Lecture 1: Interacting Factor Endowments and Trade Costs

Background paper:

Interacting factor endowments and trade costs
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(1) Focus on the interaction of endowments and trade costs with multiple countries, goods, and/or stages of production

(2) Improve on existing “higher dimensions” literature: inability to solve for world general-equilibrium avoidance of trade costs, difficulties with inequalities

(3) Provide a multi-country approach: countries can differ in trade costs and endowments countries with average endowments can trade a lot finer patterns of specialization permitted simultaneous horizontal/vertical patterns
Our approach: Countries can differ by factor endowments and trade costs

All goods are shipped to a central market and back out to other countries (alternatively, all trade costs are port costs)

Each country has a “distance” to this market therefore has a country-specific trade costs.

Bilateral trade flows are not determined but “world” prices are well defined

N = n1 x n2 countries are arrayed in a matrix.

Countries in a row all have the same trade costs
Countries in a column have the same endowments
Model 1: 3 goods, two factors (L, K), many countries
   The world endowment ratio is K/L = 50/50

\( X_1, X_2, X_3 \) are Cobb-Douglas with symmetric factor intensities
   \( X_1 \) has shares \( K/L = 75/25 \)
   \( X_2 \) has shares \( K/L = 50/50 \) (the central good)
   \( X_3 \) has shares \( K/L = 25/75 \)

There is an odd number \( n \) of country endowment ratios (41 in the simulations), countries endowments are evenly and symmetrically distributed.

Country 1 has endowments \( L = 0.10, K = 1 - L = 0.90 \)
Country \( n \) has endowments \( L = 0.90, K = 1 - L = 0.10 \)
Central country has endowments \( K = 0.50, L = 0.50 \)
All countries’ preferences are identical, CD, shares all = 1/3
Full model: non-linear complementarity problem:
31x41 = 1271 countries: 31 trade costs, 41 endowments
29236 weak inequalities in 29236 non-negative
complementary variables

i, j are countries: i gives country ij’s trade cost,
j gives its endowment

\[ A_{tij} \] activity t (production, trade, utility) for country ij
13 activities for each of 1271 countries = 16523

\[ C_{kij} \] market k (goods, factors, utility) for country ij
9 mkts, 1271 countries, three world mkts = 11442

\[ I_{ij} \] country ij’s aggregate income balance
1 equation for each of 1271 countries = 1271
Zero-Π inequal

\[ mc_{tij} \geq p_{tij} \]

Comp var

activity level \( A_{tij} \)

Description

marg cost \( \geq \) price

Mkt clear inequal

\[ SC_{kij} \geq DC_{kij} \]

Comp var

price of com \( C_{kij} \)

Description

supply \( \geq \) demand

Income balance

\[ I_{ij} = w_{ij}L_{ij} + r_{ij}K_{ij} \]

Comp var

income

Description

income balance
Figure 1: Regions of production specialization in the three-good model

Trade costs (expressed as ad valorem)

Country i’s labor endowment (capital = 1 - labor)
Figure 2: Regions of trade specialization in the three-good model

Trade costs (expressed as ad valorem)

Country i's labor endowment (capital = 1 - labor)

one non-trade good
Figure 3: Volume of trade as a share of income
Figure 4: Change in w/r as a proportion of autarky
Figure 5: Gains from trade as a proportion of autarky welfare
Results for Model 1: Low trade-cost countries: results relatively complex

exhibit multiple cones of production diversification

complex trade patterns as a function of endowment ratios (number of imported, exported, and non-traded goods)

central countries trade a lot, but gain little: trade volume not monotonic in endowment remoteness (from world average)

factor-price changes, autarky to free trade follow Stolper-Samuelson (high-cost countries as well).
Results for Model 1: High trade-cost countries: results relatively straightforward and intuitive.

degree of production specialization monotonically related to a country’s endowment remoteness (from world average)

tend to be specialized exporters (one good). number of imports increasing in endowment remoteness (number of non-trade decreasing in endowment remoteness)

trade volume and welfare gains monotonically increasing in endowment remoteness, falling in trade costs.
Model 2: two goods (X, Y), X can fragment into two production activities;

N competitive, constant-returns economies

Two factor of production: K, L

Two final goods, three production activities:
  Y - labor intensive
  X - capital intensive
  X - can fragment into C (components) and A (assembly)
    C - more capital intensive than X
    A - more labor intensive than Y

C and X are traded, assembly “services” cannot be trade (X, a “bundle” of C and A can be exported, but not A alone)
Experiments

(1) geographic wandering: cross-section comparison of countries differing in endowments and trade costs.

(2) fragmentation: comparison of world with fragmentation allowed versus ruled out.

“with fragmentation” means a country can trade C at its country-specific trade cost

(3) globalization: trade costs for the \((n1 \times n2)\) countries are all scaled up and down by a common multiple
Figure 6: Production Regimes with no fragmentation, two-good model

- X specialized in X
- Y specialized in Y

Country i's endowment of labor (capital = 1 - labor)

- X diversified: X, Y
- Y diversified: X, Y

Trade costs (ad valorem)
Figure 7: Production Regimes with fragmentation

country i's endowment of labor (capital = 1 - labor)

C  specialized in C  C A  partial specialization in C and A
Y  specialized in Y  CY  partial specialization in C and Y
A  specialized in A  YA  partial specialization in Y and A
Figure 8: Trade in C and A: analogy to affiliate production

trade costs (ad valorem)

country i's endowment of labor (capital = 1 - labor)

MO - market oriented (p) - parent's point of view
EP - export platform (h) - host's point of view
Figure 9: Change in the volume of trade following fragmentation.

Autarky before and after fragmentation.

- Volume of trade falls
- Welfare falls
- Volume of trade and welfare both fall
Figure 11: World VOT/GDP with and without fragmentation (vary trade costs for all countries)

Figure 12: World VOT/GDP for a subset of 22 countries (vary trade costs for all countries)
Results for model 2:

(1) Fragmentation produces a logical progression of specialization moving across factor-endowment space.

(2) Similarly with moving across trade costs: higher trade costs, less specialization for a given endowment ratio.

(3) Moderate trade costs produce something that resembles market-oriented affiliate production and low trade costs lead to export-platform affiliate production.

(4) Fragmentation increases welfare for fringe-endowment countries and may lower welfare of “near-middle” countries.
(4) Fragmentation, with otherwise free trade, increases trade volumes for fringe countries but also for central countries.

(5) Fragmentation decreases trade volumes for countries with moderate trade costs and moderate endowment ratios: they can trade only for the part of X they need.

(6) Over all countries, lowering trade costs larger trade volumes and world production specialization when fragmentation is permitted than when not.

(7) However, this is not true for a substantial set of countries, which trade less and specialize less with fragmentation allowed.
*THREEG.GMS MANY GOODS MODEL
*countries have double index ij: trade cost i, endowment j
*two factors, set F
*nine goods, set G
*41 endowment ratios, 31 trade costs, 3 goods

SETS    I       countries               /1*31/,
         J       countries               /1*41/,
         F       factors of production   /L,K /,
         G       goods                   /1*3/;

PARAMETERS
   TC(I)         trade cost of country i,
   ENDOW(I,J,F)  country ij's endowment of factor F,
   FX(F,G)       factor f's share (intensity) in sector G;
$CONTEXT
$MODEL: MULTI

$SECTORS:
  X(I,J,G)  ! production activity for good G
  EX(I,J,G)  ! export activity for good G
  IX(I,J,G)  ! import activity for good G
  XX(I,J,G)  ! supply of domestically produced G to home
  W(I,J)  ! welfare of country ij

$COMMODITIES:
  PW(I,J)  ! utility price index for country j
  PX(I,J,G)  ! domestic producer price (mc) of good G
  PCX(I,J,G)  ! domestic consumer price of good G
  PF(I,J,F)  ! price of factor F in country ij
  PFX(G)  ! world (central market) price of good G

$CONSUMERS:
  CONS(I,J)  !income of representative consumer in ij
$\text{PROD: } X(I,J,G) \ s:1$
- $O: PX(I,J,G) \quad Q: 100$
- $I: PF(I,J,F) \quad Q: FX(F,G)$

$\text{PROD: } EX(I,J,G)$
- $O: PFX(G) \quad Q: 100$
- $I: PX(I,J,G) \quad Q: (100*TC(I))$

$\text{PROD: } IX(I,J,G)$
- $O: PCX(I,J,G) \quad Q: 100$
- $I: PFX(G) \quad Q: (100*TC(I))$

$\text{PROD: } XX(I,J,G)$
- $O: PCX(I,J,G) \quad Q: 100$
- $I: PX(I,J,G) \quad Q: 100$

$\text{PROD: } W(I,J) \ s:1$
- $O: PW(I,J) \quad Q: (300*2/3)$
- $I: PCX(I,J,G) \quad Q: (100*2/3)$

$\text{DEMAND: } CONS(I,J)$
- $D: PW(I,J) \quad Q: (\text{SUM}(F, \ \text{ENDOW}(I,J,F)))$
- $E: PF(I,J,F) \quad Q: \text{ENDOW}(I,J,F)$
* choose world price of central good $G = 2$ as numeraire

$PFX.FX("2") = 1;$

*here is the loop that sets the endowment of country $j$
*and the trade costs of country $i$

$LOOP(I,$
$LOOP(J,$

$ENDOW(I,J,"K") = (180+(160/40) - (160/40)*ORD(J));$
$ENDOW(I,J,"L") = (20-(160/40) + (160/40)*ORD(J));$
TC("31") = 1.00025;
TC(I)$(ORD(I) LT 31) = 1 + (1.16**(30 - ORD(I)))*0.005;

*set the factor shares (intensities) of sector G

FX("L","1") = 30;
FX("K","1") = 70;
FX("L","2") = 50;
FX("K","2") = 50;
FX("L","3") = 70;
FX("K","3") = 30;

MULTI.workspace = 25;
MULTI.ITERLIM = 20000;
$INCLUDE MULTI.GENSOLVE MULTI USING MCP;
SOLVE MULTI USING MCP;