

14.581: International Trade
— Lecture 20—
Trade and Growth (Empirics I)

Plan for Today's Lecture

- Brief introduction.
- Neoclassical growth models in open economies:
 - How large are the terms-of-trade effects that come with growth?
 - Does trade liberalization promote income convergence (as FPE theorem would suggest)?
 - Structural Transformation in open economies.
- Does technology embodied in physical goods (intermediate inputs or capital equipment) lead to important international technology transfer?
- Concluding remarks

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Introduction: Trade and Growth Empirics

- Motivation:
 - Obviously growth is important so understanding whether there is anything that countries can do to promote it (eg trade policy) is clearly important.
 - Also, studies like Feyrer (2009a/b) suggest that the empirical gains from trade/openness are quite a bit larger than those predicted in any static model of trade. Perhaps 'dynamic effects' of openness (ie where openness changes technology/endowments) can have a bearing on this puzzle.
- This is also a field that should be ripe for empirical work:
 - Theory is fundamentally ambiguous about how openness affects growth rates.
 - Additionally, theories often postulate concepts like 'technological spillovers' with some parameter governing the extent to which these spillovers can occur. It is up to empirical work to measure those (extremely important) parameters.

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Acemoglu and Ventura (2002)

- In previous lecture you saw the theory part of this paper.
- Recall the key insights:
 - AK model: in autarky countries would grow at different rates.
 - Add simple (Armington with no trade costs) trade model: countries grow at the same rate.
 - Why? As a country accumulates K and produces more of its good, it floods the world market with this good. This depresses the price of its export good, and hence its terms of trade. Lower terms of trade harms the country's GDP (ie the return on its K). Lower return means less incentive to accumulate.
- Here we briefly cover the empirical side of AV (2002).
 - The punchline is that the forces for convergence created by TOT appear to be large—too large in fact.

AV (2002): Question 1: Are growth rates similar around the world?

Yes (for growth over relatively long time gaps).

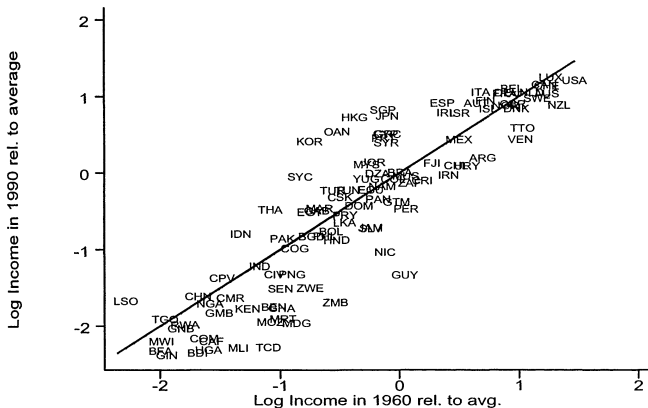


FIGURE I

Log of Income per Worker in 1990 and 1960 Relative to World Average from the Summers and Heston [1991] Data Set

The thick line is the 45 degree line.

AV (2002): Question 2: Do Terms of Trade Move Enough?

- Recall that country i 's income level (y_i) is:

$$y_i = \mu_i p_i^{1-\sigma} Y \quad (1)$$

- μ_i = index of country i 's technology level.
 - Y = world GDP level ($Y = \sum_i y_i$).
 - σ = elasticity of substitution across varieties ($\sigma > 1$).
- Taking logs this implies that TOT evolve over time (growth of TOT $\equiv \pi_{it}$) as:

$$\pi_{it} = -\frac{g_{it} - g_t}{\sigma - 1} - \Delta \ln \mu_{it} \quad (2)$$

- g_{it} = growth rate of country i 's income.
- g_t = growth rate of world income.
- Recall that price of Y is taken as the numeraire.

AV (2002): Question 2: Do Terms of Trade Move Enough?

$$\pi_{it} = -\frac{g_{it} - g_t}{\sigma - 1} - \Delta \ln \mu_{it} \quad (3)$$

- AV (2002) want to take this equation to the data (and estimate the coefficient on g_{it}).
- One challenge is that $\Delta \ln \mu_{it}$ (the country-specific technology shock) is not directly observable and that g_{it} is of course endogenous to technology growth.
- Indeed, if you look at this as a scatter plot (of π_{it} against g_{it}) the results are not encouraging at all (Figure II).

AV (2002): Question 2: Do Terms of Trade Move Enough?

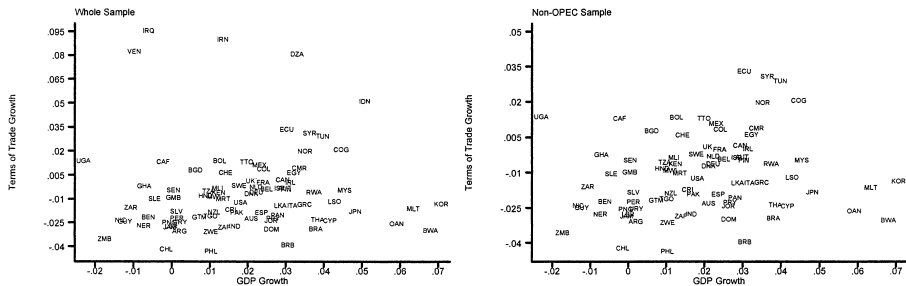


FIGURE II
Changes in Terms of Trade 1965–1985 versus GDP Growth 1965–1985

AV (2002): Question 2: Do Terms of Trade Move Enough?

$$\pi_{it} = -\frac{g_{it} - g_t}{\sigma - 1} - \Delta \ln \mu_{it} \quad (4)$$

- But the model suggests an IV: conditional convergence (if the country is out of steady-state):

$$g_{it} = -\beta \ln y_{i,t-1} + \theta Z_{it} + u_{it} \quad (5)$$

- Here β is the (conditional) convergence coefficient.
- And Z_{it} is a vector of variables that characterize where a country's steady-state level is.
- AV (2002) use $\ln y_{t-1}$ as the excluded IV (and of course also include Z_t in both the first and second stages).

AV (2002): Question 2: Do Terms of Trade Move Enough?

Once AV instrument for g_t the results are more encouraging

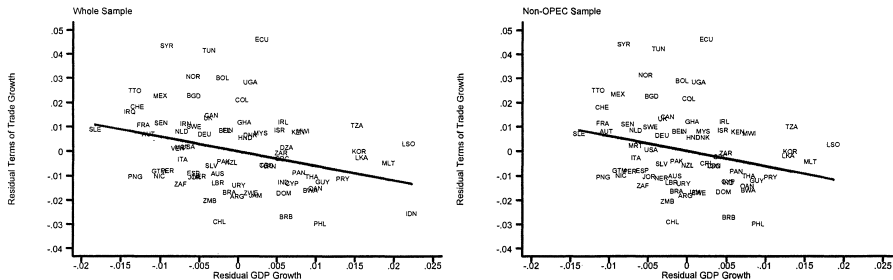


FIGURE III

The Instrumental-Variables Relationship between Changes in Terms of Trade 1965–1985 and GDP Growth 1965–1985
(Instrumented by log GDP 1965)

AV (2002): Question 2: Do Terms of Trade Move Enough?

TABLE I
IV REGRESSIONS OF GROWTH RATE OF TERMS OF TRADE

| | Main regression (1) | Detailing schooling (2) | Adding political indicat (3) | Adding change in Sch (4) | Adding change in Sch (5) | Nonoil sample (6) |
|--|------------------------|----------------------------|---------------------------------|-----------------------------|-----------------------------|----------------------|
| <i>Panel A: Two-stage least squares</i> | | | | | | |
| GDP Growth 1965–1985 | -0.595 (0.265) | -0.578 (0.261) | -0.458 (0.221) | -0.561 (0.248) | -0.455 (0.187) | -0.620 (0.354) |
| Years of schooling 1965 | -0.001 (0.002) | | -0.002 (0.002) | -0.000 (0.002) | | -0.001 (0.002) |
| Years of primary schooling 1965 | | -0.002 (0.003) | | | | |
| Years of secondary schooling 1965 | | -0.002 (0.006) | | | | |
| Years of higher schooling 1965 | | 0.019 (0.034) | | | | |
| Log of life expectancy 1965 | 0.043 (0.024) | 0.045 (0.024) | 0.034 (0.021) | 0.020 (0.027) | | 0.046 (0.030) |
| OPEC dummy | 0.091 (0.009) | 0.090 (0.009) | 0.092 (0.009) | 0.086 (0.010) | 0.087 (0.009) | |
| War dummy | | | -0.013 (0.005) | | | |
| Political instability | | | 0.007 (0.023) | | | |
| Log black market premium | | | -0.005 (0.012) | | | |
| Change in years of schooling 1965–1985 | | | | 0.008 (0.004) | 0.009 (0.003) | |
| Change in log of life expectancy 1965–1985 | | | | -0.000 (0.078) | -0.042 (0.045) | |
| <i>Panel B: First-stage for GDP growth</i> | | | | | | |
| Log of GDP 1965 | -0.019 (0.004) | -0.020 (0.004) | -0.024 (0.004) | -0.020 (0.004) | -0.020 (0.004) | -0.016 (0.004) |
| R ² | 0.35 | 0.36 | 0.54 | 0.47 | 0.47 | 0.34 |
| <i>Panel C: Ordinary least squares</i> | | | | | | |
| GDP Growth 1965–1985 | 0.037 (0.106) | 0.037 (0.107) | 0.038 (0.107) | 0.041 (0.112) | -0.005 (0.103) | 0.116 (0.114) |
| N. of obs | 79 | 79 | 70 | 79 | 79 | 74 |

AV (2002): Question 3: Are the Results Sensible?

- Effect of growth on TOT:
 - Coefficient (from 2SLS) in column 1 is -0.6. Structural interpretation of regression says that this is $-\frac{1}{\sigma-1}$, or $\sigma=2.6$.
 - This is reasonable compared to outside estimates of the Armington elasticity.
- Convergence coefficient near steady-state:
 - In the model, this is $\beta = \frac{\tau(\rho+g^*)}{\sigma}$, where τ is the share of tradables in GDP (eg, generously, around 0.3) and g^* is the steady-state world growth rate (in lecture 3 we had set τ to 1).
 - All of this implies $\beta = 0.011$, which is smaller than the $\beta = 0.02$ that Barro (1991) finds.
 - But we are not allowing for any other source of diminishing returns, or for any technological catch-up.
- The steady-state level of each country's GDP:
 - In the model, this is $y^* = \mu\phi^{(\sigma-1)/\tau} \left(\frac{s}{g^*}\right)^{(\sigma-1)/\tau}$.
 - Mankiw, Romer and Weil (QJE 1992) estimate this (in logs) and find a coefficient on $(\log) s$ of around 2.
 - With $\sigma = 2.6$ and $\tau = 0.3$, the coefficient on s is too high.

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- Ben-David (1993) asks whether we see faster convergence among countries that trade more.
- He focuses on countries within free trade areas (FTAs) to proxy for 'countries that trade more'.
 - Paper starts with the European Economic Community (EEC).
 - And then moves on to wider FTAs (EFTA and Canada-USA).

Ben-David (1993): Intra-EEC Convergence

The drop in intra-EEC tariffs and NTBs

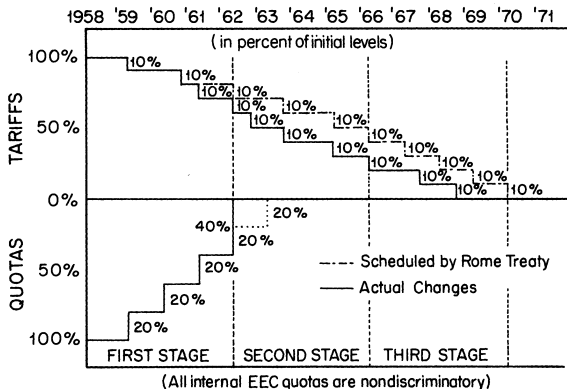


FIGURE II

Reduction of Internal EEC Trade Barriers

This graph was first used by Jensen and Walter [1965]. It was slightly altered here to include information from Bourdot [1988]. The first tariff reduction was 10 percent on *all* goods. The remaining reductions were 10 percent *on average*, and as little as 5 percent on any *one* good. Quotas were increased in steps of 20 percent *on average*, with a minimum of 10 percent on any *one* good.

Ben-David (1993): Intra-EEC Convergence

Tariff change did affect trade flows

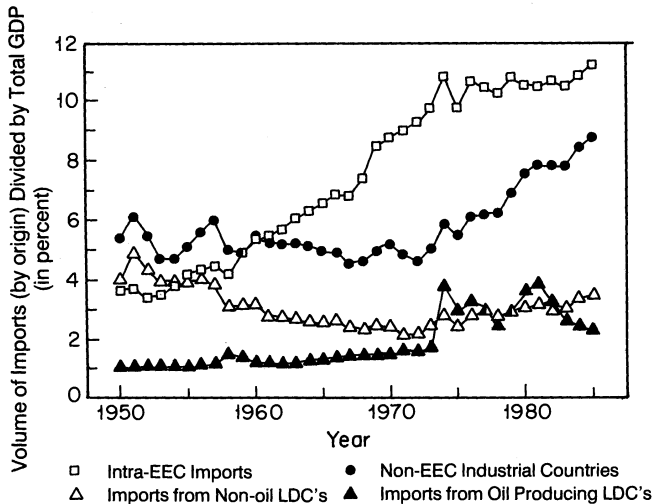


FIGURE IV
Origin of Imports, as a Percent of GDP

Ben-David (1993): Intra-EEC Convergence

Dramatic reduction in intra-EEC income disparities. But was this phenomenon already underway prior to WWII?

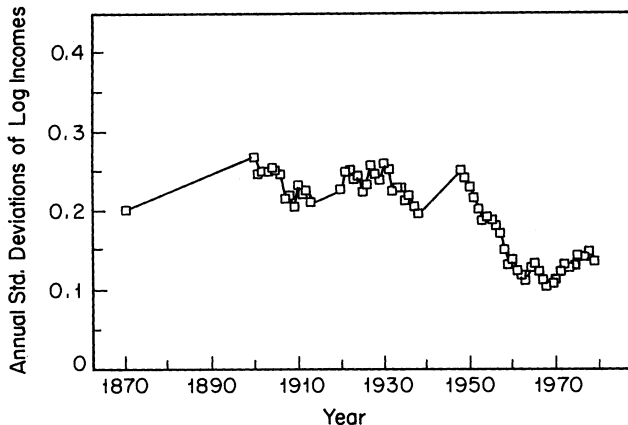


FIGURE VII

Per Capita Income Dispersion: Between Belgium, France, the Netherlands, and Italy, 1870-1979

Ben-David (1993): Intra-EEC Convergence

3 countries joined the EEC late. They converged too.

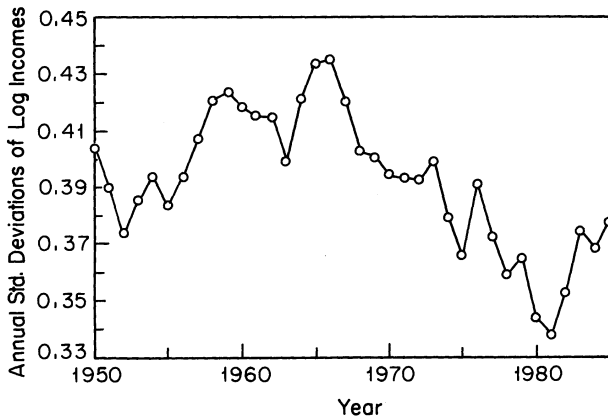


FIGURE VIII

Per Capita Income Dispersion: Between the United Kingdom, Denmark, and Ireland, 1950–1985

Ben-David (1993): Intra-EEC Convergence

Rest of world was diverging (unconditionally) at this time

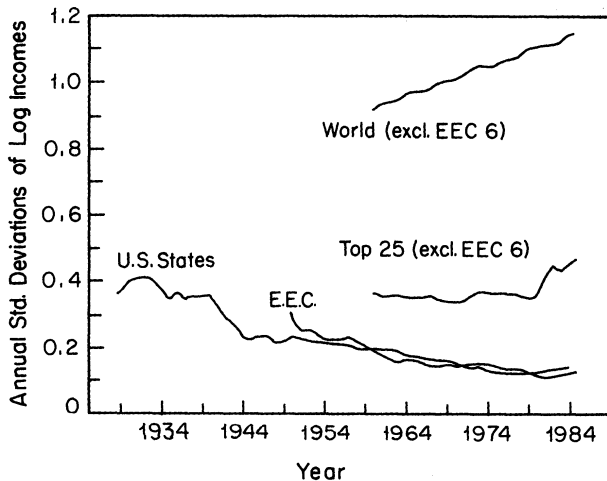


FIGURE IX
Comparison of Income Dispersions, 1929–1985

Ben-David (1993): Convergence within other FTAs

Kennedy Round (affected US-Canada), and EFTA (European countries not in EEC)

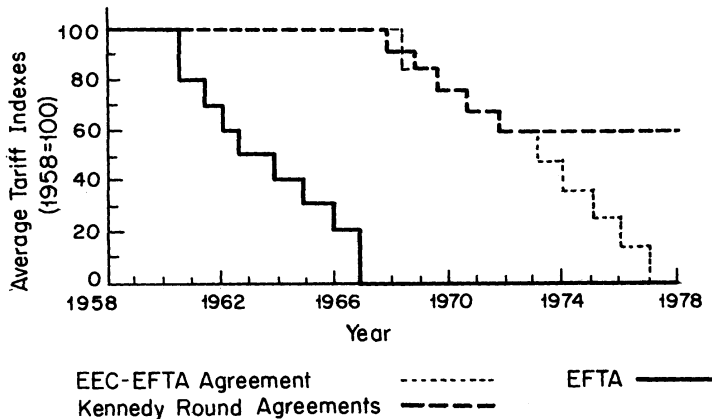


FIGURE XI
Tariff Elimination Schedules: 1958–1978

Ben-David (1993): Convergence within other FTAs

Convergence between US and Canada

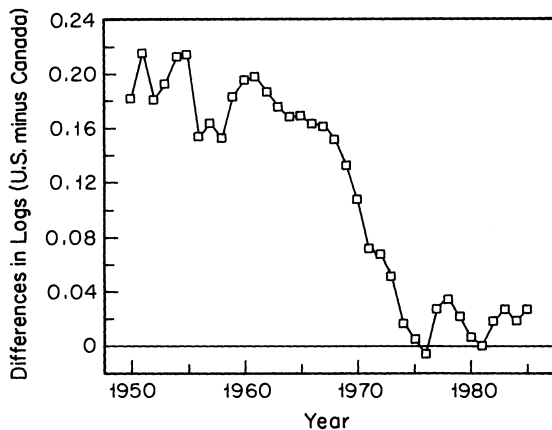


FIGURE XIII

Gap in Per Capita Incomes: Between the United States and Canada, 1950–1985

Ben-David (1993): Convergence within other FTAs

Convergence within EFTA 6

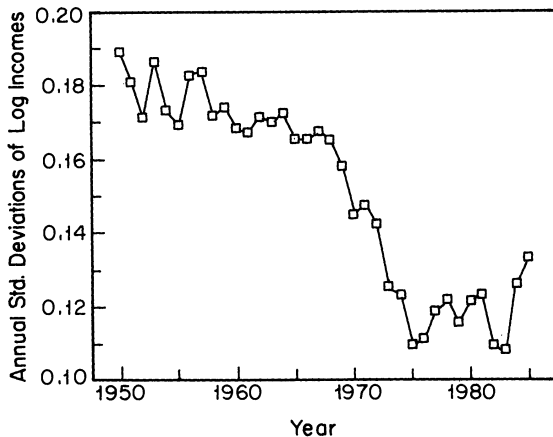


FIGURE XIV

Per Capita Income Dispersion Among EFTA 6: Switzerland, Sweden, Denmark, Norway, Finland, and the United Kingdom

Ben-David (1993)

- These are striking findings. But we need to remember some caveats:
 - ① Other aspects of economic policy were liberalized as well in this time period.
 - ② Mankiw, Romer and Weil (1992) find evidence for *conditional* convergence throughout the world, but not for unconditional convergence. Unfortunately, Ben-David (1993) presents plots (and regressions) related to unconditional convergence. There is a serious risk that FTA countries have similar Solovian fundamentals and all we are seeing is conditional convergence. (But the timing of the convergence is impressive, and a pure Solow story would require FTA members' fundamentals to become more similar as they sign up to the FTA.)

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Openness and the Structural Transformation

- The ‘structural transformation’ (shifts in sectoral output shares as GDP grows) has received a lot of recent attention.
 - Ngai and Pissarides (AER, 2007)
 - Acemoglu and Guerrieri (JPE, 2008)
 - Buera and Kaboski (2006, 2007).
 - And others—“Baumol’s curse” being the foundation.
- Most of this work (along with most of the work in the ‘growth’ literature) works with an autarkic country model and then takes it to the data.
 - This is probably misleading for thinking about growth (as, eg, Acemoglu and Ventura (2002) demonstrated).
 - But it might be even worse for thinking about inter-sectoral issues, because trade means that countries’ inter-sectoral allocations are interdependent. Matsuyama (JEEA, 2009) makes this point very nicely.
 - Uy, Yi and Zhang (JME, 2013) attempt to remedy this. See also Keohe, Ruhl and Steinberg (2015) and Cravino and Sotelo (2017)

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- New technology is often embodied in inputs that can (and do) move across countries.
- We review here a literature that has described this effect theoretically and empirically.
 - One theoretical distinction is whether the embodied technology comes in the form of intermediate inputs or capital.
 - Empirically, however, these are hard to distinguish (since they are often misclassified).

Eaton and Kortum (EER 2001): Capital Goods Trade

- EK (2001) start out by noting that for most countries (even most OECD countries), most equipment (ie a big part of capital) used is equipment imported from abroad.
 - This suggests that a key channel from trade to 'growth' is that if a country is to grow by capital accumulation it has to accumulate by purchasing capital from abroad.
 - So trade barriers will have a big effect here on GDP levels because it is durable inputs to production that are needed to be imported from abroad (not final goods or non-durable intermediate goods that make final goods).
- They develop an EK (2002)-style Ricardian model of capital production and capital trade in GE.
 - This allows them to use a gravity equation (in capital goods flows) to predict how costly it is to get equipment in every country in the world. They call this the "trade predicted price of equipment".
 - Using this 'trade predicted' price of equipment they ask how much of world Y/L variation can be accounted for by trade in equipment. The answer is nearly 25 %.

EK (2001): Most countries import equipment

Table 2
Trade in manufactures and equipment*

| No. | Country | Imports in absorption | | Imports from 'Big 7' | |
|-----|----------------|-----------------------|---------------|----------------------|---------------|
| | | Manufactures (%) | Equipment (%) | Manufactures (%) | Equipment (%) |
| 1 | Australia | 25.8 | 58.0 | 72.1 | 81.1 |
| 2 | Austria | 41.5 | 62.3 | 76.5 | 80.6 |
| 3 | Bangladesh | 50.8 | 80.9 | 36.6 | 49.0 |
| 4 | Canada | 31.7 | 62.6 | 88.8 | 91.9 |
| 5 | Denmark | 57.2 | 92.0 | 67.0 | 78.7 |
| 6 | Egypt | 33.7 | 64.6 | 59.7 | 79.7 |
| 7 | Finland | 28.0 | 57.2 | 69.4 | 78.1 |
| 8 | France | 25.3 | 40.3 | 60.4 | 75.0 |
| 9 | Germany | 26.1 | 34.1 | 49.3 | 62.5 |
| 10 | Greece | 35.4 | 67.7 | 66.4 | 76.0 |
| 11 | Hungary | 29.1 | 53.0 | 33.0 | 38.1 |
| 12 | India | 12.2 | 24.3 | 53.6 | 73.9 |
| 13 | Iran | 26.6 | 45.7 | 55.7 | 74.3 |
| 14 | Italy | 29.0 | 54.9 | 59.7 | 73.1 |
| 15 | Japan | 5.3 | 4.7 | 45.8 | 73.8 |
| 16 | Kenya | 18.7 | 60.0 | 66.1 | 74.4 |
| 17 | Korea | 23.1 | 47.9 | 80.0 | 90.0 |
| 18 | Malawi | 42.4 | 99.3 | 44.1 | 64.4 |
| 19 | Mauritius | 35.3 | 87.6 | 46.3 | 61.4 |
| 20 | Morocco | 32.8 | 66.0 | 67.3 | 82.0 |
| 21 | New Zealand | 30.3 | 57.1 | 66.7 | 75.1 |
| 22 | Nigeria | 29.1 | 73.0 | 66.1 | 72.7 |
| 23 | Norway | 41.5 | 49.9 | 67.0 | 77.4 |
| 24 | Pakistan | 33.3 | 66.4 | 64.6 | 74.4 |
| 25 | Philippines | 23.5 | 72.3 | 57.2 | 75.8 |
| 26 | Portugal | 31.1 | 74.1 | 64.0 | 76.8 |
| 27 | Spain | 16.4 | 46.0 | 74.4 | 84.1 |
| 28 | Sri Lanka | 48.9 | 94.0 | 48.4 | 72.6 |
| 29 | Sweden | 41.5 | 80.5 | 57.4 | 70.0 |
| 30 | Turkey | 22.4 | 53.2 | 64.9 | 75.1 |
| 31 | United Kingdom | 28.7 | 46.1 | 57.2 | 70.0 |
| 32 | United States | 11.9 | 16.6 | 44.4 | 58.8 |
| 33 | Yugoslavia | 15.6 | 31.4 | 55.5 | 63.8 |
| 34 | Zimbabwe | 18.8 | 64.7 | 54.7 | 72.2 |

EK (2001): Most countries import equipment

Table 3
Sources of equipment purchases*

| Importing country | Source of equipment purchases (% of absorption) | | | | | | | |
|-------------------|---|------|-------|---------|------|--------|-------|--------|
| | Home | US | Japan | Germany | UK | France | Italy | Sweden |
| Europe: | | | | | | | | |
| Austria | 37.7 | 3.2 | 3.6 | 33.0 | 2.7 | 2.4 | 3.9 | 1.5 |
| Denmark | 8.0 | 7.9 | 6.8 | 28.0 | 10.3 | 4.6 | 4.7 | 10.2 |
| Finland | 42.8 | 4.7 | 5.7 | 13.8 | 5.1 | 2.7 | 2.8 | 10.0 |
| France | 59.7 | 7.0 | 3.2 | 10.7 | 3.9 | — | 4.6 | 0.9 |
| Germany | 65.9 | 5.2 | 5.1 | — | 3.6 | 3.5 | 3.0 | 0.9 |
| Greece | 32.3 | 3.8 | 3.8 | 18.7 | 5.3 | 5.2 | 13.4 | 1.3 |
| Hungary | 47.0 | 1.6 | 2.1 | 10.9 | 1.4 | 1.6 | 1.6 | 1.1 |
| Italy | 45.1 | 6.6 | 3.7 | 16.6 | 5.6 | 6.2 | — | 1.4 |
| Norway | 50.1 | 6.1 | 3.7 | 9.9 | 6.1 | 2.0 | 2.3 | 8.5 |
| Portugal | 25.9 | 5.0 | 5.9 | 18.8 | 8.5 | 7.3 | 9.3 | 2.1 |
| Spain | 54.0 | 6.5 | 5.2 | 10.9 | 4.2 | 5.4 | 5.4 | 1.2 |
| Sweden | 19.5 | 10.3 | 8.0 | 20.7 | 9.4 | 4.7 | 3.3 | — |
| Turkey | 46.8 | 7.1 | 6.7 | 14.0 | 4.5 | 2.0 | 4.9 | 0.8 |
| UK | 53.9 | 11.0 | 5.3 | 8.5 | — | 3.4 | 2.8 | 1.3 |
| Yugoslavia | 68.6 | 2.9 | 0.6 | 8.2 | 1.6 | 1.5 | 4.0 | 1.2 |
| Pacific: | | | | | | | | |
| Australia | 42.0 | 15.9 | 16.3 | 5.5 | 4.5 | 1.2 | 2.1 | 1.5 |
| Canada | 37.4 | 45.7 | 5.8 | 2.1 | 1.8 | 0.8 | 0.7 | 0.6 |
| Japan | 95.3 | 2.7 | — | 0.4 | 0.2 | 0.1 | 0.1 | 0.1 |
| Korea | 52.1 | 12.9 | 23.9 | 2.5 | 1.0 | 1.5 | 0.4 | 0.8 |
| New Zealand | 42.9 | 11.6 | 15.6 | 4.8 | 6.7 | 1.5 | 1.7 | 1.0 |
| Philippines | 27.7 | 26.0 | 18.1 | 5.3 | 2.2 | 1.7 | 0.9 | 0.5 |
| US | 83.4 | — | 6.4 | 1.3 | 0.9 | 0.5 | 0.4 | 0.2 |
| South Asia: | | | | | | | | |
| Bangladesh | 19.1 | 5.7 | 14.9 | 6.6 | 6.7 | 4.0 | 1.6 | 0.3 |
| India | 75.7 | 3.7 | 4.0 | 4.5 | 2.9 | 1.9 | 0.8 | 0.3 |
| Iran | 54.3 | 0.9 | 7.2 | 13.4 | 4.9 | 0.9 | 5.6 | 1.1 |
| Pakistan | 33.6 | 11.5 | 12.2 | 9.7 | 8.5 | 2.5 | 3.9 | 1.2 |
| Sri Lanka | 6.0 | 8.9 | 27.8 | 10.0 | 12.9 | 3.9 | 2.5 | 2.2 |
| Africa: | | | | | | | | |
| Egypt | 35.4 | 10.0 | 8.0 | 10.7 | 5.3 | 6.3 | 10.2 | 0.9 |
| Kenya | 40.0 | 4.0 | 7.4 | 7.4 | 17.4 | 3.3 | 3.7 | 1.4 |
| Malawi | 0.7 | 8.0 | 5.6 | 7.0 | 26.9 | 8.7 | 6.3 | 1.3 |
| Mauritius | 12.4 | 1.2 | 12.0 | 5.3 | 8.4 | 23.3 | 3.2 | 0.3 |
| Morocco | 34.0 | 3.2 | 2.7 | 7.5 | 3.7 | 27.7 | 7.0 | 2.4 |
| Nigeria | 27.0 | 8.1 | 8.0 | 8.8 | 16.7 | 5.5 | 5.5 | 0.5 |
| Zimbabwe | 35.3 | 9.1 | 2.3 | 7.0 | 14.7 | 4.9 | 6.7 | 2.1 |

EK (2001) meets Hseih and Klenow (AER, 2007)

- HK (2007) cast doubt on the details of the EK (2001) mechanism.
- They argue that if EK (2001) were right, then the price of equipment would be much higher in poor countries.
 - EK (2001)'s Figure 6 plots just this: the *observed* price of equipment (from the International Comparison of Prices (ICP) project).
 - EK's reply would (presumably) be: We don't really believe this ICP data. Such data is very hard to collect (as it's hard to compare 'equipment' well). Our 'trade predicted' equipment price (which is derived from the choices that firms in poor countries make about whether to buy capital from home or from Germany) is what we believe.

EK (2001): ICP Equipment Price Data

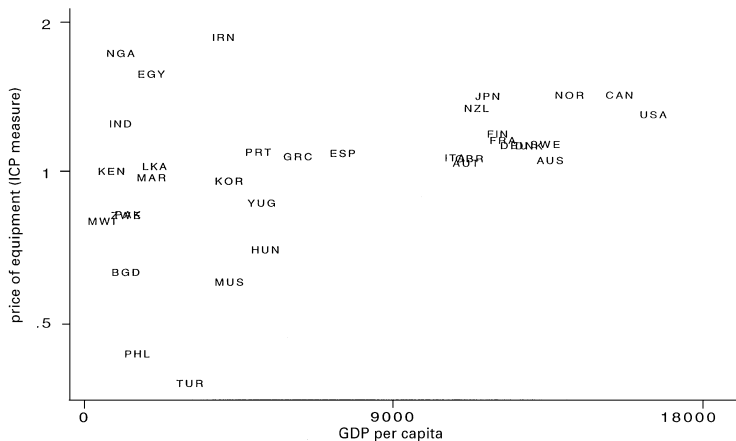


Fig. 6. Development and the price of equipment.

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Other Trade and Growth Channels

- Institutional Change:
 - Acemoglu, Johnson and Robinson (AER, 2005): Gains from “Atlantic Trade” around the industrial revolution are too big to be gains from trade. Likely that trade openness changed domestic institutions for the better.
 - Levchenko (ReStud 2007) formalized this notion.

Future Work

- Terms of trade and international growth:
 - Need better price data to measure these carefully.
 - How much do trade costs intervene in these relationships?
 - Same forces as in AV (2002) are at work intra-nationally—eg, across cities.
 - Could TOT effects be so severe as to give rise to “immiserizing growth”? (AV (2002) rule this out.)
- Openness and convergence:
 - Ben-David (1993) could be extended: diff-in-diff set up, conditional convergence.
 - Are the within-FTA convergence effects that Ben-David finds sensible in the context of H-O theory (ie they are the result of FPE).
 - Contrast convergence found by Ben-David with Krugman and Venables (QJE 1995) prediction that in IRTS settings, reducing trade costs can lead to divergence.