

MIT 14.76/760: Firms, Markets, Trade and Growth
Sp 2026, Lectures 14-15: Trade and Growth

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Trade and Growth

- Today we pivot and start exploring international dimensions of economic development.
- Voluminous public and academic debate about whether “globalization” (i.e. reduction of international trade barriers, both policy-related and not, in recent decades) has been good or bad for living standards in low-income countries.
- What do we expect to happen?

A Simple Model of Trade

- We will look at the model of Dornbush, Fischer and Samuelson (AER 1977)

A Simple Model of Trade

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- Setup:
 - 2 countries: Home and Foreign (asterisks denote variables related to the Foreign country)
 - 1 factor of production in each country—means that we call this a “Ricardian” model
 - Let L and L^* denote the endowments of labor in the 2 countries
 - And w and w^* denote the wages in the 2 countries, and let $\omega \equiv w/w^*$
 - Continuum of goods indexed by $z \in [0, 1]$
 - Constant returns to scale production
 - Perfect competition in product and factor markets

Production technologies

- We describe Home's technologies by $a(z)$: the number of units of labor required to produce one unit of good z
- Analogous object in Foreign is $a^*(z)$
- W.l.o.g, we order goods such that $A(z) \equiv \frac{a^*(z)}{a(z)}$ is decreasing
 - We then say that Home has a “comparative advantage” in the low- z goods
 - For simplicity, we'll assume strict monotonicity of $A(z)$

Who will produce what?

- Suppose these 2 countries can trade freely
- That means each good will have one common global price—denote it by $p(z)$ for good z
- Profit-maximization (by price-taking producers) requires

$$p(z) - wa(z) \leq 0, \text{ with equality if } z \text{ produced in Home} \quad (1)$$

$$p(z) - w^* a^*(z) \leq 0, \text{ with equality if } z \text{ produced in Foreign} \quad (2)$$

- **Proposition (specialization):** *There exists $\tilde{z} \in [0, 1]$ such that Home produces all goods $z < \tilde{z}$ and Foreign produces all goods $z > \tilde{z}$. Further, \tilde{z} is given implicitly by:*

$$A(\tilde{z}) = \omega \quad (3)$$

Why is this true?

- **Proof:** By contradiction. Suppose that there exists $z' < z$ such that z produced at Home and z' is produced abroad. (1) and (2) imply

$$p(z) - wa(z) = 0$$

$$p(z') - wa(z') \leq 0$$

$$p(z') - w^* a^*(z') = 0$$

$$p(z) - w^* a^*(z) \leq 0$$

This implies

$$wa(z) w^* a^*(z') = p(z) p(z') \leq wa(z') w^* a^*(z),$$

which can be rearranged as

$$a^*(z') / a(z') \leq a^*(z) / a(z)$$

This contradicts A strictly decreasing.

Interpretation

- Proposition simply states that Home will produce and export the goods in which it has a comparative advantage, but the “mass” of such goods (the size of \tilde{Z}) will depend on relative wages ω
- The above was true for any ω
- ... but to pin down ω we need to bring in the demand side of the economy

Demand side

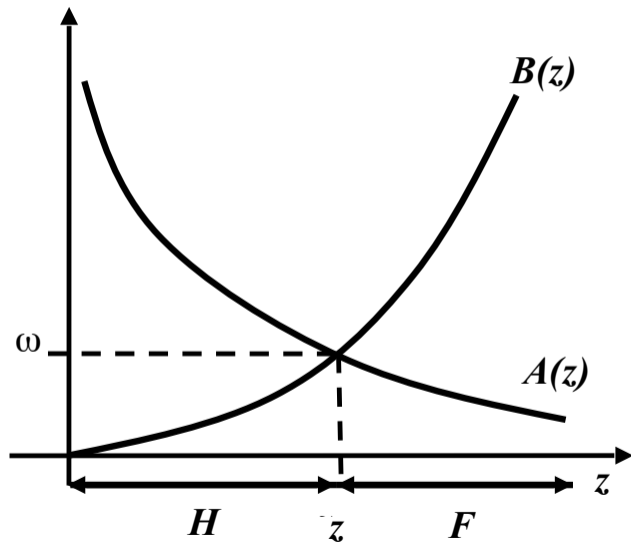
- We will gloss over details here
- But under very general conditions, can expect that demand side can be summarized by

$$\omega = B(\tilde{z}, L^*/L)$$

where $B(\cdot)$ is increasing in both arguments.

- Why?
 - Increasing in \tilde{z} : if Home were to be producing more and more of the world's products, this would bid up its relative wage (at any relative country sizes, L^*/L).
 - Increasing in L^*/L : for any value of \tilde{z} , an increase in relative country labor size has to decrease that country's relative wage

Putting things together



Does Home gain from free trade here?

- Yes!
- Say that Home's preferences over the goods are CES (for simplicity):

$$U = \left(\int_0^1 q(z)^{\frac{\sigma-1}{\sigma}} dz \right)^{\frac{\sigma}{\sigma-1}}$$

where $q(z)$ is the quantity consumed by Home consumer.

- One can work out the corresponding indirect utility function:

$$V(\mathbf{p}, w) = w \left(\int_0^1 p(z)^{1-\sigma} dz \right)^{\frac{1}{\sigma-1}}$$

- Recall that in any general equilibrium economy we can choose one good/factor to be the “numeraire”. Therefore let $w = 1$, wlog.

Does Home gain from free trade here?

- Under “autarky” (no trade), all goods produced in Home. So we know from (1) that $p(z) = wa(z) = a(z)$ for all z .
- Therefore

$$U^A = \left(\int_0^1 a(z)^{1-\sigma} dz \right)^{\frac{1}{\sigma-1}}$$

- Under free trade, we know from the Proposition that

$$U^T = \left(\int_0^{\tilde{z}} a(z)^{1-\sigma} dz + \omega^{\sigma-1} \int_{\tilde{z}}^1 a^*(z)^{1-\sigma} dz \right)^{\frac{1}{\sigma-1}}$$

- But from the Proposition, $A(z) < \omega$ for $z > \tilde{z}$. So as long as there is some trade happening (i.e. $\tilde{z} < 1$), $U^T > U^A$.

Interpretation

- Can think of trade as a form of “selection” here.
- Under autarky, must produce everything at home
- Under trade, have option to produce more than necessary of some things at home, and not at all of other things—can “select out” the bad stuff and “select in” the good stuff.
- NB: the only point of exporting (since exports don't enter U directly) is to be able to pay for imports of cheap stuff (cheaper than we could make at home at prevailing wages).
 - In an abstract sense, trade is just a “technology” for turning export goods (things we don't directly value) into import goods (things that we do directly value).
 - David Friedman: “There are two ways [Americans] can produce automobiles. We can build them in Detroit or we can grow them in Iowa....put the wheat on ships and send the ships out into the Pacific. They come back with Hondas on them.”

Generalizations

- Can show that above logic goes through under any technologies and preferences (but sticking to assumptions of perfect competition, no externalities, etc.)
- Additional general lessons:
 - Starting at infinite tariff, some trade is always better than none
 - Starting at finite tariff, reducing it is not always better. However, this argument hinges on countries being “large” (=can affect world prices) and most countries might not be very “large”.
 - If there are heterogeneous people inside Home, trade will (like most economic shocks in GE) almost surely create both “winners” and “losers”
 - Can design a taxation scheme that would, in principle, let winners compensate losers and generate a Pareto improvement. But such taxes would probably be very hard to implement in practice.

Trade and Living Standards: the Evidence

- The basic logic of CA-driven selection that we have seen suggests that, all else equal, more open countries should be richer ones.
- Is there evidence for this idea?
- Frankel and Romer (1999, AER) provided a great first step
 - What's the basic problem with identifying the effect of trade on GDP?

Trade and Living Standards: the Evidence

- The basic logic of CA-driven selection that we have seen suggests that, all else equal, more open countries should be richer ones.
- Is there evidence for this idea?
- Frankel and Romer (1999, AER) provided a great first step
 - What's the basic problem with identifying the effect of trade on GDP?
 - Key idea: FR instrument for a country's trade (really, its 'openness') by using a measure of distance: how far that country is from large (ie rich) *potential* trade partners.

FR (1999): First-Stage (Part I)

- First-stage regression has two parts.
- First is based on well-known 'gravity' equation.
 - Key idea: bilateral trade flows fall with bilateral trade costs (and variables like bilateral distance, and whether two countries share a border, appear to be correlated with trade costs).
- Gravity equation estimated is the following

$$\ln\left(\frac{\tau_{ij}}{GDP_i}\right) = a_0 + a_1 \ln D_{ij} + a_2 \ln N_i + a_3 \ln A_i + a_4 \ln N_j + a_5 \ln A_j + a_6 B_{ij} + e_{ij}$$

- Where $\tau_{ij} = (X_{ij} + M_{ij})$ is exports plus imports between country i and j , D_{ij} is distance, N is population, A is area, and B_{ij} is dummy for either country being landlocked. FR (1999) also control for each of these variables interacted with a dummy for both countries sharing a common border.

First-Stage Results (Part I)

The gravity equation

TABLE 1—THE BILATERAL TRADE EQUATION

	Variable	Interaction
Constant	-6.38 (0.42)	5.10 (1.78)
Ln distance	-0.85 (0.04)	0.15 (0.30)
Ln population (country <i>i</i>)	-0.24 (0.03)	-0.29 (0.18)
Ln area (country <i>i</i>)	-0.12 (0.02)	-0.06 (0.15)
Ln population (country <i>j</i>)	0.61 (0.03)	-0.14 (0.18)
Ln area (country <i>j</i>)	-0.19 (0.02)	-0.07 (0.15)
Landlocked	-0.36 (0.08)	0.33 (0.33)
Sample size	3220	
R^2		0.36
SE of regression		1.64

Notes: The dependent variable is $\ln(\tau_{ij}/GDP_i)$. The first column reports the coefficient on the variable listed, and the second column reports the coefficient on the variable's interaction with the common-border dummy. Standard errors are in parentheses.

FR (1999): First-Stage (Part II)

- Now FR (1999) aggregate the previously estimated gravity regression (omitting the interaction terms for simplicity) over all of country i 's bilateral partners, j :

$$\hat{T}_i = e^{\hat{a}_0 + \hat{a}_2 N_i + \hat{a}_3 A_i} \sum_{j \neq i} e^{\hat{a}_4 N_j + \hat{a}_5 A_j + \hat{a}_1 D_{ij} + \hat{a}_6 B_{ij}}$$

- This constructed variable \hat{T}_i is then used as an instrument for how much a country is actually trading (denoted T_i , ie actual exports plus imports over GDP). Think of \hat{T}_i as 'gravity predicted trade'.
- That is, the actual first-stage regression is to regress T_i on \hat{T}_i (and controls for population and area).

First-Stage Results (Part II)

The actual first stage (i.e. regress T_i on \hat{T}_i and controls).

TABLE 2—THE RELATION BETWEEN ACTUAL AND
CONSTRUCTED OVERALL TRADE

	(1)	(2)	(3)
Constant	46.41 (4.10)	218.58 (12.89)	166.97 (18.88)
Constructed trade share	0.99 (0.10)		0.45 (0.12)
Ln population		-6.36 (2.09)	-4.72 (2.06)
Ln area		-8.93 (1.70)	-6.45 (1.77)
Sample size	150	150	150
R^2	0.38	0.48	0.52
SE of regression	36.33	33.49	32.19

Notes: The dependent variable is the actual trade share. Standard errors are in parentheses.

FR (1999): The Second-Stage

- Now, finally, FR (1999) run the regression of interest—‘Does trade cause growth?’:

$$\ln \frac{Y_i}{N_i} = a + bT_i + c_1 \ln N_i + c_2 \ln A_i + u_i$$

- Here, $\frac{Y_i}{N_i}$ is GDP per capita and A_i is area.
- FR run this regression using both OLS and IV.
 - The IV for T_i is \hat{T}_i .

OLS and IV results

1 % increase in trade share \implies 2% increase in GDP/capita

TABLE 3—TRADE AND INCOME

	(1)	(2)	(3)	(4)
Estimation	OLS	IV	OLS	IV
Constant	7.40 (0.66)	4.96 (2.20)	6.95 (1.12)	1.62 (3.85)
Trade share	0.85 (0.25)	1.97 (0.99)	0.82 (0.32)	2.96 (1.49)
Ln population	0.12 (0.06)	0.19 (0.09)	0.21 (0.10)	0.35 (0.15)
Ln area	-0.01 (0.06)	0.09 (0.10)	-0.05 (0.08)	0.20 (0.19)
Sample size	150	150	98	98
R^2	0.09	0.09	0.11	0.09
SE of regression	1.00	1.06	1.04	1.27
First-stage F on excluded instrument		13.13		8.45

Notes: The dependent variable is log income per person in 1985. The 150-country sample includes all countries for which the data are available; the 98-country sample includes only the countries considered by Mankiw et al. (1992). Standard errors are in parentheses.

Comments I

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- Countries that are close to big countries are rich potentially not just because of trade, but because of spatially correlated true determinants of prosperity (eg, 'institutions').
- 'Openness' is potentially proxying for lots of true treatment effects of proximity to neighbors: multinational firms, technology transfer, knowledge spillovers, migration, political spillovers. Not just 'Trade'.

Comments II

- It's also very surprising that the IV coefficients are *larger* than the OLS coefficients. Why?

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- It's also very surprising that the IV coefficients are *larger* than the OLS coefficients. Why? Reasons we might expect OLS to be upward-biased:
 - Countries liberalizing trade made other growth-inducing policy changes.
 - Poor countries have no other revenue but from import/export taxes.
 - Rich countries can afford to build infrastructure that generates trade.
 - Rich countries demand more specialized varieties.
- All lead to positive correlation between trade and error term.

Follow-on Work from FR (1999), part I

- Because of importance of question, and surprising findings, FR (1999) generated a lot of controversy and follow-on work.
- Rodrik and Rodriguez (2000) were most critical.
- Fundamental message (that has now also been confirmed for many cross-country studies, no matter what the outcome or regressors are) is that these regressions are not that robust.
 - Inclusion of various controls can change the results a great deal.
 - Different measures of 'openness' yield quite different results.
 - None of this is very surprising when we are trying to tease out patterns from ≈ 100 enormously heterogeneous data points
- RR (2000) also critical of the identification assumption behind FR (1999)'s IV. What are they most worried about?

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 - Geography directly affects health, institutions, endowments.

Follow-on Work from FR (1999), part II

- In two very nice papers, James Feyrer revamped interest in the cross-country approach by using panel data and an IV based on a time-varying component of ‘distance’.
 - Feyrer (2019): “Trade and Income—Exploiting Time Series in Geography”
 - Feyrer (2020): “Distance, Trade, and Income—The 1967 to 1975 Closing of the Suez Canal as a Natural Experiment”

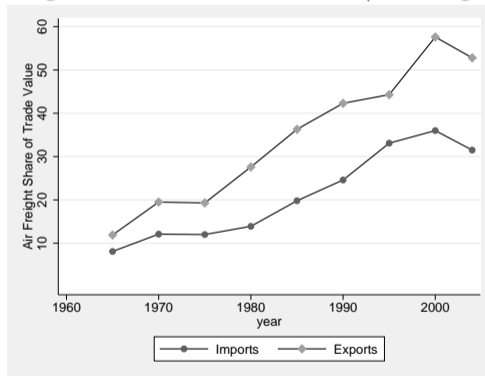
Feyrer (2019)

- Uses panel of country-level GDP and trade data from 1960-1995
- Exploits fact that marginal cost of shipping via air fell faster over this period than marginal cost of shipping via sea.
- This will make trade costs (or 'distance') fall over time. And importantly, trade costs between country pairs will be affected very differently by this:
 - Germany-Japan sea distance is 12,000 miles, but only 5,000 air miles. ('Treatment')
 - Germany-USA sea and air distances are basically the same. ('Control')
- Feyrer uses this variation to get a time-varying instrument for trade openness, and then pursues a FR 1999 approach.

US Trade by Mode of Transport

Consistent with a change in relative cost of using each mode

Figure 1: Air Freight Share of US Trade Value (excluding North America)

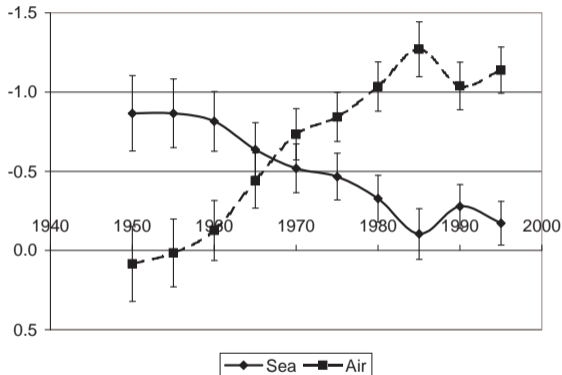


source: Hummels (2007), pp 133.

Coefficients on Air and Sea Distance

$$\ln(\text{Trade}_{ijt}) = \gamma_i + \gamma_j + \gamma_t + \beta_{sea,t} \ln(\text{seadist}_{ij}) + \beta_{air,t} \ln(\text{airdist}_{ij}) + \varepsilon_{ijt}$$

Figure 3: The Change in Elasticity of Trade with Respect to Sea and Air Distance over Time



source: Coefficients from regression table 9 column 2.

Each point represents the coefficient on (sea or air) distance over a 5 year interval. Estimates are from a gravity model with country fixed effects.

Error bars represent plus or minus two standard errors for each coefficient.

Feyrer (2019): IV results (OLS is 0.446)

IV is predicted trade (aggregated across partners) from gravity equation

Table 5: Panel Estimates of Trade on per capita GDP

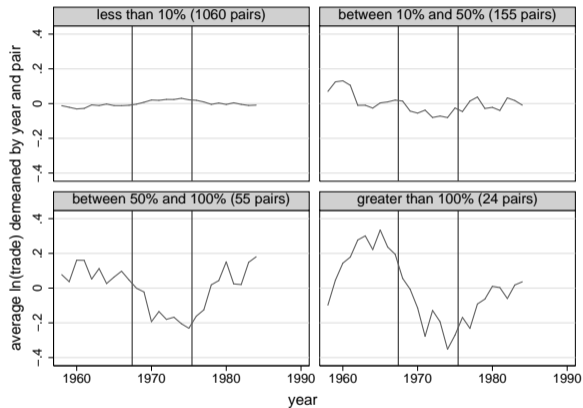
	(1)	(2)	(3)	(4)	(5)	(6)
IV RESULTS						
ln(Real GDP per Capita)						
ln(trade)	0.578 (0.082)**	0.589 (0.090)**	0.427 (0.078)**	0.429 (0.075)**	0.459 (0.097)**	0.417 (0.092)**
FIRST STAGE						
ln(trade)						
ln(predicted trade)	0.993 (0.144)**	0.942 (0.145)**	2.055 (0.418)**	2.033 (0.410)**	1.385 (0.251)**	1.696 (0.365)**
R^2	0.975	0.975	0.958	0.958	0.973	0.954
F-stat on Instrument	47.6	42.2	24.2	24.6	30.4	21.6
Instrument Partial R^2	0.170	0.163	0.216	0.223	0.100	0.145
REDUCED FORM						
ln(Real GDP per Capita)						
ln(predicted trade)	0.573 (0.116)**	0.555 (0.119)**	0.877 (0.242)**	0.873 (0.234)**	0.636 (0.185)**	0.708 (0.226)**
R^2	0.947	0.947	0.958	0.959	0.943	0.956
Observations	774	774	560	560	774	560
Countries	101	101	62	62	101	62
Years	10	10	10	10	10	10
characteristics of predicted trade regressions						
Bilateral Controls	no	yes	no	yes	—	—
Balanced Panel	no	no	yes	yes	no	yes
Country dummies	yes	yes	yes	yes	no	no
Pair Dummies	no	no	no	no	yes	yes

Feyrer (2019)

- IV coefficient in Feyrer (2019) is still large (and similar to FR when converted to level on log).
- Perhaps OVB was not as big an issue as previously thought?
- But a fundamental question of *interpretation* remains:
 - Is 'openness' capturing channels related purely to the trade of goods, or is it possible that this variable is (also) proxying for other elements of international interaction (FDI, migration, knowledge flows) made cheaper by the rise of air travel?
- Feyrer (2020) exploits the closing and re-opening of the Suez Canal between 1967 and 1975 to dig deeper:
 - (Implicit) logic: No one is doing FDI or migration by sea during this period, so only thing a change in sea distance can affect is trade.
 - Short-run shock.
 - Can trace the timing of the impact.
 - Very nice feature that it turns off and on: Should expect symmetric results from static trade models, but asymmetric results if driven purely by (eg) spread of knowledge.

Feyrer (2020): Trade and Sea Distance

Figure 1: Average bilateral trade residuals grouped by Suez Distance Increase



Source: IMF direction of trade database, author's calculations.

The vertical lines mark the closing and reopening of the Canal in 1967 and 1975.

Residuals from a regression with country pair and year dummies.

Feyrer (2020): OLS and IV results

Table 5: Output and Trade

	(1)	(2)	(3)	(4)	(5)	(6)
IV RESULTS						
	ln(GDP per capita)					
ln(trade)	0.228*	0.253**	0.157**	0.170**	0.179**	0.159**
	(0.087)	(0.094)	(0.052)	(0.063)	(0.062)	(0.057)
FIRST STAGE						
	ln(trade)					
Suez Shock	-0.941**			-1.318**		
	(0.245)			(0.263)		
ln(Predicted Trade)		3.301**			4.817**	
		(0.950)			(0.941)	
ln(Predicted Trade) dynamic			3.341**			3.022**
			(0.676)			(0.651)
Instrument R-squared	0.010	0.010	0.023	0.018	0.019	0.020
Instrument F-Stat	14.8	11.9	24.4	25.1	26.1	21.5
REDUCED FORM						
	ln(GDP per capita)					
Suez Shock	-0.215+			-0.224+		
	(0.120)			(0.116)		
ln(Predicted Trade)		0.834+			0.863*	
		(0.472)			(0.423)	
ln(Predicted Trade) dynamic			0.525*			0.480+
			(0.252)			(0.254)
Countries	80	80	80	80	80	80
Observations	1,771	1,771	1,771	1,351	1,351	1,351
Transition Years Included	Yes	Yes	Yes	No	No	No

** p<0.01, * p<0.05, + p<0.1

Years 1967-1969 and 1975-1977 are the transition periods.

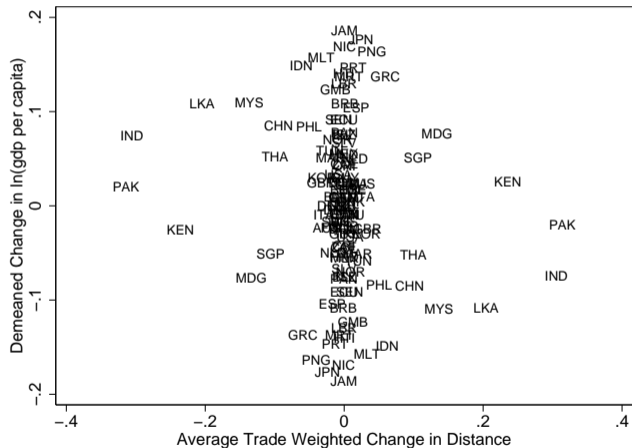
All regressions include a set of country and year dummies.

Standard errors clustered by country

Feyrer (2020): Reduced Form

Note how few (and which) country obs are driving the result. Why is this a worry?

Figure 7: Log change in GDP per capita versus Suez Distance Shock



Source: World Development Indicators, author's calculations.

GDP change based on average for three periods, 1960-1966, 1970-1974, 1978-1984.

Other Evidence

1. Pascali (AER, 2017):

- Uses the invention of steam-powered oceanic shipping (which affected relatively more those countries with poor wind-powered connections to other countries) to estimate relationships similar to Feyrer's (c. 1900) .
- Surprisingly, this IV-driven openness seems to have only benefited small number of (relatively rich) countries with "inclusive institutions" and actually *harmed* initially relatively poor countries.

2. Zimring (JIE, 2015):

- Studies the blockade imposed on the Gaza Strip from 2007-2010 (compared to West Bank)
- Modern setting, so has access to price data as well as household consumption and firm production data (and so can also look at inequality).
- Large measured losses of 14-27% (and return after 2010), in particular due to reduced labor productivity (and reallocation from manuf. into services).