14.581 MIT PhD International Trade —Lecture 10: Increasing Returns to Scale and Monopolistic Competition (Empirics)—

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Plan of Today's Lecture

1. **Introduction**
2. Discussion of various pieces of evidence for (the importance of) increasing returns in explaining aggregate trade flows:
   - 2.1 Intra-industry trade.
   - 2.2 Preponderance of North-North trade.
   - 2.3 The impressive fit of the gravity equation.
   - 2.4 The importance of market access for determining living standards.
   - 2.5 The home market effect.
   - 2.6 Path dependence.

The Big Question

- There are two fundamental reasons for why countries trade:
  1. Countries are *ex ante* different (so they trade according to the traditional theory of comparative advantage).
  2. Countries are *ex ante* identical, but due to increasing returns to scale (ITRS) they specialize and become different *ex post*. (One could actually think of this as a particularly extreme form of comparative advantage, and one that is endogenously-driven.)

- It is important to know (for both positive and normative motives) how relatively important these two forces of trade are in the real world.

- Given these two fundamentally different forces of trade, one might think that this would be an easy task.
  - Unfortunately it isn't!
  - This lecture will review what has been done to date on testing for CA versus IRTS as explanations for trade.

Attempts to Answer The Big Question

- We will review 6 different types of empirical predictions that show some promise for testing between CA and IRTS:
  1. The existence of Intra-industry trade (IIT).
  2. Most trade is between similar-looking countries.
  3. The gravity equation fits well.
  4. Market access matters for standards of living.
  5. The home market effect.
  6. Path dependence (in response to shocks).

- Ironically, it is often claimed that 'New' Trade theory (ie trade theory with IRTS and/or imperfect competition) came about because neoclassical trade models (ie models with CRTS and perfect competition) couldn't explain 1-4.
  - Unfortunately, this is not true. (But of course NTT has many attractions even absent this.)
  - One *can* write down neoclassical trade models that generate findings 1-4. Hence IRTS isn't necessary to generate findings 1-4.
  - Findings 5-6 are harder to explain in neoclassical models.

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'Test' 1: Intra-Industry Trade

- Grubel and Lloyd (1975) famously characterized IIT systematically and well.
  - Grubel-Lloyd index: $GL_i \equiv 1 - \frac{|X_i - M_i|}{X_i + M_i}$.
  - Typically takes values higher than 0.5, and this has been growing (see, eg, Helpman (JEP, 1998)).
- Bhagwati and Davis (1993) in a Chipman *festschrift* volume discuss the issues involved in inferring what IIT implies for the importance of IRTS.
  - Chipman did pioneering work on this.

What is an industry? Two definitions

- Goods that are close substitutes in consumption (closer within than between).
  - This is how the field of IO defines industries.
  - And this is probably close to how statistical agencies construct industry groupings.
  - But this is not how neoclassical trade thinks of industries, since typically the only restriction on tastes is that they're homothetic.
- Goods that use similar factor intensities in production.
  - This is how HO trade theory defines an industry.
  - This is probably not how statistical agencies construct industry groupings.
  - Indeed, Finger (1975): K/L ratios differ more within 3-digit industries than between them. (Though Maskus (1991) updated this and found there to be slightly more between than within.)

Aggregation

- GL (1975) noted that IIT is very sensitive to aggregation.
- Aggregation at what level?
  - Most obvious issue is aggregation over goods (see below).
  - But can also have aggregation over time ('seasonal trade'—where trade goes from country A to B in one season, but from B to A in another season) or over space ('border trade'; hypothetical example would be where Seattle sells cars to Vancouver, but Toronto sells cars to Detroit.)
- Chipman (1992) has looked at the extent of IIT over different levels of SITC groupings.
  - Fitting an equation and extrapolating it, he finds that all IIT would disappear by 18-digit goods. (But note that the finest international trade data is at the 10-digit level.)
  - But if the existing industry categories are not appropriately defined in the context of a given theory, then it is hard to know what to make of these results.

An Aggregation Theorem I

- Chipman (1991) proved an 'Aggregation theorem' about IIT:
  - In a conventional HO economy with G goods, F factors and N countries, with $G = F$,
  - And with the world economy inside the FPE set,
  - Given *any* aggregation of the G goods into $\bar{G} < G$ groupings,
  - There exists an allocation of world endowments such that any given share of trade is intra-industry trade.
- Note that the aggregation scheme here is unspecified.
  - So it could be based on consumption similarity, production similarity, or any other dimension of similarity (eg, ease of data collection, idiosyncratic whims of the person who created SITC classifications...) you want.

An Aggregation Theorem II

- The intuition behind this result:
  - Imagine a perfectly symmetric world in which there is no trade.
  - Now let the countries exchange some of their relative endowments such that incomes (and hence consumption patterns) remain unchanged. Production, however, will change.
  - If the endowment change promotes production of good X in one country and good Y in the other country, and if goods X and Y are 2 goods that we've chosen to be inside the same 'industry' grouping, then the only trade that emerges is 'intra-industry'.
- Note that 'inside the FPE set' is not innocuous here.
  - It requires that the $A(w)$ matrix is non-singular, which requires that each good G is using (even slightly) different factor intensities at w.
  - So the two goods aggregated together into an industry can have 'similar', but not identical, factor intensities.

Chipman (1992)

- Chipman (1991) said that it is *possible* to get IIT in an HO model. But how much IIT should we expect in a 'typical' HO model?
- Chipman (1992) works with a simple example, but the intuition that emerges is, 'a lot'.
  - That is, IIT is likely to be the rule rather than the exception in an HO-style model.
  - The basic intuition is that as the technologies for making 2 goods become more similar, the PPF becomes flatter, which gives rise to more specialization.
  - So if we group goods into 'industries' based on production similarity, there will be lots of scope for intra-industry specialization within these groupings, and hence lots of scope for IIT.
- Rodgers (1988) extended this in a more formal direction, defining production similarity on a Euclidian norm operating on Cobb-Douglas elasticities.

Davis (JIE, 1995)

- Davis (1995) provides what is probably the best-known result about IIT in neoclassical settings.
- The above examples suggested that intra-industry specialization (IIS) is the key to generating IIT.
  - Scale economies generate IIS, but so too can Ricardian forces of differential technologies (in a simple Ricardian model, if we define the entire economy as one 'industry' then there is clearly both IIS and IIT).
- So Davis develops a HO-Ricardian model in which there is an arbitrary amount of IIT.
  - This is true even though the aggregation of goods into industries is based on *identical* factor intensities.
  - This is different from Chipman's (1991, 1992) pure-HO cases in which the aggregation had to be over 'similar', but non-identical, factor intensities.

Davis (1995): Minimial working example

- 3 goods: X_1, X_2, and Y.
  - X_1 and X_2 are the 2 goods in an 'industry', with identical factor intensities.
- 2 countries:
  - Country 1: $X_1 = AF(K_{X1}, L_{X1})$, $X_2 = F(K_{X2}, L_{X2})$ and $Y = G(K_Y, L_Y)$.
  - Country 2: $X_1 = F(K_{X1}, L_{X1})$, $X_2 = F(K_{X2}, L_{X2})$ and $Y = G(K_Y, L_Y)$.
  - So $A > 1$ is the essential Ricardian element of this otherwise HO model.
- Davis solves for the Integrated Equilibrium (IE):
  - And shows that it will always involve techniques such that country 1 is capable of producing the entire world supply of good X_1.

The FPE set

Point $V(1)$ is the vector of factors the IE would use to make good 1, which is then the new origin for country 1.

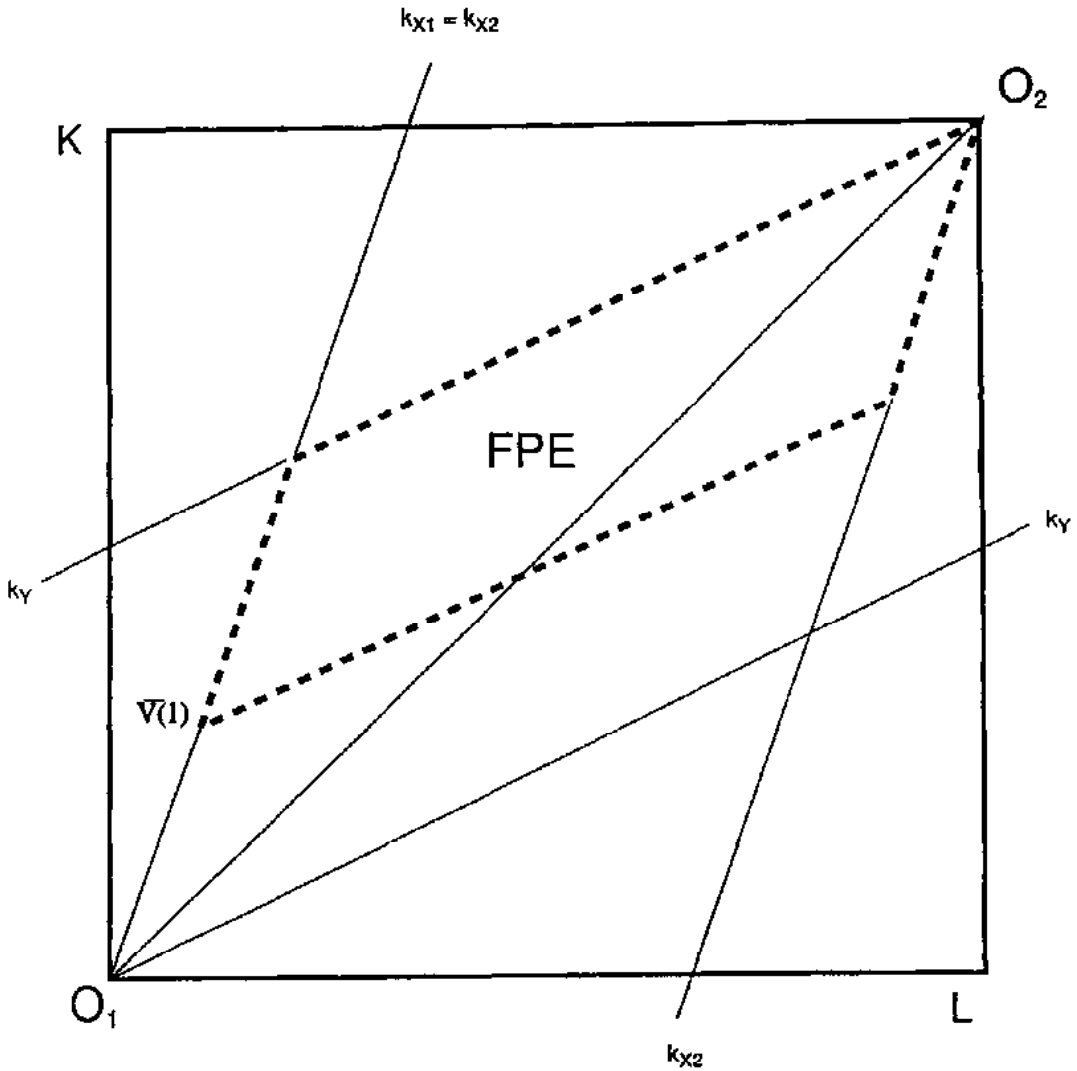

Fig. 1. The integrated equilibrium.

Figure from Davis, Donald. "Intra-industry Trade: A Heckscher-Ohlin-Ricardo Approach." *Journal of International Economics* 39, no. 3 (1995): 201-26. Courtesy of Elsevier. Used with permission.

Generating Arbitrary Amounts of IIT

Consider moving from endowments at A, B, C and D. The slope of the A-D line is $-w/r$, so incomes (and hence the factor content of consumption) are constant. As we move from A to D, country 2 produces less Y and more X_2.

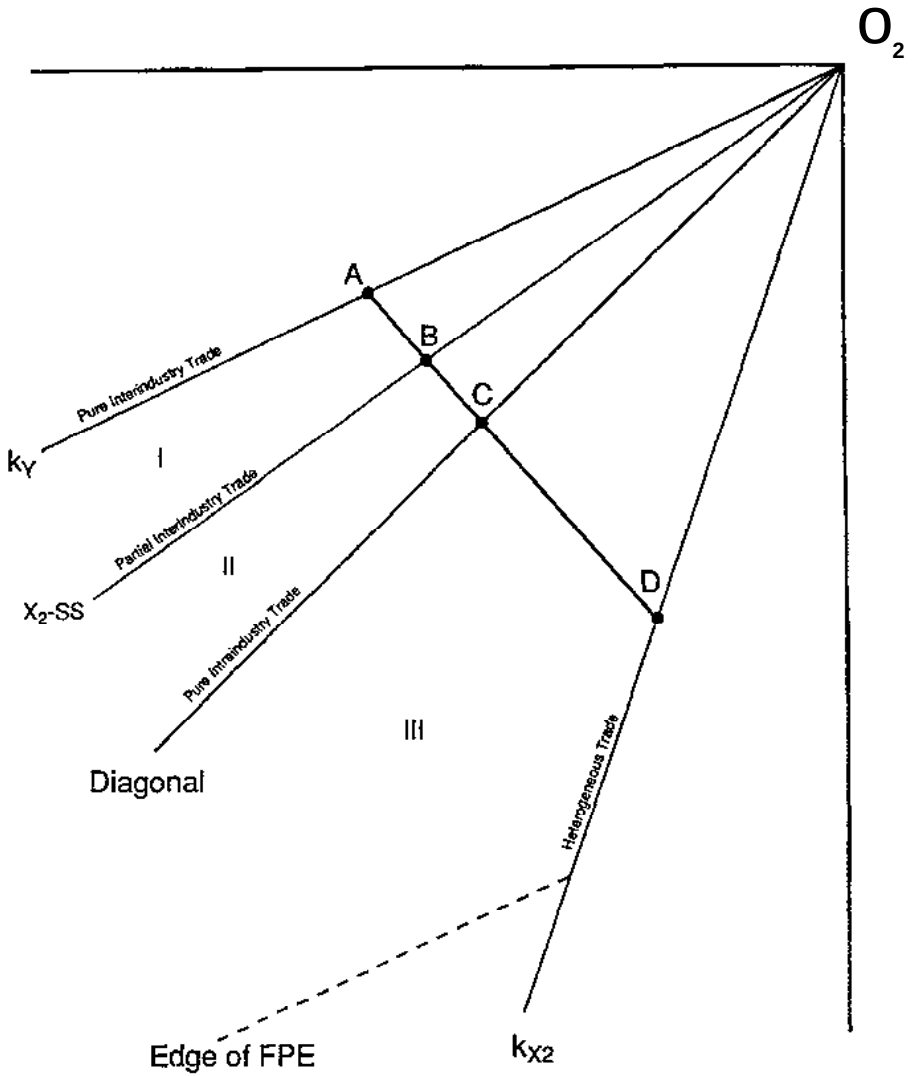

Fig. 2. The pattern of trade.

Figure from Davis, Donald. "Intra-industry Trade: A Heckscher-Ohlin-Ricardo Approach." *Journal of International Economics* 39, no. 3 (1995): 201-26. Courtesy of Elsevier. Used with permission.

Davis (1995): A final point

- It has often been argued that product differentiation and IIT go hand in hand.
  - Eg: Grubel-Lloyd (1975) subtitle: *The theory and measurement of international trade in differentiated products*.
- And product differentiation and IRTS are often argued to go hand in hand.
- But Davis (1995) points out that a rise in the number of products G relative to factors F (ie the presence of $G > F$, which we might think of as 'product differentiation') also makes any technology differences across countries *more* likely to generate IIT (even with CRTS).

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'Test' 2: Most trade is North-North; or, most trade is between similar-looking countries.

- It was never formally claimed that this could *never* happen in a neoclassical model.
- Key obstacle is that, with more than 2 countries, neoclassical models typically don't make bilateral predictions about who trades with whom.
  - Though non-FPE versions of the H-O model, like that in Helpman (1984), are exception, and do make bilateral statements.
- Davis (JPE, 1997):
  - Showed in an elegant and transparent manner how endowment differences translate into trade flow differences.
  - He hence documented the conditions under which, even in a pure HO model, similarly-endowed countries trade less with one another than do differently-endowed countries.

Davis (JPE, 1997)

- Consider a $4 \times 4 \times 4$ framework:
  - 2 Northern countries, 2 Southern countries.
  - Northern countries relatively endowed with 'North-type' factors. Endowments inside FPE set.
  - 2 'North-type' industries (to be defined shortly), and 2 'South-type' industries.

Davis (JPE, 1997)

- Let technology-techniques matrix, $A(w)$ be given by:

$$A(w) = B + \delta \underbrace{\begin{bmatrix} 1 & 1 & -1 & -1 \\ 1 & 1 & -1 & -1 \\ -1 & -1 & 1 & 1 \\ -1 & -1 & 1 & 1 \end{bmatrix}}_{\equiv D} + \epsilon \underbrace{\begin{bmatrix} e_1 & -e_1 & e_2 & -e_2 \\ -e_1 & e_1 & -e_2 & e_2 \\ e_2 & -e_2 & e_1 & -e_1 \\ -e_2 & e_2 & -e_1 & e_1 \end{bmatrix}}_{\equiv E}$$

- Here, first 2 columns are goods in North-type industries; first 2 rows are North-type factors.

$A \quad B + \delta D + \epsilon E$

- So the B matrix represents 'average' input coefficients.
- The D matrix represents technological dispersion between industries.
- The E matrix represents technological dispersion within industries
- And then the notion of an 'industry' (based on technological similarity) comes from conditions which (are not unambiguous but) generally require δ to exceed a mixture of ϵ and e_1 and e_2.
  - That is, there is more dispersion in A between industries than within.

Davis (1997): Results

- From this, Davis (1997) shows that the HOV equations imply the following:
  1. $V^N - V^S = 2t^{NS}\delta D_1$ (where t^{NS} is the total trade volume of the North with the South, and D_1 is the first row of D).
  2. $V^N - V^N = 2t^{NN}\epsilon E_1$ (defined similarly).

- Hence, for fixed endowment differences, the volumes of trade depend critically on δ and ϵ.
  1. If the goods in which N and S specialize are very different in their input intensities (high δ) then only a small amount of trade (low t^{NS}) is needed to accomplish the required amount of factor trade.
  2. If the goods in which N and N' specialize are very similar (low ε) then even though the *net* content of factor services traded will be small, there is lots of back-and-forth factor services trade, which is accomplished by lots of goods trade (high t^{NN}).

Davis (1997): Another Result

- From this framework, Davis (1997) constructs an example in which $t^{NN} > t^{NS} > t^{SS}$, which is roughly what we see in the world today.
- But note how this was achieved without allowing for:
  - Higher levels of trade protection in the South (leading to little N-S or S-S trade).
  - Non-homothetic tastes (which might make consumption patterns in the North relatively similar, promoting N-N trade).
  - The North to be richer, and hence to trade more with anyone (leading to more N-N trade).
  - Trade costs that are proportional to distance (to allow for the fact that, in the real world, 'N' countries are probably closer to other 'N' countries than 'S' countries.)

Davis and Weinstein (2003)

- DW (2003) explore the factor content of N-N trade empirically.
- They use the data (from DW (AER, 2001)) on *actual, reported* $\bar{B}^c(w^c)$ matrices in each country.
  - So there is no real HO model content here. (This is not a test of HO.)
  - Their interest here is in how to decompose *entirely, tautologically, accurate* measures of $F_c \equiv \bar{B}^c(w^c)E_c - \sum_{c'} \bar{B}^{c'}(w^{c'})M_{cc'}$, where E_c is net exports from country c, and $M_{cc'}$ is net imports into country c from country c'.

DW (2003) Results

1. The pure intra-industry component of F_c is significant (42 % of all F_c).
   - In a conventional HO model (with FPE) there is no IIT FCT.
   - In fact, as discussed above, the existence of IIT has been taken as evidence against the HO model.
   - But in this setting, where the $\bar{B}^c(w^c)$ matrices are allowed to differ (and, strikingly, do differ) we see that, even within the richest countries in the OECD, IIT is a conduit for much factor services trade.

2. For the median G10 country, lots of factor services trade is within the North.
   - For K: 48 % is within North.
   - For L: 37 % is within North.

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The Gravity Equation

- The gravity equation is one of the best fitting and most established empirical relationships in all of Trade.
  - Though as an aside (which we will see more of in a later lecture), Trefler and Lai (2002) demonstrate how the segments of the variation that the gravity equation fits well require only assumptions that virtually any economic model would maintain (eg market clearing).
- For a long time, the impressive fit of the gravity equation was seen as evidence for the importance of IRTS in trade.
  - This is partly because Helpman (1987) and Bergstrand (ReStat, 1989) showed how elegantly the monopolistic competition theory of trade (eg Helpman and Krugman (1985)) could be manipulated into a gravity equation form.
  - But really, the field had known since at least Anderson (AER, 1979) that the Armington model could deliver a gravity equation, and the Armington model is really just an extreme Ricardian model. (We'll see more of the Armington model in a later lecture.)

The Gravity Equation II

- It is now widely recognized that the key to a gravity equation-style relationship is just specialization.
  - This point was very nicely made in Deardorff (1988).
- We will see in a later lecture how a wide range of very applicable trade models all predict the gravity equation:
  - Armington (ie Anderson, 1979).
  - Krugman (1980).
  - Ricardian model as in Eaton and Kortum (2002). (Also, a DFS (1977) Ricardian model delivers the gravity equation pretty easily).
  - Various extensions of Melitz (2003) (but not actually Melitz (2003) itself, in its full generality).
- Anderson and van Wincoop (JEL, 2004) provide sufficient conditions for a gravity equation.

The Gravity Equation III

- Deardorff (1998) also discusses how the HO model has gravity-like features to it.
  - At first glance this is surprising, since bilateral trade isn't pinned down in the HO model.
  - But Deardorff points out that bilateral trade isn't determined because buyers are indifferent about where they buy from.
  - So if buyers (somewhat plausibly?) settled this indifference randomly, and in proportion to the 'number' of sellers offering them goods from each country, the resulting bilateral trades would be gravity-like.

Evenett and Keller (JPE, 2002)

- EK (2002) go beyond simply estimating a gravity equation across all country pairs.
- Instead, they note that:
  - While both IRTS and HO *can* predict gravity, they have different predictions on where (ie for which country pairs) we're likely to see it at work.
- The EK (2002) argument:
  - IRTS (a la Krugman (1980)) always predicts gravity. And IRTS predicts high IIT. So in country pairs with 'high IIT', we should see gravity holding well.
  - HO (simple 2×2) predicts gravity only to the extent there is specialization. Specialization rises in the difference between the 2 countries' endowments. So in country pairs with wide endowment differences, we should also see gravity holding. But HO does not predict IIT, so this should be true even in the 'low IIT' country pairs.

EK (2002): 4 Models

- They compare 4 models:
  1. Pure-IRTS: Complete specialization, so $M_{ij} = \alpha \frac{Y_i Y_j}{Y^W}$ with $\alpha = 1$. This is true in high-IIT samples, and more true as IIT rises.
  2. Pure-HO with complete specialization ('multicone HO'): so again $\alpha = 1$. But this is in low-IIT samples, and more true as endowment differences ('FDIF') rise.
  3. Mix HO-IRTS (a la Helpman and Krugman (1985)): now $\alpha = 1 - \gamma^i$, and γ^i being the share of GDP that is in the CRTS sector. This is true in high-IIT samples, and more true as IIT rises.
  4. Pure HO with incomplete specialization ('unicone HO'): now $\alpha = \gamma^i - \gamma^j$, with γ^i being the share of GDP in one of the 2 sectors. This is in low-IIT samples, and more true as endowment differences ('FDIF') rise.

EK (2002): Results I

Estimates of α_v, for each quintile v based on either IIT-ness (GL index) or FDIF-ness

Benchmark Case

	IRS/Heckscher-Ohlin Model: High-Grubel-Lloyd Sample ($GL > .05$)				Heckscher-Ohlin Model: Low-Grubel-Lloyd Sample ($GL < .05$)			
	IRS model (IRS/IRS goods)		IRS/Unicone Heckscher-Ohlin model (IRS/CRS goods)		Multicone Heckscher-Ohlin model (CRS/CRS goods)		Unicone Heckscher-Ohlin model (CRS/CRS goods)	
	α_υ	5% 95%	α_υ	5% 95%	α_υ	5% 95%	α_υ	5% 95%
	Ranked by Grubel-Lloyed Index				Ranked by FDIF			
$\upsilon = 1$	.016 (.012)	.012 .044	.078 (.005)	.072 .087	.039 (.007)	.030 .049	.021 (.004)	.012 .026
$\upsilon = 2$	.044 (.005)	.036 .052	.053 (.005)	.047 .060	.111 (.014)	.087 .132	.027 (.008)	.025 .043
$\upsilon = 3$	.139 (.013)	.120 .164	.117 (.009)	.112 .141	.047 (.005)	.040 .056	.058 (.008)	.039 .066
$\upsilon = 4$	.069 (.017)	.049 .097	.123 (.005)	.109 .124	.039 (.003)	.034 .044	.048 (.006)	.046 .064
$\upsilon = 5$	.099 (.015)	.083 .125	.128 (.006)	.119 .134	.039 (.004)	.033 .045	.080 (.007)	.069 .101
All observations	.087 (.009)	.076 .104	.086 (.004)	.079 .092	.052 (.003)	.047 .056	.040 (.003)	.034 .044
Only perfect specialization of production	Yes		No		Yes		No	
H_0: $\alpha_i = \alpha$ $\forall i$	Reject		Reject		Reject		Reject	
H_0: $\alpha_1 = \alpha_5$	Reject		Reject		Do not reject		Reject	
Share of bilateral comparisons correct	N.A.		9/10		N.A.		9/10	

EK (2002): Results II

Model comparisons

Measures of Fit for the Benchmark Case

	IRS/Heckscher-Ohlin Model: High-Grubel-Lloyd Sample (GL>.05)						Heckscher-Ohlin Model: Low-Grubel-Lloyd Sample (GL<.05)					
	IRS Model (IRS/IRS Goods)			IRS/Unicone Heckscher-Ohlin Model (IRS/CRS Goods)			Multicone Heckscher-Ohlin Model (CRS/CRS Goods)			Unicone Heckscher-Ohlin Model (CRS/CRS Goods)		
	ln ($e'e$)	AIC	R^2	ln ($e'e$)	AIC	R^2	ln ($e'e$)	AIC	R^2	ln ($e'e$)	AIC	R^2
	Ranked by Grubel-Lloyed Index						Ranked by FDIF					
$\upsilon = 1$	44.61	39.79	1.083	43.74	39.30	.832	43.36	37.26	.238	43.24	37.37	.712
$\upsilon = 2$	45.21	40.39	.456	44.93	40.46	.619	45.61	39.51	.455	45.25	39.38	.605
$\upsilon = 3$	48.81	43.99	.958	48.75	44.26	.674	44.72	38.62	.417	44.24	38.38	.484
$\upsilon = 4$	47.17	42.34	.917	46.45	41.93	.869	44.45	38.35	1.963	43.88	38.03	.793
$\upsilon = 5$	50.61	45.79	.214	49.61	45.04	.934	44.32	38.22	.596	43.84	37.95	.690
All observations	50.91	44.46	.280	51.03	44.69	.105	46.74	39.03	.451	46.96	39.30	.195
Only perfect specialization of production	Yes			No			Yes			No		

Image by MIT OpenCourseWare.

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'Test' 4: Market Size matters

- Two tests of this:
  - Redding and Venables (JIE, 2004): does measured 'market access' (as measured from the fixed effects in a gravity equation) predict Y/L? Yes.
  - Redding and Sturm (AER, 2008): When Germany was partitioned, did cities on the Eastern edge of West Germany (who lost market access) suffer? Did they recover when Germany was re-unified? Does 'market access' predict the magnitude of these effects? Yes, yes and yes.
- Unfortunately, the models used to generate a 'market access' term in these papers are all effectively 'gravity models', which (as discussed above) is a class of models that includes both IRTS and neoclassical variants. So the demonstrated evidence that 'market size matters' can't be taken as evidence for IRTS over neoclassical forces.

Redding and Venables (2004): Results

MA ('Market access') is constructed using an inverse trade-cost weighted sum of gravity equation fixed effects.

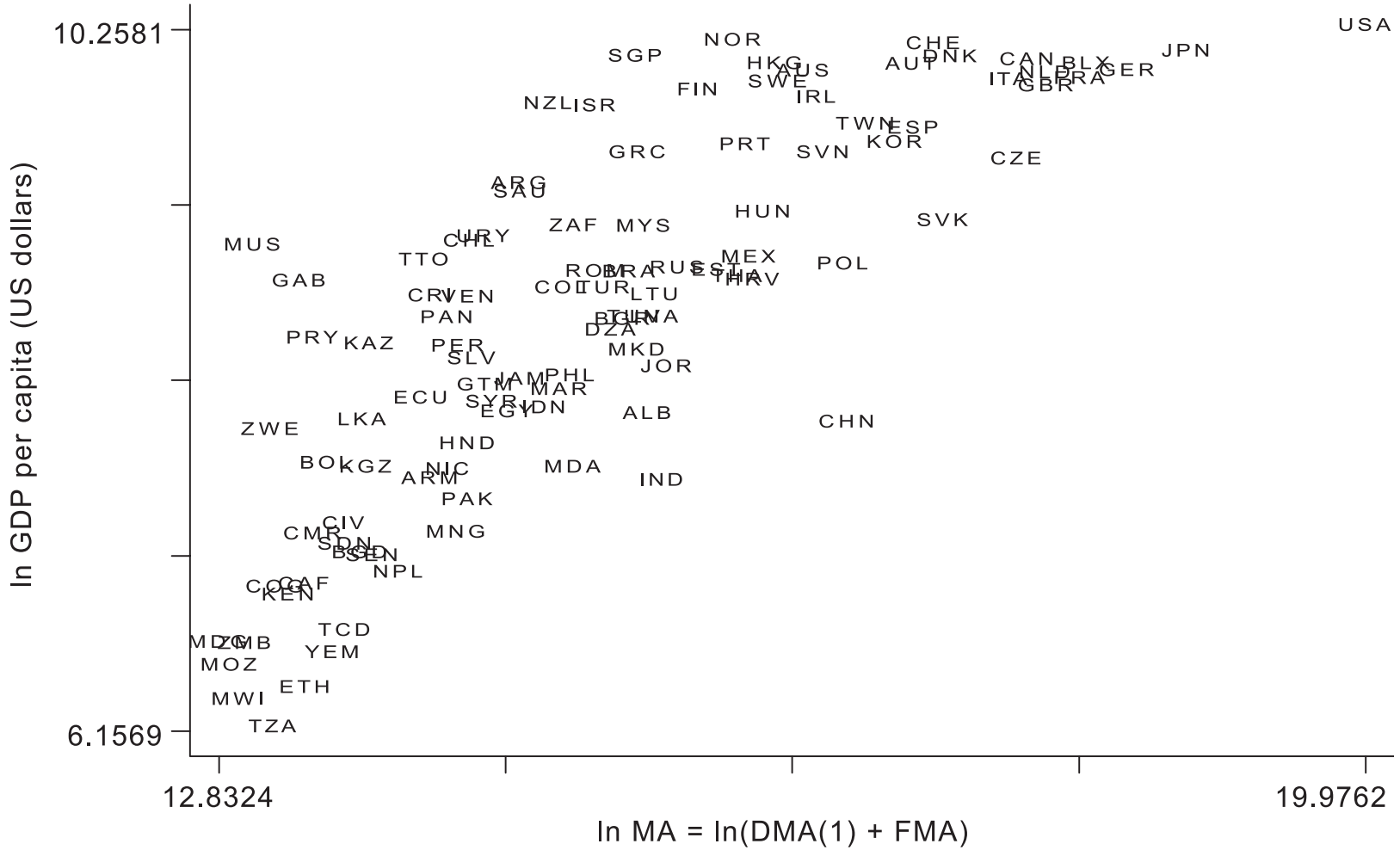


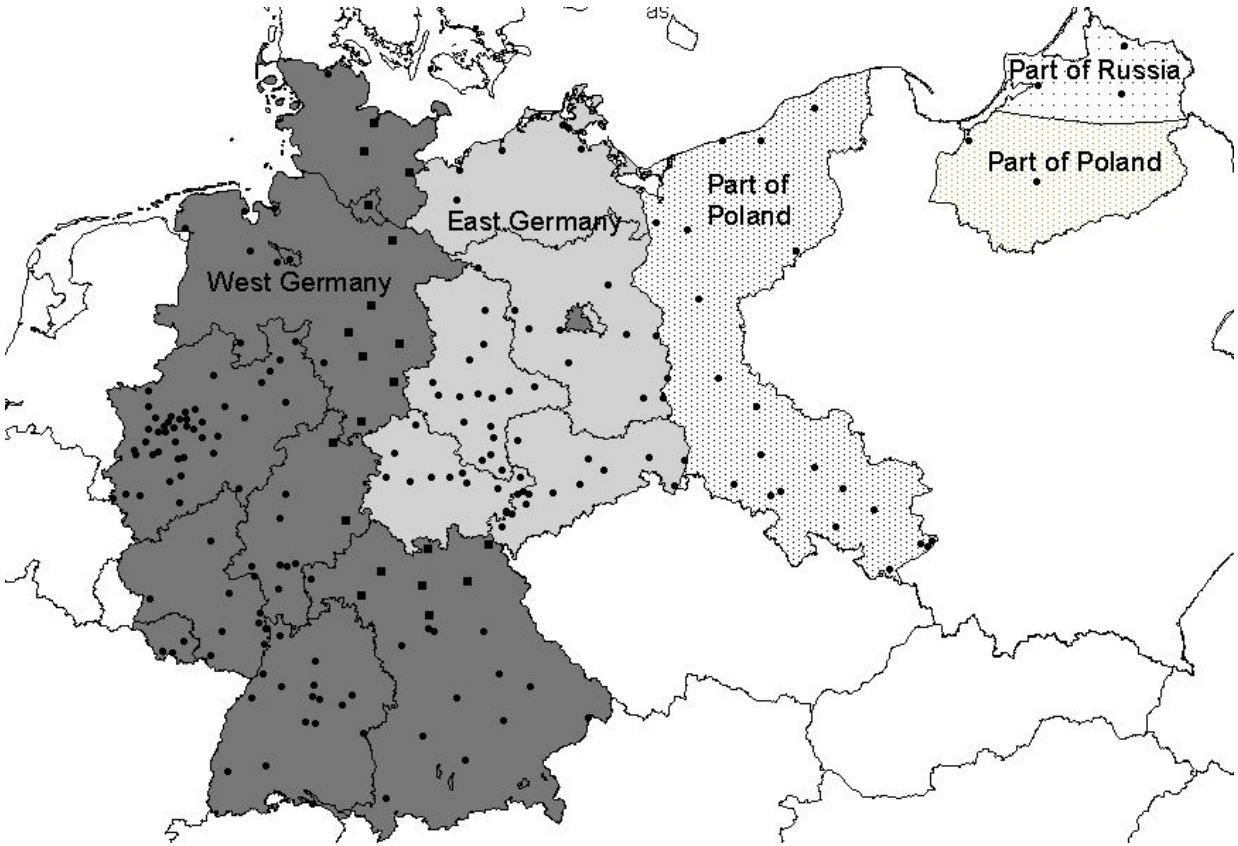
Fig. 2. GDP per capita and MA = DMA(1) + FMA.

Figure from Redding, Stephen, and Anthony Venables. "Economic Geography and International Inequality." *Journal of Political Economy* 62, no. 1 (2004): 53-82. Courtesy of Elsevier. Used with permission.

Redding and Sturm (2008): Results

The Partition of Germany: some Western Germany cities (ie those near the E-W border) lost a great deal of market access

Map 1: The Division of Germany after the Second World War



Notes: The map shows Germany in its borders prior to the Second World War (usually referred to as the 1937 borders) and the division of Germany into an area that became part of Russia, an area that became part of Poland, East Germany and West Germany. The West German cities in our sample which were within 75 kilometers of the East-West German border are denoted by squares, all other cities by circles.

Redding and Sturm (2008): Results

'Treatment' cities are in West Germany, but within 75km of East-West border

Figure 3: Indices of Treatment & Control City Population

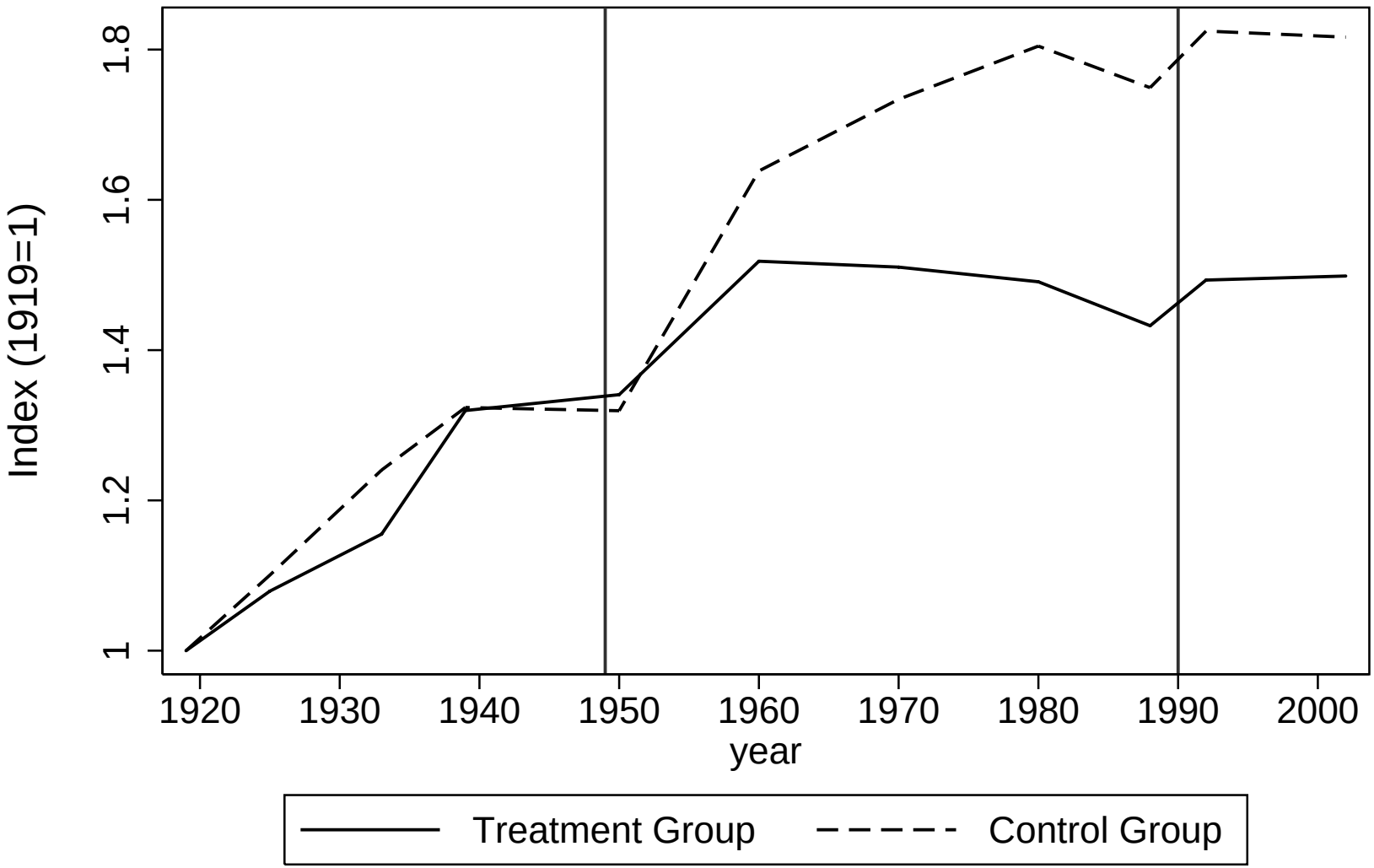


Figure from Redding, Stephen J., and Daniel M. Sturm. "The Costs of Remoteness: Evidence from German Division and Reunification." *American Economic Review* 98, no. 5 (2008): 1766–97. Courtesy of American Economic Association. Used with permission.

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Test 5: The Home Market Effect

- Recall the HME (as in Krugman, 1980):
  - In a 2-country world, with at least one sector featuring IRTS and transport costs, and FPE holding (driven in Krugman (1980) by the assumption of a perfectly competitive, homogeneous, zero-trade cost outside good), the country with higher relative demand for the IRTS good will export that good.

Test 5: The Home Market Effect

- The HME has been characterized as one particularly novel finding to emerge from IRTS theories of trade.
  - In particular, in a CRTS world (with trade costs or not), it would be strange for an increase in a country's relative demand for a good to cause that country to export more of the good.
  - This is actually possible in a CRTS world, but would require very perverse import demand and export supply curves.
- HME is important, not just for distinguishing IRTS from CRTS in Trade theory:
  - Important policy ramifications if HME is true.
  - All of the 'New' Economic Geography (really, models of agglomeration based on pecuniary externalities through trade costs, as opposed to non-pecuniary externalities like knowledge spillovers) literature relies on the HME.

Test 5: The Home Market Effect

- So testing for the HME is attractive as a test for the importance of IRTS in trade.
  - Unfortunately, testing for it is not trivial.
  - We would like to nest it in an otherwise standard neoclassical model, which is hard.
  - We would like to generalize it to many countries/industries, which is hard.
  - We would like to drop the FPE assumption but this is also hard.
- Despite these difficulties, researchers have made progress here:
  - Davis and Weinstein (JIE, 2003)
  - Hanson and Xiang (AER, 2004)
  - Behrens et al (2009)

Davis and Weinstein (2003)

- NB: A lot of what is going on in this paper is explained more fully in DW (1996, working paper).
- DW (2003) use data on OECD manufacturing and try to nest H-O with a version of Krugman (1980) that delivers an HME.
- They focus on the implications of the HME for *production* rather than exporting behavior, but the same intuition goes through for exporting.

DW (2003): 2 Nested Models

- Model 1: Pure HO:
  - HO working at the 4-digit industry level, with $G = F$.
  - Let n index 'industries', which DW take to be 3-digit industries.
  - And let g index 'goods' within these 3-digit industries, which are then 4-digit industries.
  - Since this is the 'even case' we can write: $X_{ngc} = R_{ng} V_c$, where R_{ng} is the (row corresponding to good g in industry n of the) Rybczinski matrix.

DW (2003): 2 Nested Models

- Model 2: Krugman-HO:
  - HO now is assumed to work at the 3-digit level.
  - And (with CES preferences, iceberg trade costs, and the assumption that both fixed and marginal production costs use the same bundle of factors), all goods g inside an industry n will use the same factor bundles, so R_{ng} continues to convert factors into production.
  - But production within industries is indeterminate. So DW assume that, absent idiosyncratic demand differences, each country will allocate factors across goods within an industry in the same proportion as all other countries: $X_{ngc} = \frac{X_{ng,ROW}}{X_{n,ROW}} \times X_{nc}$. Define $SHARE_{ngc} \equiv \frac{X_{ng,ROW}}{X_{n,ROW}} \times X_{nc}$.
  - Idiosyncratic demand differences will tilt this. A country that has higher demand for a good will produce more of the good (how much more depends on whether we have a HME or not).
  - Define this 'tilt' as $IDIODEM_{ngc} = (\frac{\widetilde{D}_{ngc}}{\widetilde{D}_{nc}} - \frac{\widetilde{D}_{ng,ROW}}{\widetilde{D}_{n,ROW}})X_{nc}$, where $\widetilde{D}$ is absorption, to be defined shortly.

DW (2003): The Test

- Based on the above logic, DW (2003) argue that:
  - Production (X_{ngc}) should depend on fundamental HO forces (ie $X_{ngc} = R_{ng} V_c$).
  - But we should also allow for a potential adjustment to this that is increasing in $SHARE_{ngc}$ and $IDIODEM_{ngc}$.
  - They just let production be linear in these last 2 terms and estimate:

$$X_{ngc} = \alpha_{ng} + \beta_1 SHARE_{ngc} + \beta_2 IDIODEM_{ngc} + R_{ng} V_c + \varepsilon_{ngc}.$$

- We expect the following:
  - $\beta_2 = 0$: zero-trade costs world (IRTS or CRTS).
  - $\beta_2 \in (0, 1]$: CRTS with trade costs.
  - $\beta_2 > 1$: IRTS (HME).

DW (2003): Constructing $SHARE_{ngc}$

- How do we measure a country's total 'demand' (really, absorption) for a good, ie $\widetilde{D}_{ngc}$?
  - DW (1996) used simply the amount of local demand in country c for this good g in industry n.
  - DW (2003) instead use the derived demand for country c's goods both at home and in its trading partners as well. To measure this they first regress, industry-by-industry, a gravity equation to get the effect of distance on demand. From this they can sum over all trade partners, down-weighting by distance, to get a sense of the 'market size' for g, n faced by country c.
  - This distinction turns out to have big effects.

- An important concern is simultaneity bias: do un-modeled production differences drive idiosyncratic demand differences (for example, by changing prices, or even tastes?)
  - DW use lagged (by 15 years) demand data to try to mitigate this.
  - Various other discussions in text.

DW (2003): Results

Estimates pooled across all industries

Pooled runs (Dependent variable is 4-digit output; standard errors below estimates)

	1	2	3	4
Idiodem	1.67 0.05	1.67 0.05	1.57 0.10	1.57 0.10
Share	0.96 0.01	0.92 0.02		
Exported		0.07 0.02		0.01 0.04
Factors	No	No	Yes	Yes
Observations	650	650	650	650

Idiodem is idiosyncratic demand, **Share** is the share of 4-digit output in 3-digit output in the rest of the world, **Exported** is a dummy variable that is one if the country is a net exporter of the good, and **Factors** indicates whether the coefficients on factor endowments were allowed to differ across 4-digit sectors. No indicates that the coefficients on factor endowments were constrained to be the same for every 3-digit sector; Yes means they varied by 4-digit sector.

DW (2003): Interpretation

- Strong evidence for $\beta_2 > 1$, so an HME.
  - Endowments account for around 50 % of production variation, and CRTS around 30 %.
  - Running this regression industry-by-industry reveals that $\beta_2 > 1$ in around half of the industries. At face value, these are not obviously the industries where you might expect to see the strongest tendency for an HME.
- This contrasts starkly with DW (1996), which used only local demand to construct D, where $\beta_2 = 0.3$.
- In parallel work, DW (EER, 1999) did a similar exercise to DW (1996) on Japanese regions and estimated $\beta_2 = 0.9$, which suggests greater scope for an HME within countries.
  - Though these results are hard to compare with DW (1996, 2003) since the Japanese data are at a coarser level of industry aggregation.

Hanson and Xiang (AER, 2004)

- Hanson and Xiang (2004) is probably the most cited paper with reference to evidence for the HME.
- HX construct a Krugman (1980)-style model that makes predictions about which industries are *more likely* exhibit an HME, and then looks for that in export data.
    - A nice feature is its 'difference-in-difference' design, which is there to try to difference out some unobserved and/or endogenous terms.

HX (2004): 2-country model

- They build intuition for their main, multi-country empirical specification by developing a 2-country model with many industries.
  - 2 countries (H and F), with $L_H > L_F$.
  - A continuum of industries (z), each of which is a Krugman (1980) sector (ie a continuum of varieties, with Dixit-Stiglitz tastes, CES parameter $\sigma(z)$ and trade costs $\tau(z)$.)
  - Have to restrict technologies a bit to simplify the cross-industry specialization. Recall the goal here is to get an industry-level prediction on how much HME there is in industry z.

HX (2004): 2-country model

- Can then derive the following intuitive results (where T and C are meant to make you think of 'treatment' and 'control'):

  1. Say that there is a larger HME in industry T than in C iff $n_H(T)/n_F(T) > n_H(C)/n_F(C) > L_H/L_F$, where n is the number of varieties (recall that with CES the output per variety is the same everywhere, so counting varieties is what matters).

  2. Then, if industries T and C are such that $\tau(C)^{1-\sigma(C)} = \tau(T)^{1-\sigma(T)}$, but $\sigma(C) > \sigma(T)$ then there will be a larger HME in industry T than in C.

  3. Likewise, if industries T and C are such that $\tau(C)^{1-\sigma(C)} = \tau(T)^{1-\sigma(T)}$, but $\tau(C) < \tau(T)$ then there will be a larger HME in industry T than in C.

HX (2004): N-country model

- HX (2004) then consider an N-country model, with a discrete number of industries.
  - The only other modification is to write trade costs (from country j to country k in industry k) as: $\tau^i_{jk} = t^i_{jk}(d_{jk})^{\gamma_i}$, where t^i_{jk} is the tariff on this trade and d_{jk} is the distance between j and k.
- They then show the following (which is a simple matter of writing down CES demand functions and substituting in the very simple supply side of a Krugman (1980) model):

$$\frac{S^T_{jk}/S^T_{hk}}{S^C_{jk}/S^C_{hk}} = \frac{n^T_j/n^T_h}{n^C_j/n^C_h}\frac{(w^T_j/w^T_h)^{1-\sigma_T}}{(w^C_j/w^C_h)^{1-\sigma_C}}(d_{jk}/d_{hk})^{(1-\sigma_T)\gamma_T-(1-\sigma_C)\gamma_C}$$

HX (2004): N-country model

$$\frac{S_{jk}^T/S_{hk}^T}{S_{jk}^C/S_{hk}^C} = \frac{n_j^T/n_h^T}{n_j^C/n_h^C}\frac{(w_j^T/w_h^T)^{1-\sigma_T}}{(w_j^C/w_h^C)^{1-\sigma_C}}(d_{jk}/d_{hk})^{(1-\sigma_T)\gamma_T-(1-\sigma_C)\gamma_C}$$

- Here, S_{jk}^T is the total sales (ie exports) of country j to country k in industry T, and w is the wage (or more generally the total factor input cost...but doing this properly with more than one factor is hard).
- The industries T and C are deliberately chosen to be 2 industries with differing σ and/or τ such that they satisfy the conditions in the 2 results above.
- Note that tariffs dropped out, by differencing and then differencing—that is, by making this a comparison of country j's exports to k relative to country h's exports to k (the first difference), and then all of this in industry T relative to industry C (the second difference).

HX (2004): Empirical Specification

- Finally, they argue that because the 2-country model said that $L_j > L_h \Rightarrow \frac{n_j^T / n_h^T}{n_j^C / n_h^C}$, it is plausible that they can run the following regression:

$$\ln\left(\frac{S_{jk}^T / S_{hk}^T}{S_{jk}^C / S_{hk}^C}\right) = \alpha + \beta f(Y_j / Y_h) + \phi(X_j - X_h) + \theta \ln(d_{jk} / d_{hk}) + \varepsilon_{TCjkh} \tag{1}$$

- Here, the model prediction is that $\beta > 0$.
- And $\phi(X_j - X_h)$ denotes a set of controls for cost differences between countries j and h.
- It's not clear how all of this follows from the 2-country model, let alone a fully-fledged N-country model.

HX (2004): Results

TABLE 5—DIFFERENCE-IN-DIFFERENCE GRAVITY EQUATION, POOLED SAMPLE OF INDUSTRIES

Independent variables	(1)	(2)	(3)	(4)
ln(GDP)	0.420		0.420	
	(3.46)		(3.45)	
$\ln(GDP)^2$	0.026			
	(0.72)			
GDP − 1		0.105		0.104
		(1.71)		(4.40)
$(GDP - 1)^2$		0.000		
		(−0.03)		
Distance	−0.273	−0.264	−0.275	−0.264
	(−5.01)	(−4.95)	(−5.07)	(−4.99)
Common language	−0.420	−0.346	−0.422	−0.345
	(−3.39)	(−2.65)	(−3.34)	(−2.81)
Common border	0.888	0.811	0.893	0.811
	(10.33)	(8.91)	(10.13)	(9.13)
Capital/worker	1.697	1.819	1.699	1.819
	(4.62)	(4.53)	(4.69)	(4.49)
Wage in low-skill industries	−1.897	−1.730	−1.901	−1.729
	(−8.37)	(−7.33)	(−8.35)	(−8.00)
Area/population	0.253	0.160	0.243	0.159
	(2.43)	(1.97)	(2.32)	(2.12)
Average education	−3.090	−3.492	−3.139	−3.496
	(−7.03)	(−7.95)	(−7.22)	(−8.88)
Constant	−0.260	−0.308	−0.191	−0.306
	(−1.80)	(−2.13)	(−1.51)	(−2.44)
R^2	0.077	0.074	0.077	0.074

Notes: This table shows estimation results for the specification in equation (11), in which the dependent variable is, for a pair of countries, log relative exports in a treatment industry minus log relative exports in a control industry. GDP is the GDP ratio for a country pair. Other variables are expressed as differences (Common language, Common border) or log differences (all other variables) for a country pair. *T*-statistics (calculated from standard errors that have been adjusted for correlation of the errors across observations that share the same pair of exporting countries) are in parentheses. The sample is exports by 107 country pairs to 58 importing countries pooled across the 273 treatment-control industry matches in the data (N = 1,396,395).

Other work on the HME

- Head and Ries (AER, 2001):
  - Studying which firms expanded and contracted in Canada around NAFTA.
- Behrens , Lamorgese, Ottaviano and Tabuchi (2009):
  - Point out that extending Krugman (1980) from 2 to N countries is hard, and that the simple HME doesn't survive.
  - This also casts doubt on Hanson and Xiang (2004) extension from 2 to N countries.

Plan of Today's Lecture

1. Introduction
2. **Discussion of various pieces of evidence for (the importance of) increasing returns in explaining aggregate trade flows:**
   - 2.1 Intra-industry trade.
   - 2.2 Preponderance of North-North trade.
   - 2.3 The impressive fit of the gravity equation.
   - 2.4 The importance of market access for determining living standards.
   - 2.5 The home market effect.
   - 2.6 **Path dependence.**

Test 6: Path Dependence

- Under certain conditions, models of IRTS can generate path dependence: initial, random advantage can become permanent.
  - This is what happens when the HME (in Krugman 1980) is combined with factor mobility (as Krugman (JPE, 1991) did to great effect).
- Tests of path dependence (have been contradictory!):
  - Davis and Weinstein (AER, 2002): Did city population shares in Japan return to normal after WWII bombing? Yes.
  - Davis and Weinstein (JRS, 2008): Did city-by-industry manufacturing output/employment shares do the same? Yes.
  - Bleakley and Lin (2010): Is current US population clustered in places that have natural resources that were *previously* productive, but are no longer of any productive use? Yes.

Davis and Weinstein (2002)

The big two returned to normal

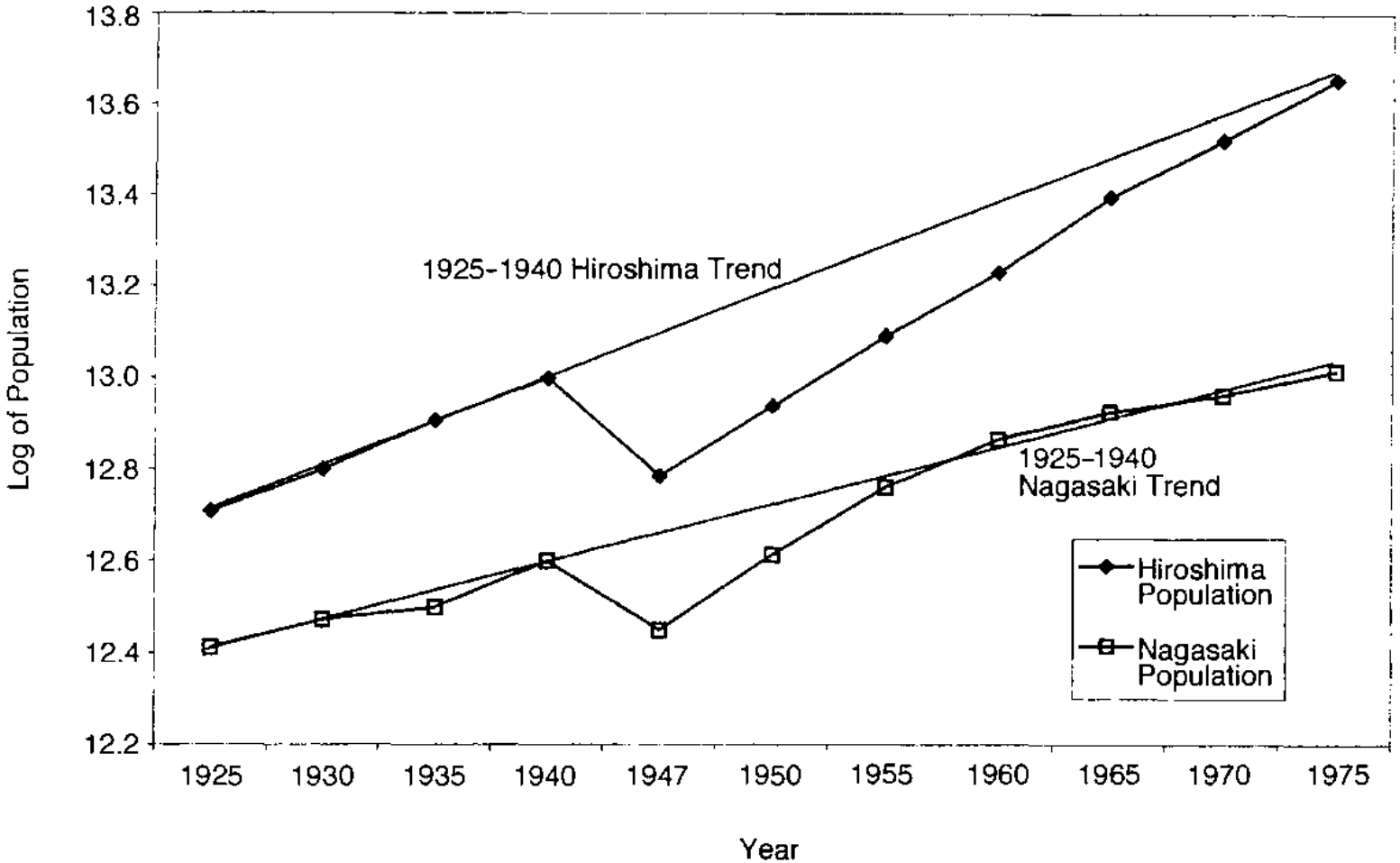


FIGURE 2. POPULATION GROWTH

Davis and Weinstein (2002)

And in general, we see mean reversion (ie the opposite of path dependence)

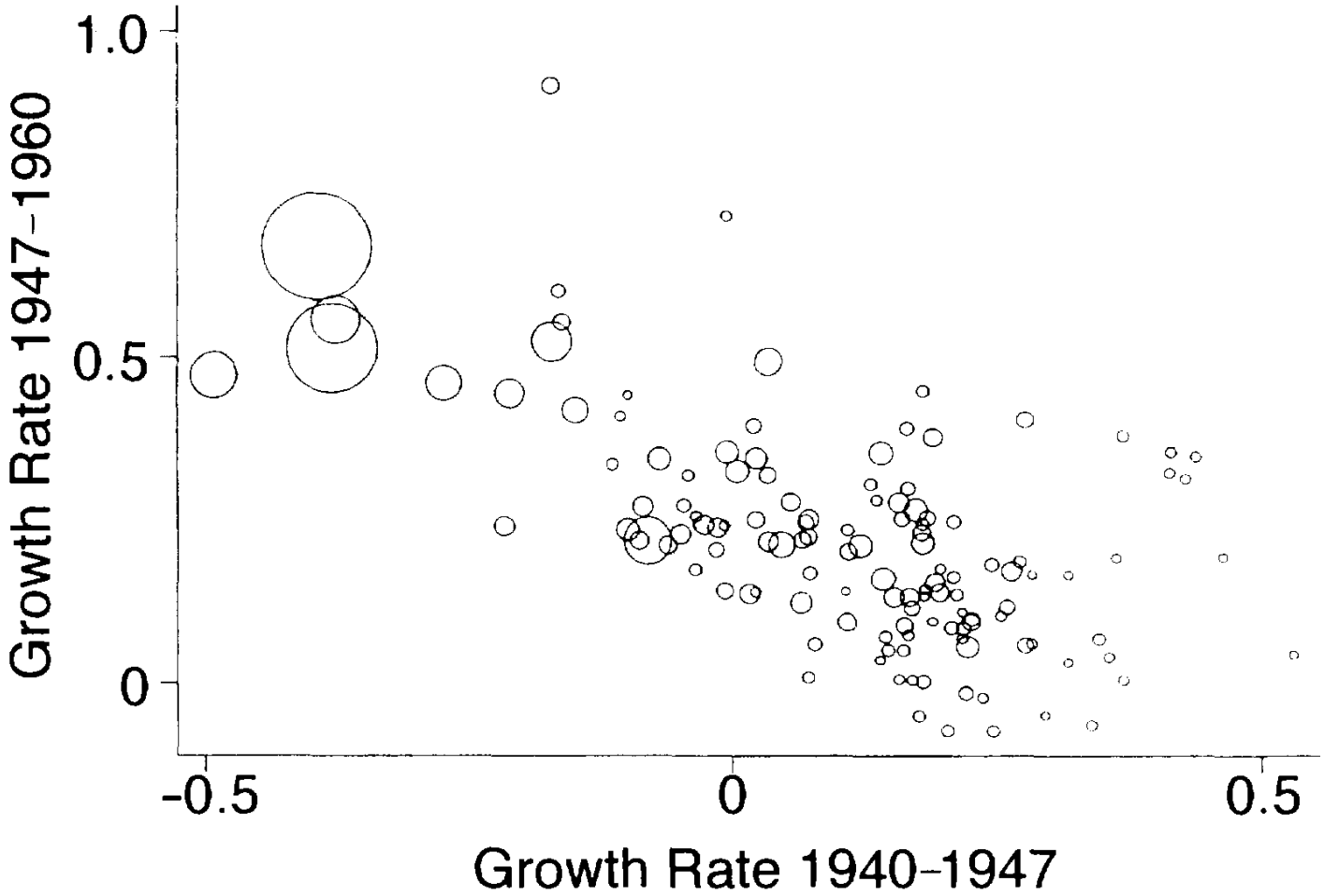


FIGURE 1. EFFECTS OF BOMBING ON CITIES WITH MORE THAN 30,000 INHABITANTS

Davis and Weinstein (2008)

Mean reversion in industry output

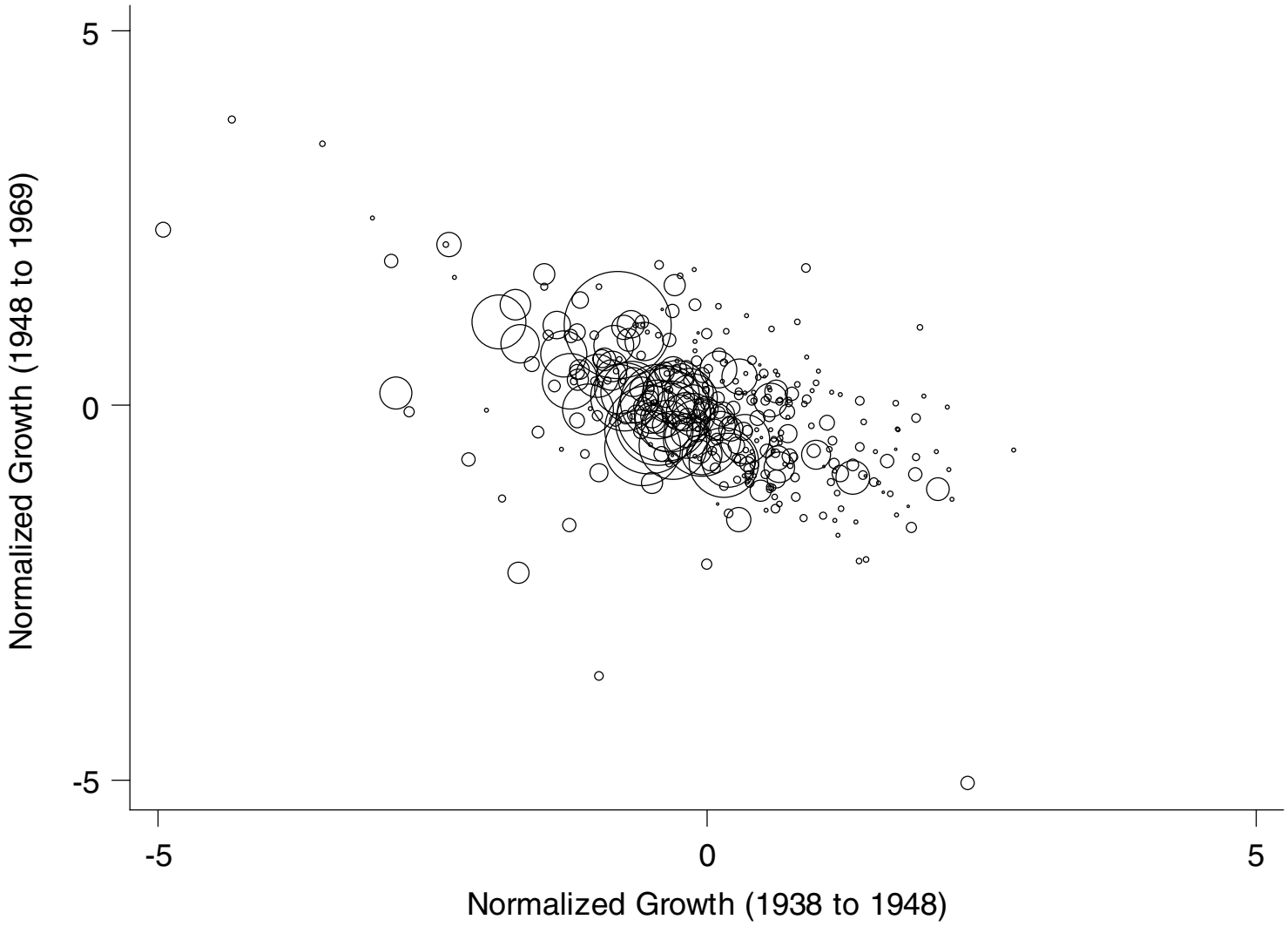


FIGURE 7: Mean-Differenced Industry Growth Rates.

Davis and Weinstein (2008)

Mean reversion in industry output

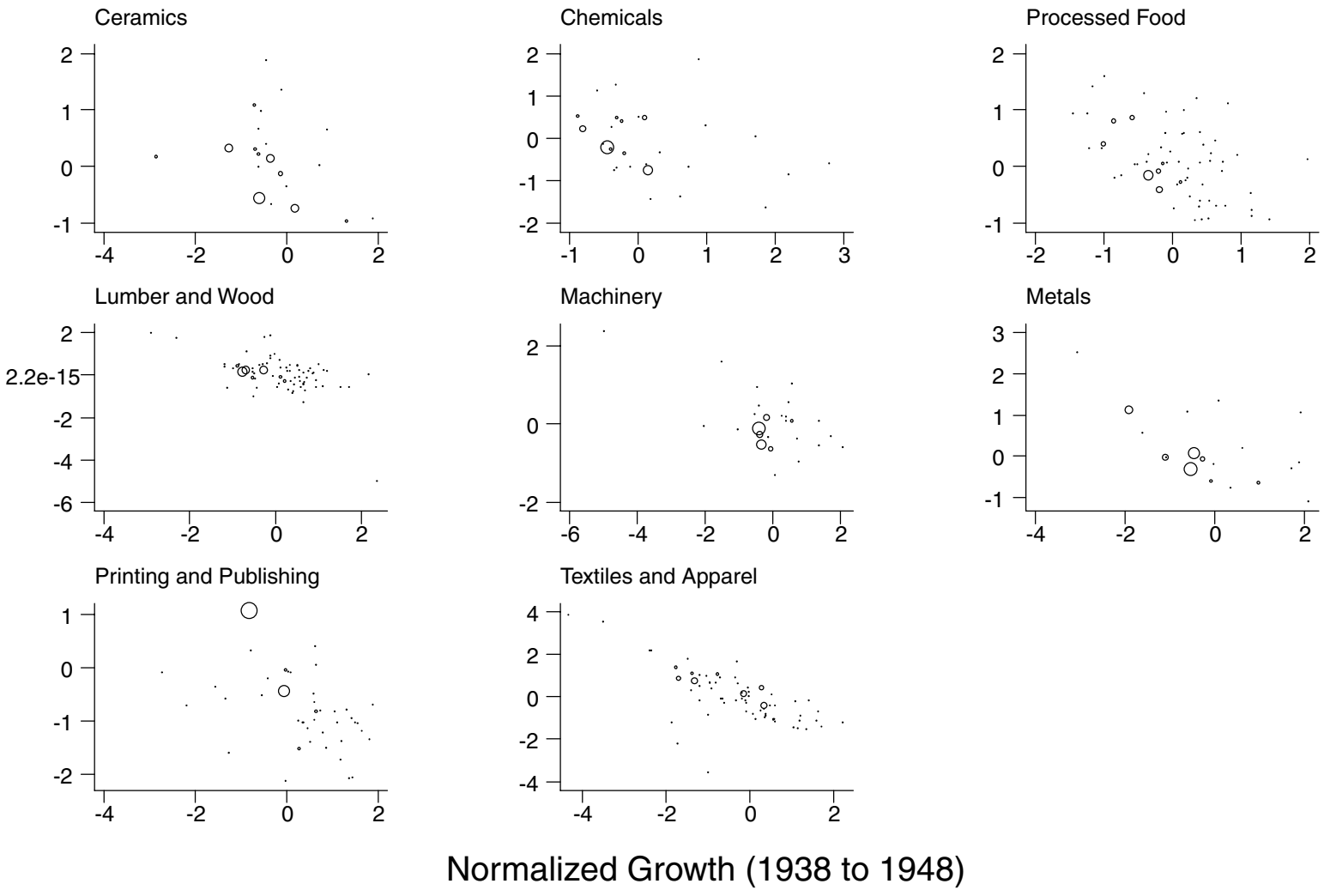
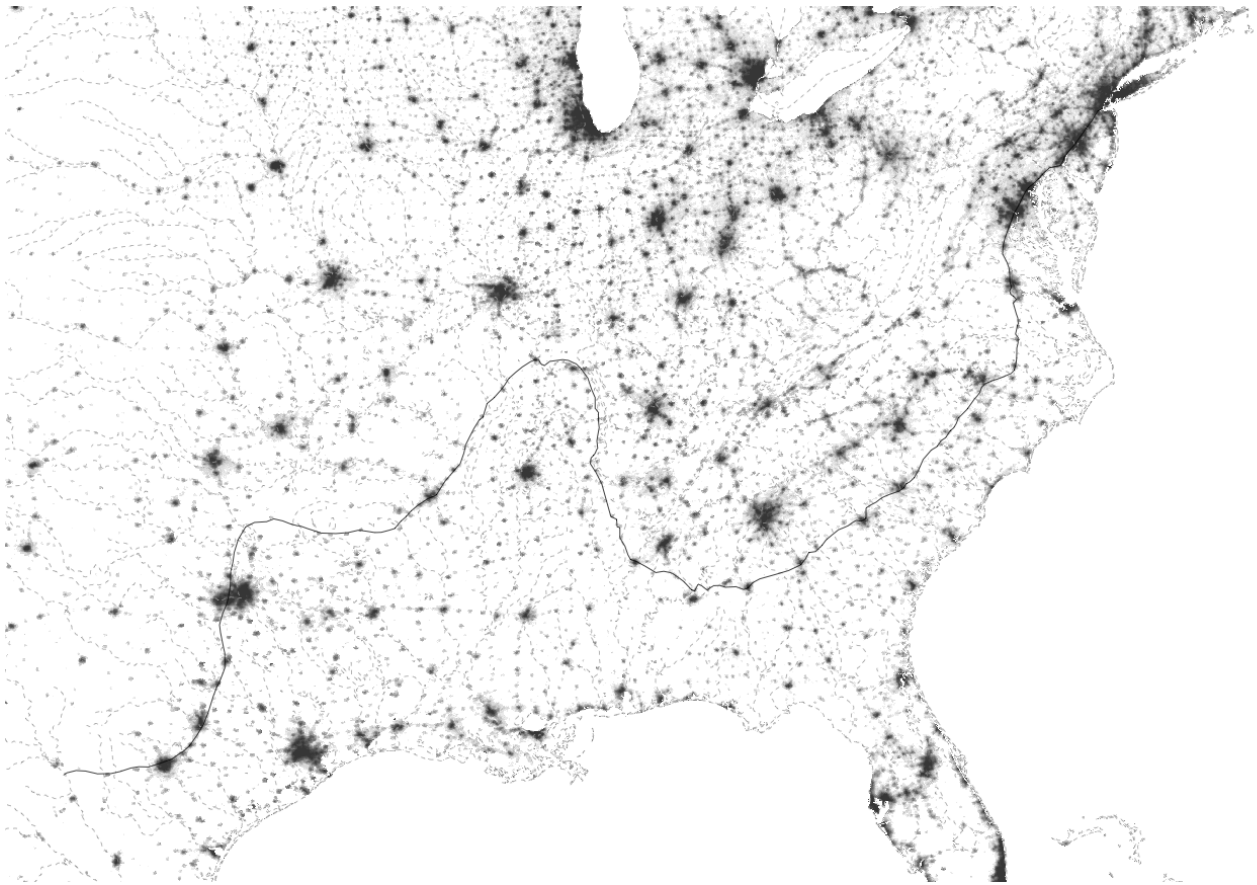


FIGURE 8: Prewar vs Postwar Growth Rate.

Bleakley and Lin (2010)

The 'fall line' is a geological feature. If one were traveling upstream from the ocean prior to the use of locks/canals, it the first point at which one would have had to engage in 'portage' (ie unload the boat and re-load a different boat upstream).

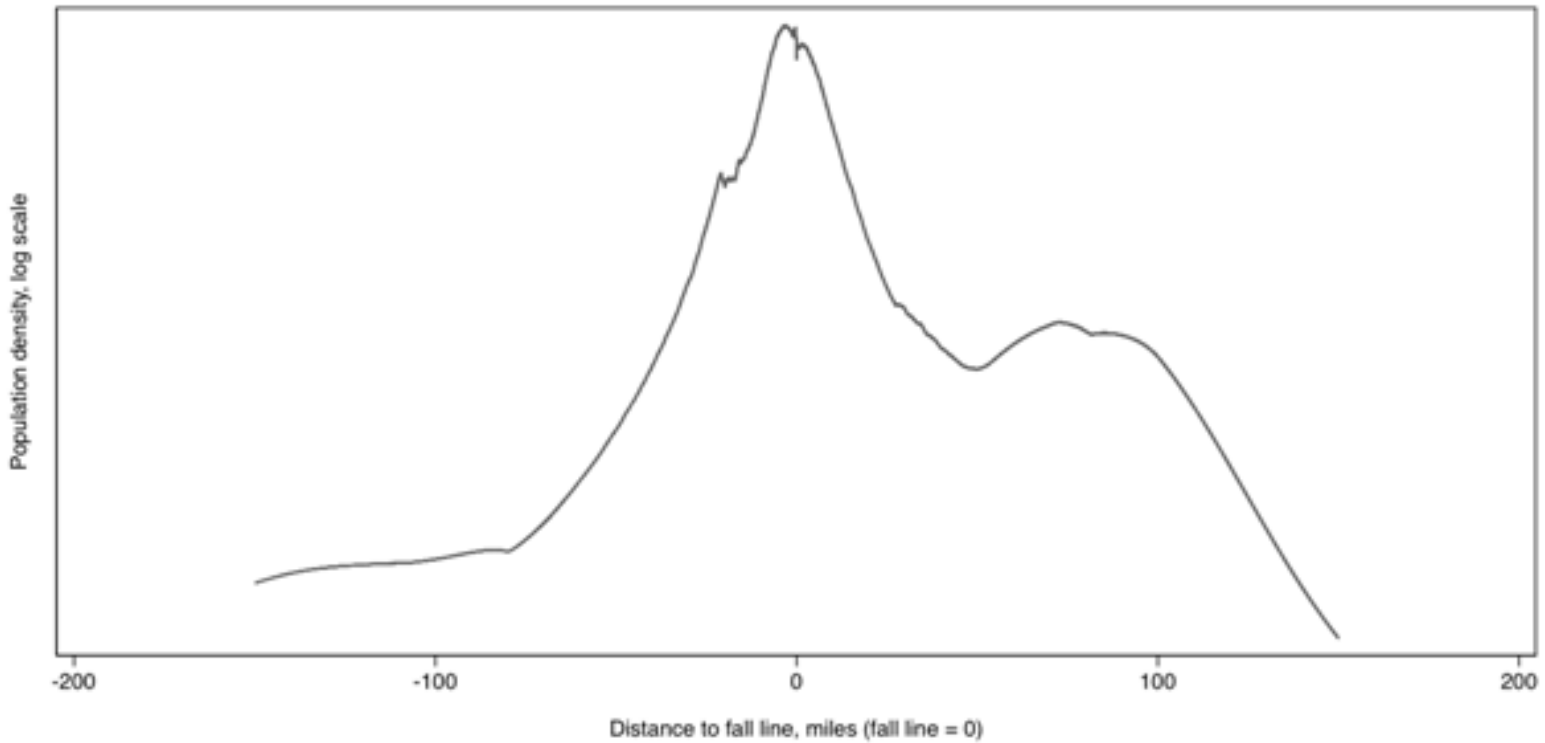
Appendix Figure A: The density of economic activity near intersections between the fall line and fall-line rivers



Notes: this map shows the contemporary distribution of economic activity across the southeastern U.S., measured by the 1996-7 nighttime lights layer from NationalAtlas.gov. The nighttime lights are used to present a nearly continuous measure of present-day economic activity at a high spatial frequency. The fall line (solid) is digitized from *Physical Divisions of the United States*, produced by the U.S. Geological Survey. Major rivers (dashed gray) are from NationalAtlas.gov, based on data produced by the U.S. Geological Survey. Many fall line-river intersections lie in present-day metropolitan areas, including (from the northeast) New Brunswick, Trenton, Philadelphia, Washington, Richmond, Fayetteville, Columbia, Augusta, Macon, Columbus, Tuscaloosa, Little Rock, Fort Worth, Austin, and San Antonio.

Bleakley and Lin (2010)

Panel A: Average by absolute distance from the fall line



14.581 International Economics I

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