Trading Tasks: A Simple Theory of Offshoring

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March, 2012
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

$$c_j = wa_{Lj}(1 - l_j) + w^* a_{Lj} \int_0^{l_j} \beta t(i) di + sa_{Hj} + \ldots$$

- Firm will offshore tasks $[0, l]$ where

$$w = \beta t(l) w^*,$$

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

$$
c_j = w a_{Lj} (1 - I) + w^* a_{Lj} \int_0^I \beta t(i) di + sa_{Hj}
$$

$$
= w a_{Lj} (1 - I) + wa_{Lj} \frac{\int_0^I t(i) di}{t(I)} + sa_{Hj}
$$

$$
= wa_{Lj} \Omega(I) + sa_{Hj}
$$

where

$$
\Omega(I) = 1 - I + \frac{\int_0^I t(i) di}{t(I)} \quad \text{with} \quad \Omega'(I) \leq 0
$$

- 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

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

These 4 equations determine \( x, y, w\Omega, s \) as functions of \( p, l \) 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.

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

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

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:

  $w\Omega = w^*A^*$
  $s = s^*A^*$
Large Heckscher-Ohlin Economy

- This implies that both countries have similar $a_{Fj}$, so factor clearing conditions are given by

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

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

or

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

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

- After some algebra

\[ x + x^* = \frac{a_{Ly} (H + \frac{H^*}{A^*}) - a_{Hy} \left( \frac{L}{\Omega} + \frac{L^*}{A^*} \right)}{\Delta a} \]

\[ y + y^* = \frac{a_{Hx} \left( \frac{L}{\Omega} + \frac{L^*}{A^*} \right) - a_{Lx} (H + \frac{H^*}{A^*})}{\Delta a} \]

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

\[
\begin{align*}
    w &= w^* \beta_L t_L(l_L) \\
    s &= s^* \beta_H t_H(l_H)
\end{align*}
\]

and (given incomplete specialization)

\[
\begin{align*}
    a_{Lx} w \Omega_L + a_{Hx} s \Omega_H &= 1 \\
    a_{Ly} w \Omega_L + a_{Hy} s \Omega_H &= p
\end{align*}
\]

- These equations together determine $w, s, l_L, l_H$ given $p, w^*, s^*$. 

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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