

# Lecture 8: Intermediate Input Trade and Wage Inequality

14.581: International Economics I

Pol Antràs

Harvard & MIT

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# Plan of the Lecture

- So far we have largely ignored the role of intermediate inputs in international trade although (casual) evidence suggests that they account for a large fraction of trade flows.
- In this lecture, we will briefly discuss how to introduce intermediate inputs in the standard Heckscher-Ohlin model.
- We will review the work of Feenstra and Hanson who have argued that the prevalence of input trade may help us rationalize some puzzling facts in the data regarding the effects of trade flows on the wages of different types of workers.
- We will also discuss the provocative recent work of Grossman and Rossi-Hansberg and conclude with a brief overview of the Krugman vs. Leamer (2000) debate.
- But first, we will review some evidence on the relationship between trade and wage inequality.

# Trade and Wage Inequality

- The wage of college-educated U.S. workers relative to that of non-college-educated U.S. workers rose dramatically in the period 1979-1995 (see Katz and Autor, 1999)
  - the real wage of the latter group actually declined over this period.
- During the same period, there was a marked increase in the relative supply of skilled workers. Hence, the increase in the wage premium was driven by “demand” factors.
- Similar patterns have been recorded in other developed economies (see Berman, Bound and Machin, 1998).
- Two main explanations have been put forth for the increase in the relative demand of skilled workers:
  - skill-biased technological change (e.g., computerization);
  - trade integration with unskilled-labor abundant countries (Stolper-Samuelson at work!).

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# Problems with the Trade Explanation

- It may be tempting to use the evidence to support the empirical validity of the Stolper-Samuelson theorem, but there are several problems with the trade explanation.
- First, according to the trade explanation, we should have observed the increase in the relative demand for skill resulting from shifts in the sectoral distribution of employment. Instead, most shifts in employment (skill upgrading) occurred *within* industries.
- Perhaps the most damaging piece of evidence against the “trade hypothesis” is that in most developed countries, prices in skill-intensive industries have fallen relative to prices in unskilled-intensive industries (see Lawrence and Slaughter, 1993).
  - So Stolper-Samuelson would actually predict a fall in the wage premium!
- In addition, several authors have argued that trade integration is associated with increased wage inequality in some less developed economies too.

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# Feenstra and Hanson's Defense

- Feenstra and Hanson (1996a,b, 1999, 2003) attempt to rehabilitate the hypothesis that trade might be responsible for a significant part of the increase in the skill premium in both developed and developing countries.
- Their defense of the importance of trade is based on the following observations:
  - A substantial part of the increase in international trade in recent years is associated with a vertical disintegration of the production process *within industries*
  - Offshoring naturally increases the relative demand of skill in North
  - Perhaps more surprisingly, in models with full specialization, it may also increase it in South
  - Finally, these type of model do not have clear predictions for the cross-section of final-good prices, so the Lawrence-Slaughter critique can be salvaged.
- Feenstra and Hanson's own econometric work shows that measures of offshoring have sizeable effects on wage inequality in the U.S. and Mexico.
  - In their QJE 1999 paper, they conclude that in the U.S. case, offshoring can explain about 11% to 15.2% of this increase, while computerization can explain up to 31.5% of the increase (see their Table III).

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## A Simple H-O Model with Intermediate Inputs

- Consider the  $2 \times 2$  small open economy model in Lecture 4, but now assume that final goods  $A$  and  $B$  are produced with skilled labor, unskilled labor and two intermediate inputs  $Z_1$  and  $Z_2$ .
- Consider the case in which production of  $Z_1$  uses skilled labor more intensively than production of  $Z_2$ . Denote the unit costs by  $c_{Zn}(w_H, w_L)$  for  $n = 1, 2$ .
- The unit cost of production in sector  $i$  is now expressed as  $c_i(w_H, w_L, p_{Z1}, p_{Z2})$ , where  $p_{Zn}$  is the price of intermediate input  $n = 1, 2$ .
- We consider a situation in which our small economy produces both final goods as well as both inputs.
- Then we have

$$p_i = c_i(w_H, w_L, p_{Z1}, p_{Z2}) \text{ for } i = A, B \quad (1)$$

$$p_{Zn} = c_{Zn}(w_H, w_L) \text{ for } n = 1, 2 \quad (2)$$

- Now consider an increase in  $p_{Z1}/p_{Z2}$  (which proxies trade integration with an unskilled-labor abundant South).

## A Simple H-O Model with Intermediate Inputs (cted.)

- As in the analysis in Lecture 4, we have that the two equations in (2) will uniquely pin down factor prices in terms of goods prices.
  - **Key difference:** “goods prices” are now **input** prices.
- Repeating Stolper-Samuelson analysis in section 4, we will conclude that  $w_H/w_L$  will go up. In fact,

$$\hat{w}_H \geq \hat{p}_{Z1} > \hat{p}_{Z2} \geq \hat{w}_L$$

- Hence, trade integration in the form of offshoring leads to an increase in the wage premium.
- What happens to final-good prices? Using Jones' hat algebra, we have that
$$\hat{p}_i = \theta_{Hi}\hat{w}_H + \theta_{Li}\hat{w}_L + \theta_{Z1i}\hat{p}_{Z1} + \theta_{Z2i}\hat{p}_{Z2},$$
where the  $\theta_i$ 's are the cost shares.
- The mapping between skill intensity of employment (in the North) and final-good prices is now less clear (c.f. Lawrence and Slaughter, 1993) – indeterminacies in production.

# A Productivity Effect: Grossman & Rossi-Hansberg (2006)

- The conclusion so far is that intermediate input trade will affect the wage premium in a manner analogous to the standard H-O model.
- Grossman and Rossi-Hansberg propose an alternative model of offshoring that (may) generate very different conclusions.
- Consider a simple (or better simplistic) version of their model. We again have two factors  $H$  and  $L$ , two final goods  $A$  and  $B$ , and two inputs  $Z_1$  and  $Z_2$ .

But now we further assume:

- 1  $A$  and  $B$  are produced with  $H$ ,  $Z_1$  and  $Z_2$ ;
- 2  $A$  is skill intensive relative to  $B$ , but relative intensity of  $Z_1$  and  $Z_2$  is independent of  $i$ ;
- 3 Home produces both final goods. Together with 1. and 2., this implies
$$p_i = c_i(w_H, g(p_{Z1}, p_{Z2}));$$
- 4  $Z_1$  and  $Z_2$  are produced with  $L$  only;
- 5 Home produces  $Z_1$  but imports  $Z_2$  at an iceberg cost  $\tau > 1$ . Hence

$$\begin{aligned}p_{Z1} &= w_L \\ p_{Z2} &= \tau w_L^*\end{aligned}$$

# A Productivity Effect: Grossman & Rossi-Hansberg (2006)

- What happens when  $\tau$  falls, i.e., offshoring becomes cheaper? We hold prices and ROW wage constant (relaxed in their paper).

- Using the Jones algebra, and noting that prices are constant, we have that

$$0 = \theta_{Hi} \hat{w}_H + (1 - \theta_{Hi}) (\gamma_{Z1} \hat{w}_L + (1 - \gamma_{Z1}) \hat{\tau}),$$

which necessarily implies

$$\hat{w}_L = -\frac{(1 - \gamma_{Z1}) \hat{\tau}}{\gamma_{Z1}}$$

$$\hat{w}_H = 0.$$

- Hence unskilled labor is better off and the wage premium falls!
- What's going on? Improved possibilities of offshoring act like  $L$ -augmenting technological change. It is as if the “effective” supply of unskilled labor increased.
- So offshoring that “directly” competes with unskilled labor can improve welfare of unskilled workers.
- Note what happens to the relative output of  $A$  and  $B$ ? Rybczinski!

# Wage Inequality in South: Feenstra and Hanson (1996a)

- The fact that offshoring seems to be associated with an increase in the wage premium in South provides a challenge for standard theory.
- Feenstra and Hanson (1996a) develop a theoretical model of vertical specialization that is consistent with increased wage premia in both North and South. **Key:** drop FPE and diversification in production.
- World of two countries (North and South) producing a continuum of goods with two factors ( $H, L$ ).
- Consumers derive utility from consuming a unique final good  $Y$  which is assembled from a continuum of intermediate inputs, indexed by  $i \in [0, 1]$ :

$$\ln Y = \int_0^1 \alpha(i) \ln x(i) di.$$

- Cost function for input  $i$  in country  $k$  is

$$c(w_H^k, w_L^k, i) = \phi^k \cdot [a_L(i) w_L^k + a_H(i) w_H^k],$$

and it is assumed that  $a_H(i) / a_L(i)$  is increasing.

## Feenstra and Hanson (1996a) cited.

- Suppose that  $H^N/L^N \gg H^S/L^S$  so that FPE fails (see D-F-S 1980) and  $w_H^S/w_L^S > w_H^N/w_L^N$ . Then we have that

$$\frac{c(w_H^N, w_L^N, \phi^N, i)}{c(w_H^S, w_L^S, \phi^S, i)} = \frac{\phi^N}{\phi^S} \left[ \frac{a_L(i) w_L^N + a_H(i) w_H^N}{a_L(i) w_L^S + a_H(i) w_H^S} \right]$$

is decreasing in  $a_H(i)/a_L(i)$  and therefore in  $i$ .

- So South has comparative advantage in relatively non-skill intensive (low  $i$ ) inputs, while the North has comparative advantage in relatively skill-intensive (high  $i$ ) inputs.
- Provided that each country produces a subset of inputs (which is ensured by factor market clearing) there will be a threshold  $i^*$  such that the South produces all inputs with  $i < i^*$  and the North produces all inputs with  $i > i^*$ :

$$c(w_H^N, w_L^N, \phi^N, i^*) = c(w_H^S, w_L^S, \phi^S, i^*). \quad (3)$$

## Feenstra and Hanson (1996a) cted.

- Now consider factor market clearing in North:

$$\frac{H^N}{L^N} = \frac{\int_{i^*}^1 \left[ a_H(i) \frac{\alpha(i)E}{a_L(i)w_L^N + a_H(i)w_H^N} \right] di}{\int_{i^*}^1 \left[ a_L(i) \frac{\alpha(i)E}{a_L(i)w_L^N + a_H(i)w_H^N} \right] di}, \quad (4)$$

- The right hand side is the relative demand for skilled workers. It is decreasing in  $w_H^N/w_L^N$  and increasing in  $i^*$  provided that  $a_H(i^*)/a_L(i^*) < H_N/L_N$  (which is true).
- In South, we have

$$\frac{H^S}{L^S} = \frac{\int_0^{i^*} \left[ a_H(i) \frac{\alpha(i)}{a_L(i)w_L^S + a_H(i)w_H^S} \right] di}{\int_0^{i^*} \left[ a_L(i) \frac{\alpha(i)}{a_L(i)w_L^S + a_H(i)w_H^S} \right] di}. \quad (5)$$

where RHS is again decreasing in  $w_H^S/w_L^S$  and increasing in  $i^*$  provided that  $a_H(i^*)/a_L(i^*) > H_S/L_S$  (which is true).

## Feenstra and Hanson (1996a) cited.

- Now consider an decrease in  $\phi^S$ . So South becomes more efficient (cf. Zhu and Trefler, 2005).
  - Alternatively,  $\phi^k$  reflects the cost of a third factor (capital), and we consider capital flow from  $N$  to  $S$  (offshoring is FDI here)
- From equation (3), the effect “on impact” is to raise  $i^*$  (South gains comparative advantage in new inputs).
  - there is of course a general equilibrium feedback from factor prices adjusting, but it can be shown to be dominated
- We thus conclude that  $i^*$  goes up and applying the implicit function theorem on (4) and (5), we have that the wage premium will increase in both North and South!
- **Key idea** is that international outsourcing is associated with a de-location of production processes that are unskilled-intensive from the point of view of the North, but that are skill intensive from the point of view of the South.
  - This is what ultimately generates an increase in the skill premium in both countries.

# The Krugman vs. Leamer (2000) Debate

- We have focused on a discussion of whether the trade explanation “makes sense.” But does the skilled-bias technological change story make sense?
- **Benchmark:** Skilled-biased technological change in a diversified small open economy has no effect on the wage premium. Only sector-biased technological change matters.
  - the first result follows from the Factor Price Insensitivity theorem;
  - the second result is analogous to Stolper-Samuelson effect (but observed shifts in employment are *within* industries).
- Another Implication: effect of trade on wages is independent of size of net factor content of trade.
- But there are two crucial assumptions in the result:
  - in a large enough economy, skilled-biased technological change **will** have an effect on goods prices, and the wage premium will go up;
  - even for a small open economy, if skill-bias technological change is *global*, the same will be true.
- In addition, for a large enough economy:
  - the effect of trade on wages depends on size of net factor content of trade;
  - the effect of sector-biased technological change is ambiguous.

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