The Heckscher-Ohlin Model: Features, Flaws, and Fixes

II: What's Not to Like about the H-O Model?

Alan V. Deardorff
University of Michigan

Themes of the 3 Lectures, Again

- The HO Model is largely well behaved in 2 dimensions, even when you include trade costs
- ✍In higher dimensions, it is not so well behaved, especially when you include trade costs
- Various modifications and extensions of the HO model offer some promise of making it behave better

Outline

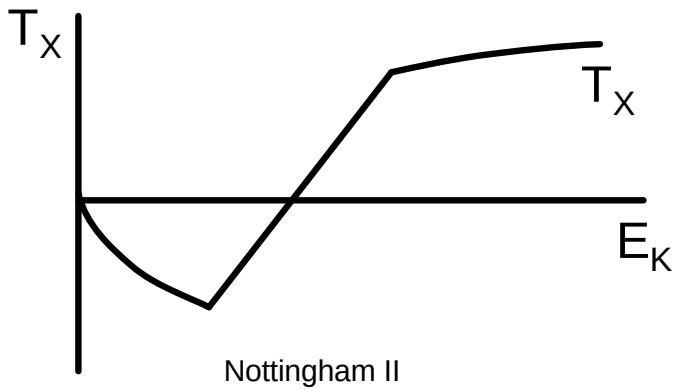
- Flaws of the HO Model
  - Minor Inconveniences of the 2×2 Model
  - Major Inadequacies in Higher Dimensions
    - Indeterminacy of production and trade
    - Hypersensitivity to Trade Costs
    - Specialization
  - What Would a General Model Look Like?

Minor Inconveniences of the 2×2 Model

- The Prediction of Factor Price Equalization (FPE)
  - Ohlin's belief in "only a tendency toward FPE" is
    - Wrong, in the exact version of the model that we have, but
    - Much easier to believe about the real world
  - But trade costs
    - Suffice to prevent complete FPE
    - Preserve tendency toward FPE in 2×2 Model

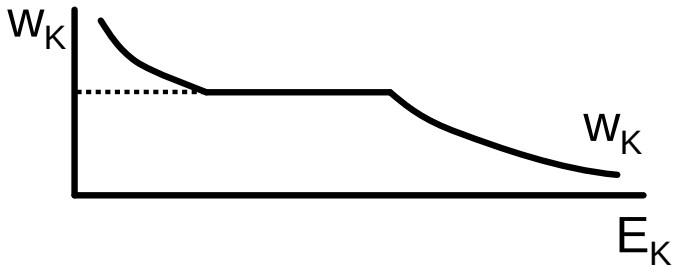
Minor Inconveniences of the 2×2 Model

- Transitions among equilibrium types are abrupt
  - I.e., variables vary continuously, but not smoothly (not continuously differentiable)
  - Example: Effects of factor endowments on trade:



Minor Inconveniences of the 2×2 Model

- Factor Price Insensitivity (Leamer and Levinsohn's variation on FPE)
  - Factor prices depend, perhaps strongly, on factor endowments up to the point of diversification, then not at all:



Minor Inconveniences of the 2×2 Model

- Hard to apply to real world data
  - What are the two sectors?
    - Exports and imports?
      - What if they change?
      - Gross or net?
    - Capital- and labor-intensive goods?
      - How do you draw the line?
      - Both are traded both ways
  - What are the two factors?
  - If two countries, second country doesn't match HO assumptions (e.g., factor mobility)
  - Doesn't allow for reality of intra-industry trade

Major Inadequacies in Higher Dimensions

- These minor problems in two dimensions may suggest simply extending the HO Model to more goods, factors, and countries.
  - G goods, F factors, C countries

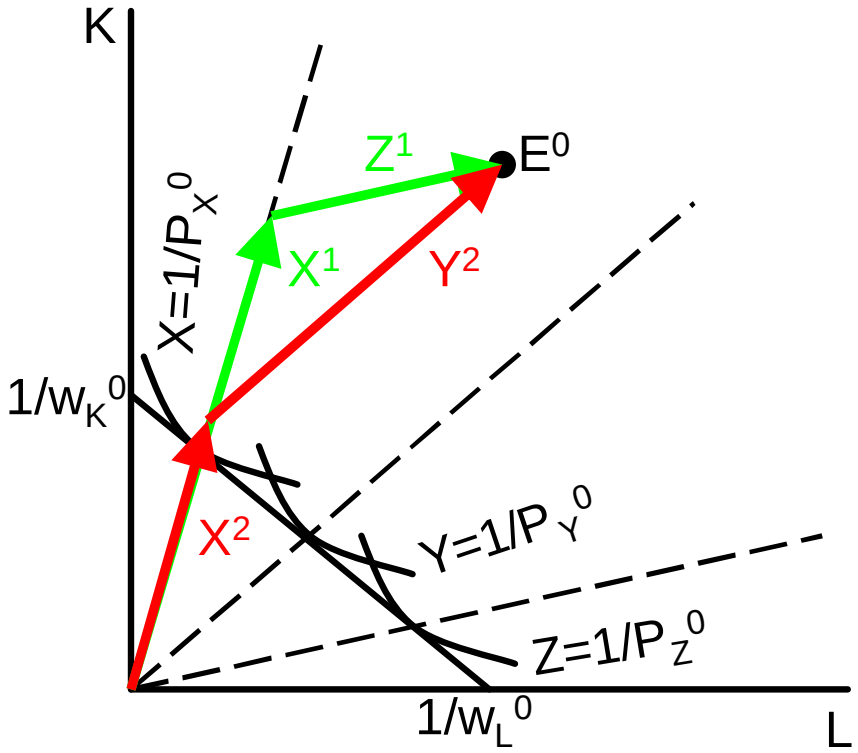
Major Inadequacies in Higher Dimensions

- Immediate problem:
  - G > F ? Production is indeterminate
  - G = F
    - Implausible
    - Not helpful (too many determinants of trade)
  - G < F
    - Specific factors model
    - Where did the specific factors come from?

Major Inadequacies in Higher Dimensions

- Production Indeterminacy
  - Enough to consider G=3, F=2
  - If prices align so that all three goods can be produced, then infinitely many possible production patterns are possible
  - Implies indeterminacy of trade also
  - World market equilibrium does not resolve this (see Melvin 1968)

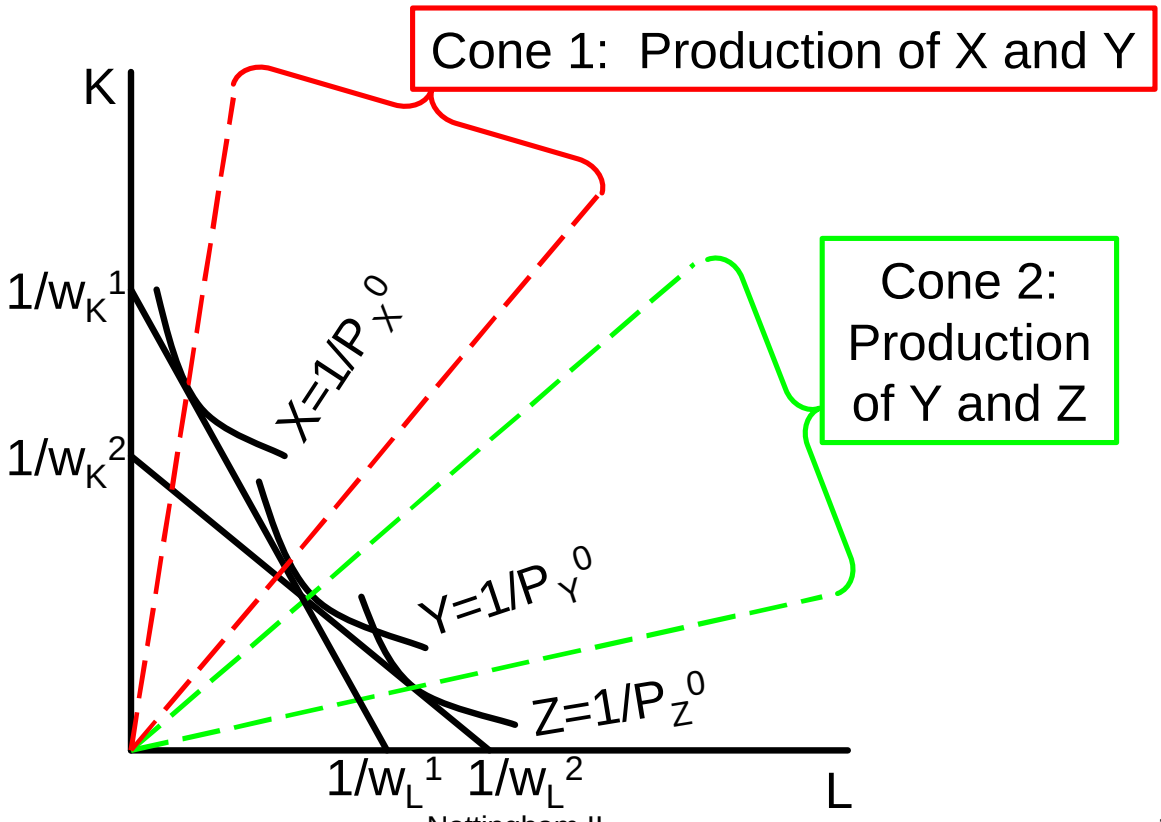
3-Good Lerner Diagram: Production Indeterminacy



Major Inadequacies in Higher Dimensions

- Production Indeterminacy
  - Alternative is prices that do not permit all three goods to be produced: Two-Cone HO Model

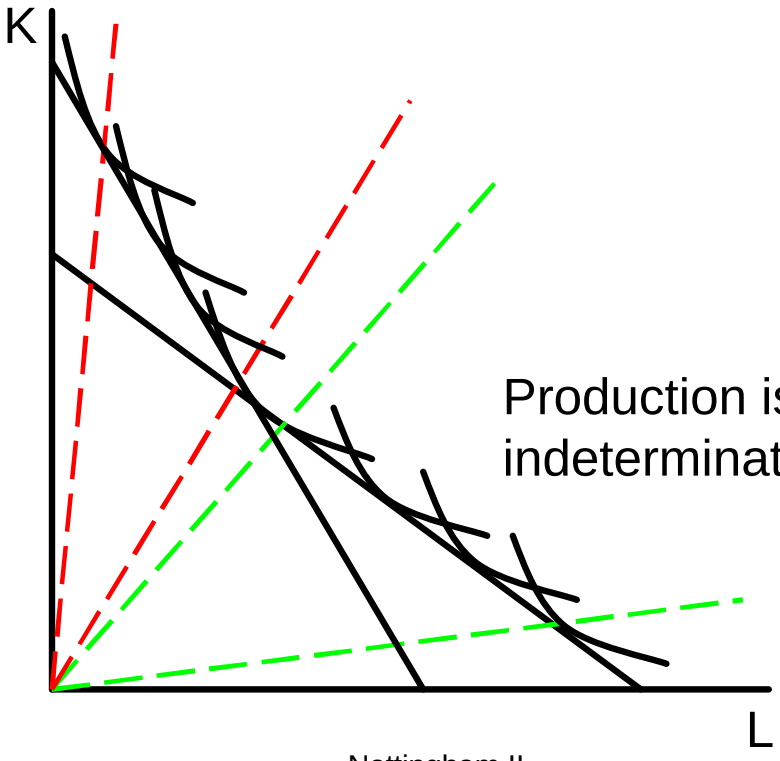
3-Good Lerner Diagram: Two-Cone Model



Major Inadequacies in Higher Dimensions

- Production Indeterminacy
  - Two-cone model is attractive in many ways,
    - but with G>>F, there will be multiple goods in each cone,
    - and indeterminacy persists within cones.

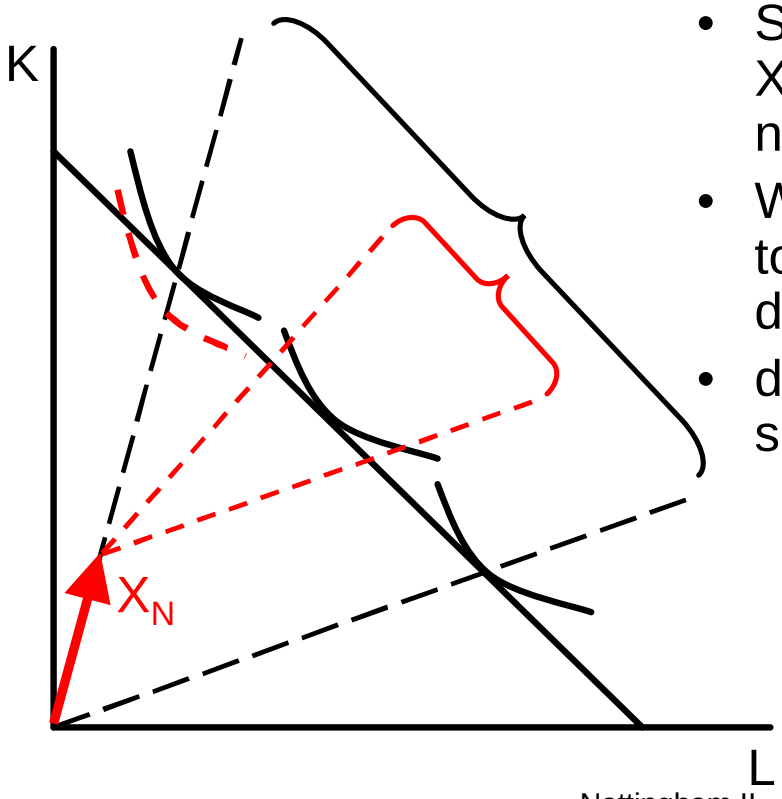
Many-Good Lerner Diagram: Two-Cone Model



Can Trade Costs Help?

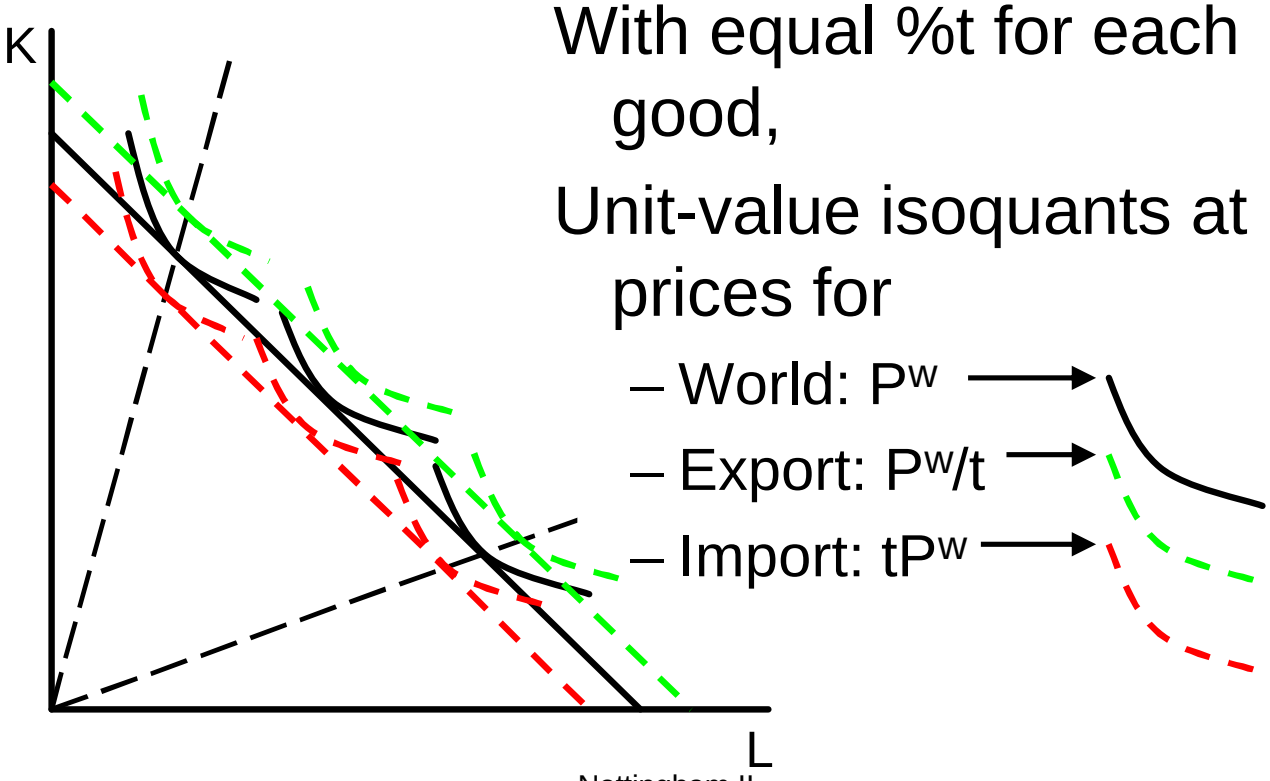
- Yes, but they create other problems
- Example 1: Suppose small country, A, trades with rest of world that has
  - More goods than factors
  - FPE
  - No trade costs
  - Then world prices align so that, without trade costs, production is indeterminate
  - Cases:
    1. Country A has small trade cost, t, on just one good
    2. Country A has equal % t on each good
    3. Country A has unequal % t on each good

Three-Good Lerner Diagram: FPE in Rest of World – Case 1.



- Small trade cost on good X causes it to become nontraded.
- With factors X_N then used to satisfy domestic demand,
- diversification cone shrinks

Three-Good Lerner Diagram: FPE in Rest of World – Case 2.

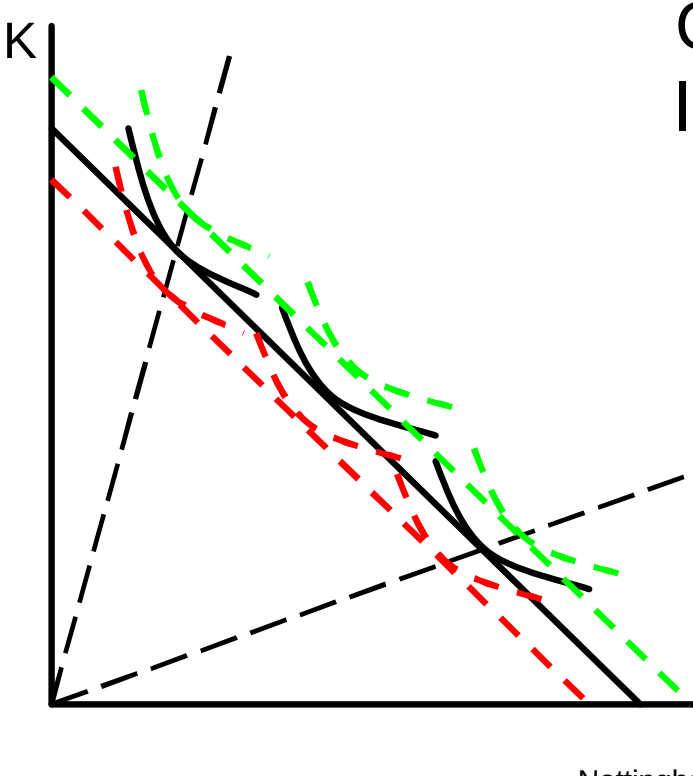


With equal %t for each good,

Unit-value isoquants at prices for

- World: P^w
- Export: P^w/t
- Import: tP^w

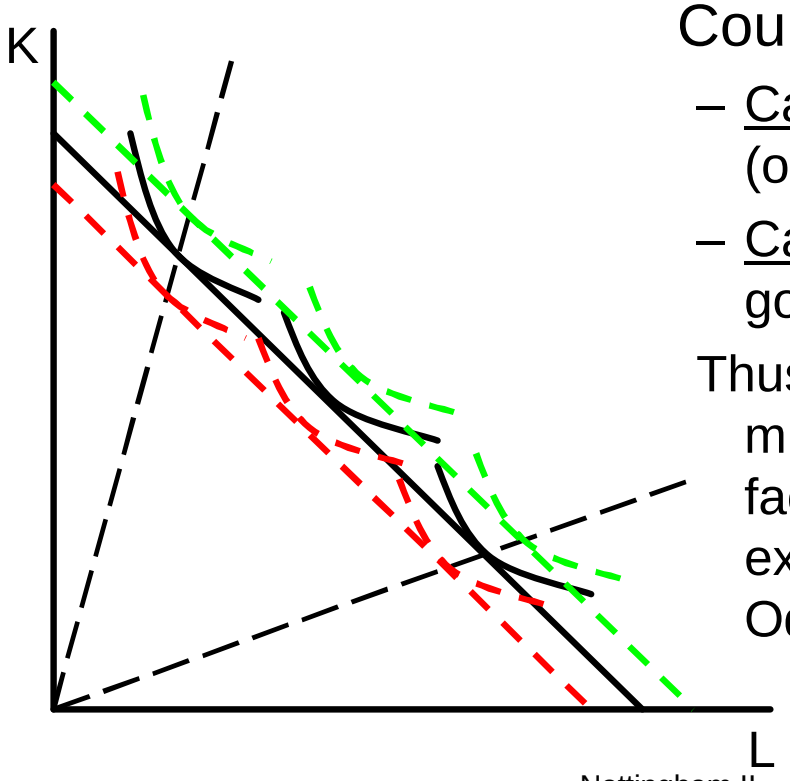
Three-Good Lerner Diagram: FPE in Rest of World – Case 2.



Country A's factor price line must

- Be tangent to green for any good it exports
- Lie inside (or be tangent to) red for any good it imports
- Lie between red and green for nontraded

Three-Good Lerner Diagram: FPE in Rest of World – Case 2.



Country A

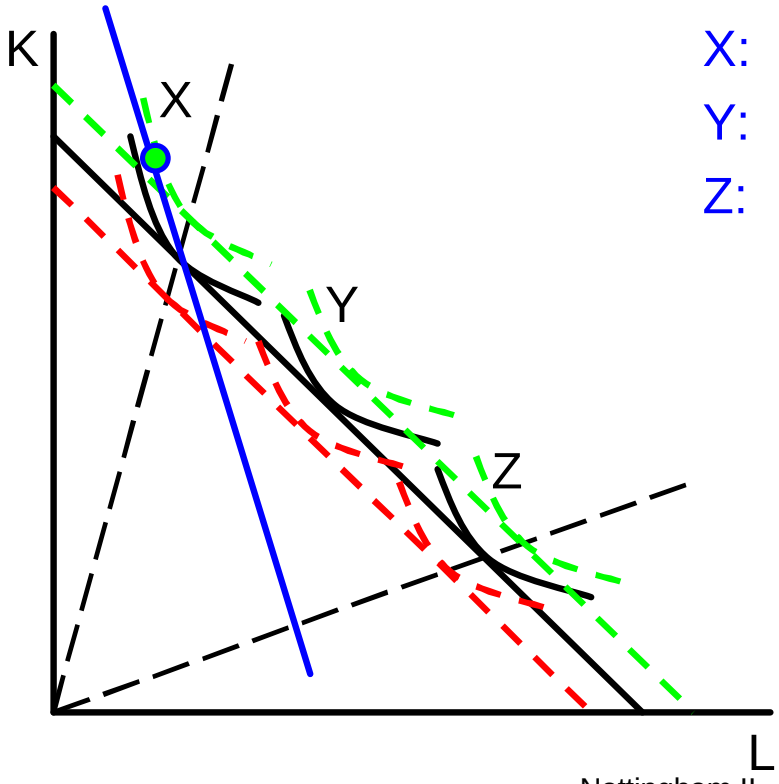
- Cannot export middle good (or goods, if there were more)
- Cannot export both extreme goods

Thus, even a country in the middle of the world's range of factor endowments must export from the extremes Odd!

The Source of Indeterminacy

- Production and trade indeterminacy requires
  - More goods than factors (G>F)
  - Also, a country's factor prices must be such that there are more goods than factors that it both
    - Produces, and
    - Trades
- In the example (Case 2.) that is not possible
- See the possible factor prices below

Three-Good Lerner Diagram: FPE in Rest of World – Case 2.

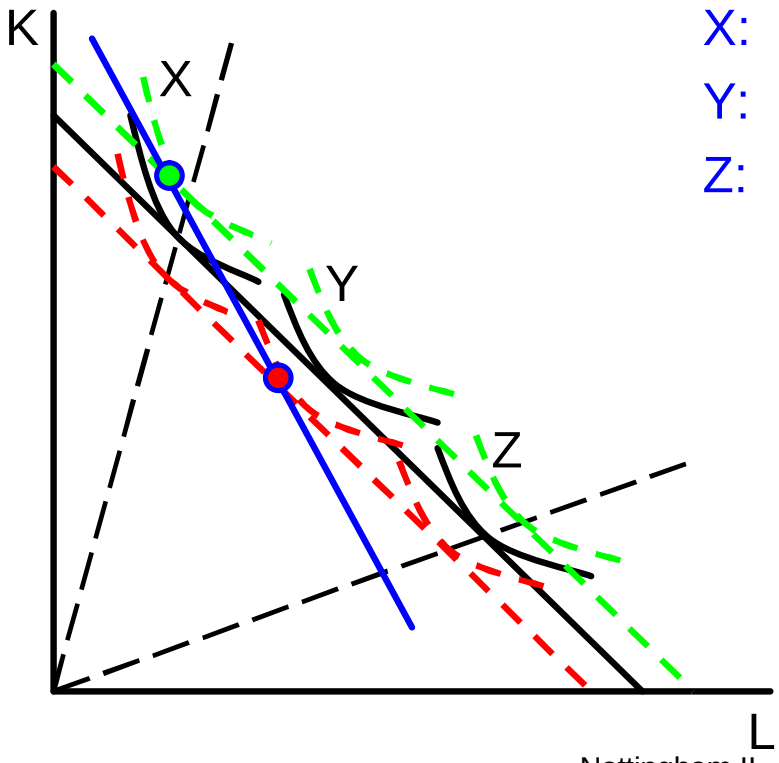


X: Exported

Y: Not produced (imported)

Z: Not produced (imported)

Three-Good Lerner Diagram: FPE in Rest of World – Case 2.

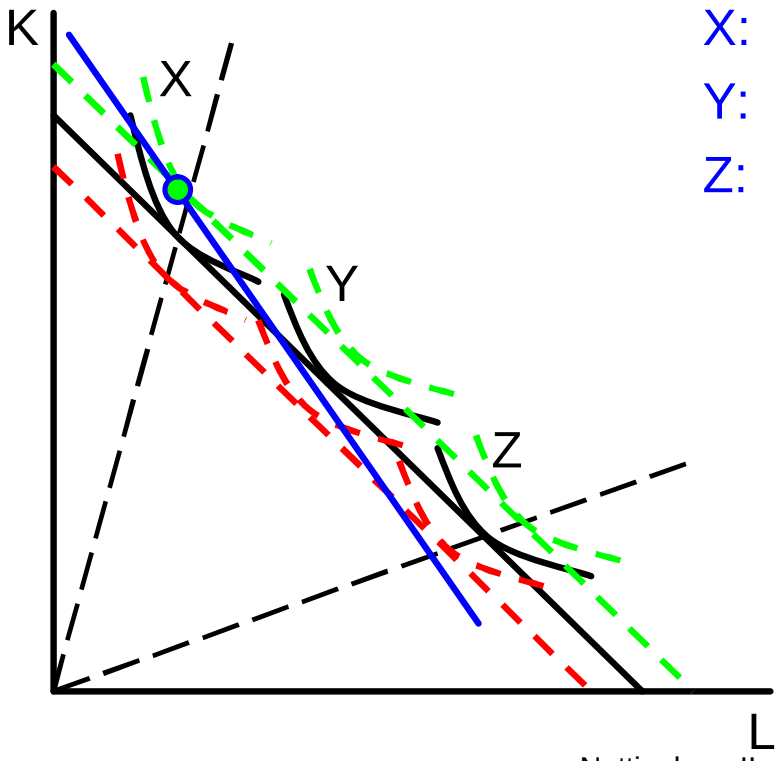


X: Exported

Y: Produced & imported

Z: Not produced (imported)

Three-Good Lerner Diagram: FPE in Rest of World – Case 2.

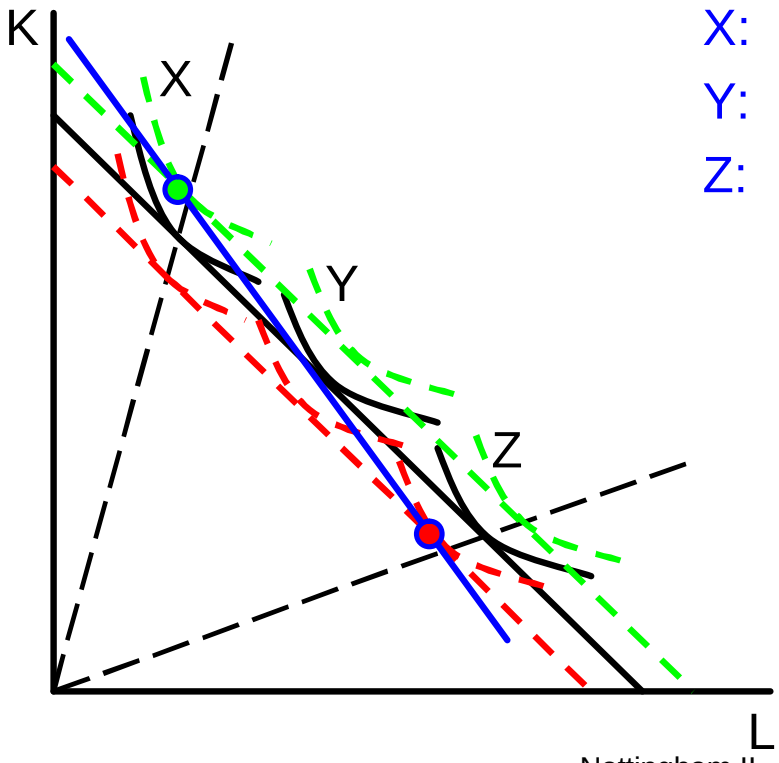


X: Exported

Y: Not traded

Z: Not produced (imported)

Three-Good Lerner Diagram: FPE in Rest of World – Case 2.

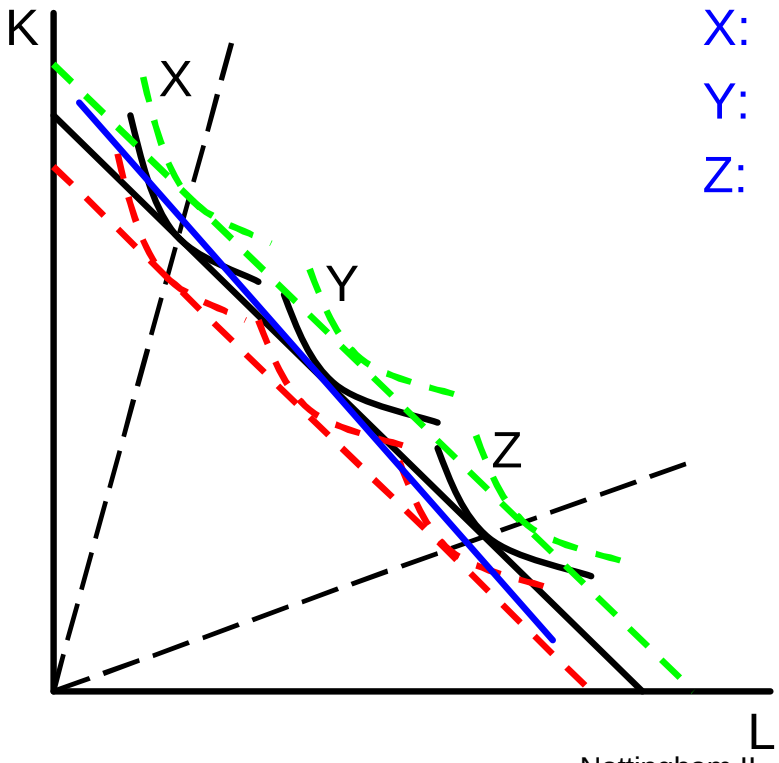


X: Exported

Y: Not traded

Z: Produced & imported

Three-Good Lerner Diagram: FPE in Rest of World – Case 2.



X: Not traded

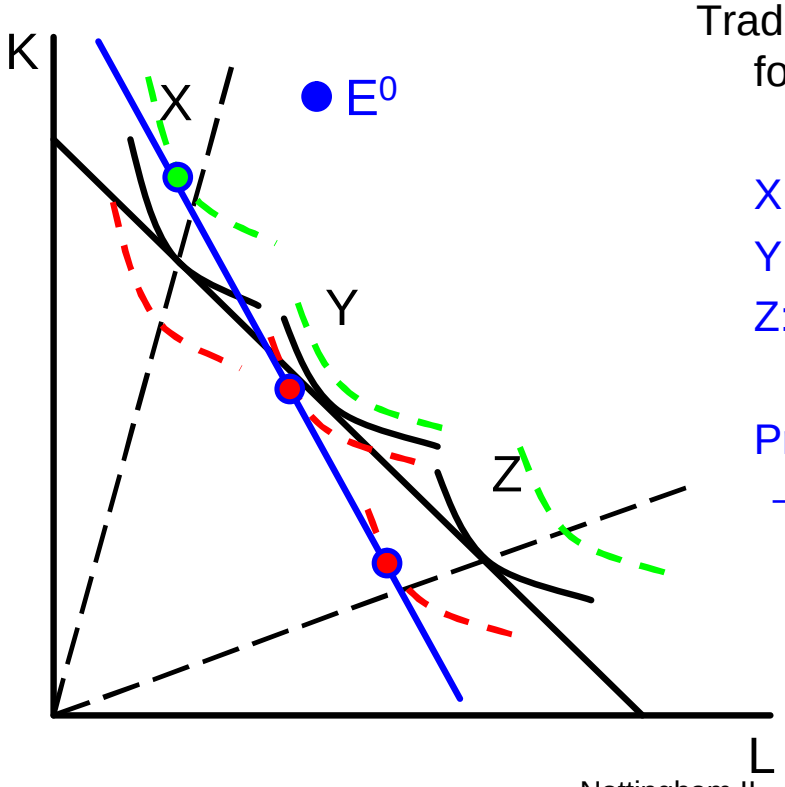
Y: Not traded

Z: Not traded

The Source of Indeterminacy

- Can indeterminacy arise with G>F and trade costs?
- Yes, but it requires trade costs and prices to align perfectly
  - This makes the indeterminacy itself “unlikely”
  - But it also implies that production and trade are “hypersensitive” to trade costs
- See Example, Case 3.

Three-Good Lerner Diagram: FPE in Rest of World – Case 3.



Trade cost is smaller for Y than for Z

X: Exported

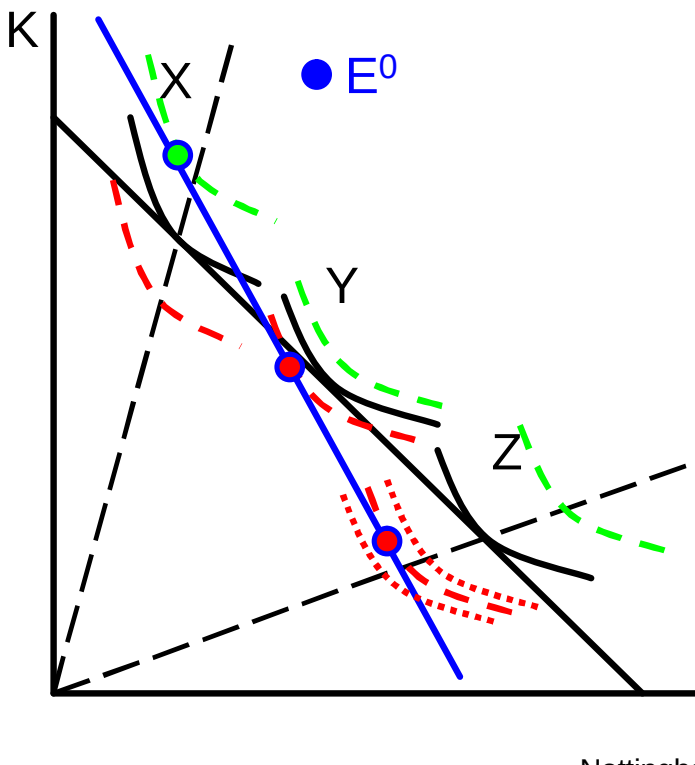
Y: Produced and imported

Z: Produced and Imported

Production is indeterminate:

– With endowment E^0, production of Y or Z can be zero

Three-Good Lerner Diagram: FPE in Rest of World – Case 3.



But <u>now</u>, a slight change in trade cost of any good can force output of either Y or Z to zero

Examples:

Rise in t_Z forces import of Z to zero

Fall in t_Z forces import of Y to zero

Hypersensitivity to Trade Costs

- This is just one example of how both production and trade in the HO model are very sensitive to trade costs:
  - Taking the model literally, an “epsilon” change in trade costs can cause positive trade and/or production to appear or disappear
  - Behavior is discontinuous in trade costs
  - I call this “hypersensitivity”

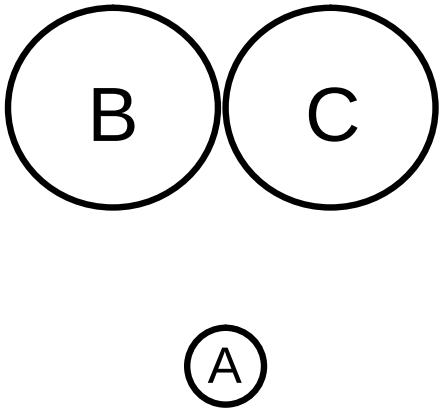
Hypersensitivity to Trade Costs

- Causes of hypersensitivity that I'm aware of
  - Indeterminacy with G > F
  - Product homogeneity: Nobody cares with whom they trade, except for trade costs

    See Example 2

Hypersensitivity to Trade Costs

- Example 2:
  - F=2, G=2, C=3
  - Country A is small compared to both B and C
  - B and C have zero trade costs between them
  - A has trade costs with both B and C,
  - but these may be different

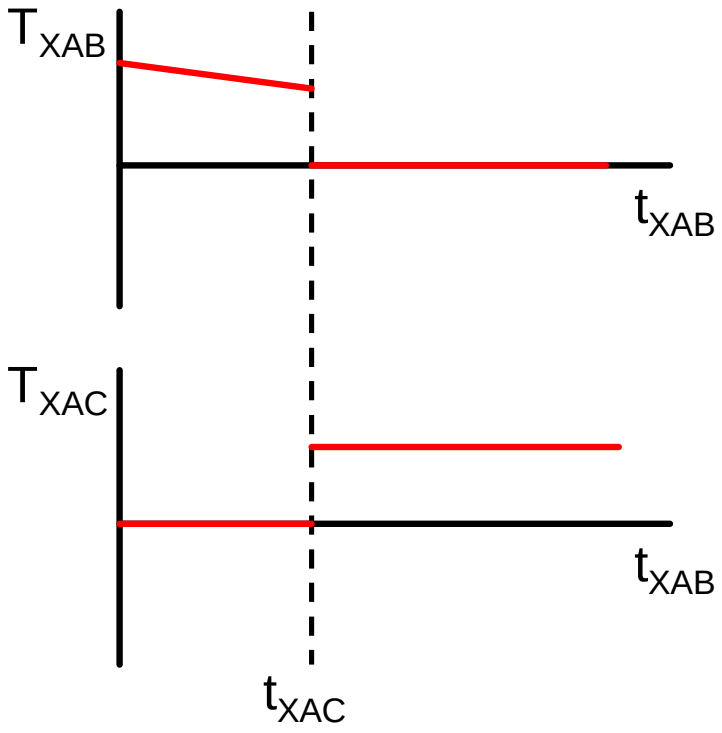


Hypersensitivity to Trade Costs

- Case 1:
  - B and C identical, thus same autarky prices
  - A is capital abundant compared to B and C, so A has comparative advantage in X
  - A will trade based on 2×2 HO model, exporting X and importing Y
  - With whom A trades depends on trade costs
- Let
  - T_{IJK} be net export of good I from country J to country K, and
  - t_{IJK} be iceberg transport cost for that trade flow

Effects of Increasing t_{XAB}, Case 1.

- A's trade flows with B and C both change discontinuously at $t_{XAB}=t_{XAC}$



Hypersensitivity to Trade Costs

- Case 2:
  - If B and C have different factor endowments, but still no trade cost between them, then
    - A's comparative advantage depends on its autarky price relative to B and C's free trade price
    - Again, who it trades with depends discontinuously on its bilateral trade costs
    - (But having these trade costs differ is a bit weird, given the zero trade cost between them)

Hypersensitivity to Trade Costs

- Case 3:
  - If B and C have different factor endowments, and trade costs between them, then
    - A's comparative advantage can depend on its factor endowments relative to just B or C, depending on which it is closest to ("Local Comparative Advantage")
    - Here the response of trade (that is, of what A trades as well as with whom) to trade costs does <u>not</u> seem to be hypersensitive

Specialization

- With multiple countries, HO Model with trade costs predicts relatively few bilateral trade flows
- This cannot be seen in the 2×2×2 model, where so few are possible
- As number of countries grows, number of possible bilateral trade flows grows with square of C. Maximum number of equilibrium trade flows (except with zero probability) grows only with C.

Specialization

- Argument
  - Suppose first that all factor prices and all trade costs are arbitrary (random)
  - Factor prices
    - Determine production costs in each country
    - And together with trade costs determine prices of exports to each other country
  - In equilibrium each country
    - Imports each good only from the one lowest cost other country (countries tie only with zero probability)
    - Or does not import a good at all, buying only from itself

Specialization

- Argument (cont.)
  - Maximum equilibrium trade flows would be one for each good and country, except for lowest-cost country which would not import
  - Let R be the number of good/country-pair "routes" along which trade will take place
  - With arbitrary factor prices R will be at most

$$R_1 = G(C- 1)$$

Specialization

- Argument (cont.)
  - But factor prices are not arbitrary: they adjust to achieve equilibrium
  - Suppose that they adjust,
    - Not to achieve equilibrium in factor markets,
    - But to achieve the largest number of possible equilibrium active trade routes
  - That would require equating export prices (production cost plus trade cost) of additional countries in destination countries
  - For each trade route that is not active with arbitrary factor prices, adjustment now seeks an equation of its export price with the price that is active

Specialization

- Argument (cont.)
  - There are only F factors and C countries, so only FC factor prices to achieve such equalities (one of which must be invariant as numeraire)
  - Thus number of additional trade routes that can be activated by adjusting factor prices (except by zero-probability coincidence) is FC- 1
  - Result is a new upper limit on the active trade routes:

$$R_2 = G(C - 1) + FC - 1$$

Specialization

- Argument (cont.)
  - In the HO Model factor prices adjust for a different purpose, but they can't achieve more active trade routes than this. Thus the number of active trade routes in the HO Model, R_{HO}, is

$$R_{HO} = R_2 = G(C - 1) + FC - 1$$

Specialization

- Argument (cont.)
  - The number of possible trade routes that exist includes every good between every pair of countries:

    $R_{MAX1} = GC(C- 1)$
  - Excluding cross-hauling, it is

    $R_{MAX2} = GC(C- 1)/2$
  - Excluding intra-industry trade (as the HO Model does), the number depends on how many countries export, and how many import, each good. If half do each for each good, this is

    $R_{MAX3} = GC^2/4$
  - Note that all of these rise with C^2

Specialization

- Argument (cont.)
  - Using the larger of these limits, the fraction of possible trade routes that will be active in the HO Model with positive trade costs is

$$\frac{R_{HO}}{R_{MAX}} ? \frac{G(C ? 1) ? FC ? 1}{GC(C ? 1)} ? \frac{1}{C} ? \frac{F ? (1/C)}{G(C ? 1)}$$

  - This clearly goes to zero as C rises, unless F rises as fast as GC
    - With, say, 1000 goods, 148 countries (the WTO), and even Leamer's 9 factors, this fraction is approximately 1/148=0.007 (less than 1%)

Specialization

- Argument (cont.)
  - The argument is really about how many sources of supply there will be, and thus could be redone to include domestic supply.
    - Obviously we can't predict that little will be supplied domestically, since high enough trade costs could lead to autarky
    - But the same kind of argument does suggest that the more that countries buy abroad, the less they will buy at home.

What Would a General Model Look Like

- Factors: f = 1,…,F
- Goods: g = 1,…,G
- Countries: c = 1,…,C
- S_{gc} = Supply of g by c
- D_{gc} = Demand for g by c
- $T_{gcc'}$ = Net export of g by c to c'
- $t_{gcc'}$ = (1+iceberg) trade cost for g from c to c'
- P_{gc} = Price of g in c
- w_{fc} = Price of f in c
- E_{fc} = Endowment of f in c

What Would a General Model Look Like

- The HO Model provides a structure for determining
  - For a small country, c: S_c, D_c, T_c, P_c, and w_c given E_c, t_c, and $P_{\sim c}$ (where ~c={c'?c})
  - For the world: S, D, T, P, and w given E and t
- My concerns are that this structure
  - Fails to determine all the variables uniquely and/or implies fractions of goods produced or trade routes utilized that are (unrealistically?) low
  - Has a solution that is hypersensitive to t (and perhaps also to E in the presence of t)

What Would a General Model Look Like

- Ideally, the HO model would yield solutions

$$S_{gc} \; ? \; S_{gc}(E_c, E_{\sim c}, t_c, t_{\sim c})$$

$$T_{gcc'} \; ? \; T_{gcc'}(E_c, E_{\sim c}, t_c, t_{\sim c})$$

$$w_{fcc'} \; ? \; w_{fcc'}(E_c, E_{\sim c}, t_c, t_{\sim c})$$

- that
  - are single valued
  - display the main theorems of the HO model in at least some weak form
  - vary continuously and perhaps smoothly with their arguments
  - have empirically plausible fractions of $S_{gc}>0$ and $T_{gcc'}>0$

What Would a General Model Look Like

- The examples I've examined here suggest that this will not be possible under standard HO assumptions, especially if G>F and C>2.