MIT 14.662 Spring 2018: Lecture 9 and 10 – Trade and Labor Markets: Ricardian Models + Empirical Evidence

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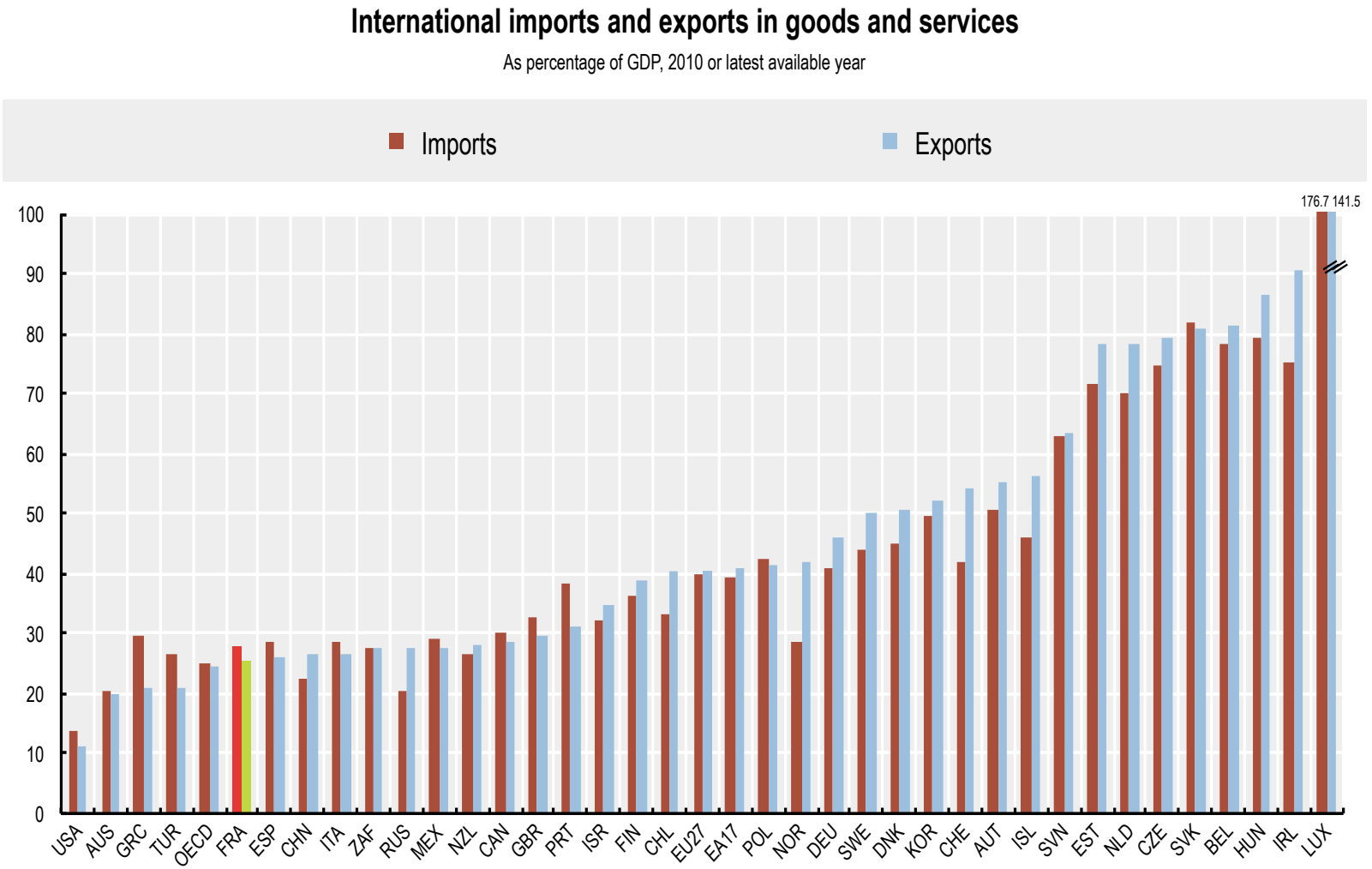
Agenda

1. **Some motivating facts**
2. **The Ricardian Model**
   - Ricardo's two-by-two model
   - The chain of comparative advantage
   - A continuum of goods
   - Trade costs
   - Adding more countries
3. **Putting Ricardo to Work**
4. **Connecting Trade Flows to Labor Markets**
5. **Evidence from the 'China Shock'**

Some Key Stylized Facts about International Trade

1. Large countries trade less relative to GDP
2. All countries import more from larger countries
3. Trade between countries diminishes with distance
4. Prices vary across locations, with greater price differences between countries that are further apart

Large Countries Trade Less as a Share of GDP



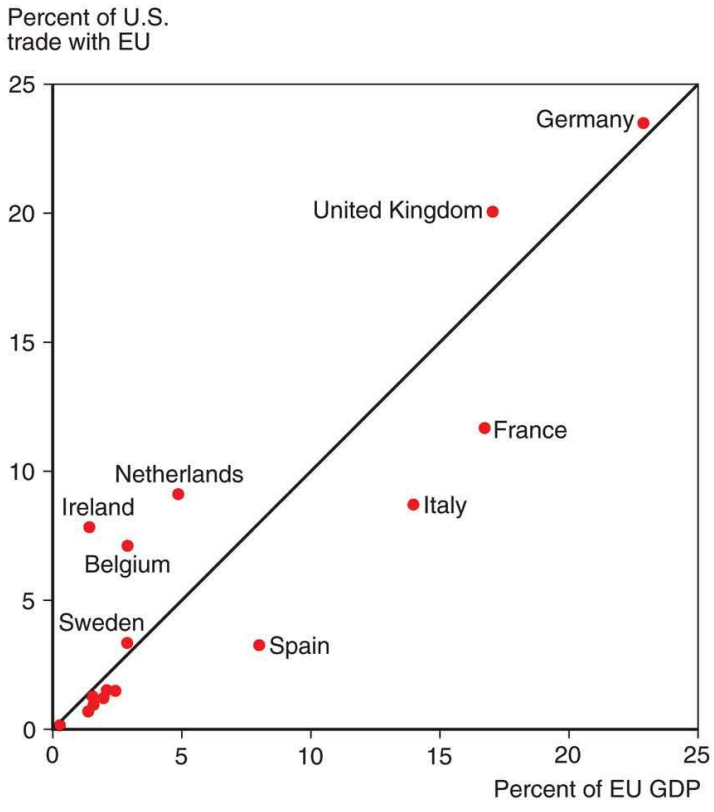
Countries Import More from Larger Countries

Countries' Percent of U.S. Trade with EU versus Countries' Percent of EU GDP

Figure 2-2

The Size of European Economies, and the Value of Their Trade with the United States

Source: U.S. Department of Commerce, European Commission.



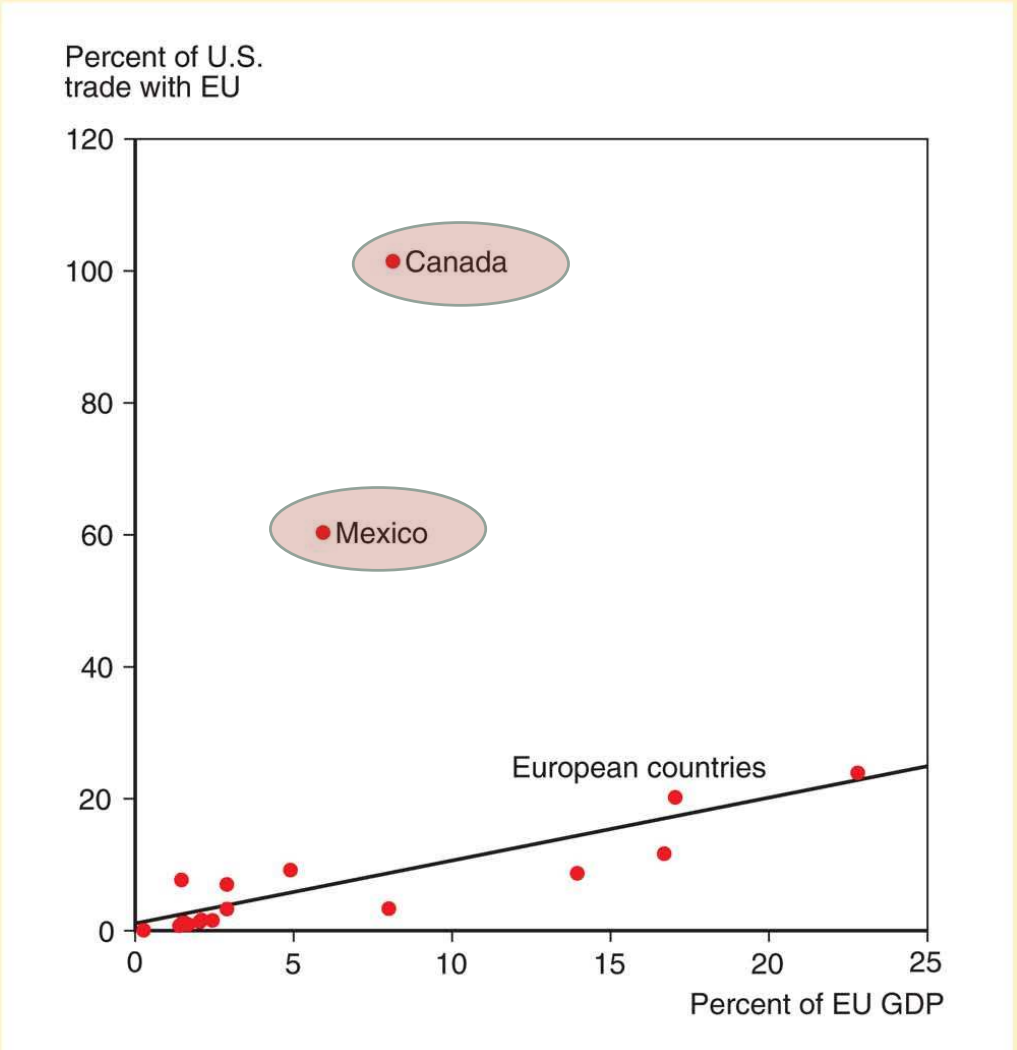
Countries Trade More with their Neighbors

Figure 2-3

Economic Size and Trade with the United States

The United States does markedly more trade with its neighbors than it does with European economies of the same size.

Source: U.S. Department of Commerce, European Commission.



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What do we Want to Get Out of this Model?

Basic

1. Why do large countries trade less relative to GDP?
2. Why do all countries import more from larger countries?
3. Why does trade between countries diminishes with distance?
4. Why do prices vary across locations, with greater price differences between countries that are further apart?

Deeper

1. How do productivity differences affect trade flows?
2. How does productivity growth in one country affects labor markets in others?
3. Why do countries buy more from themselves than others?
4. What are the economic consequences of trade deficits?
5. How large are the gains from trade?

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Two-by-Two Example

Ricardo imagined two countries making two goods each

- **Example**: Brazil and Costa Rica trading sugar and coffee

Labor required per 100 kilos		
	Brazil	Costa Rica
Coffee	100	120
Sugar	75	150

- Brazil has an absolute advantage in both activities
- Brazil has comparative advantage in Sugar
- Assume that the world relative price of coffee and sugar is 1

$$\left(\frac{P_s^B}{P_c^B} = \frac{75}{100}\right) < \left(\frac{P_s^{CR}}{P_c^{CR}} = \frac{150}{120}\right)$$

Two-by-Two Example

Labor required per 100 kilos		
	Brazil	Costa Rica
Coffee	100	120
Sugar	75	150

- Assume that the world relative price of coffee and sugar is 1

$$\left(\frac{P_s^B}{P_c^B} = \frac{75}{100}\right) < \left(\frac{P_s^W}{P_c^W} = 1\right) < \left(\frac{P_s^{CR}}{P_c^{CR}} = \frac{150}{120}\right)$$

- Brazil will export sugar and Costa Rica will export Coffee
- Brazil gets 100 kilos of Coffee with only 75 units of labor (instead of 100)
- Costa Rica can get 100 kilos of Sugar for only 120 units (instead of 150)

Two-by-Two Example

Even this simple example has holes. What's the equilibrium?

1. Brazil produces only sugar and Costa Rica produces only coffee (complete specialization)
2. Brazil produces only sugar and Costa Rica produces both goods (incomplete)
3. Costa Rica produces only coffee and Brazil produces both good (incomplete)

Two-by-Two Example

With incomplete specialization...

- Relative prices of goods must meet market clearing conditions within a country
- If Brazil produces both goods, marginal product of Brazilian labor must be equated in coffee and sugar (as in H-O)
- Once those prices pinned down, we have to check whether consumer demands are consistent with market clearing
- If not, we've got to check alternative cases

The model is clunky even in this barebones case

- It is not going to get prettier when we add more goods and more countries

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The Chain of Comparative Advantage

Rather than assume $P_s/P_c = 1$, normalize $w_B = 1$

- Determine the wage in Costa Rica, w_{CR} that is consistent with equilibrium

If trade occurs

- World price of coffee and sugar equated in both countries in purchasing power terms
- Write these prices as $p(c)$ and $p(s)$, and invoke cost minimization
- $p(c) = \min\{120w_{CR}, 100w_B\}$, $p(s) = \min\{150w_{CR}, 75w_B\}$

Implies that

1. $w_{CR} \geq 0.50$: Costa Rica's sugar price equals Brazil's, $150w_{CR} = 75w_B \Rightarrow w_{CR} = \frac{75}{150} = 0.5$
2. $W_{CR} \leq 0.83$: Costa Rica's coffee price equals Brazil's $120w_{CR} = 100w_B \Rightarrow w_{CR} = \frac{100}{120} = 0.83$
3. Since CR has an absolute disadvantage, must be that $w_{CR} < 1$, but that's already implied

The Chain of Comparative Advantage

Extend to many goods

- Write unit labor requirements as $a_B(c), a_B(s)$ and $a_{CR}(c), a_{CR}(s)$ for Brazil and Costa Rica
- Since Brazil has a comparative advantage in sugar, write

$$\frac{a_B(c)}{a_B(s)} > \frac{a_{CR}(c)}{a_{CR}(s)}$$

The Chain of Comparative Advantage

Chain of comparative advantage

$$\frac{a_B(c)}{a_B(s)} > \frac{a_{CR}(c)}{a_{CR}(s)}$$

- Series of inequalities that express the comparative advantage in one country relative to the other
- An equilibrium is the w that breaks the chain
  - One set of goods is produced in Brazil, another in Costa Rica.
  - At most one good can be produced in common
  - Occurs if at wage w, Brazil and Costa Rica have identical costs for producing the marginal good j
- Note that this set of inequalities is insufficient to pin down the equilibrium—need further assumptions on demands and endowments

The Chain of Comparative Advantage

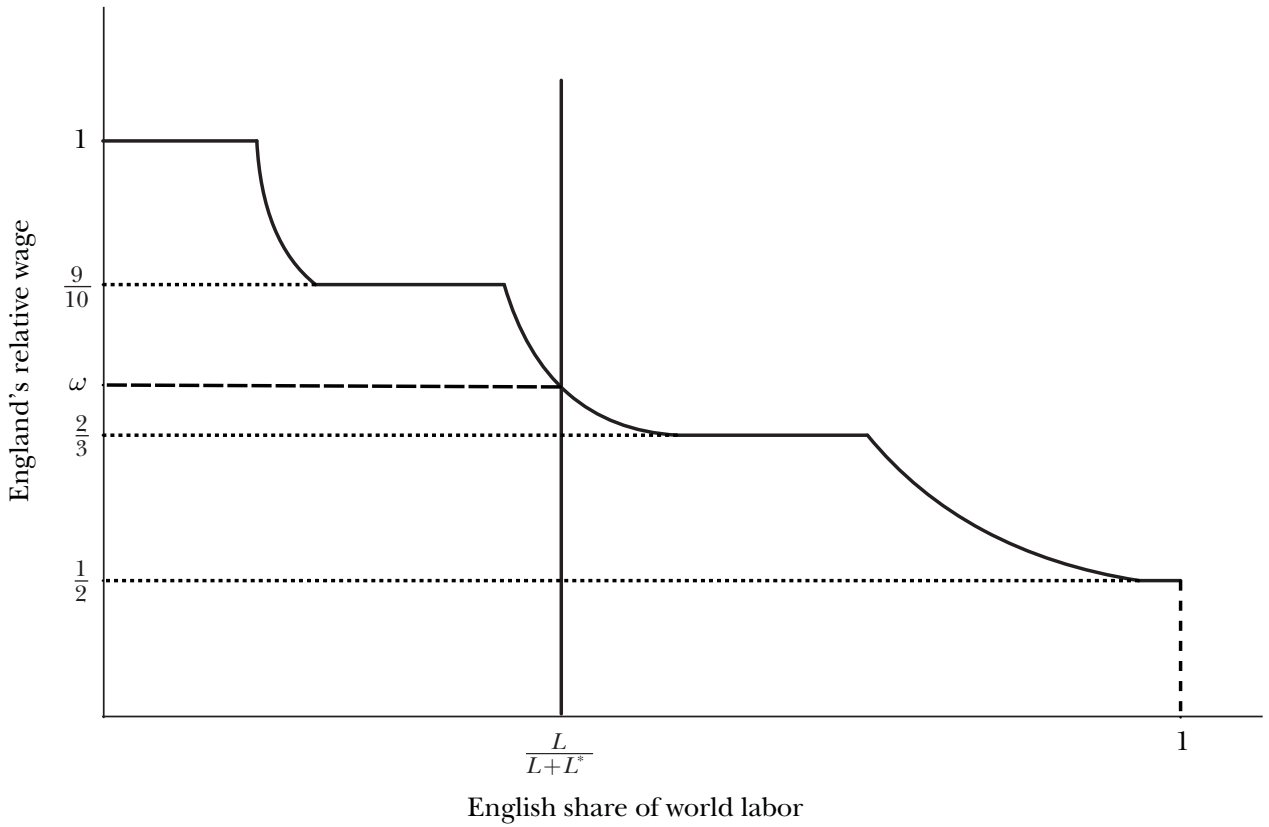
Useful observation

- The demand curve with a finite number of goods will be non-smooth
- In regions where the cost of the marginal good j is the same in the two comparison countries, demand for labor is perfectly elastic in each country because j can be produced in either country at same cost

Wage Determination in the Many Good Model

Figure 1

Wage Determination in the Many Good Model



Source: Authors.

Note: The solid downward-sloping line is the relative demand curve for English labor, and the solid vertical line is the relative supply curve for English labor.

Eaton and Kortum 2012

The Chain of Comparative Advantage

Thought experiment illustrates how messy this is

1. England and Costa Rica trading
2. England's share of world labor supply expands such that it begins to take over production of additional goods
3. In the region where England and Costa Rica are producing the same good, demand for labor is perfectly elastic—so output expansions have no wage effects
4. When England takes over production of the marginal good entirely—so the two countries produce no goods in common—labor demand elastic again
5. The more of the original j good that England produces, the more its price falls
6. If labor supply expands England now competitive in next good, j'
7. Then labor demand hits another flat spot

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A Continuum of Goods

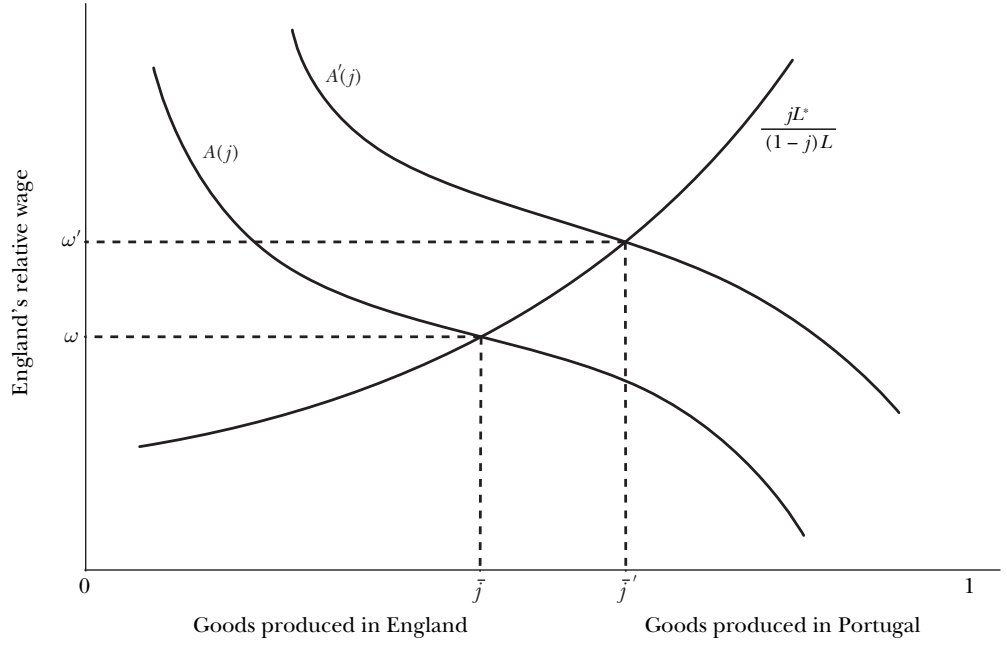
Problem with 'the chain' is that comparative statics are a mess

- Dornbusch, Fischer, Samuelson *AER* 1977: Continuum of goods
- Goods j arrayed on the unit interval $j \in [0, 1]$ where
  - The ratio $A(j) = a_E(j) / a_{CR}(j)$ is non-increasing in j
  - $A(j)$ is smooth and strictly decreasing
  - Thus, England's comparative advantage is rising in the index j
- Here, chain of comparative advantage has no flat spots—always a marginal good that is equally costly to produce in both countries.
- If $w_{CR} = 1$, the marginal good $\bar{j}$ satisfies

$$w_E \cdot a_E(\bar{j}) = w_{CR} a_{CR}(\bar{j}) = a_{CR}(\bar{j})$$
$$w_E = a_{CR}(\bar{j}) / a_E(\bar{j})$$

Wage Determination with a Continuum of Goods

Wage Determination with a Continuum of Goods



Source: Authors.
Notes: On the *x*-axis is a continuum of goods from 0 to 1 with England having the strongest comparative advantage in goods nearer 0 and Portugal in goods nearer 1. England produces the goods from 0 to $\bar{j}$. Portugal produces the goods from $\bar{j}$ through 1. The figure illustrates how a shift up in the productivity curve $A(j)$, meaning that England gets relatively more productive at making every good, raises England's relative wage ω and expands the share of goods it produces. A partial derivation for the equation describing the upward-sloping curve is provided in footnote 2.

Eaton and Kortum 2012

If England becomes more productive, England's share of goods produced rises, wage in England rises

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Adding Trade Costs

How do we know that trade costs matter?

1. Most countries consume a disproportionate share of their own output
2. Distant countries trade less with one another
3. Remote countries trade less with everyone

Adding Trade Costs

DFS modeled these phenomena with 'iceberg' transportation costs

- A fraction of cargo decays (melts) in transit
- Amount of decay is proportional to transit time or distance

Formally, DFS assume

- Delivering one unit of a good from country i to k requires shipping $d_{ik} > 1$ units of the good
- d_{ik} differs among country pairs
- Usually assumed that d does not differ among goods *within* a country pair, but this can be relaxed
- Triangle inequality: $d_{ik} \times d_{km} \geq d_{im}$ (a no-arbitrage condition)

Adding Trade Costs

Trade costs are crucial for realism

- With non-zero trade costs, 'perfect' competition is still consistent with heterogeneous prices for each good
- Same good can have different prices in different markets
- Low-cost producer of a good for one country may not be the low-cost producer for another country

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Adding More Countries

Okay, we need to add more countries—two is not going to cut it

- Imagine many goods and many countries
- *You wouldn't expect the continuity/ranking assumptions to hold for many countries*
- (See Jones 1961, *IER* for formal proof)

Adding more countries with no chain of comparative advantage...

- We're back in the guess-and-check world

DFS trick doesn't pass the laugh test

- You can't just assume a 'continuum' of countries
- See https://www.youtube.com/watch?v=3q_iqrvnC_4 (minute 1:48): "There are probably *hundreds* of countries in the world..."

A Probabilistic Approach...

Here's the trick (Eaton-Kortum '02 Ecma)

- Assume a continuum of goods $j \in [0, 1]$
- Assume an integer number of countries $i = 1, 2, ..., I$
- Allow the productivity of each industry j in each country i to be a *probabilistic* draw
- With well-chosen functional forms, this reintroduces smoothness to many-goods, many-country setting

So it's like the DFS trick (continuum of goods) for the 21st century

A Probabilistic Approach...

1. Countries $i = 1, 2, ..., I$
2. Goods $j \in [0, 1]$
3. Iceberg transport costs
   - $d_{ii'} > 1$ and $d_{ii} = 1$ and $d_{ii''} < d_{ii'} \times d_{i'i''}$
4. Unit labor requirements for good i in country j are $a_i(j)$
5. Draws of $a's$ are Fréchet

A Probabilistic Approach...

Draws of $a's$ are Fréchet

$$\Pr\left[a_i\left(j\right) < x\right] = 1 - e^{-\left(A_i x\right)^{\theta}}$$

- Where A_i is country $i's$ overall productivity level (it's TFP) and $\theta > 1$ **is the dispersion of draws**
  - Low $\theta \rightarrow$ high dispersion $\rightarrow$ large role for *comparative advantage*
  - High $\theta \rightarrow$ low dispersion $\rightarrow$ large role for *price competition*
- In reality, it's *all price competition*
  - High dispersion of $a's$ means some $a_i\left(j\right)'s$ *much better* than others
  - If so, small price $\Delta's$ have little effect on $ij's$ market share
  - Thus dispersion and elasticity are inverses

The Price Distribution: What Price do Countries Pay for Each Good?

What price do countries pay for each good?

- Let w_i equal the labor cost in country i
- The cost of producing good j in country i and delivering it country n is

$$c_{ni}(j) = a_i(j) w_i d_{ni}$$

- The price that country n pays for j is of course the **minimum** of all prices available to it

$$c_n(j) = \min\{c_{ni}(j)\}$$

With non-zero trade costs that differ among country pairs, the *price for a good j will vary across countries*

The Price Distribution

The cumulative distribution of the cost of good j produced in country i and offered in country n is given by

$$\Pr\left[c_{ni}\left(j\right) < c\right] = 1 - e^{-\left(cA_i/w_i d_{ni}\right)^{\theta}}$$

The *cumulative* distribution of prices for good j that country n faces across *all* supplier countries is

$$\begin{aligned}\Pr\left[p_n\left(j\right) < p\right] &= 1 - \prod_i \Pr\left[c_{ni}\left(j\right) > p\right] \\ &= 1 - e^{-\left(\bar{A}_n p\right)^{\theta}} \\ \text{where } \bar{A}_n &= \left[\sum_{i=1}^{I}\left(A_i/w_i d_{ni}\right)^{\theta}\right]^{\frac{1}{\theta}}\end{aligned}$$

The term $\bar{A}_n$ is a country specific purchase price parameter

The Price Distribution

$\bar{A}_n$ is a country specific purchase price parameter

$$\bar{A}_n = \left[\sum_{i=1}^{I} \left(A_i / w_i d_{ni} \right)^{\theta} \right]^{\frac{1}{\theta}}$$

Higher $\bar{A}_n$ corresponds to a lower price index

- A country's PPP is rising in its $\bar{A}_n$

Shows how three forces govern prices in each country n

1. States of technology around the world: $A's$
2. Input costs around the world: $w's$
3. Trade barriers with each country: $d's$

The Price Distribution

Trade enlarges each country's effective technology frontier

$$\bar{A}_n = \left[\sum_{i=1}^{I} \left(A_i / w_i d_{ni} \right)^{\theta} \right]^{\frac{1}{\theta}}$$

- $\bar{A}_n$ reflects technology available from all other countries to n discounted by input costs and geographic barriers

  1. In a world with no geographic barriers ($d_{ni} = 1$ for all n and i), $\bar{A}_n$ is the same everywhere $\rightarrow$ law of one price holds for each good
  2. At the other extreme of autarky ($d_{ni} \rightarrow \infty$ for $n \neq i$), $\bar{A}_n$ reduces to A_n / w_n, country n's own state of technology, down-weighted by its input cost

Adding Preferences $\rightarrow$ Purchasing Power

Simplest case (WLOG): Preferences are symmetric Cobb-Douglas, with equal shares on all goods

- Ideal price index for each country n is geometric mean of price distribution

$$\rho_n = \frac{\gamma}{\bar{A}_n} \text{ with } \bar{A}_n = \left[\sum_{i=1}^{I} \left(A_i / w_i d_{ni}\right)^{\theta}\right]^{\frac{1}{\theta}}$$

  where $\gamma = e^{-\epsilon/\theta}$ and ϵ is Euler's constant

- *Lower* values of ρ_n mean higher purchasing power
- $\bar{A}_n$ enters inversely, a higher value of $\bar{A}_n$ corresponds to *higher* purchasing power

Purchasing Power

WLOG: preferences are symmetric Cobb-Douglas, with equal shares on all goods

- Ideal price index for each country n is geometric mean of price distribution

$$\rho_n = \frac{\gamma}{\bar{A}_n} \text{ with } \bar{A}_n = \left[\sum_{i=1}^{I} \left(A_i / w_i d_{ni}\right)^{\theta}\right]^{\frac{1}{\theta}}$$

- Factors that raise $\bar{A}_n$ (lowering ρ_n) are
  - Higher own-productivity (A_i)
  - Lower bilateral trade costs (d_{ni})
  - Lower input costs (w_i)
  - Lower θ, reflecting greater productivity dispersion—greater comparative advantage—among countries (recall $\theta > 1$)
- Model delivers PPP differences as a function of primitives: technologies, costs, trade frictions

Who Buys What from Whom?

Who buys what from whom?

- Probability π_{ni} that country i is the lowest cost supplier of any specific good j to country n is

$$\pi_{ni} = \Pr\left[c_{ni}(j) = p_n(j)\right] = \left(\frac{A_i / w_i d_{ni}}{\bar{A}_n}\right)^{\theta}$$

  not subscripted by j because probability does not differ across goods
- With a continuum of goods, π_{ni} is also the share of all goods consumed in n that are supplied by i
- Higher world productivity (higher $\bar{A}_n$) lowers probability that country i is low cost producer of j for country n
- θ is trade elasticity with respect to w_i or d_{ni}

$$\frac{\partial \ln \pi_{ni}}{\partial \ln d_{ni}} = -\theta$$

Expenditure

1. With a continuum of goods, π_{ni} is also the share of all goods consumed in n that are supplied by i
2. Due to exponential distribution, expected value of conditional and unconditional distribution of draws are identical
    - Thus, expected price of goods does not vary by source conditional on purchase

- Implication of (1) and (2) is that π_{ni} is also the fraction of n's expenditure spent on goods from i
- Let X equal expenditure. Country $n's$ **share** of total expenditure on goods produced in country i is

$$\pi_{ni} = \frac{X_{ni}}{X_n} = \left(\frac{A_i / w_i d_{ni}}{\bar{A}_n} \right)^{\theta}$$

Sales, Imports, and Exports

- Country $n's$ share of total expenditure on goods produced in country i

$$\pi_{ni} = \frac{X_{ni}}{X_n} = \left(\frac{A_i / w_i d_{ni}}{\bar{A}_n} \right)^{\theta}$$

- Now let's consider country $i's$ sales to all countries m including itself

$$\begin{aligned} X_i &= \sum_m X_m \pi_{mi} \\ &= \sum_m X_{mi} = \left(\frac{A_i}{w_i} \right)^{\theta} \sum_{m=1}^{N} \frac{d_{mi}^{-\theta} X_m}{\bar{A}_m^{\theta}} \end{aligned}$$

Sales, Imports, and Exports

- Country i's total sales X_i to all countries m (including itself)

$$X_i = \sum_n X_{ni} = \left(\frac{A_i}{w_i}\right)^{\theta} \sum_{n=1}^{N} \frac{d_{ni}^{-\theta} X_n}{\bar{A}_n^{\theta}}$$

- Solve for X_{ni} , **exports from** i **to** n

$$X_{ni} = \frac{\left(\bar{A}_n d_{ni}\right)^{-\theta} X_n}{\sum_M \left(\bar{A}_m d_{mi}\right)^{-\theta} X_m} X_i = \frac{X_i X_n \left(\frac{d_{ni}}{\rho_n}\right)^{-\theta}}{\sum_M \left(\frac{d_{mi}}{\rho_m}\right)^{-\theta} X_m}$$

using

$$\pi_{ni} = \frac{X_{ni}}{X_n} = \left(\frac{A_i / w_i d_{ni}}{\bar{A}_n}\right)^{\theta} \Rightarrow \left(\frac{A_i}{w_i}\right)^{\theta} = \left(\frac{X_{ni}}{X_n}\right) \times \left(\frac{\bar{A}_n}{d_{ni}}\right)^{\theta}$$

Unpacking the expression for exports

Exports from i to n

$$X_{ni} = \frac{X_i X_n \left(\frac{d_{ni}}{\rho_n}\right)^{-\theta}}{\sum_M \left(\frac{d_{mi}}{\rho_m}\right)^{-\theta} X_m}$$

- Increasing in exporter i's total economic size, X_i
- Rising in importer $n's$ total economic size X_n
- Declining in bilateral trade costs d_{ni}
  - d_{ni} is deflated by the importer's price level ρ_n
  - Import costs matter more when the destination market is more competitive

Unpacking the expression for exports

Exports from i to n

$$X_{ni} = \frac{X_i X_n \left(\frac{d_{ni}}{\rho_n}\right)^{-\theta}}{\sum_M \left(\frac{d_{mi}}{\rho_m}\right)^{-\theta} X_m}$$

- Denominator $\left(\frac{d_{mi}}{\rho_m}\right)^{-\theta} X_m$, is the size of each destination market m as perceived by i
- Higher X_m means that i has a larger market into which to sell
- Higher bilateral trade costs d_{mi} and a lower price level ρ_m in market m reduces i's sales into m

Why Do They Call it the Gravity Model?

Traditional gravity regression for trade btwn country pairs

$$\ln(X_{ni}) = \beta_0 + \underset{(+)}{\beta_1} \ln(M_n) + \underset{(+)}{\beta_2} \ln(M_i) + \underset{(-)}{\beta_3} \ln(d_{ni}) + e_{ni}$$

- X_{ni} is exports from i from n, M_n, M_i are economic "masses" of n and i, d_{ni} is trade cost/distance
- Substitute X_n for M_n and X_i for M_i and take logs

$$\ln X_{ni} = \ln \left[X_{ni} = \frac{X_i X_n \left(\frac{d_{ni}}{\rho_n} \right)^{-\theta}}{\sum_M \left(\frac{d_{mi}}{\rho_m} \right)^{-\theta} X_m} \right]$$

$$\ln X_{ni} = \ln X_i + \ln X_n - \theta \ln d_{ni} + \theta \ln p_n - \ln \left[\sum_M \left(\frac{d_{mi}}{\rho_m} \right)^{-\theta} X_m \right]$$

Voilà, gravity!

Closing the Model

Straightforward to close model if all income is labor income

- Let L_i be the labor endowment of country i
- Then country $i's$ total income is

$$w_i L_i = \sum_{n=1}^{I} \pi_{ni} \left(w_n L_n + D_n \right)$$

- D_n is the trade deficit in county n, equal to what it spends in excess of its labor income
- π_{ni} is the share $n's$ consumption purchased from i
- As above $\pi_{ni} = \frac{X_{ni}}{X_n} = \left(\frac{A_i / w_i d_{ni}}{\bar{A}_n} \right)^{\theta}$
- This is a system of I linear equation, will have to be solved numerically

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How Does Productivity Growth in one Country Affect Labor Markets in Others?

Crucial point

- A rise in the productivity (or fall in the trade costs) of one country affects output in other nations not only by displacing domestic production (through imports) but also by displacing exports that these other countries would have made
- As a country becomes more productive or faces lower trade barriers, its probability of becoming the low cost producer of each good for every other country rises
- Thus, exports from this 'rising' country displace exports to other countries from their prior suppliers

Why Do Countries Buy Disproportionately from Themselves? The Home Share of Spending on Manufactures

Country	*World GDP share (%) in 2006*	*Home share of spending*		*Implied gains from trade*	
		Level in 2006 (%)	*Change since 1996 (percentage points)*	*Level in 2006 (%)*	*Change since 1996 (percentage points)*
Austria	0.66	31.4	–16.2	21.3	8.1
Canada	2.60	49.1	–1.5	12.6	0.6
Czech Republic	0.29	42.6	–14.7	15.3	5.5
Denmark	0.56	25.6	–18.1	25.5	10.7
Estonia	0.03	2.5	–19.6	85.4	56.7
Finland	0.42	58.2	–7.3	9.4	2.1
France	4.60	56.9	–10.3	9.9	3.0
Germany	5.94	53.7	–16.4	10.9	4.8
Greece	0.54	52.7	–11.6	11.3	3.6
Hungary	0.23	26.0	–34.5	25.1	16.4
Iceland	0.03	27.9	–10.0	23.7	6.2
Ireland	0.46	39.6	9.9	16.7	–5.7
Italy	3.80	68.9	–7.1	6.4	1.7
Japan	8.88	84.9	–5.6	2.8	1.1
Korea	1.94	77.2	–0.7	4.4	0.1
Mexico	1.94	58.3	–7.9	9.4	2.3
New Zealand	0.22	53.6	–8.2	11.0	2.6
Norway	0.68	51.9	–2.5	11.6	0.9
Poland	0.69	53.4	–15.8	11.0	4.7
Portugal	0.41	50.8	–10.2	12.0	3.4
Slovenia	0.08	27.2	–15.5	24.3	9.0
Spain	2.51	62.8	–10.2	8.1	2.7
Sweden	0.81	49.2	–10.0	12.5	3.4
Switzerland	0.80	35.3	–20.0	18.9	8.6
United States	27.26	73.5	–8.3	5.3	1.9
All others	33.62				

Eaton and Kortum 2012

Why Do Countries Buy Disproportionately from Themselves?

If all countries had identical, homothetic preferences, all would consume same bundle of goods

- But countries tend to buy disproportionately more goods from themselves – 'Home bias'. *Why?*

1. Could be endogenous preference formation
   - e.g. Hákarl
2. Could be transport costs
   - Creates a range of goods that are not traded because each country makes them more cheaply for itself
   - Countries may be low cost provider of their own goods due to transport costs

Economic Consequences of Trade Deficits I

Deficits affect distribution of economic activity through trade costs

- Consider a transfer of D from England to Portugal
- Diverts spending from non-traded goods that England was producing for itself
- Increases production of those goods in Portugal
- English wage falls
- English exports rise
- Portuguese exports fall

Would not occur in a world with no trade frictions

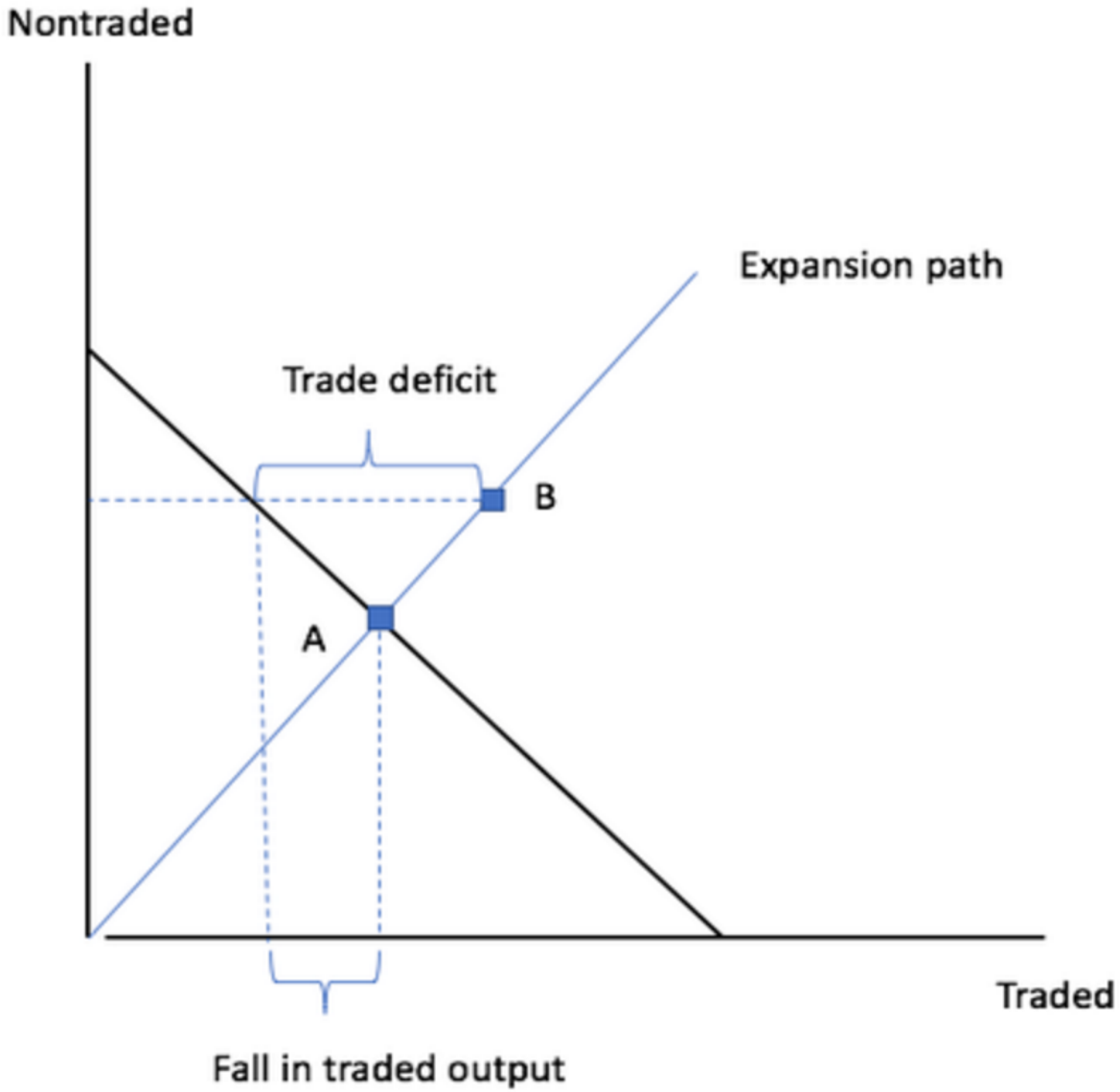
- If England transferred D to Portugal, Portugal would spend D on English goods in the same proportions that England would

Economic Consequences of Trade Deficits II

Deficits affect the distribution of economic activity within countries

- Trade deficit in i: Country i imports manufactured goods that it would otherwise have produced
- Assume $i's$ consumption shares across goods categories remain balanced...
  - $i's$ manufacturing sector shrinks
  - $i's$ non-manufacturing sector grows
- This affects labor allocation between manufacturing and non-manufacturing
- [In the longer run, manufacturing must grow again—often through a fall in prices—to pay back debt]

In Simplest Terms, Merchandise Trade Deficit Reallocates Employment from Manufacturing to Non-Manufacturing



Krugman, *NYT* 2016

Consequences of Eliminating Current Account Imbalances on Wages and Manufacturing Share

	Data			*Counterfactuals*		
				Change in		
Country	*GDP (US$ billions)*	*Current account balance (% GDP)*	*Manufactures trade balance (% GDP)*	*Relative wage (%)*	*Real wage (%)*	*Change in mfg share (percentage points)*
Australia	973.7	–5.0	–8.1	–4.6	–1.4	3.5
Austria	382.0	2.4	1.2	11.4	0.3	–1.9
Belgium-Luxembourg	525.2	0.6	7.4	8.3	0.0	–0.5
Canada	1337.6	–3.4	–4.7	–1.0	–0.7	2.6
China	5050.5	4.7	10.6	13.4	0.3	–4.1
Czech Republic	190.2	–3.7	6.4	3.1	–0.9	3.3
Denmark	308.9	3.1	1.3	13.3	0.4	–2.4
Estonia	19.3	4.2	–3.9	17.5	1.5	–2.6
Sweden	403.5	6.7	4.8	18.6	1.0	–5.2
Switzerland	492.3	7.5	4.6	18.9	1.3	–5.7
Turkey	613.8	–2.7	–2.7	2.9	–0.6	2.2
United States	13939.0	–3.2	–2.6	0.0	–0.5	2.6
ROW	13961.0	0.9	–5.4	9.4	0.2	–0.6

Eaton and Kortum 2012

Gains from Trade

Gains from trade: Real income in country i is

$$\frac{w_i}{\rho_i} = \gamma^{-1} A_i \pi_{ii}^{-1/\theta}$$

$$\ln\left(w_i/\rho_i\right) = -\ln\gamma + \ln A_i - \frac{1}{\theta}\ln\pi_{ii}$$

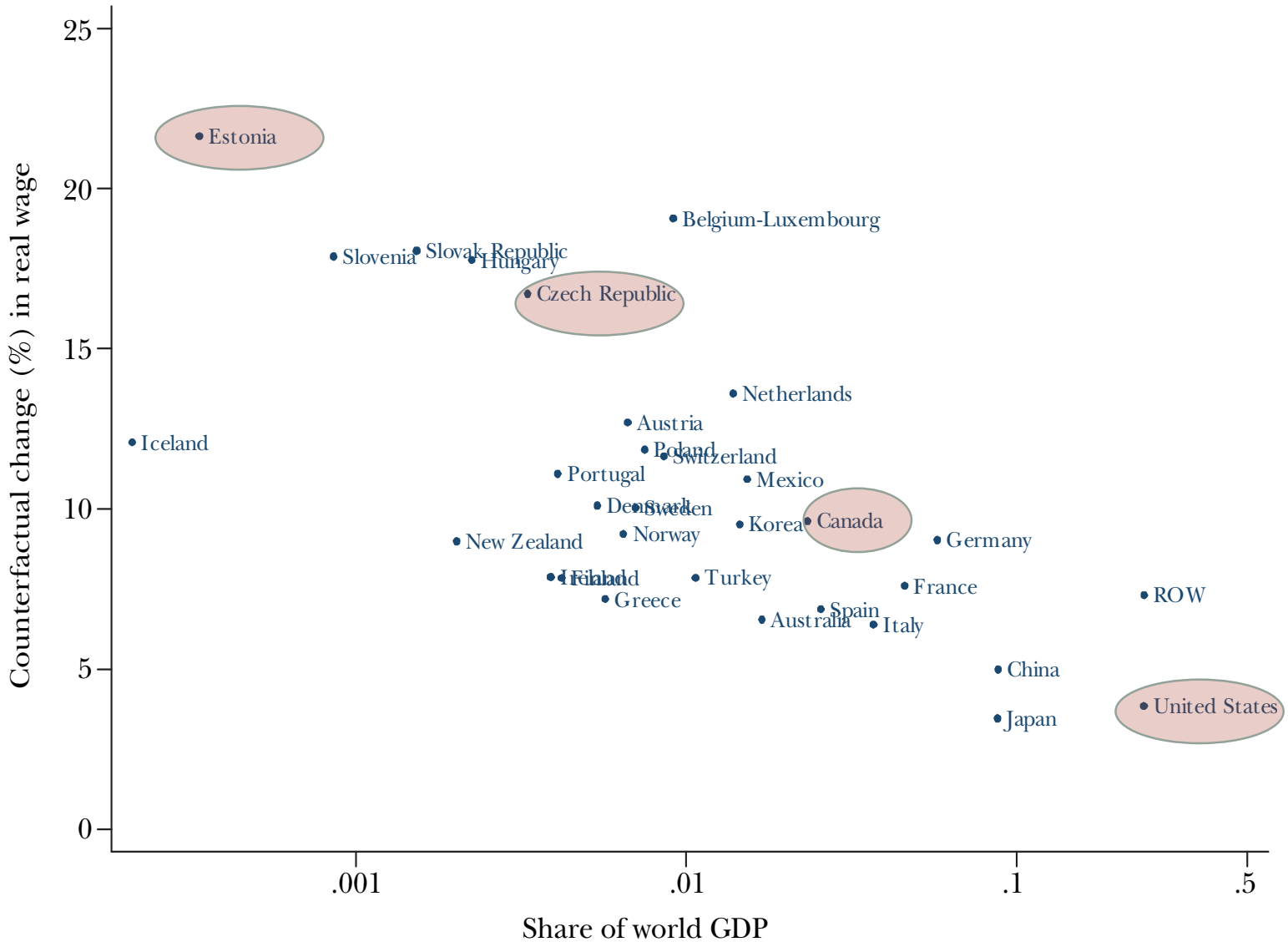
This expression says that a country's income is

- Increasing in its absolute advantage A_i
- Declining in its home share of consumption π_{ii} (why?)
- If it doesn't trade at all $(\pi_{ii} = 1)$, final term is zero, real wage is determined entirely by domestic productivity A_i

Let's say that $\theta \simeq 4$ and π_{ii} falls from 1.0 to 0.75

- Elasticity of trade w.r.t. price of traded goods ≈ 4
- Welfare rises by $-\frac{1}{4}\ln 0.75 \simeq 0.072$, about 7.5%
- See 2012 *AER* paper by Arkilakos, Costinot, Rodriguez-Claire

Real Wage Response to a Decrease in Trade Barriers (Uniform 25% Drop in Trade Costs)



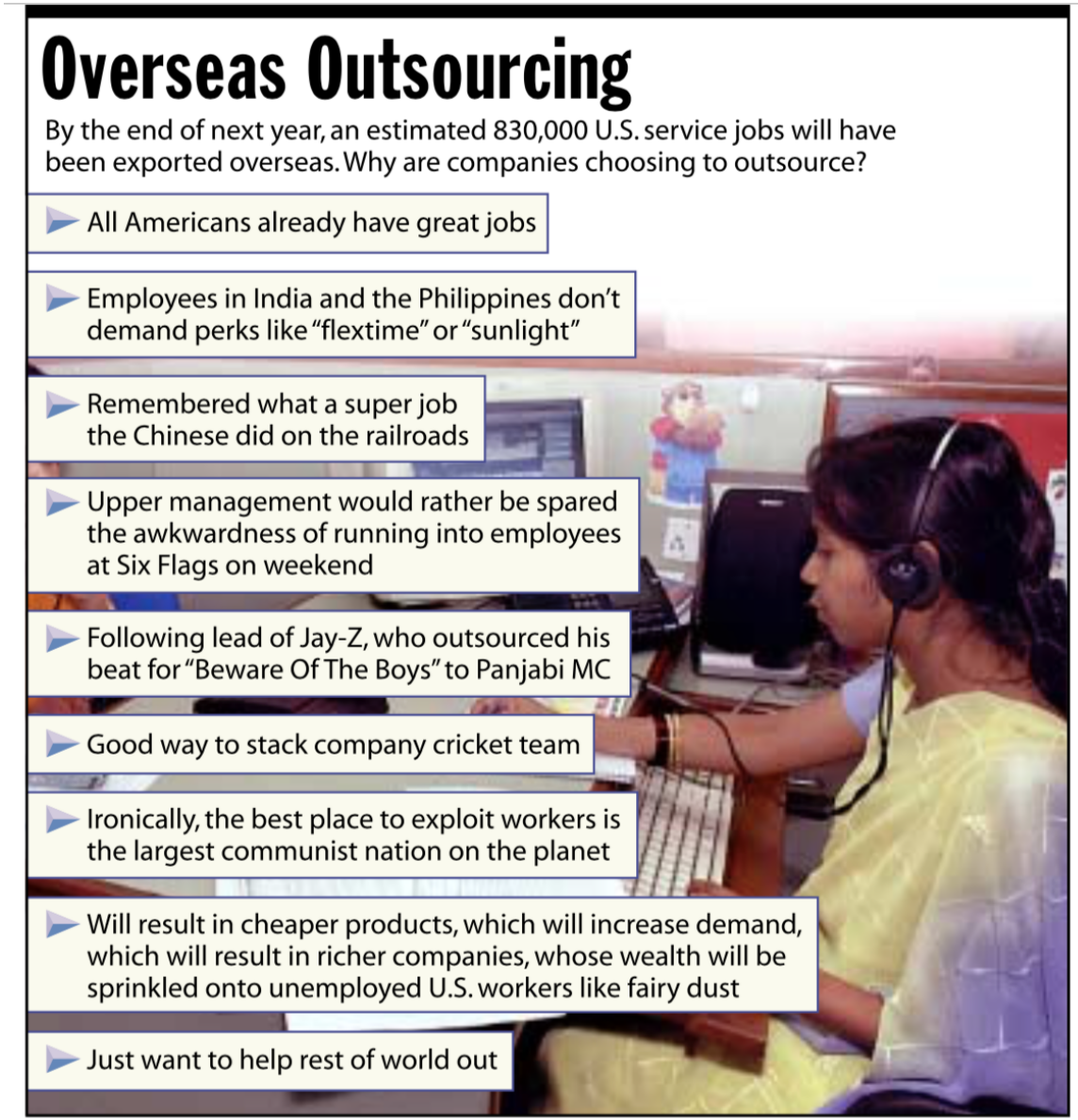
Eaton and Kortum 2012

Why are companies choosing to outsource?

Overseas Outsourcing

By the end of next year, an estimated 830,000 U.S. service jobs will have been exported overseas. Why are companies choosing to outsource?

- All Americans already have great jobs
- Employees in India and the Philippines don't demand perks like "flextime" or "sunlight"
- Remembered what a super job the Chinese did on the railroads
- Upper management would rather be spared the awkwardness of running into employees at Six Flags on weekend
- Following lead of Jay-Z, who outsourced his beat for "Beware Of The Boys" to Panjabi MC
- Good way to stack company cricket team
- Ironically, the best place to exploit workers is the largest communist nation on the planet
- Will result in cheaper products, which will increase demand, which will result in richer companies, whose wealth will be sprinkled onto unemployed U.S. workers like fairy dust
- Just want to help rest of world out



Agenda

1. **Some motivating facts**
2. **The Ricardian Model**
   - Ricardo's two-by-two model
   - The chain of comparative advantage
   - A continuum of goods
   - Trade costs
   - Adding more countries
3. **Putting Ricardo to Work**
4. **Connecting Trade Flows to Labor Markets**
5. **Evidence from the 'China Shock'**

Connecting Trade Flows to Labor Markets

When a country's manufacturing import share rises, what does this tell us about its domestic productivity and labor demand?

- This is the heart of the Autor-Dorn-Hanson *AER* 2013 'China Syndrome' paper

Connecting Trade Flows to Labor Markets

Let the demand for labor in industry j by region i be given by $L_{ij} = L^d(w_{ij}, Q_{ij})$

- where w_{ij} is unit production costs and Q_{ij} is output
- Think of an industry as containing a continuum of goods
- All reasoning above about "shares" by countries applies to shares by industries within and across countries

Connecting Trade Flows to Labor Markets

Using the E-K model, region i's sales in industry j to destination market n can be written as

$$X_{nij} = \frac{A_{ij}(w_{ij}d_{nij})^{-\theta}}{\bar{A}_{nj}}X_{nj},$$

- where θ is describes the dispersion in productivity among firms
- A_{ij}, determines mean of firm productivities in an industry and region
- $\bar{A}_{nj} \equiv \sum_h A_{hj}(w_{hj}d_{nhj})^{-\theta}$ describes the extent of competition in destination market n in industry j
- Reflects production and trade costs in the locations that supply products to market n

Connecting Trade Flows to Labor Markets

Using the E-K model, region i's sales in industry j to destination market n can be written as

$$X_{nij} = \frac{A_{ij}(w_{ij}\, d_{nij})^{-\theta}}{\bar{A}_{nj}} X_{nj},$$

For region i, sales to destination market n in industry j are function of

1. its technological capability (A_{ij})
2. its unit production costs (w_{ij})
3. bilateral trade costs (d_{nij})
4. expenditure in destination market n for goods of industry j (X_{nj})

Region i will capture a larger share of market n's purchases in industry j when it has high productivity, low production costs, and low trade costs relative to other suppliers

Connecting Trade Flows to Labor Markets

- **Define**

$$\tilde{A}_{ij} \equiv A_{ij} w_{ij}^{-\theta}$$

as cost-adjusted productivity of region i in industry j

- Summing over destination markets for region i, its total output in industry j is

$$Q_{ij} = \tilde{A}_{ij} \sum_{n} \frac{X_{nj} d_{nij}^{-\theta}}{\bar{A}_{nj}}$$

Connecting Trade Flows to Labor Markets

China is among the countries that each U.S. region competes in serving destination markets

- When China's productivity expands or its foreign trade costs fall, this increases the value of $\bar{A}_{nj}$ in each destination market, diverting product demand from U.S. regions that also serve these markets
- Crucial point: A rise in the productivity (or fall in the trade costs) of one country affects output in other nations not only by displacing domestic production (through imports) but also by displacing exports that these other countries would have made
- As a country becomes more productive or faces lower trade barriers, its probability of becoming the low cost producer of each good for every other country rises
- Thus, exports from this 'rising' country displace exports to other countries from their prior suppliers

Connecting Trade Flows to Labor Markets

Consider effect on Q_{ij} of a rise in China's competitive position

1. An increase in A_{cj}, where c indexes China
2. *or* a reduction in trade costs d_{ncj}, e.g., due to China's accession to the WTO

Direct effect of $\Delta's$ in China's productivity and trade costs on Q_{ij}

$$\hat{Q}_{ij} = -\sum_n \frac{X_{nij}}{Q_{ij}} \frac{X_{ncj}}{X_{nj}} (\hat{A}_{cj} - \theta \hat{d}_{ncj})$$

- where $\hat{x} \equiv d \ln x$, X_{nij}/Q_{ij} is the share of exports to destination market n in region i's output in industry j
- X_{ncj}/X_{nj} is the share of imports from China in spending by destination market n in industry j

Connecting Trade Flows to Labor Markets

The fall in region i's output in industry j is larger

$$\hat{Q}_{ij} = -\sum_n \frac{X_{nij}}{Q_{ij}} \frac{X_{ncj}}{X_{nj}} (\hat{A}_{cj} - \theta \hat{d}_{ncj})$$

1. the greater is the cost-adjusted productivity growth in China $\hat{A}_{cj}$
2. the larger is the reduction in trade costs facing China $\hat{d}_{ncj}$
3. the more dependent region i is on market n (X_{nij})
4. the more important China is as a source of supply to market n (X_{ncj})

Connecting Trade Flows to Labor Markets

In applying expression for $\hat{Q}_{ij}$, ADH focus on competition that CZs face from China in the U.S. market

- Limit the summation above to $n = u$, that is, to outputs produced and consumed in the United States
- Includes only the *direct* effect of shocks to Chinese productivity and trade costs on the demand for output in region i
- It ignores indirect effects of these changes on factor prices and spending in region i and in other regions and countries
- Changes in factor prices may cause changes in aggregate spending by countries—reverberating through global economy
- In general equilibrium, $\Delta' s$ in China's productivity + trade costs affect wages + factor prices in countries where China competes

Connecting Trade Flows to Labor Markets

Key virtue of this framework

- Provides a link between observed changes in *quantities* of goods imported and changes in the demand for the output of a local economy (e.g., a Commuting Zone)
- Provides an empirical toehold for quantities of goods traded to local demand for labor
- Essentially non-existent in the H-O framework
- ADH also focus on employment and public transfer benefits, not just wages — this was absent from trade and labor markets literature

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Autor-Dorn-Hanson '13: Setup

Applying EK framework to U.S. labor markets using 'China Shock'

- Measure of import exposure at the CZ-level

$$\Delta IPW_{uit} = \sum_j \frac{L_{ijt}}{L_{ujt}} \frac{\Delta M_{ucjt}}{L_{it}}$$

- Instrumented by

$$\Delta IPW_{oit} = \sum_j \frac{L_{ijt-1}}{L_{ujt-1}} \cdot \frac{\Delta M_{ocjt}}{L_{it-1}}$$

- Estimating equation (2SLS)

$$\Delta L_{it}^m = \gamma_t + \beta_1 \Delta IPW_{uit} + \mathbf{X}_{\mathrm{it}}' \beta_2 + e_{ct}$$

Autor-Dorn-Hanson '13: Setup

Empirical proxy for ΔCZ's import exposure

$$\Delta IPW_{uit} = \sum_j \frac{L_{ijt}}{L_{ujt}} \frac{\Delta M_{ucjt}}{L_{it}}$$

- Allocates to each CZ a share of national import growth
- Divides this value by a CZ's total employment
- Yields measure of "import growth per worker" in $\$1K$ units

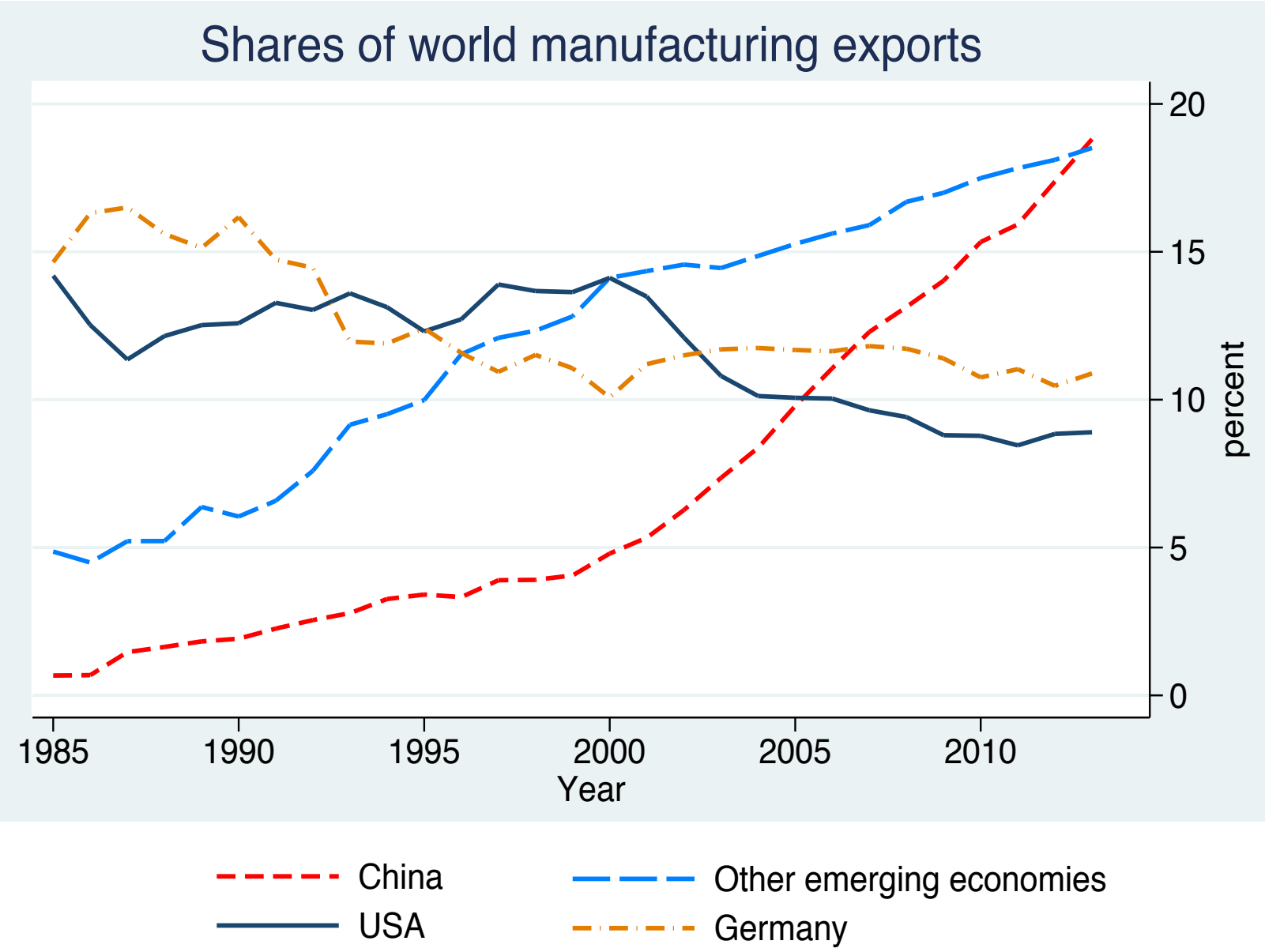
Note two sources of variation in this measure

1. Variation in CZ's manufacturing *mix*
2. Overall CZ manufacturing share: by controlling for initial manufacturing share, ID comes from industry mix

ΔIPW_{uit} **is trade-induced demand shock to CZ's goods output**

- How demand shock affects employment, wages, etc. in manufacturing and non-manufacturing in CZ is empirical question

China's Rising Share of World Manufacturing Exports, 1985 - 2012



U.S. Imports from China Divided by Total U.S. Goods Expenditures, 1987 - 2007

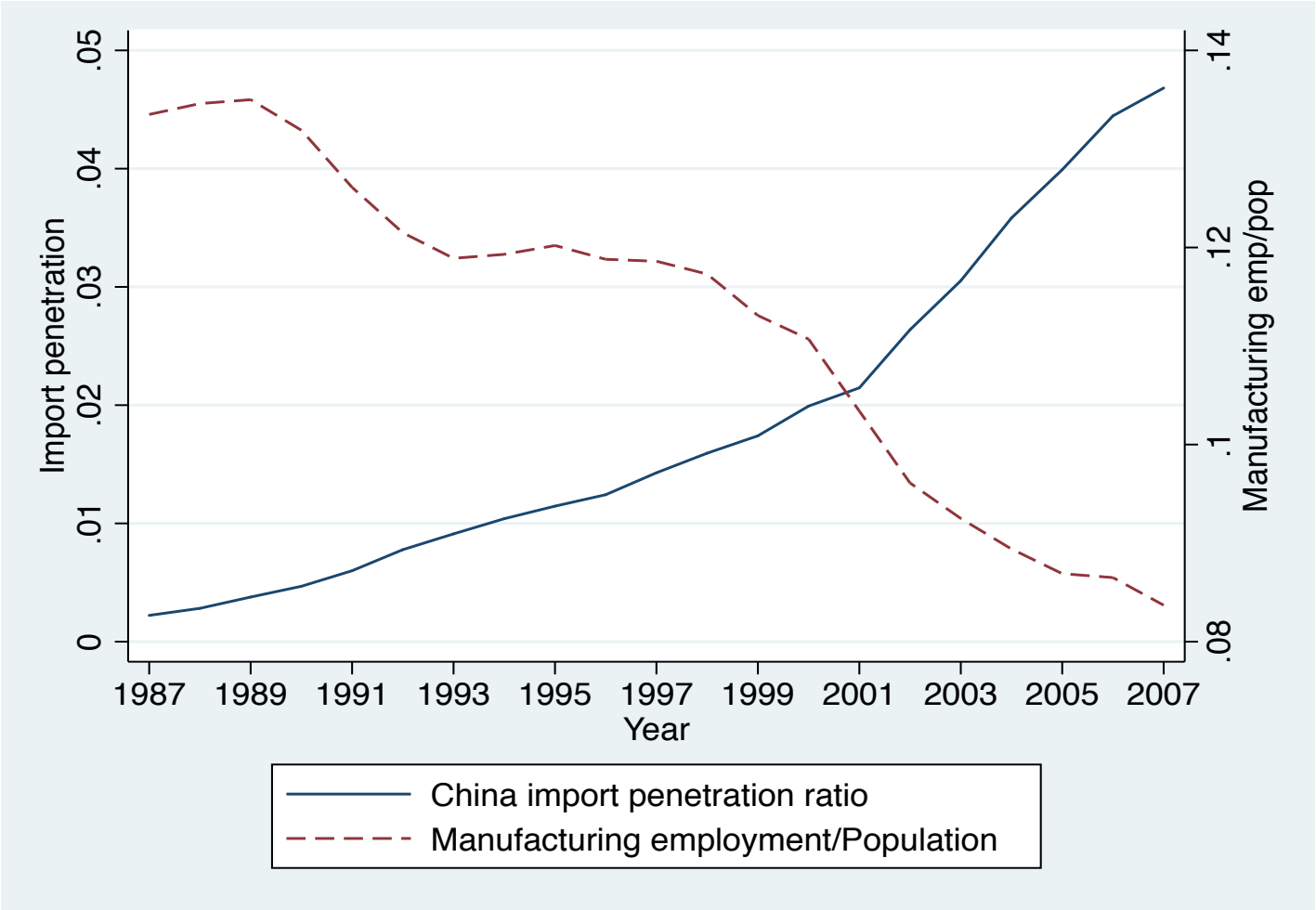
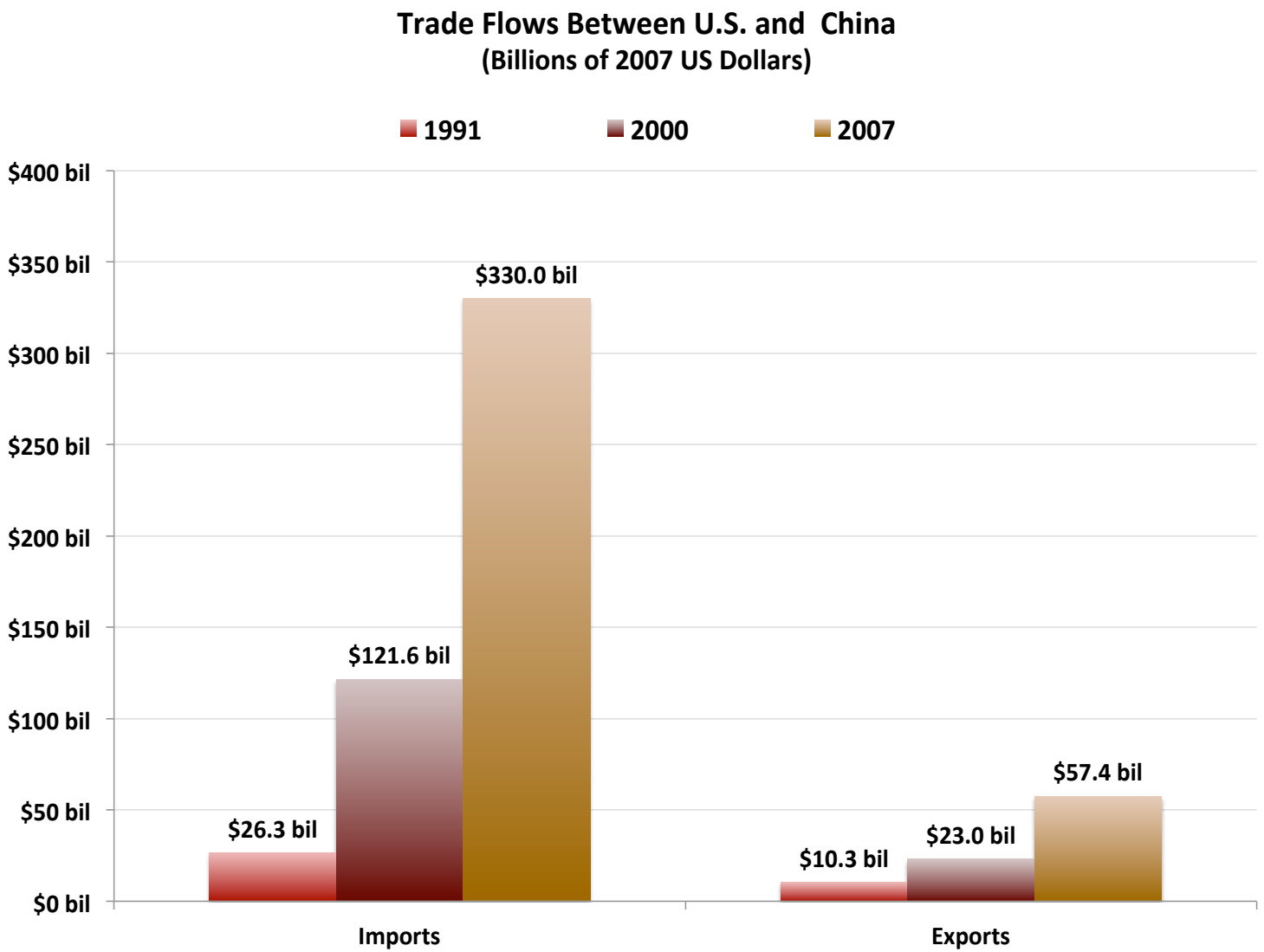


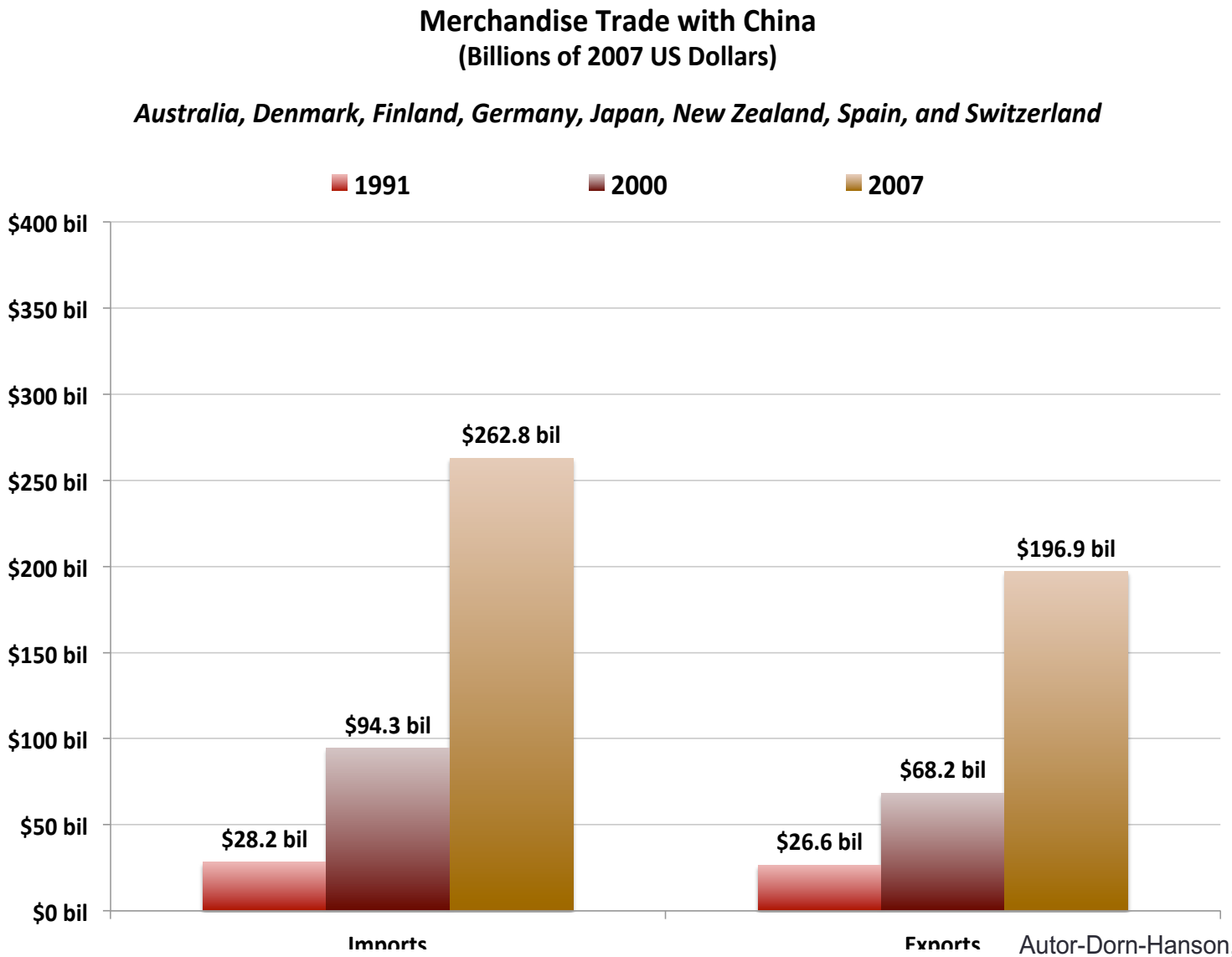
Figure 1.
Import Penetration Ratio for U.S. Imports from China (left scale), and Share of U.S. Working-Age Population Employed in Manufacturing (right scale).

Trade Flows: U.S. and China



Autor-Dorn-Hanson, 2013

Trade Flows: Eight Other Rich Countries and China



Autor-Dorn-Hanson, 2013

Trade Flows: China, U.S., Other Rich Countries 1991 - 2007

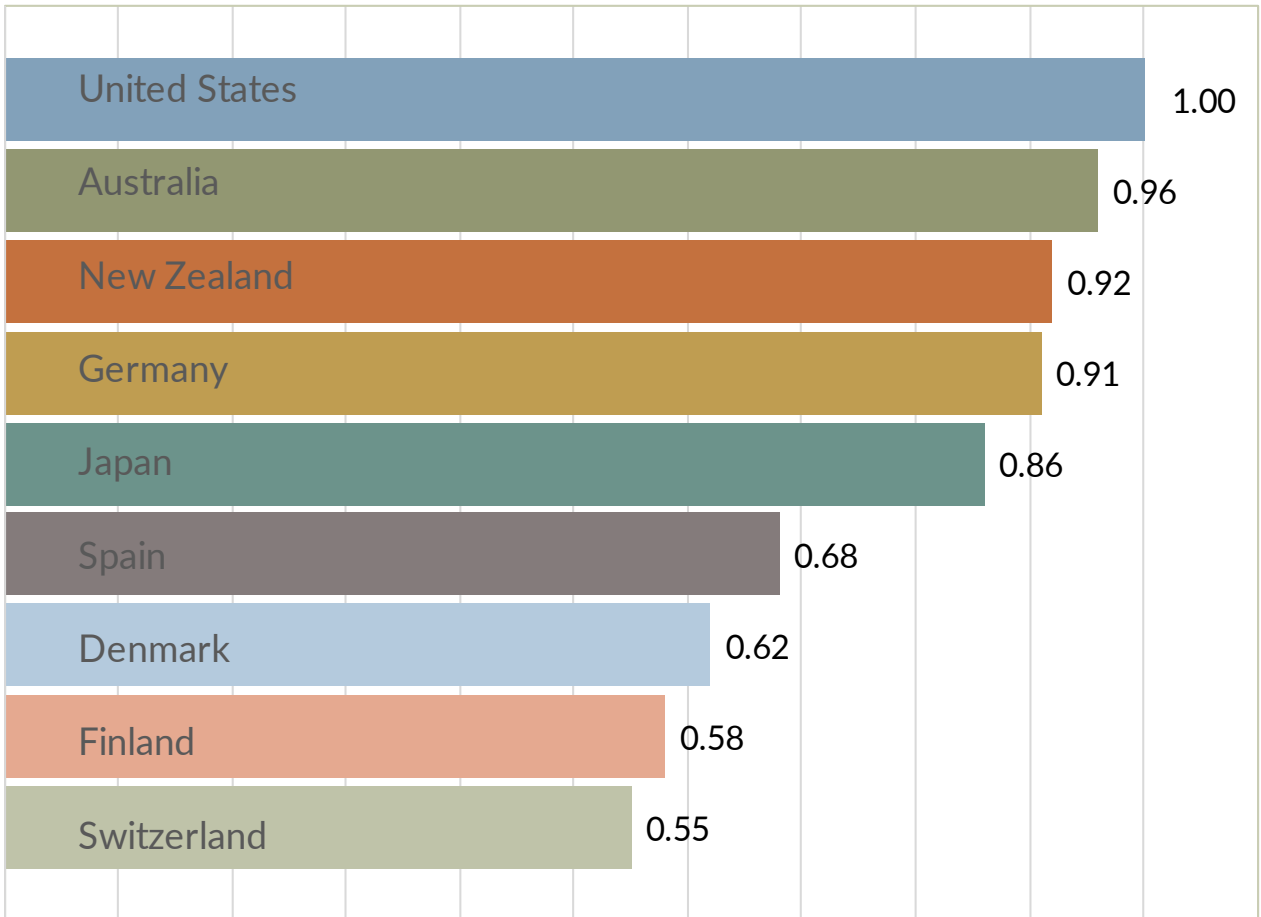
TABLE 1—VALUE OF TRADE WITH CHINA FOR THE US AND OTHER SELECTED HIGH-INCOME COUNTRIES AND VALUE OF IMPORTS FROM ALL OTHER SOURCE COUNTRIES, 1991/1992–2007

	I. Trade with China (in billions 2007 US$)		II. Imports from other countries (in billions 2007 US$)		
	Imports from China	Exports to China	Imports from other low-inc.	Imports from Mexico/ CAFTA	Imports from rest of world
	(1)	(2)	(3)	(4)	(5)
Panel A. United States					
1991/1992	26.3	10.3	7.7	38.5	322.4
2000	121.6	23.0	22.8	151.6	650.0
2007	330.0	57.4	45.4	183.0	763.1
Growth 1991–2007	1,156%	456%	491%	375%	137%
Panel B. Eight other developed countries					
1991/1992	28.2	26.6	9.2	2.8	723.6
2000	94.3	68.2	13.7	5.3	822.6
2007	262.8	196.9	31.0	11.6	1329.8
Growth 1991–2007	832%	639%	236%	316%	84%

Notes: Trade data is reported for the years 1991, 2000, and 2007, except for exports to China which are first available in 1992. The set of "other developed countries" in panel B comprises Australia, Denmark, Finland, Germany, Japan, New Zealand, Spain, and Switzerland. Column 3 covers imports from all countries that have been classified as low income by the World Bank in 1989, except for China. Column 4 covers imports from Mexico and the Central American and Carribean countries covered by the CAFTA-DR. Column 5 covers imports from all other countries (primarily from developed countries).

Autor-Dorn-Hanson, 2013

Bivariate Correlations: China-U.S. vs. China-Other Import Penetration, 1990 - 2007: 392 Goods Categories

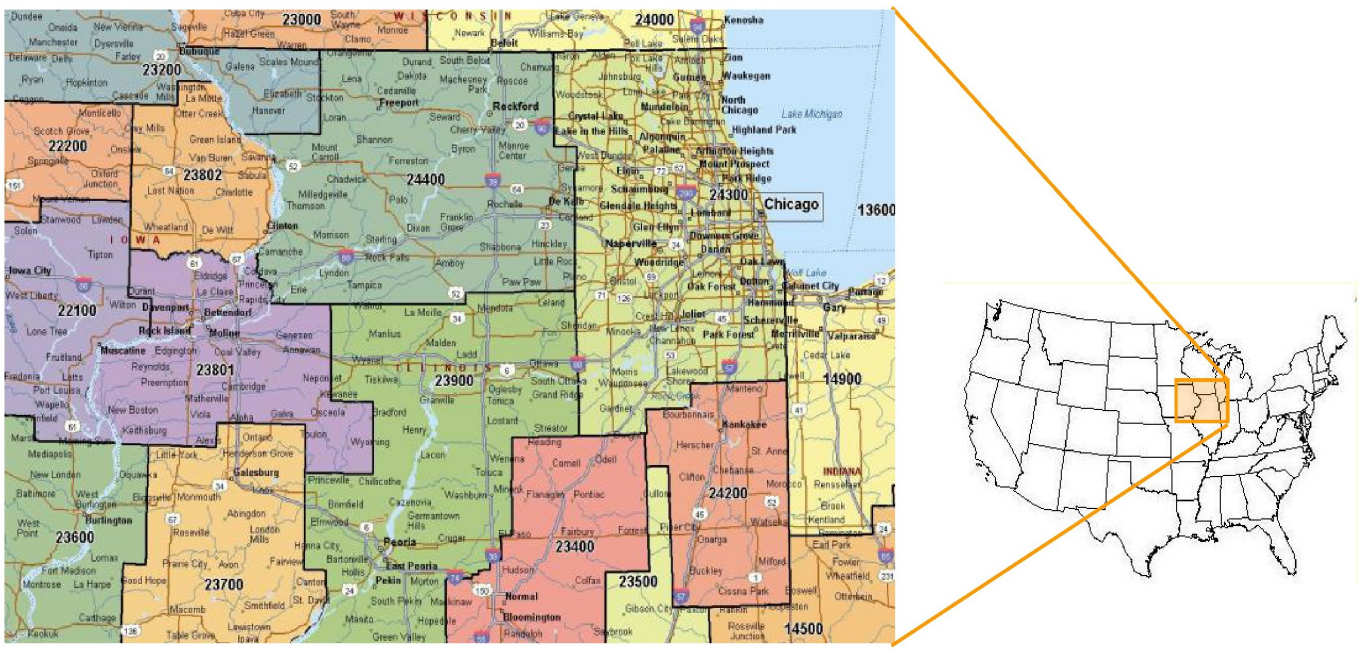


Autor-Dorn-Hanson '17

Defining "Local Labor Markets"

Based on commuting patterns among countries in 1990

- Cluster US counties in 722 commuting zones (CZ), strong commuting within a CZ, weak commuting across CZs
- Can map Census Public Use Micro Areas to CZs



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Magnitude of Rise in Trade Exposure Across CZs, 1990 - 2007

Δ China imports per worker (in 1,000s of US$) across CZs

Appendix Table 1. Descriptive Statistics for Growth of Imports Exposure per Worker across C'Zones

I. 1990-2000		II. 2000-2007	
A. Percentiles			
90th percentile	2.05	90th percentile	4.30
75th percentile	1.32	75th percentile	3.11
50th percentile	0.89	50th percentile	2.11
25th percentile	0.62	25th percentile	1.60
10th percentile	0.38	10th percentile	1.03

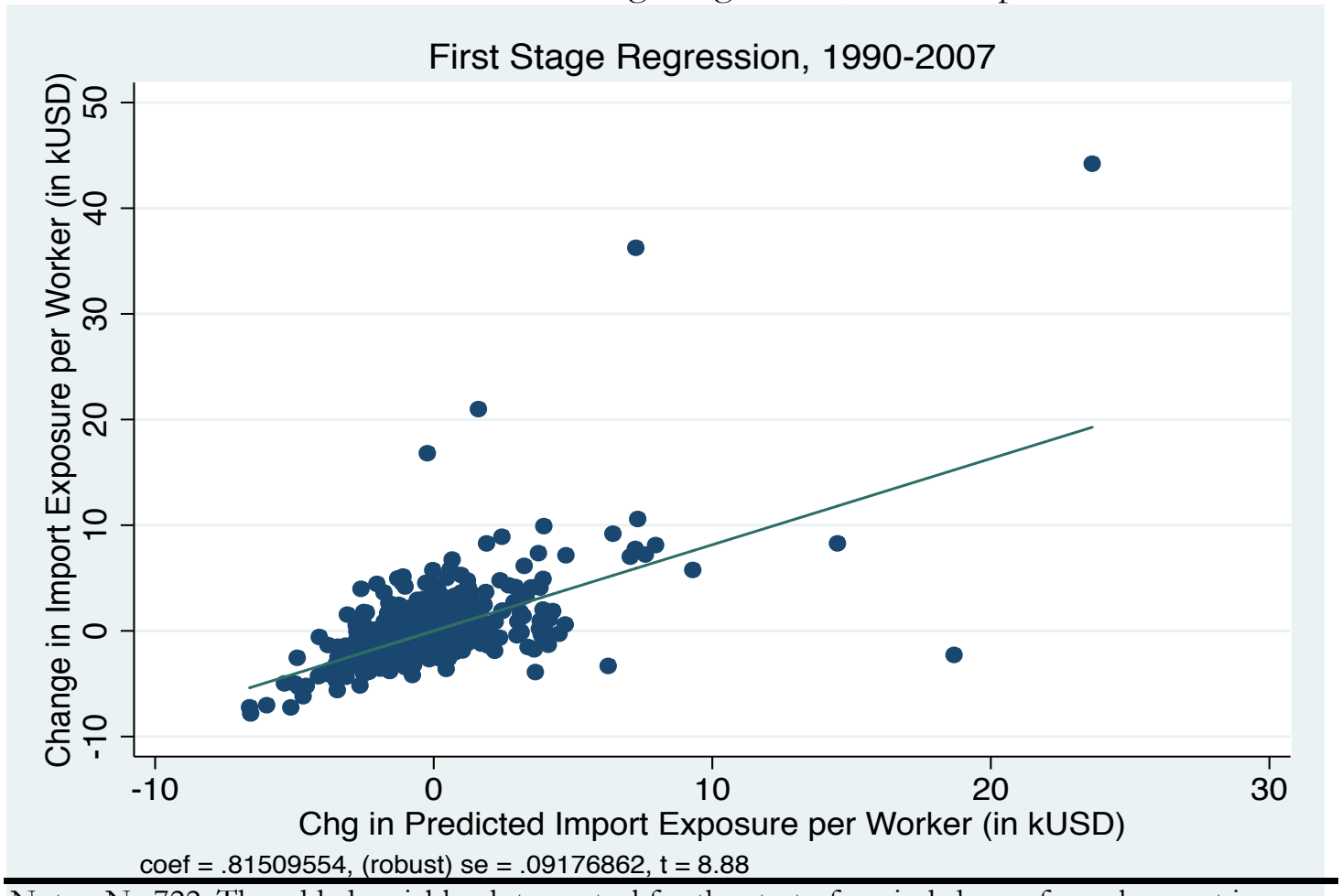
Over all CZ's:

- 75/25 percentile Δ: $1,510 in 2000-2007 (over 10 yrs)
- 75/25 percentile Δ: $700 in 1990-2000
- Average per decade over 1990-2007: $1,105

Autor-Dorn-Hanson, 2013

First Stage: Commuting Zone Level Changes in Potential Chinese Import Exposure

Panel A: 2SLS 1st Stage Regression, Full Sample



Notes: N=722. The added variable plots control for the start of period share of employment in manufacturing industries. Regression models are weighted by start of period commuting zone share of national population.

Reduced Form: Commuting Zone Level Changes in Potential Chinese Import Exposure and Manufacturing Emp/Pop

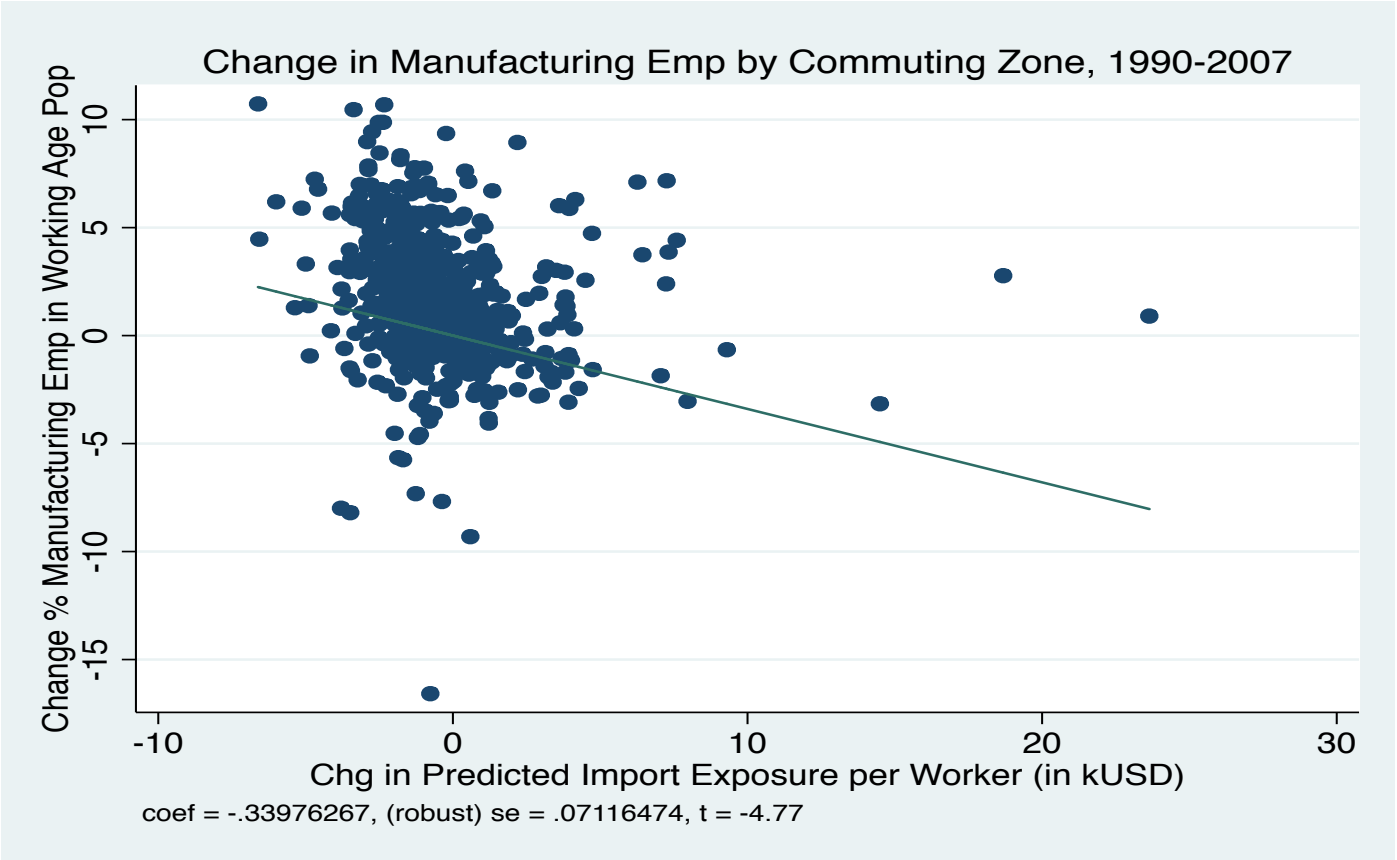


Figure 2.
Change in Import Exposure per Worker and Decline of Manufacturing Employment: Added Variable Plots 2SLS and Reduced Form Estimates

Notes: N=722. The added variable plots control for the start of period share of employment in manufacturing industries. Regression models are weighted by start of period commuting zone share of national population.

2SLS Estimates by Decade: Import Exposure and Manufacturing Emp/Pop

TABLE 2—IMPORTS FROM CHINA AND CHANGE OF MANUFACTURING EMPLOYMENT IN CZS, 1970–2007: 2SLS ESTIMATES

Dependent variable: 10 × annual change in manufacturing emp/working-age pop (in % pts)

	I. 1990–2007			II. 1970–1990 (pre-exposure)		
	1990–2000	2000–2007	1990–2007	1970–1980	1980–1990	1970–1990
	(1)	(2)	(3)	(4)	(5)	(6)
(Δ current period imports from China to US)/worker	−0.89***	−0.72***	−0.75***			
	(0.18)	(0.06)	(0.07)			
(Δ future period imports from China to US)/worker				0.43***	−0.13	0.15
				(0.15)	(0.13)	(0.09)

Notes: $N = 722$, except $N = 1{,}444$ in stacked first difference models of columns 3 and 6. The variable "future period imports" is defined as the average of the growth of a CZ's import exposure during the periods 1990–2000 and 2000–2007. All regressions include a constant and the models in columns 3 and 6 include a time dummy. Robust standard errors in parentheses are clustered on state. Models are weighted by start of period CZ share of national population.

Autor-Dorn-Hanson, 2013

Pooled 2SLS Estimates 1990-2007: Import Exposure and Manufacturing Emp/Pop

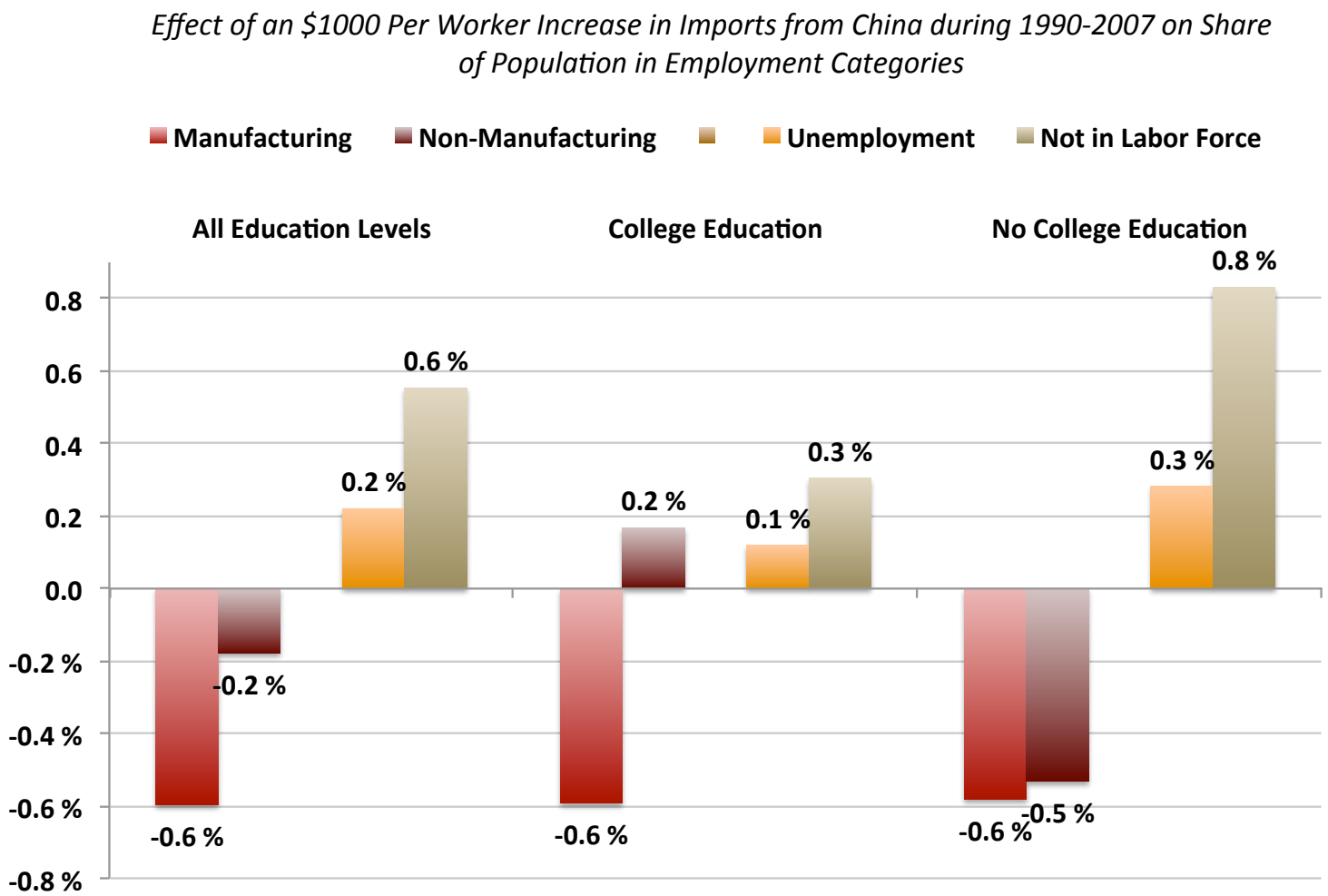
TABLE 3—IMPORTS FROM CHINA AND CHANGE OF MANUFACTURING EMPLOYMENT IN CZS, 1990–2007: 2SLS ESTIMATES

Dependent variable: 10 × annual change in manufacturing emp/working-age pop (in % pts)

	I. 1990–2007 stacked first differences					
	(1)	(2)	(3)	(4)	(5)	(6)
(Δ imports from China to US)/ worker	−0.746*** (0.068)	−0.610*** (0.094)	−0.538*** (0.091)	−0.508*** (0.081)	−0.562*** (0.096)	−0.596*** (0.099)
Percentage of employment in manufacturing$_{-1}$		−0.035 (0.022)	−0.052*** (0.020)	−0.061*** (0.017)	−0.056*** (0.016)	−0.040*** (0.013)
Percentage of college-educated population$_{-1}$				−0.008 (0.016)		0.013 (0.012)
Percentage of foreign-born population$_{-1}$				−0.007 (0.008)		0.030*** (0.011)
Percentage of employment among women$_{-1}$				−0.054** (0.025)		−0.006 (0.024)
Percentage of employment in routine occupations$_{-1}$					−0.230*** (0.063)	−0.245*** (0.064)
Average offshorability index of occupations$_{-1}$					0.244 (0.252)	−0.059 (0.237)
Census division dummies	No	No	Yes	Yes	Yes	Yes
	II. 2SLS first stage estimates					
(Δ imports from China to OTH)/ worker	0.792*** (0.079)	0.664*** (0.086)	0.652*** (0.090)	0.635*** (0.090)	0.638*** (0.087)	0.631*** (0.087)
R^2	0.54	0.57	0.58	0.58	0.58	0.58

Autor-Dorn-Hanson, 2013

Import Exposure and Changes in Manufacturing and Non-Manufacturing Emp/Pop by Education



Autor-Dorn-Hanson, 2013

Magnitudes

- **Δ Chinese imports $\rightarrow$ ΔUS manuf emp/pop**
  - 1990 - 2000: + \$1,140 per worker
  - 2000 - 2007: + \$1,839 per worker
- **Δ US manuf fell $1/3^{rd}$ 1990–2007: 12.7% $\rightarrow$ 8.51%**
  - 1990 - 2000: -2.07%.
  - 2000 - 2007: -2.73%
- **Drop in manufacturing due to China supply shock**
  - 1990 - 2000: - 548K manuf workers (16% of Δ)
  - 2000 - 2007: - 982K manuf workers (26% of Δ)
  - 1990 - 2007: - 1,430K manuf workers (21% of Δ)

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Pooled 2SLS Estimates 1990-2007: Import Exposure and Δ Population

TABLE 4—IMPORTS FROM CHINA AND CHANGE OF WORKING-AGE POPULATION IN CZ, 1990–2007: 2SLS ESTIMATES

Dependent variables: Ten-year equivalent changes in log population counts (in log pts)

	I. By education level			II. By age group		
	All	College	Noncollege	Age 16–34	Age 35–49	Age 50–64
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. No census division dummies or other controls						
(Δ imports from China to US)/worker	−1.031**	−0.360	−1.097**	−1.299	−0.615	−1.127***
	(0.503)	(0.660)	(0.488)	(0.826)	(0.572)	(0.422)
R^2	—	0.03	0.00	0.17	0.59	0.22
Panel B. Controlling for census division dummies						
(Δ imports from China to US)/worker	−0.355	0.147	−0.240	−0.408	−0.045	−0.549
	(0.513)	(0.619)	(0.519)	(0.953)	(0.474)	(0.450)
R^2	0.36	0.29	0.45	0.42	0.68	0.46
Panel C. Full controls						
(Δ imports from China to US)/worker	−0.050	−0.026	−0.047	−0.138	0.367	−0.138
	(0.746)	(0.685)	(0.823)	(1.190)	(0.560)	(0.651)
R^2	0.42	0.35	0.52	0.44	0.75	0.60

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Pooled 2SLS Estimates 1990-2007: Import Exposure and Δ ln Emp and Δ ln Wage

TABLE 7—COMPARING EMPLOYMENT AND WAGE CHANGES IN MANUFACTURING AND OUTSIDE MANUFACTURING, 1990–2007: 2SLS ESTIMATES

Dependent variables: Ten-year equivalent changes in log workers and average log weekly wages

	I. Manufacturing sector			II. Nonmanufacturing		
	All workers (1)	College (2)	Noncollege (3)	All workers (4)	College (5)	Noncollege (6)
Panel A. Log change in number of workers						
(Δ imports from China to US)/worker	−4.231*** (1.047)	−3.992*** (1.181)	−4.493*** (1.243)	−0.274 (0.651)	0.291 (0.590)	−1.037 (0.764)
R^2	0.31	0.30	0.34	0.35	0.29	0.53
Panel B. Change in average log wage						
(Δ imports from China to US)/worker	0.150 (0.482)	0.458 (0.340)	−0.101 (0.369)	−0.761*** (0.260)	−0.743** (0.297)	−0.822*** (0.246)
R^2	0.22	0.21	0.33	0.60	0.54	0.51

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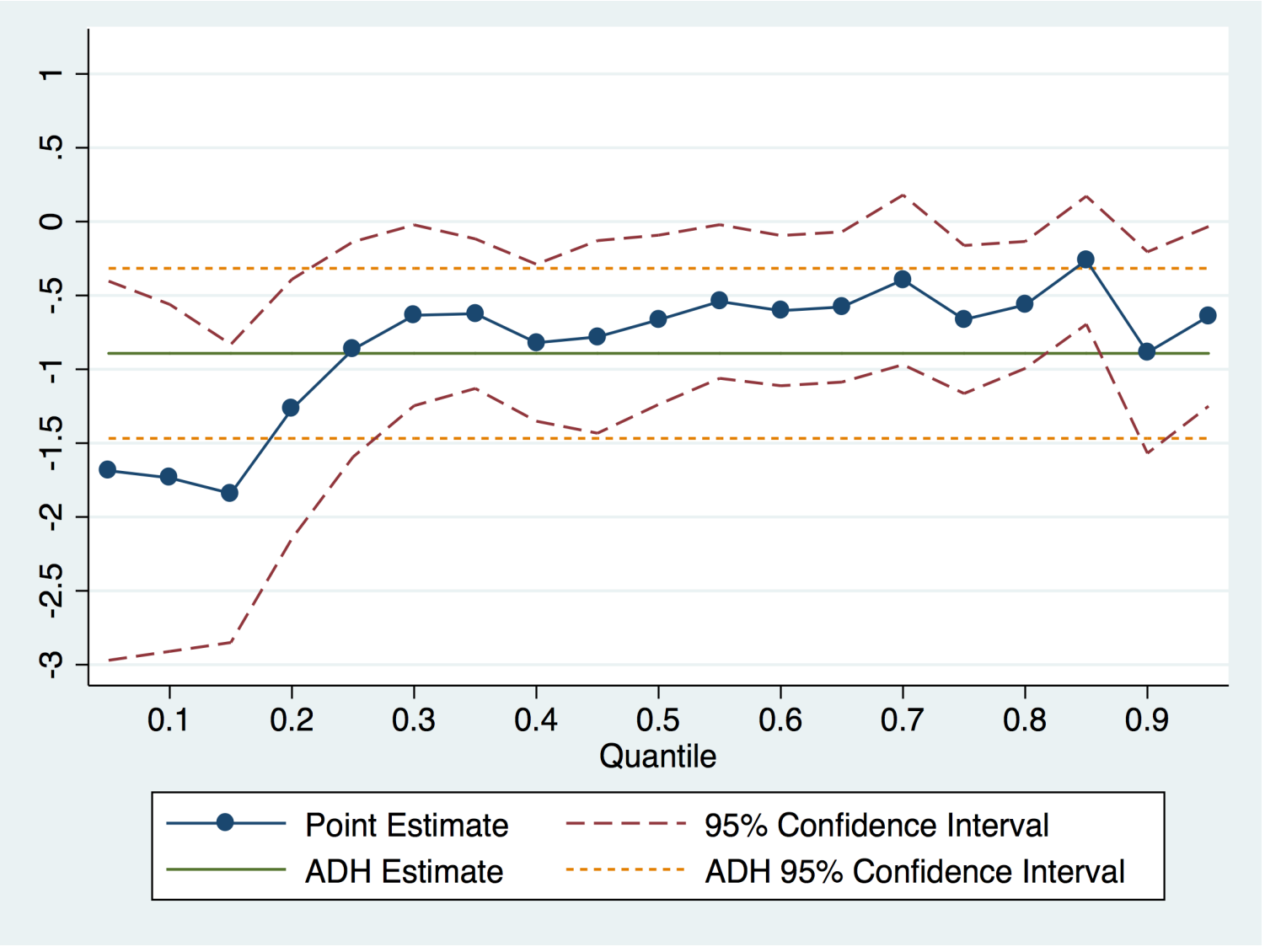
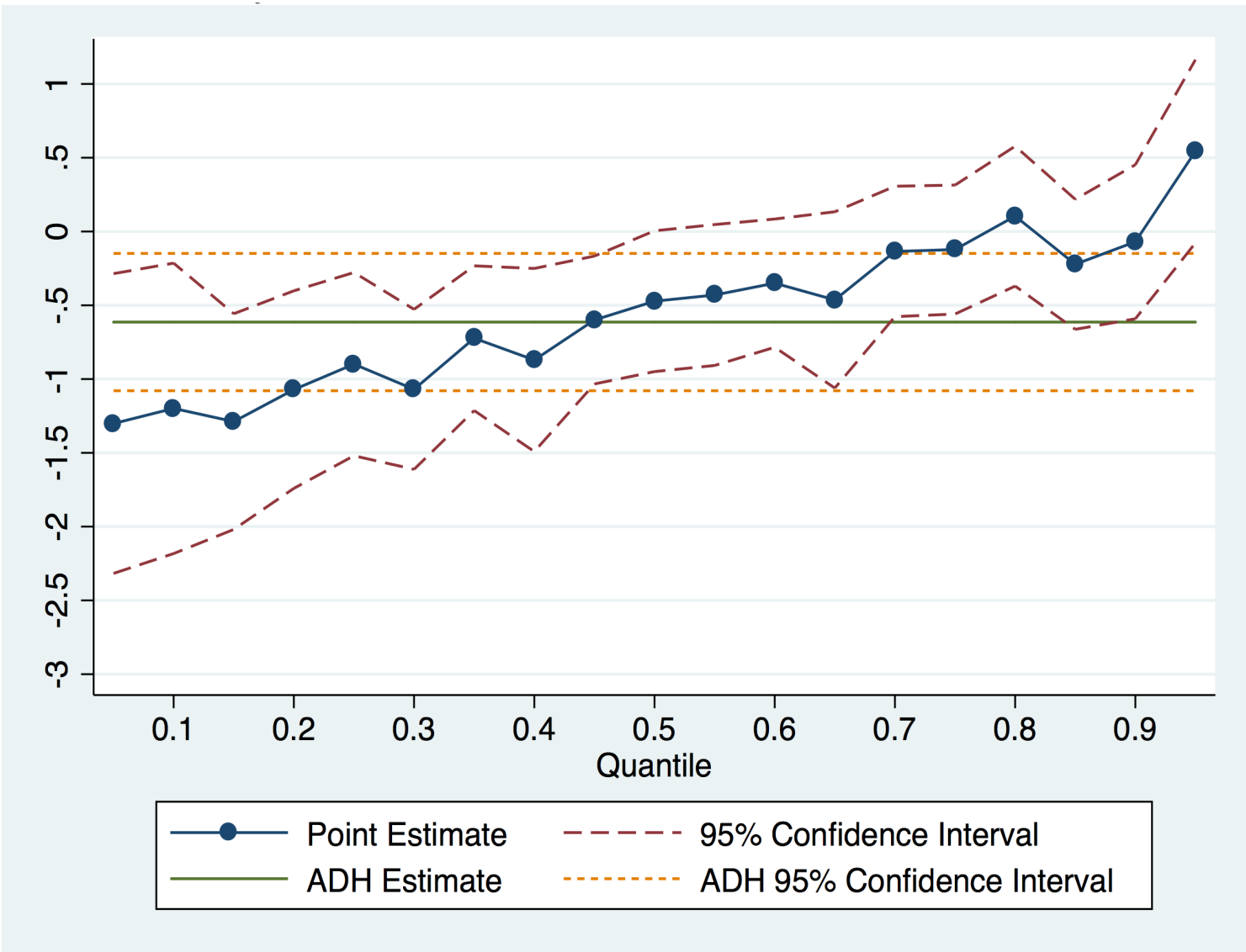
Grouped IV Estimates – Impact of Chinese Import Competition on Conditional Wage Distribution: Men



Chetverikov, Larsen and Palmer, *Ecma* 2016

Grouped IV Estimates – Impact of Chinese Import Competition on Conditional Wage Distribution: Women



Chetverikov, Larsen and Palmer, *Ecma* 2016

Pooled 2SLS Estimates 1990-2007: Import Exposure and Transfer Payments

TABLE 8—IMPORTS FROM CHINA AND CHANGE OF GOVERNMENT TRANSFER RECEIPTS IN CZs, 1990–2007: 2SLS ESTIMATES

Dep vars: Ten-year equivalent log and dollar change of annual transfer receipts per capita (in log pts and US$)

	Total individual transfers (1)	TAA benefits (2)	Unemployment benefits (3)	SSA retirement benefits (4)	SSA disability benefits (5)	Medical benefits (6)	Federal income assist (7)	Educ/ training assist (8)
Panel A. Log change of transfer receipts per capita								
(Δ imports from China to US)/worker	1.01***	14.41*	3.46*	0.72*	1.96***	0.54	3.04***	2.78**
	(0.33)	(7.59)	(1.87)	(0.38)	(0.69)	(0.49)	(0.96)	(1.32)
R^2	0.57	0.28	0.48	0.36	0.32	0.27	0.54	0.33
Panel B. Dollar change of transfer receipts per capita								
(Δ imports from China to US)/worker	57.73***	0.23	3.42	10.00*	8.40***	18.27	7.20***	3.71***
	(18.41)	(0.17)	(2.26)	(5.45)	(2.21)	(11.84)	(2.35)	(1.44)
R^2	0.75	0.28	0.41	0.47	0.63	0.66	0.53	0.37

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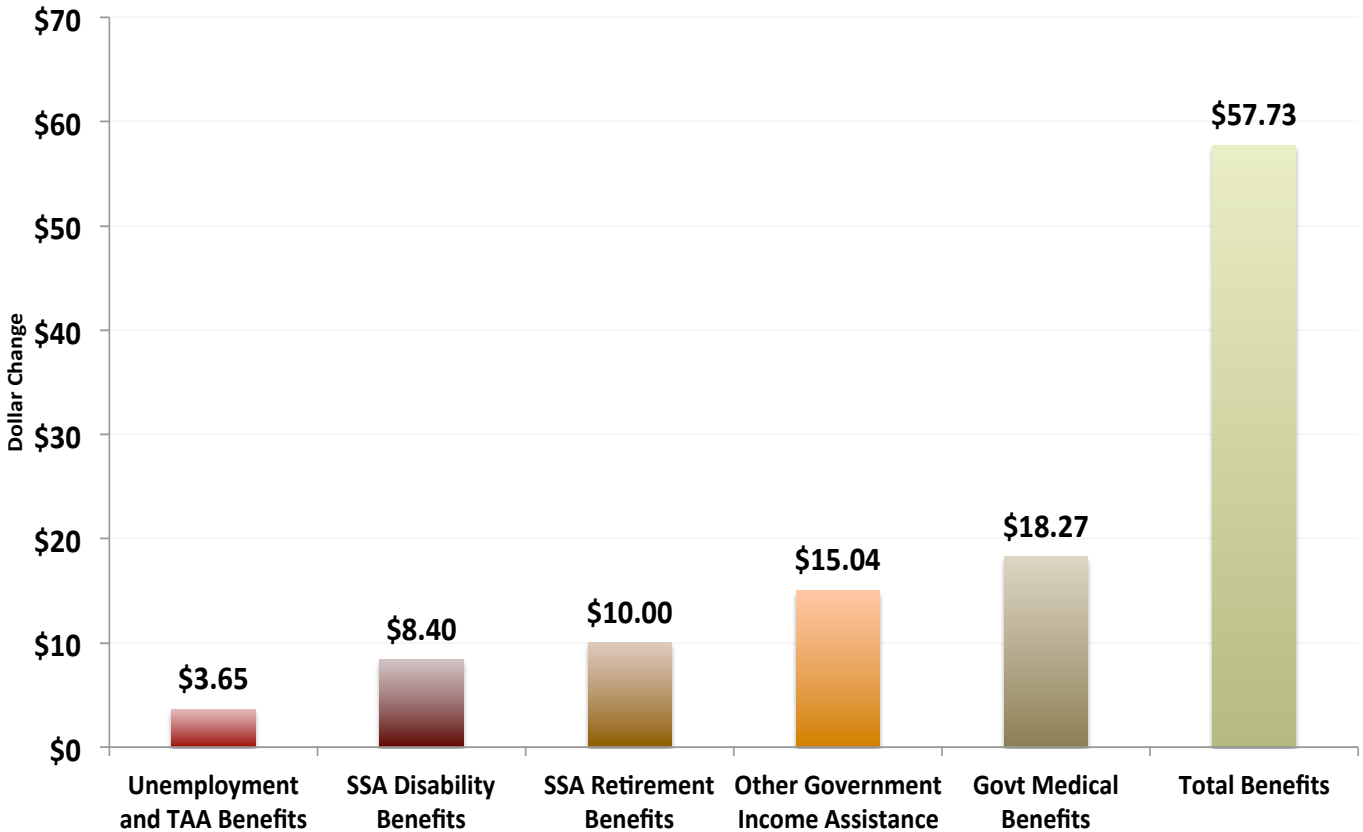
Pooled 2SLS Estimates 1990-2007: Import Exposure and Transfer Payments

Imports from China and Change of Government Transfer Receipts in Commuting Zones (1990-2007)

Effect of an $1000 Per Worker Increase in Imports from China during 1990-2007 on Dollar Change of Annual Transfer Receipts per Capita



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