An Account of Global Factor Trade

by

Donald R. Davis

and

David E. Weinstein

Heckscher-Ohlin and HOV

• H-O theory is a pillar of international economics
• Deep intuition: goods serve as a vehicle to arbitrage factor price differences
• Relatively robust version: Heckscher-Ohlin-Vanek
• Prediction: A country’s net factor trade equals the difference between its endowment and the endowment typical in the world for a country that size
Paradoxes and Mysteries

• Efforts to verify this simple intuition on international data have ended disastrously
  – Leontief (1953): “paradox”
  – Gabaix (1997): “dominated by white noise”

• Time to give up?

Strategy in Recent Research

• Clear that the simple HOV framework fails
• Consider amendments to simple model
  – Technological differences
    • Hicks-neutral
    • Factor augmenting
    • Etc.
  – Absorption
    • Home bias in demand
Difficulties

• Key amendments concern
  – Technological differences
  – Absorption
• Yet typically data contains
  – One observation on technology (US)
  – No observations on absorption
• Hence statistical selection of preferred model leaves structural relation unclear

New Strategy

• Examine hypotheses directly on the relevant data
  – Technology matrices
  – Measured absorption
• Having selected the best models of technological differences and absorption
  – Impose these on HOV equations to see if they account for factor trade
What Find

- Consider a few simple and plausible amendments
- Confirm them directly on the relevant data
- When implement these in HOV equations
  - Countries export abundant factors
  - In approximately the right magnitude
- HOV works

Theory (1)

- Technology/production
  - Identical technologies, equal to US (P1)
  - Identical technologies, equal to “average” technology (P2)
  - Hicks-neutral technical differences (P3)
  - Dornbusch-Fischer-Samuelson, approximate FPE & specialization in tradables (P4)
  - Helpman no-FPE
Theory (continued)

• Absorption
  – Preferred production model features specialization in tradables
  – Rationalizes use of gravity model of import demand
  – Accounts for costs of trade, a crucial feature of the real world

Data Sources

• 10 OECD countries (those in IO database): Australia, Canada, Denmark, France, Germany, Italy, Japan, Netherlands, United Kingdom, United States
  – OECD input-output database (production, demand and trade)
  – OECD STAN (capital and labor for manufacturing)
  – International sectoral database (capital and labor for non-manufacturing)
  – 34 sectors total
Data Sources (Continued)

- 20 other countries (those reporting gross output or value added): rest of world (ROW)
  - Capital From Summers and Heston
  - Labor from ILO
  - Gross output From *UN Industrial Statistics Yearbook*
- Bilateral trade flows from Feenstra, Lipsey and Bowen (1997)

Data Issues

- First use of relevant data on technology and absorption to test hypotheses underlying HOV
- OECD data highly consistent, matched
- Construction of technology matrices internally consistent
- Quality of data on ROW consistent with prior work
Choice of Factors

• Previous studies have had many factors; have only capital and aggregate labor here
• Cannot separate high-skilled from low-skilled workers
  – Not available by sector for sample

Does Choice of Factors Bias Results?

• Omit land and mineral factors, which worked best in prior studies
• Factors included exhibit standard pathologies from prior tests
• In later tests, conversion to efficiency units may provide some remedy
Technology Data

• Basis for estimation is set of total factor input matrices constructed for 10 OECD countries
  – Capital derived from GFCF by sector and perpetual inventory method
  – Labor
    • Manufacturing: STAN “number engaged”
    • Non-manufacturing: ISDB “total employment”
  – Input-output matrix from OECD IO

Estimating Technology

• (P1) US matrix
• (P2) “average matrix”
  – $\ln B_{fi}^c = \beta_{fi}^c + \epsilon_{fi}^c$
• (P3) Hicks-neutral technical differences
  – $\ln B_{fi}^c = \theta^c + \beta_{fi}^c + \epsilon_{fi}^c$
  – $\exp(\theta^c) = \lambda^c$
• Results plausible
  – Measured precisely, US most productive
  – Range of productivities for 10 in 1985 is a factor of two
Estimating Technology (continued)

• (P4) Continuum DFS model with H-N Technology Differences and FPE
  \[ \ln B_{fi}^c = \theta^c + \beta_{fi} + \gamma_{fi} \ln(K_c/L_c) + \phi_{fi}^c \]
  – Normalization: \( \Sigma_{fi} \gamma_{fi} = 0 \) so country’s K/L does not affect productivity level
  – Standard H-O model predicts \( \gamma_{fi} = 0 \)
  – Actual elasticity in tradables: 0.8

Estimating Technology (continued)

• (P5) Helpman (1998) No-FPE model
  – Under (P4), input ratios in traded vary with country abundance, but not in non-traded
  – Under (P5) they vary in both
    • In tradables due to specialization
    • In non-tradables due to factor substitution
  – Data show elasticity of 0.9 in non-tradables
Which Model of Technology Is Best?

• The tests are nested, so (P5) selected due to statistical and economic significance of
  – Hicks-neutral technical differences
  – Dependence of industry input ratios on country capital abundance in both tradables and nontradables
• Use Schwartz criterion to select among all
• (P5) the preferred model

Caution

• Data on technology for 10 OECD, but NOT for ROW
• Potentially Problematic
  – Projecting to a ROW that is much less capital abundant, different policy setting, etc.
    • UK (lowest K/L) is 2.5 times more K-abundant than ROW
• Potentially Important
  – ROW is largest net trader for each factor
• May need to consider alternatives with ROW
Estimating the Gravity Model

- Gravity model justified by
  - Identical homothetic preferences
  - Specialization in tradables (P5)
  - Fact that trade costs limit integration

- Standard form for bilateral imports
  \[ \ln M_{i}^{cc'} = \alpha_{0i} + \alpha_{1i} \ln(s_i^{Tc} X_i^{c'}) + \delta_i \ln(d^{cc'}) + \ln \zeta_{i}^{cc'} \]

- As many gravity regressions have shown, frictionless model is rejected

Taking Stock

- True statistical work is done
- Preferred model features
  - Hicks-neutral technical differences
  - No FPE
  - Specialization in tradables
  - Gravity absorption model
- But will it reconcile predicted and measured net factor trade?
  - Must move to measures of HOV model fit
Implementing the HOV Model:
Measures of Model Fit

- Production tests
  - Production slope test: MFCP = PFCP
  - Median error test
- Trade tests
  - Trade slope test: MFCT = PFCT
  - Sign test: \( \text{sign}(MFCT) = \text{sign}(PFCT) \)
  - Variance ratio test: \( \frac{\text{var}(MFCT)}{\text{var}(PFCT)} = 1? \)

Plots and Regressions

- Production
  - Plots (P1) to (P5)
  - Regressions for all Factors
- Trade
  - Plots (T1) to (T7)
  - Regressions for all factors
Conclusions

• Implement a new approach
  – Examine key hypotheses on relevant data on technology and absorption
  – Allows us to have confidence we have identified the structural economic parameters of interest

• Striking confirmation of amended HOV
  – Countries export abundant factors
  – They do so in the right order of magnitude

• In short: HOV works