equally into the two goods

$$U_0 = \frac{1}{2}(1 + \Delta)$$

- Trade has increased wellbeing in both countries
- This is the standard argument for comparative advantage

A two period model: free trade

- Now consider what happens in the second period
- Country alpha, specializing in manufacturing, has an output of $(1 + \Delta)(1+ f(1))$, while agricultural output in beta stagnates
- Given utility functions, expenditure on the two commodities is the same. Then in period 1

$$p(1 + \Delta) = (1 + \Delta)(1 +f(1))$$

Or $p = 1+f(1)$

- Beta benefits fully from the innovation in alpha through a terms of trade effect
  - By the same token, alpha suffers from the adverse term of trade effect.
  - Thus, utility in each country the second period is given by

$$½ (1 + \Delta)(1+f(1))^{.5}$$

A two period model: free trade

- Thus, trade has increased utility if and only if

$$(1 + \Delta)\,[1 + f(1)^{.5}] > (1 + \Delta)^{.5}(1 - \Delta)^{.5}(1 + f(1/2))$$

- If Δ is arbitrarily small, this will be satisfied if and only if

$$f(1)^{.5} > f(.5)$$

i.e. if there is a sufficiently large increase in learning from expanding production in country alpha

- If, for example, there is rapidly diminishing returns on learning so that $f(1) \approx f(1/2)$, then the above condition would require that

$$f(.5)^{.5} < 1, \text{ or } f(.5) < 1$$

If the discount rate is not too high, the loss of welfare in the second period can exceed the gain in welfare in the first period.

Free trade is welfare reducing

Dynamics (continuous time): short run

- We assume that the rate of increase of productivity is given by f(l), where l is the allocation of labor to the manufacturing sector
    - In autarky, the country grows at the rate $f(l_M) = f(1/2)$, so

$$(8)\quad U(t) = \tfrac{1}{2}(1+\Delta)^{1/2}(1-\Delta)^{1/2}\, e^{f(.5)t}$$

- So the present discounted value of utility, W_A, assuming a discount rate of r, is just

$$W_A = \tfrac{1}{2}(1+\Delta)^{1/2}(1-\Delta)^{1/2} / r - f(.5)$$

where we assume $r > f(.5)$.

- By contrast, under free trade, because of the terms of trade effect, each country has equal incomes,

$$e^{f(1)t} = p$$

so

$$(10)\quad U(t) = \tfrac{1}{2}(1+\Delta)e^{.5f(1)t}$$

- Comparing (8) and (10), it is clear that initially (a) static comparative advantage dominates—both countries suffer from autarky; and (b) the rate of growth of utility is greater with autarky than with free trade if $f(.5) > .5\, f(1)$, which it may well be.

Longer Run Welfare

- We can compare the discounted value of welfare, W_{FT}:

$$W_{FT} = (1 + \Delta)/[r - .5f(1)]$$

So

$$W_A > < W_{FT} \text{ as } [(1-\Delta)/(1 + \Delta)]^{.5} > < \{r - f(.5)\}/\{r - .5f(1)\}$$

- If there is sharply diminishing returns to learning (e.g. $f(1) \approx f(.5)$, autarky is always preferred to free trade for country beta
- With diminishing returns to learning, the advantages of concentrating production in one country become less, so free trade becomes undesirable
- For arbitrary small Δ, condition for autarky to be preferred is $f(.5) > .5\, f(1)$

Growth of the global economy

- The growth of the global economy at fixed prices (at date t)

$$(1/2)f(1) > < f(.5)$$

- Which depends simply on the extent of increasing or diminishing returns to learning. With diminishing returns, free trade leads to lower growth

A critical qualification

The above analysis ignored a critical constraint on the value of p

- The equal expenditure condition implied that

$$p(t) = e^{f(1)t}$$

- But there is a limit to the value of p, after which country alpha starts producing agricultural goods, and the price remains at the relative production costs of the two goods in country alpha
- The switch occurs at time T when

$$p(T) \equiv p^{**} = (1 + \Delta) / (1 - \Delta) = e^{f(1)T}$$

- After that, p is fixed at p**, and income in country beta remains totally stagnant at an income of p**(1+Δ), and so does its utility
  - Country alpha grows more rapidly than in autarky, and from a higher base
  - Asymptotically, country alpha grows at the rate it grew in autarky, though from a higher base

A critical qualification

- With less labor devoted to manufacturing in country alpha, the growth rate of productivity slows, but it still grows faster than in autarky and there are no longer any adverse terms of trade effects

- The disparity in incomes between the two countries grows, and eventually country beta becomes infinitesimally small compared to alpha, and country alpha grows at the same rate that it would have grown in autarky
- At T, under free trade utility in both countries (recall that up to this date, utility in the two countries are identical because of the terms of trade effect) :

$$U_{FT}(T) = 1/2(1+\Delta)e^{.5f(1)T} = 1/2(1+\Delta)^{1.5}/(1-\Delta)$$

- By contrast, at T, with autarky (because of symmetry, utilities in the two countries are the same)

$$U_A(T) = 1/2(1+\Delta)^{1/2}(1-\Delta)^{1/2}\, e^{f(.5)T}$$

A critical qualification

- Thus, at T, U_A (T) > or < U_{FT} (T) as $e^{f(.5)T}$ > or < $(1 + \Delta)/ (1 - \Delta)^{3/2}$

- But $e^{f(.5)T} < e^{f(1)T} = (1 + \Delta) /(1 - \Delta) < (1 + \Delta)/ (1 - \Delta)^{\frac{3}{2}}$,

- So utility is higher along the free trade path *for both countries* in the initial stages relative to autarky, until beta becomes so relatively unproductive in agriculture than alpha starts to produce agricultural goods as well, at which point beta stagnates (for ever), with eventually the utility of autarky for beta exceeding that with free trade
  - While for alpha, utility is always better with free trade

- **That means that so long as the interest rate is not too high, beta is worse off with free trade than with autarky**

Conclusions

- We have presented here an extremely stylized model, a polar representation of the world, where knowledge moves freely from one sector to another within a country, but not at all across countries, and where knowledge is only produced as a by-product of production, but only in one sector of the economy

- Under weak conditions, over the long run, free trade is worse than autarky for the country with a comparative static disadvantage in the sector where knowledge is created when both countries open up to trade
  - At least initially, while free trade increases global output and welfare, it may reduce the rate of growth
  - So that eventually global GDP is lower
  - And eventually, inequality between the two countries increases
  - In PDV, more than all of the long run gains from trade have gone to the country with the initial (ever so slight) comparative advantage in manufacturing

Conclusions

- The possibility of a significant slowdown of global growth should not be a surprise:
  - In autarky, all workers are experiencing productivity increases
  - But under free trade, without transfer of knowledge, productivity increases are limited to half (in our simplistic model) of the global population

- The benefits of the concentration in knowledge production have to be great to overcome this marked disadvantage arising from free trade

Conclusion

- Not only is global growth slowed, but over the long run, growth is concentrated in one country, and the disparity in income between that country and the other increases: inequality increases

- Under standard welfare functions for the global economy, free trade is unambiguously welfare decreasing

- Given the negative dynamic effects from free trade on the global economy, compensation in the form of transfer of goods would not be sufficient to make the global economy better off in the case of free trade
  - More than that would be needed for such an outcome: a transfer of knowledge from the initially advantaged country to the initially disadvantaged country, to avoid a “knowledge impoverishment” in the disadvantaged country as the consequence of free trade

- This is a key matter for the design of the international rules for trade (Guzman-Stiglitz 2024, OxREP)
  - Imposing free trade on the disadvantaged countries would work in a way that replicates trade patterns during colonial times—a form a “neocolonialism”
  - For policy: the problem is not with free trade per se but with its consequences for knowledge creation and difusion

A critical issue left outside of the paper: power

- A richer environment, not described in our paper: there are distributional consequences from free trade within the disadvantaged country, but the country's position in the international sphere for the determination of the trade rules will depend on the domestic power dynamic
  - Thus, corporate interests that benefit from free trade could advance that agenda even if it is detrimental to the welfare of the population as a whole

- Power is also relevant in the determination of how rules are enforced
  - Even though the US was central in writing current rules, when the rules proved inconvenient, it violated the rules with impunity

- Dealing with the global implications of US and European industrial policies is critical to evaluating their long run effects and welfare consequences
  - Issues have to be seen within a global general equilibrium with endogenous technology where geo-politics is pivotal