Trade with Search Frictions: Identifying New Gains from Trade

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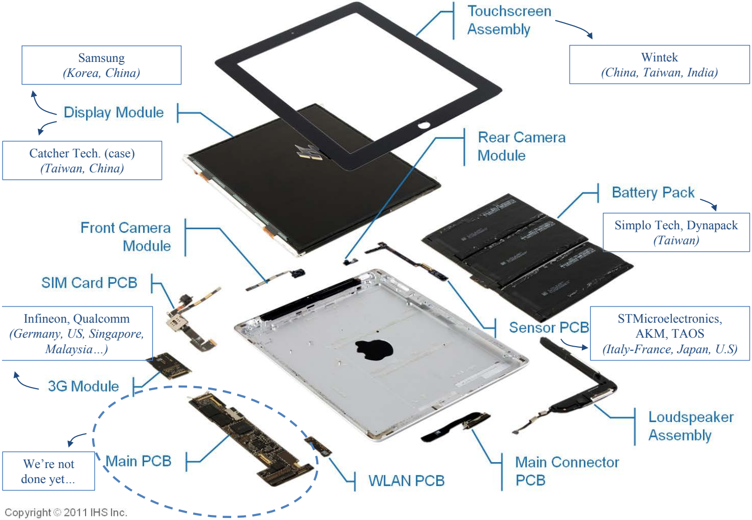
Motivation

- Firms often search for suppliers to procure specialized inputs:
  1. While a few core inputs are made in-house, other non-core inputs are largely purchased from outside suppliers
  2. IT revolution makes it easier to search for suppliers not only within borders but also across borders
  3. Access to a wide range of outsourced inputs improves production technology of firms

  $\Rightarrow$ Consider Apple's sourcing strategy

Motivation


Touchscreen Assembly
Wintek
(China, Taiwan, India)
Samsung
(Korea, China)
Display Module
Catcher Tech. (case)
(Taiwan, China)
Rear Camera Module
Battery Pack
Simplo Tech, Dynapack
(Taiwan)
Front Camera Module
SIM Card PCB
Infineon, Qualcomm
(Germany, US, Singapore, Malaysia...)
Sensor PCB
STMicroelectronics, AKM, TAOS
(Italy-France, Japan, U.S)
3G Module
Loudspeaker Assembly
We're not done yet...
Main PCB
WLAN PCB
Main Connector PCB
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Motivation

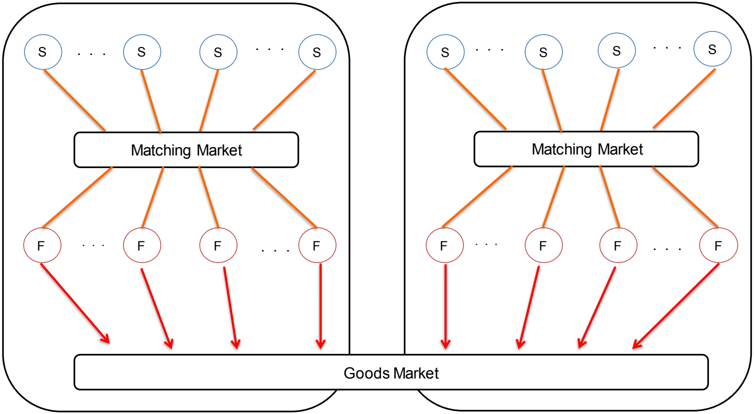
- Search and matching $\Rightarrow$ Input trade:
  1. About two thirds of world trade are accounted by intermediate inputs (Johnson and Noguera, 2012)
  2. Traded goods produced at the upstream stage have been rapidly increasing (Antràs et al., 2012)
  3. The share of differentiated inputs has more than doubled between 1962–2000 (Antràs and Staiger, 2012)

Question and results

- Question:
  - What is the welfare impact of economic integration through trade in the presence of search frictions?

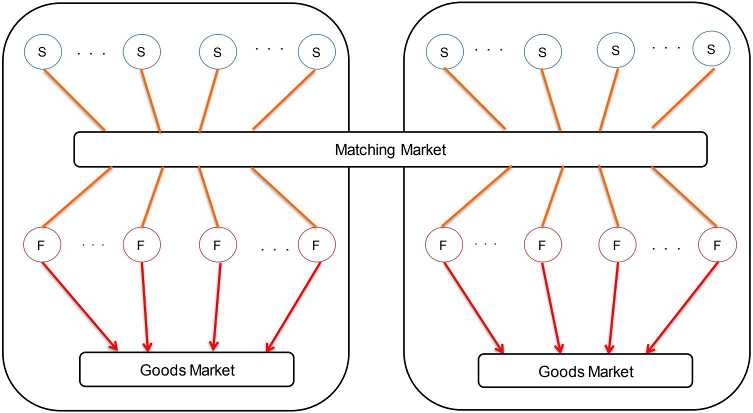
- Two types of economic integration:
  1. Goods market integration $\Rightarrow$ Trade allows firms to ship final products abroad (in classical sense)
  2. Matching market integration $\Rightarrow$ Trade allows firms to source intermediate inputs from abroad

Question and results



Goods market integration ⇒ Welfare gains are amplified

Question and results



Matching market integration $\Rightarrow$ Welfare losses may occur

Related literature

- Key assumptions:
  1. Firms and suppliers randomly match and bargain over generated surplus (Pissarides, 2000)
  2. Firms and suppliers have one-to-one relationships in their search process (Sugita et al., 2021)
  3. Matched firms can enjoy a love-of-variety effect from an input expansion (Ethier, 1982; Romer, 1990; Grossman and Helpman, 1991)

Setup

- Consumer preferences:

$$U = \left(\int_{\omega} y(\omega)^{\frac{\sigma-1}{\sigma}} d\omega \right)^{\frac{\sigma}{\sigma-1}}, \quad \sigma > 1$$

- Demand and expenditure for variety ω:

$$y(\omega) = Ap(\omega)^{-\sigma}$$
$$r(\omega) = Ap(\omega)^{1-\sigma}$$

where A is the index of industry demand

Setup

- Firm technology:

$$y(\omega) = \left((x^F(\omega))^{\frac{\sigma-1}{\sigma}} + \mathbb{1}(\omega)(x^S(\omega))^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}$$

where both inputs are produced competitively

- Firm marginal cost:

$$c(\omega) = \left((wa^F)^{1-\sigma} + \mathbb{1}(\omega)(wa^S)^{1-\sigma} \right)^{\frac{1}{1-\sigma}} = \frac{wa^F}{\varphi(\omega)}$$

where

$$\varphi(\omega) \equiv \left(1 + \mathbb{1}(\omega) \left(\frac{a^F}{a^S} \right)^{\sigma-1} \right)^{\frac{1}{\sigma-1}}$$

Setup

- Profit-maximization problem:

$$\max_{x^F(\omega),\, x^S(\omega)} \; r(\omega) - wa^F x^F(\omega) - \mathbb{1}(\omega) wa^S x^S(\omega)$$

- Optimal pricing, output and revenue:

$$p(\varphi) = \frac{\sigma}{\sigma - 1} \frac{wa^F}{\varphi}$$

$$y(\varphi) = A \left(\frac{\sigma - 1}{\sigma} \frac{\varphi}{wa^F} \right)^{\sigma}$$

$$r(\varphi) = A \left(\frac{\sigma - 1}{\sigma} \frac{\varphi}{wa^F} \right)^{\sigma - 1}$$

Setup

- Number of matches:

$$m(u^F, u^S)$$

which satisfies CRS in matching

- Probability of matches:

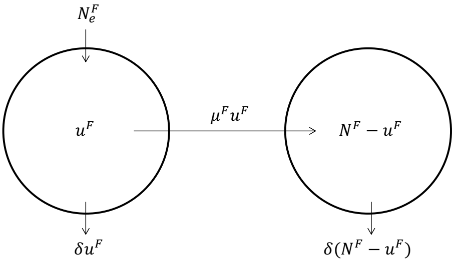
$$\mu^F \equiv m(u^F, u^S)/u^F = m(1, \theta)$$
$$\mu^S \equiv m(u^F, u^S)/u^S = m(1/\theta, 1) = \mu^F/\theta$$

where $\theta \equiv u^S/u^F$

- Probability of a bad shock: δ

Setup

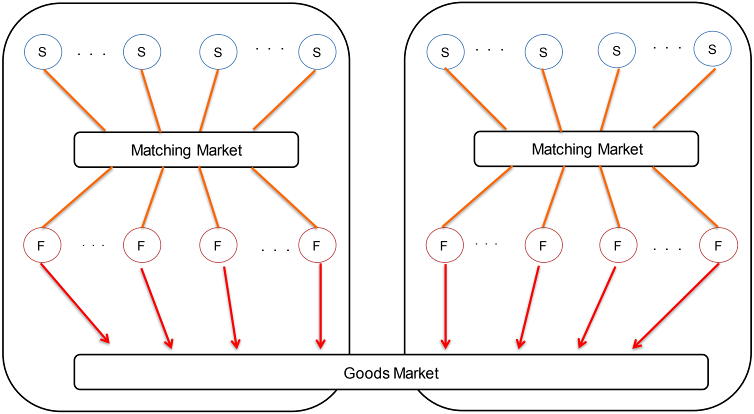
- Search process for firms:



- The law of motion:

$$\dot{N}^F = \delta N^F - N_e^F$$
$$\dot{u}^F = (\delta + \mu^F) u^F - N_e^F$$
$$\dot{N}^F - \dot{u}^F = \delta(N^F - u^F) - \mu^F u^F$$

X-integration



X-integration

- When only matched firms export, the Bellman equations are given by

$$\begin{aligned}
\gamma V^F &= \frac{r}{\sigma} + \mu^F \left(V^F(\varphi) - F_x - V^F \right) - \delta V^F + \dot{V}^F \\
\gamma V^F(\varphi) &= \frac{r^F(\varphi)}{\sigma} - \delta V^F(\varphi) + \dot{V}^F(\varphi) \\
\gamma V^S &= \mu^S \left(V^S(\varphi) - F_d - V^S \right) - \delta V^S + \dot{V}^S \\
\gamma V^S(\varphi) &= \frac{r^S(\varphi)}{\sigma} - \delta V^S(\varphi) + \dot{V}^S(\varphi)
\end{aligned}$$

  where F_d and F_x are a one-time investment cost

X-integration

- Assuming that $\gamma = 0$ and setting $\dot{V}^F = \dot{V}^F(\varphi) = 0$:

$$V^F = \frac{r}{\delta\sigma} + \left(\frac{\mu^F}{\delta + \mu^F}\right)\left(\frac{r^F(\varphi)}{\delta\sigma} - \frac{r}{\delta\sigma} - F_x\right)$$

$$V^F(\varphi) = \frac{r^F(\varphi)}{\delta\sigma}$$

  where the probability δ introduces an effect similar to time discounting

- Similarly, setting $\dot{N}^F = \dot{u}^F = \dot{N}^F - \dot{u}^F = 0$:

$$n = \left(\frac{\mu^F}{\delta + \mu^F}\right) N^F$$

  where $n \equiv N^F - u^F$

X-integration

- Bargaining within matched agents:

$$\max_{\frac{r^F(\varphi)}{\sigma},\frac{r^S(\varphi)}{\sigma}} \left(V^F(\varphi) - F_x - V^F\right)\left(V^S(\varphi) - F_d - V^S\right)$$

subject to $r^F(\varphi)/\sigma + r^S(\varphi)/\sigma = r(\varphi)/\sigma$

- Optimal sharing rule:

$$\frac{r^F(\varphi)}{\delta\sigma} - \frac{r}{\delta\sigma} - F_x = \beta\left(\frac{r(\varphi)}{\delta\sigma} - \frac{r}{\delta\sigma} - F_d - F_x\right)$$

$$\frac{r^S(\varphi)}{\delta\sigma} - F_d = (1-\beta)\left(\frac{r(\varphi)}{\delta\sigma} - \frac{r}{\delta\sigma} - F_d - F_x\right)$$

where $\beta \equiv (\delta + \mu^F)/(2\delta + \mu^F + \mu^S)$

X-integration

- FE conditions:

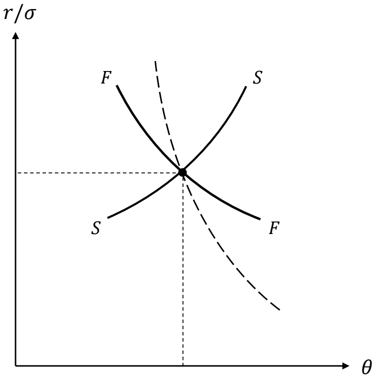
$$V_e^F \equiv V^F - F_e^F = 0$$
$$V_e^S \equiv V^S - F_e^S = 0$$

- From the steady-state relationships, this can be written as

$$\frac{r}{\sigma} + \frac{n}{N^F}\beta\left(\frac{r(\varphi)}{\sigma} - \frac{r}{\sigma} - f_d - f_x\right) - f_e^F = 0$$
$$\frac{n}{N^S}(1-\beta)\left(\frac{r(\varphi)}{\sigma} - \frac{r}{\sigma} - f_d - f_x\right) - f_e^S = 0$$

where $f_d \equiv \delta F_d$, $f_x \equiv \delta F_x$, $f_e^F \equiv \delta F_e^F$ and $f_e^S \equiv \delta F_e^S$

X-integration



$$\theta = u^S/u^F = (N^S - n)/(N^F - n)$$

- *FF* curve

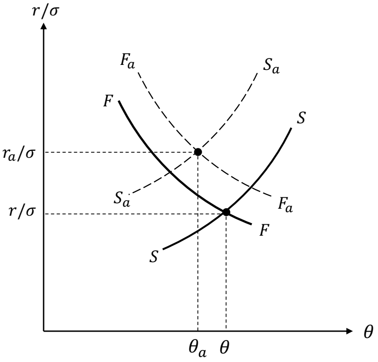
  $\theta \uparrow \Rightarrow \ \mu^F \uparrow \Rightarrow \ r/\sigma \downarrow$

- *SS* curve

  $\theta \uparrow \Rightarrow \ \mu^S \downarrow \Rightarrow \ r/\sigma \uparrow$

- θ and r/σ are consistent with free entry in X-integration equilibrium

X-integration



- Impact of X-integration

$$\theta > \theta_a$$
$$r/\sigma < r_a/\sigma$$

- Matched firms get a larger rent by reductions in trade costs ($\tau_x, f_x \downarrow$)

$$\frac{r(\varphi)}{\sigma} - \frac{r}{\sigma} - f_d - f_x \quad \uparrow$$

which induces new entry of agents

X-integration

- Gains from trade (GFT) in X-integration:
  1. $r/\sigma < r_a/\sigma \implies$ Resources are reallocated from (less efficient) unmatched firms to (more efficient) matched firms
  2. $\theta > \theta_a \implies$ Firms have the higher probability to meet suppliers $(n/N^F > n_a/N_a^F)$, enhancing overall production efficiency of the industry

X-integration

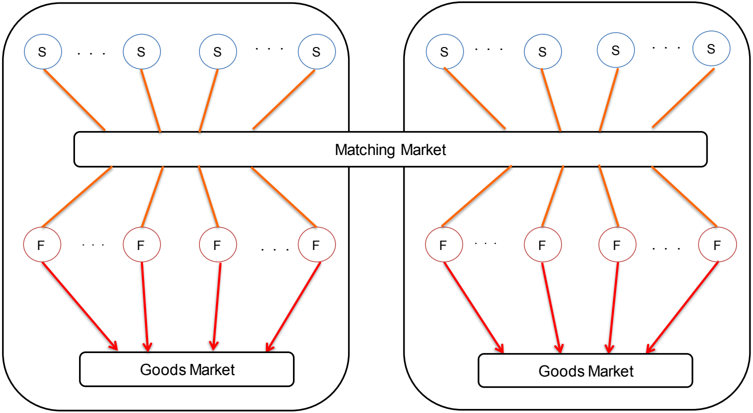
- GFT are expressed as

$$\frac{W}{W_a} = \left[\left(\frac{N_a^F + (\varphi^{\sigma-1} - 1)n_a}{N^F + (\varphi^{\sigma-1} - 1)n} \right) \lambda \right]^{-\frac{1}{\sigma-1}}$$

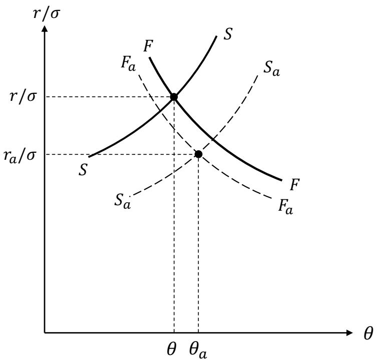
where λ is the expenditure share on domestic goods

1. In Krugman (1980) where $n = n_a = 0$ and $N^F = N_a^F$, this ratio is simply given as $W/W_a = \lambda^{-1/(\sigma-1)}$ (Arkolakis et al., 2012)
2. In our model where $n/N^F > n_a/N_a^F$, the values in the brackets (endogenous firm matches) matter for welfare
3. Numerical solutions $\Longrightarrow$ GFT are 0.9% without search but 2.4% with search

M-integration



M-integration



- Impact of M-integration

$$\theta < \theta_a$$

$$r/\sigma > r_a/\sigma$$

- M-integration has three types of firms
  1. Least efficient unmatched firms
  2. Moderately efficient firms matched with Foreign suppliers
  3. Most efficient firms matched with Home suppliers

Summary

- Main findings:
  - Search frictions in workhorse trade models may lead to contrasting welfare effects from economic integration
  - Goods market integration $\Rightarrow$ Welfare gains are amplified
  - Matching market integration $\Rightarrow$ Welfare losses may occur