Trading Tasks: A Simple Theory of Offshoring

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Introduction

The nature of international trade has changed

For centuries, trade largely entailed an exchange of complete goods

Now, trade increasingly involves bits of value being added in many different locations: *Trade in tasks!*

  - Boom in “offshoring” of both manufacturing tasks and other business functions

Need for a new paradigm, one that puts task trade at center stage

The paper develops a simple and tractable model of offshoring that features such trade in tasks
Some Evidence of Task Trade

- Hard evidence on the growing scale of task trade is hard to come by
  - Trade data are collected and reported as gross flows rather than as foreign value added (NRC, 2006)
  - Some of this trade leaves no paper trail

- But hints of the global disintegration of the production process abound:
  - Share of imported inputs in total inputs used by goods-producing sectors in the US rose from 7% in 1972 to 18% in 2000
  - Intra-firm trade accounted for 47% of U.S. total imports in 2005
  - In the US, imports of Business, Professional and Technical (BPT) services have increased by more than 66% in real terms from 1997 to 2004
Towards a New Paradigm

- A different conceptualization of the production process
  - Production of every good requires the performance of a continuum of tasks by each of the factors of production
  - Tasks might be performed in different locations
  - Firms are motivated to offshore tasks by factor-cost savings, but trading tasks is costly

- A model with two industries, perfect competition, and two factors of production
  - The authors study how decreases in offshoring costs affect the wages of different types of labor
  - They find that low-skilled workers may benefit from the production of low-skilled tasks abroad
The Model

- Model allows trade in tasks, as well as trade in goods
- Production involves a continuum of $L$ tasks and continuum of $H$ tasks
- Industries differ in factor intensity, as usual
- Normalize measure of tasks of each type to one
- Cost of offshoring task $i$ is given by $\beta t(i) \geq 1$
- Order tasks so $t'(i) \geq 0$ and assume $t(i)$ is continuously differentiable
- For the moment only $L$-tasks can be offshore and same $t(i)$ schedule in each industry
Firm’s Problem

- Consider production in sector \( j \in \{X, Y\} \)
- Assume firms, or industry, produces using a Constant Returns to Scale technology
- Firms maximize profits

\[
\max_{Y_j, l_j} \{ p_j Y_j - c_j Y_j \}
\]

where

\[
c_j = w a_{Lj}(1 - l_j) + w^* a_{Lj} \int_0^{l_j} \beta t(i) di + sa_{Hj} + ...
\]

- Firm will offshore tasks \([0, l_j]\) where

\[
w = \beta t(l_j) w^*,
\]

and if the firm produces a positive amount

\[
p_j = c_j
\]
Marginal Costs

- Cost of producing good \( j \) using home technology are given by

\[
c_j = w a_{Lj} (1 - I) + w^* a_{Lj} \int_{0}^{l} \beta t(i) di + s a_{Hj}
\]

\[
= w a_{Lj} (1 - I) + w a_{Lj} \frac{\int_{0}^{l} t(i) di}{t(l)} + s a_{Hj}
\]

\[
= w a_{Lj} \Omega(I) + s a_{Hj}
\]

where

\[
\Omega(I) = 1 - I + \frac{\int_{0}^{l} t(i) di}{t(l)} \quad \text{with} \quad \Omega'(I) \leq 0
\]

- So possibility of offshoring affects costs exactly as labor-augmenting technological change
Equilibrium

- To allow for all the potential effects of offshoring, we need a model with (at least) three factors and (at least) two goods.
- Assume that both industries are active, then price is equal to unit cost (good \( X \) is numeraire and skill intensive):

\[
1 = w \Omega a_{Lx} + sa_{Hx} \\
p = w \Omega a_{Ly} + sa_{Hy}
\]

- Factor market clearing implies:

\[
a_{Lx} x (1 - I) + a_{Ly} y (1 - I) = L \\
a_{Lx} x + a_{Ly} y = \frac{L}{1 - I} \\
a_{Hx} x + a_{Hy} y = H.
\]

- These 4 equations determine \( x, y, w \Omega, s \) as functions of \( p, I \) and \( L, H \).
Equilibrium

- $p$ and $I$ are endogenous—determined in world equilibrium.
- To close the model, we need to specify the foreign country's equilibrium conditions and the world market clearing conditions, which will allow us to determine $I$ and $p$.
- If for the moment $I$ and $p$ are exogenous, then by differentiating totally the 4-equation system on the previous slide, we obtain:

\[
\hat{w} = -\hat{\Omega} + \mu_1 \hat{p} \\
\hat{s} = -\mu_2 \hat{p}
\]

where $\hat{w}$ is the log change.

Small Heckscher-Ohlin Economy

- Consider a small economy (\( p \) and \( w^* \) fixed) with two factors, \( L \) and \( H \), and two goods. Then

\[
\begin{align*}
1 & = w\Omega a_{Lx}(w\Omega/s) + sa_{Hx}(w\Omega/s) \\
p & = w\Omega a_{Ly}(w\Omega/s) + sa_{Hy}(w\Omega/s)
\end{align*}
\]

which implies that \( w\Omega \) and \( s \) depend only on \( p \). That is,

\[
\hat{w} = -\hat{\Omega} \text{ and } \hat{s} = 0
\]

- Therefore, if \( \beta \) goes down, then \( I \) goes up and, thereby, \( \Omega \) goes down, implying that

\[
\hat{w} \geq 0.
\]
Large Heckscher-Ohlin Economy

Need a reason for differences in factor prices across countries

Assume foreign country has inferior technology so that offshoring flows in one direction

Let $A^*$ measure Hicks-neutral technological inferiority in both industries, then

with incomplete specialization

\[ A^* a_{Lx} w^* + A^* a_{Hx} s^* = 1 \]
\[ A^* a_{Ly} w^* + A^* a_{Hy} s^* = p \]

Incomplete specialization implies that in equilibrium there is adjusted Factor Price Equalization:

\[ w \Omega = w^* A^* \]
\[ s = s^* A^* \]
This implies that both countries have similar $a_{Fj}$, so factor clearing conditions are given by

$$A^* a_{Lx} x^* + A^* a_{Ly} y^* + \beta \int_0^1 t(i) \, di \, (a_{Lx} x + a_{Ly} y) = L^*$$

$$A^* a_{Hx} x^* + A^* a_{Hy} y^* = H^*$$

or

$$a_{Lx} x^* + a_{Ly} y^* = \frac{L^*}{A^*} - \frac{\beta L}{A^* (1 - I)} \int_0^1 t(i) \, di$$

$$a_{Hx} x^* + a_{Hy} y^* = \frac{H^*}{A^*}$$
Large Heckscher-Ohlin Economy

- After some algebra

\[
\begin{align*}
x + x^* &= \frac{a_{Ly} \left( H + \frac{H^*}{A^*} \right) - a_{Hy} \left( \frac{L}{\Omega} + \frac{L^*}{A^*} \right)}{\Delta a} \\
y + y^* &= \frac{a_{Hx} \left( \frac{L}{\Omega} + \frac{L^*}{A^*} \right) - a_{Lx} \left( H + \frac{H^*}{A^*} \right)}{\Delta a}
\end{align*}
\]

where \( \Delta a = a_{Hx} a_{Ly} - a_{Lx} a_{Hy} > 0 \).

- Goods market equilibrium:

\[
\frac{y + y^*}{x + x^*} = D(p)
\]

where \( D(p) \) is the world relative demand: \( D'(p) < 0 \).

- If \( \beta \downarrow \implies I \uparrow \) and \( \Omega \downarrow \). This in turn implies that \( \frac{y + y^*}{x + x^*} \uparrow \) and \( p \) falls: \( \hat{p} < 0 \).
Large Heckscher-Ohlin Economy

- Hence, $p \downarrow$ implies Relative Price Effect favors $H$ and harms $L$

- Overall:

\[
\hat{w} = -\hat{\Omega} + \mu_1 \hat{p}
\]

and

\[
\hat{s} = -\mu_2 \hat{p}
\]

- $H$ must gain, $L$ may gain or lose

- Possible Pareto gains for home country if productivity effect large enough

- Note complete analogy with labor-augmenting technological progress in home country
Offshoring Skill-Intensive Tasks

- Recent policy debate has focused on offshoring of white collar jobs
- May interpret this as offshoring of $H$-tasks
- Offshoring of $H$-tasks can be easily incorporated, for example, in small $HO$ economy. Then

$$w = w^* \beta_L t_L(l_L)$$

$$s = s^* \beta_H t_H(l_H)$$

and (given incomplete specialization)

$$a_L w \Omega_L + a_H s \Omega_H = 1$$

$$a_L w \Omega_L + a_H s \Omega_H = p$$

- These equations together determine $w, s, l_L, l_H$ given $p, w^*, s^* $.
In fact, \( w\Omega_L \) and \( s\Omega_H \) are determined independently of \( \beta_L \) and \( \beta_H \).

As a result, if \( \beta_H \) falls, then \( w\Omega_L \) and, thereby, \( w \) are unchanged, while \( s \) increase (as \( \Omega_H \) falls):

\[
\hat{w} = -\hat{\Omega}_L, \\
\hat{s} = -\hat{\Omega}_H.
\]
Conclusion

- In the past:
  - Countries produced mostly complete products that they consumed and traded with other nations

- Today:
  - Drastic reductions in transport and communication costs have facilitated direct trade in tasks
  - Traditional benefits from worker specialization plus gains generated when tasks are performed at the lowest cost location

- Proposed a new paradigm where task trade takes center stage and:
  
  *Offshoring of a particular factor’s tasks is equivalent to factor-augmenting technological progress*

- Offshoring may lead to Pareto gains for source country