Multinationals and the Globalization of Production

Vertical FDI 1

Penn State // Fall 2017

Administrative things

- Sign in to Arkaive.com (course code: 84ST)
  - If not working, sign in up front
- Problem set #3
  - Due end of class, Thursday 10/19
  - Available on course website

Roadmap

- Building a model of vertical FDI
  - Break up production across countries
  - FDI to save on factor costs (factors = inputs)
  - Need a model with multi-stage production

- Tuesday: work through the production function
- Today: how does firm structure depend on transport costs?

Fixed-proportions production function

- Often called the *Leontief production function*
- Big idea: Inputs are used in fixed proportions
  - No ability to substitute inputs
- Examples (simplified)
  - 4 tires + 1 motor + 2 windshield wipers = 1 car
  - 2 sq. yds. denim + 1 zipper + 3 ft. thread = 1 pair jeans
  - 1 screen + 1 keyboard + 1 case = 1 laptop
- Too few inputs $\rightarrow$ no output (car with 3 tires?)
- Too many inputs $\rightarrow$ inputs go unused (jeans with two zippers?)

Fixed-proportions production function

- Two inputs
  - ℓ_s = skilled labor (wage w_s)
  - ℓ_u = unskilled labor (wage w_u)
- Unit input requirements
  - θ_s = hours of skilled labor needed to make one unit output
  - θ_u = hours of unskilled labor needed to make one unit output

$$x = \min\left\{\frac{\ell_u}{\theta_u}, \frac{\ell_s}{\theta_s}\right\}$$

- The unit cost is

$$c(w_u, w_s) = \theta_u w_u + \theta_s w_s$$

$$X = \min\{X_b, X_a\}$$

$$X_b = \min\left\{\frac{l_u}{\theta_{bu}}, \frac{l_s}{\theta_{bs}}\right\}$$

$$X_a = \min\left\{\frac{l_u}{\theta_{au}}, \frac{l_s}{\theta_{as}}\right\}$$

Two stage production

- The final good is made up of two parts
  1. Component parts b (b for circuit *boards*)
  2. Assembly services a
- 1 unit of parts and 1 unit of assembly combine to make the final good

$$x = \min\{x_a, x_b\}$$

Final "calculation"

- The unit cost of the final good is

$$c(w_u, w_s) = c_a(w_u, w_s) + c_b(w_u, w_s)$$

Factor intensity

technologies differ.

- Two goods, a and b
- Good a: $\theta_{ua} = 5$ and $\theta_{sa} = 1$
- Good b: $\theta_{ub} = 1$ and $\theta_{sb} = 10$
- Good b is *skilled-labor* intensive
  - Good a skilled to unskilled labor ratio = 1/5
  - Good b skilled to unskilled labor ratio = 10/1
- Factor intensity is a relative concept

In class problem: Where to produce?

- $\theta_{ua} = 5$ and $\theta_{sa} = 1$; $\theta_{ub} = 1$ and $\theta_{sb} = 10$

Countries differ

- Two locations that differ by wages
  - Location 1: $w_u = 10$ (\$/h) and $w_s = 20$ (\$/h)
  - Location 2: $w_u = 2$ (\$/h) and $w_s = 30$ (\$/h)

\$10 \$210

- What is the unit cost of the final good in location 1?

$= [5 \times \$10 + 1 \times \$20] + [1 \times \$10 + 10 \times \$20] = \$280$

- What is the unit cost of the final good in location 2?

$= [5 \times \$2 + 1 \times \$30] + [1 \times \$2 + 10 \times \$30] = 40 + 302 = \$342$

- What is the unit cost of the final good when components and assembly are carried out in the cheapest locations?

Assembly in ctry 2
Components in ctry 1

$= \$40 + \$210 = \$250$

Final good cost = $c_a(\,) + c_b(\,)$

Geography

- Missing from our simple example: trading costs
- Two trade costs
  - τ_b = cost of shipping good b
  - τ = cost of shipping final good
- Costs of shipping from 1 to 2 = costs of shipping from 2 to 1

Intermediate good.

DIFFERENCES IN FACTOR PRICES

vs.

COSTS OF MOVING GOODS

Possible firm structures

a, b in cty 1 sell to cty 1
a, b in cty 2 sell to cty 2

a, b in cty 1
sell to cty 1 + 2

1. Do a and b in each country (HFDI)
2. Do a and b in country 1, export to country 2 (export)
3. Do b in country 1, both countries do a (partial fragmentation)
4. Do b in country 1, do a in country 2 and ship final good to 1 (complete fragmentation)

- We can rule out
  - Do a and b in country 2, export final good to 1
  - Do b in country 2, do a in country 1 and ship final good to 2

Structure 1 (HFDI)

FDI substitute for trade.

country 1

country 2

no trade

$$c^1 = c_a(w_s^1, w_u^1) + c_b(w_s^1, w_u^1)$$

$$c^2 = c_a(w_s^2, w_u^2) + c_b(w_s^2, w_u^2)$$

Structure 2 (Export)

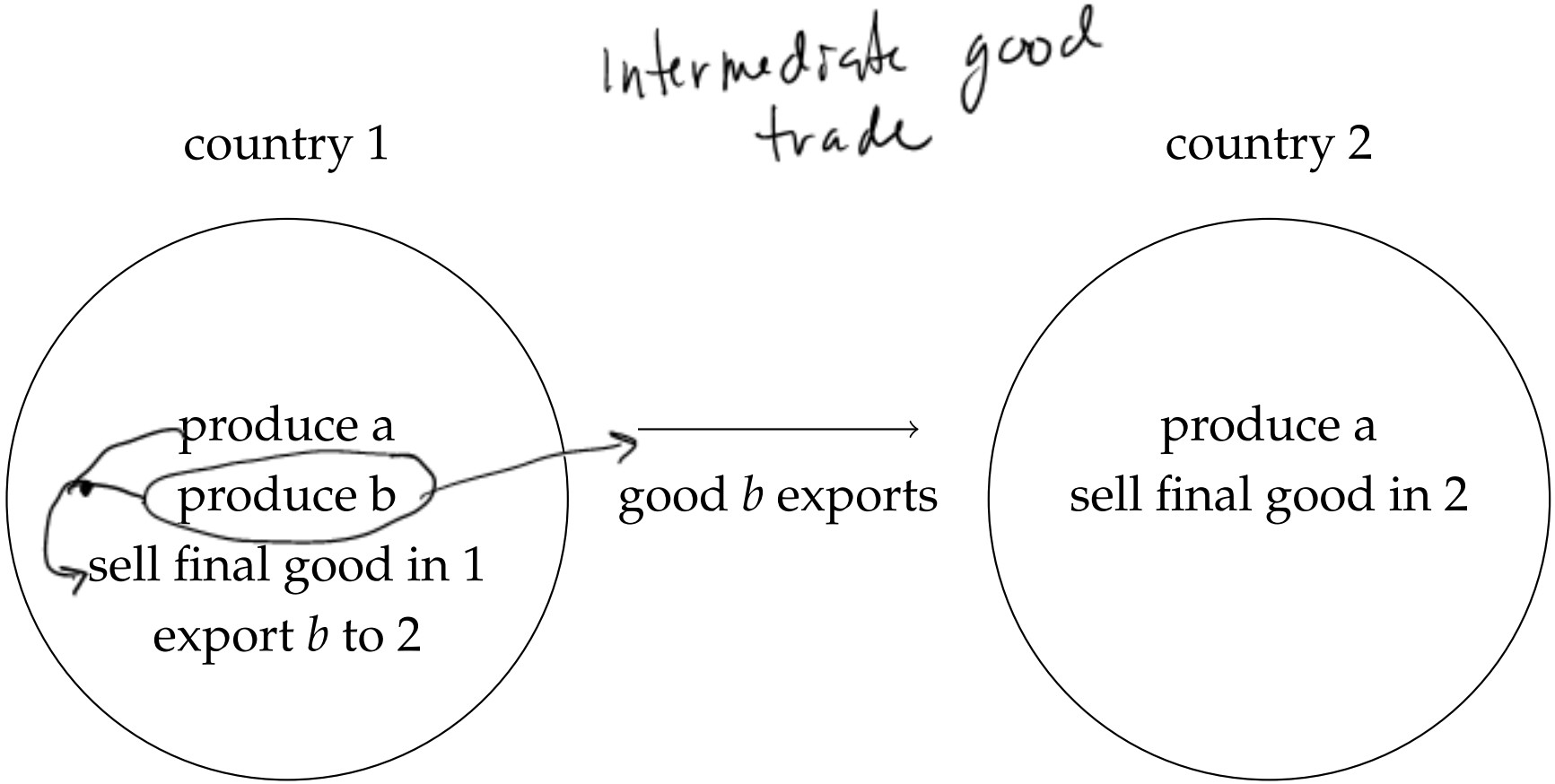
TRADE Substitute for FDI

$$c^1 = c_a(w_s^1, w_u^1) + c_b(w_s^1, w_u^1)$$

$$c^2 = \left[c_a(w_s^1, w_u^1) + c_b(w_s^1, w_u^1)\right](1+\tau)$$

$c^2 = c^1(1+\tau)$

Structure 3 (Partial fragmentation)



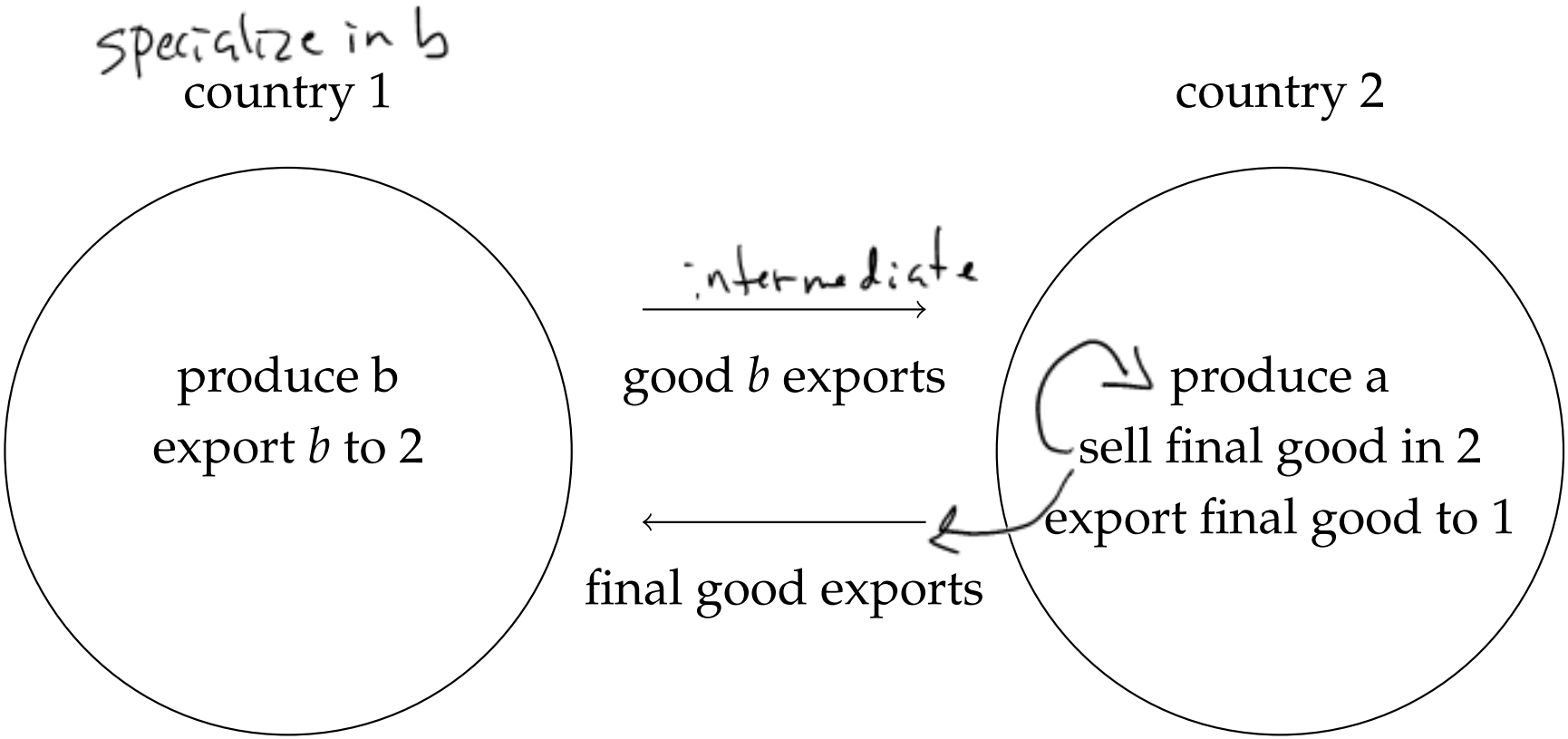
$$c^1 = c_a(w_s^1, w_u^1) + c_b(w_s^1, w_u^1)$$

same as 1. & 2.

$$c^2 = c_a(w_s^2, w_u^2) + c_b(w_s^1, w_u^1)(1 + \tau_b)$$

delivered price of b in cty 2.

Structure 4 (Complete fragmentation)



$$c^2 = c_a(w_s^2, w_u^2) + c_b(w_s^1, w_u^1)(1 + \tau_b)$$

$$c^1 = \left[c_a(w_s^2, w_u^2) + c_b(w_s^1, w_u^1)(1 + \tau_b)\right](1 + \tau)$$

Possible firm structures

1. Do a and b in each country (HFDI)

$$c^1 = c_a(w_s^1, w_u^1) + c_b(w_s^1, w_u^1)$$
$$c^2 = c_a(w_s^2, w_u^2) + c_b(w_s^2, w_u^2)$$

2. Do a and b in country 1, export to country 2

$$c^1 = c_a(w_s^1, w_u^1) + c_b(w_s^1, w_u^1)$$
$$c^2 = \left[c_a(w_s^1, w_u^1) + c_b(w_s^1, w_u^1)\right](1+\tau)$$

3. Do b in country 1, both countries do a

$$c^1 = c_a(w_s^1, w_u^1) + c_b(w_s^1, w_u^1)$$
$$c^2 = c_a(w_s^2, w_u^2) + c_b(w_s^1, w_u^1)(1+\tau_b)$$

4. Do b in country 1, do a in country 2 and ship final good to 1

$$c^1 = \left[c_a(w_s^2, w_u^2) + c_b(w_s^1, w_u^1)(1+\tau_b)\right](1+\tau)$$
$$c^2 = c_a(w_s^2, w_u^2) + c_b(w_s^1, w_u^1)(1+\tau_b)$$

Which firm structure?

- Which production structure would a firm choose?
- Depends on w_s^1, w_u^1, w_s^2, w_u^2, τ_b, and τ
- Hold fixed wages, focus on trading costs

trade off: differences in wages ⟹ cost savings

un/skill intensive

VS.

transportation costs

12:30

In class problem: Where to produce?

$c_a = \theta_{ua} w_u + \theta_{sa} w_s$

$c_b = \theta_{ub} w_u + \theta_{sb} w_s$

$c = c_a + c_b$

- $\theta_{ua} = 5$ and $\theta_{sa} = 1$; $\theta_{ub} = 1$ and $\theta_{sb} = 10$
- $w_u^1 = 10, w_s^1 = 20, w_u^2 = 2, w_s^2 = 30, \tau_b = 0.05, \tau = 0.05$
- Already know: $c^1 = c_a(w_s^1, w_u^1) + c_b(w_s^1, w_u^1) = 280$ (70 + 210)
- Already know: $c^2 = c_a(w_s^2, w_u^2) + c_b(w_s^2, w_u^2) = 342$ (40 + 302)
- How should the firm structure itself?

HFDI: $c_1 = 280$ $c_2 = 342$

Export: $c_1 = 280$ $c_2 = 280 \times 1.05 = 294$

P.F.: $c_1 = 280$ $c_2 = \underbrace{210 \times 1.05}_{220.5} + 40 = 260.50$

C.F.: $c_1 = \left[210 \times \underbrace{1.05}_{\tau_b} + 40\right] \times \underbrace{1.05}_{\tau} = 273.5$ $c_2 = 260.50$

In class problem: Where to produce?

- Now increase τ_b
- $\theta_{ua} = 5$ and $\theta_{sa} = 1$; $\theta_{ub} = 1$ and $\theta_{sb} = 10$
- $w_u^1 = 10$, $w_s^1 = 20$, $w_u^2 = 2$, $w_s^2 = 30$, $\tau_b = 0.15$, $\tau = 0.05$
- Already know: $c^1 = c_a(w_s^1, w_u^1) + c_b(w_s^1, w_u^1) = 280$
- Already know: $c^2 = c_a(w_s^2, w_u^2) + c_b(w_s^2, w_u^2) = 342$

- How should the firm structure itself?

HEDI: $c_1 = 280$ $c_2 = 342$

Exporting: $c_1 = 280$ $c_2 = 280 \times 1.05 = 294$

P.F.: $c_1 = 280$ $c_2 = 210 \times 1.15 + 40 = 281.50$

C.F.: $[210 \times 1.15 + 40]\,1.05 = 295.6$

241.5

$c_2 = 281.50$

Increasing the trade cost of intermediates

- Increasing the trade cost of b...
  - did not shut down trade in b
  - it shut down trade in the final good?!
- What happened?
  - The b goods have to pay 2 trade costs to get to country 1, then back to country 2
  - This double "tax" makes the cost of structure 4 (specialization) increase quickly with τ_b

In class problem: Where to produce?

- Now increase τ_b even more
- $\theta_{ua} = 5$ and $\theta_{sa} = 1$; $\theta_{ub} = 1$ and $\theta_{sb} = 10$
- $w_u^1 = 10$, $w_s^1 = 20$, $w_u^2 = 2$, $w_s^2 = 30$, $\tau_b = 0.30$, $\tau = 0.05$
- Already know: $c^1 = c_a(w_s^1, w_u^1) + c_b(w_s^1, w_u^1) = 280$
- Already know: $c^2 = c_a(w_s^2, w_u^2) + c_b(w_s^2, w_u^2) = 342$

- How should the firm structure itself?

Increasing the trade cost of intermediates

- For small enough τ_b...
  - Complete fragmentation
- Increasing the trade cost of b...
  - Move to incomplete fragmentation
- Increasing the trade cost of b more...
  - Move to exporting

- How does this depend on final good trade costs (τ)?