The Pace of Technology Transfer in Anticipation of Joint Venture Breakup.

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Stylized facts

- **One of the key engines of growth for emerging markets**:

Technology transfer from developed economies.

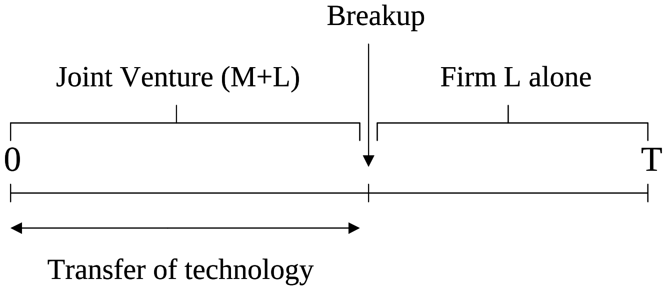
- **Major issue for Joint Ventures:**

JV breakup (often within a few years).

- **Absorptive capacity**:

Pace matters, the costs associated to technology transfer increase with the pace.

The Story



- *M* cannot prevent *L* from breaking away after receiving its technology transfer ⇒ *Enforcement of contracts is incomplete*:

Key elements of the model

- *Dynamic model* of principal (M) - agent (L) relationship (JV, labor contract...) with

1. Pace of technology transfer.
2. Evolution of profit sharing.

- Previous models: two periods; Ethier and Markusen (1996), Markusen (2001), Roy Chowdhury and Roy Chowdhury (2001).

Main result

- Credit Market failure + Property Rigths failure (dev. economy) ⇒ Second best contracts:

1. **Pace:** the pace and aggregate amount of technology transfer deviate from the first best.
   - Is the speed of technology transfer reduced?
   - Is the cumulative amount of technology transfer lower?
2. **Profit Sharing:** a flow of side payments from M to encourage L to stay longer.
   - Does the side payment increase over time?
   - What is the optimal time to let the local firm break away?

The Basic Model

Notations

- Time is a continuous variable, $t \in [0, T]$.
- $h(t)$: rate of technology transfer.
- $H(t) = \int_0^t h(\tau)\, d\tau$: state of technological knowledge of the local firm.
- $C(h(t))$: "absorption costs".
- $\pi(H(t))$: the (reduced-form) gross profit of a firm with knowledge $H(t)$.

Outline of the analysis:

1. Characterize the first best (efficient) time path of technology transfer.
2. Discuss whether this path can be achieved if L can break away and become a stand alone entity that captures all the post-breakaway profit.

The answer depends on what kind of contract is feasible:

- **Credit market failure?**

Can L borrow some money?

- **Property rights failure?**

Is compensation from L to M after the breakaway allowed?

(II) The first best solution

The first best solution 1/3:

- First best situation: L cannot break away/ Joint surplus maximization:

$$\underset{\{h(t),t\in[0,T]\}}{Max}\left[V=\int_0^T\left[\pi(H(t))-C(h(t))\right]dt\right]$$

s.t. $\dot{H}(t)=h(t)$, $H(0)=H_0=0$ and $0\leq h\leq h_{\max}$.

- We consider*:

$$h(t) = \begin{cases} h & \text{if } t \in [0, t_S] \\ 0 & \text{if } t \in (t_S, T] \end{cases} \tag{1}$$

- t_S: "technology-transfer-stopping time".
- New maximization programme:

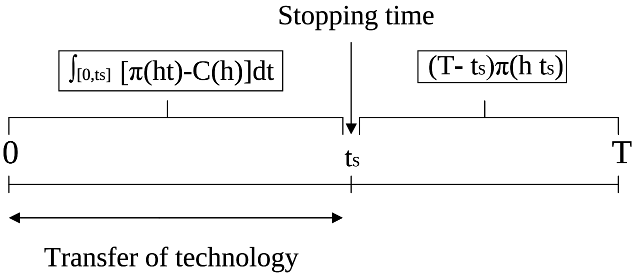
$$\underset{h,t_S}{Max} \left[V(h, t_S) = \int_0^{t_S} [\pi(ht) - C(h)]\, dt + [T - t_S]\, \pi(ht_S) \right] \tag{2}$$

s.t. $0 \leq h \leq h_{\max}$ and $0 \leq t_S \leq T$.

The first best solution 2/4:

Two phases:

1. Investment in technology:
   $V - R = \int_0^{t_S} [\pi(ht) - C(h)]\, dt$
2. Exploitation of knowledge: $R = [T - t_S]\, \pi(ht_S)$



The first best solution:

Proposition 1: *The solution of the (first-best) optimization problem (2) of the joint venture exists, is unique, and has the following properties:*
(i) $0 < h^* < h_{\max}$ *for* t in $[0, t_S^*]$.
(ii) $0 < t_S^* < T$.
(iii)

$$C'(h^*) - \frac{C(h^*)}{h^*} = \frac{1}{t_S^*} \int_0^{t_S^*} \left[\frac{\partial}{\partial h} \pi(h^* t) \right] dt$$

(iv)

$$(T - t_S^*)\pi'(h^* t_S^*) = \frac{C(h^*)}{h^*}.$$

(III) Joint venture contracts and breakaway

Payoffs with side payments

- t_B: Breakaway time chosen by L.
- $w(t)$: flow of payment from M to L before the breakaway (wage).
- $\phi(t)$: flow of compensation payment from L to M after the breakaway (royalties).

- L has an incentive to break away before t_S: $t_B \leq t_S$.
- The total payoffs of M and L:

$$V_M \equiv \int_0^{t_B} \left[\pi(H(t)) - C(h(t)) - w(t)\right] dt + \int_{t_B}^{T} \phi(t)\, dt,$$

and

$$V_L \equiv \int_0^{t_B} w(t)\, dt + \int_{t_B}^{T} \left[\pi(H(t)) - \phi(t)\right] dt.$$

Market failures

Credit market failure (C1): L cannot borrow any money

$$0 \leq \int_0^t w(\tau)\, d\tau \text{ for all } t \in [0, t_B].$$

Property rights failure (C2): M cannot get any compensation payments from the local firm after t_B

$$\phi(t) = 0 \text{ for all } t \in [t_B, T],$$

Technology transfer with two market imperfections

$$\max_{h,t_S,w(.)} V_M = \int_0^{t_B} \left[\pi(H(t)) - C(h(t)) - w(t)\right] dt$$

$$t_B = \arg\max_t \left[V_L = \int_0^t w(\tau)\, d\tau + (T-t)\pi(H(t))\right] \quad \text{(IC)}$$

$$0 \leq \int_0^t w(\tau)\, d\tau \text{ if } t \in [0, t_B] \quad \text{(BC)}$$

Where $H(t) = \int_0^t h(\tau) d\tau$ and

$$h(t) = \begin{cases} h & \text{if } t \in [0, \min(t_S, t_B)] \\ 0 & \text{if } t \in (\min(t_S, t_B), T] \end{cases}$$

The local firm's secure payoff

What can L secure in the "worst" case ($w(.) \equiv 0$) ?

- M firm takes 100% of the profit of the JV $(w(.) \equiv 0)$.
- Given (h, t_S), L will choose $\widehat{t}_B$ in $[0, t_S]$, to maximize

$$R(h, t_B) \equiv (T - t_B)\pi(ht_B) \text{ where } t_B \in [0, t_S]$$

Example 1

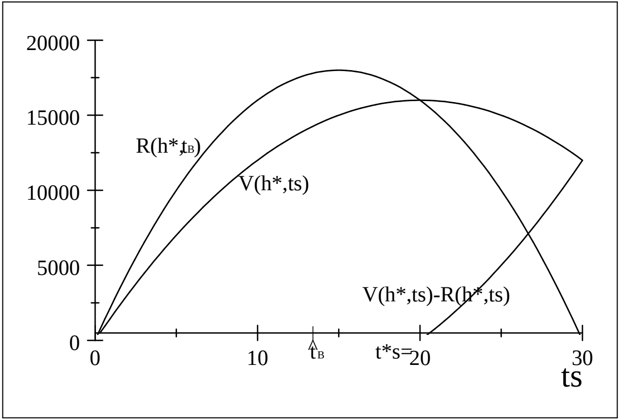


Fig. 1: Case where the local firm breaks away before the first best transfer-stopping time.

Example 2

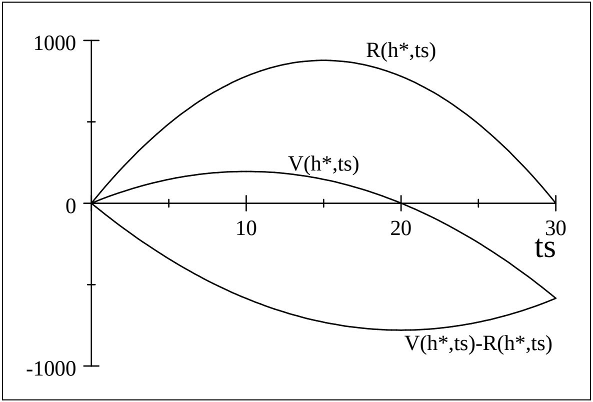


Fig. 2: Case where the local firm breaks away at the first best transfer-stopping time $\left(\widehat{t}_B\left(h^*\right) = t_S^* = 10\right)$.

Incentive compatible contracts with credit constraint

- The local firm can secure $\underline{V}_L(h) = (T - \widehat{t}_B(h))\pi(h\widehat{t}_B(h))$.
- Given $(h, w^C())$, the breakaway time is t_B^C.

For h given, the multinational firm chooses an optimal flow of side payments, $w^C(.)$:

$$\begin{aligned} \int_0^{\widehat{t}_B(h)} w^C(t)\,dt &= 0 \text{ and} \\ \int_{\widehat{t}_B(h)}^{t_B^C} w^C(t)\,dt + (T - t_B^C)\pi(ht_B^C) &= \underline{V}_L(h) \end{aligned}$$

Reformulation of M's programme

$$\max_{h, t_B^C, w^C(.)} V_M = \int_0^{t_B^C} \left[\pi(H(t)) - C(h(t)) - w^C(t) \right] dt$$

$$\begin{aligned} \int_0^{t_B^C} w^C(t)\, dt + (T - t_B^C)\pi(h t_B^C) &= \underline{V}_L(h) \text{ (IC)} \\ \int_0^{\widehat{t}_B(h)} w^C(t)\, dt &= 0 \text{ (BC)} \end{aligned}$$

Where $H(t) = \int_0^t h(\tau) d\tau$ and $h(t) = \begin{cases} h & \text{if } t \in [0, t_B^C] \\ 0 & \text{if } t \in (t_B^C, T] \end{cases}$

- Has M an incentive to reduce the pace of technology transfer?

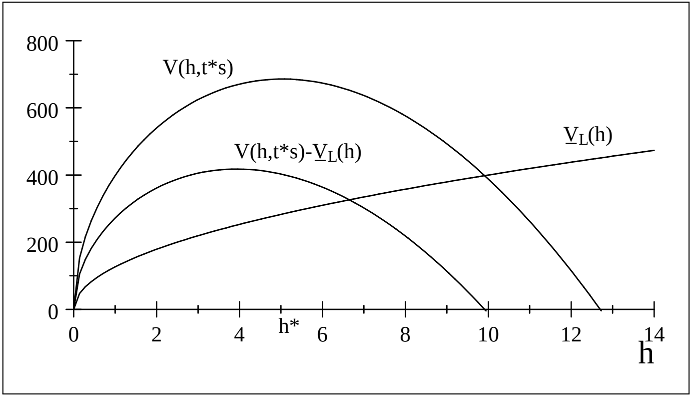


Fig. 3: The secure value of the local firm and the pace of technology transfer.

Comparison with the first best

- The (second best) optimal pace and the optimal breakaway time $\left(h^C, t_B^C\right)$ are such that:

$$h^C < h^* \text{ and } t_B^C > t_S^*$$

- The (second best) amount of technology transferred H^C is lower than the first best one H^*.
- The flow of side payment increases throught time, $\frac{dw^C}{dt} \geq 0$.

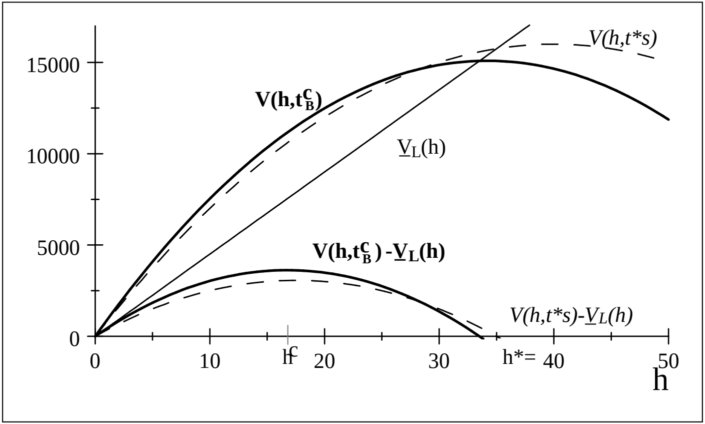


Fig. 3: The secure value of L and the pace of technology transfer.

Intuition

The intuition behind our results:

- M knows that L will always want to breakaway at some stage.
- Given (h, t_S), L will breakaway at $\widehat{t}_B(h) \leq t_S$, earning a "secure payoff" $\underline{V}_L(h)$.
- M reduces h to counter L's opportunistic behavior.
- The positive flow of side payments written in the contract $(w^*(.))$ is a bribe to induce L to stay longer in the JV.

THANKS !

Implications of tariff policies, wages policies and spillover effects

Tariff policies, wages policies

- An increase in the tariff rate will raise the profit of the joint venture which leads to an increase in both h^* and H^*.
- The second best amount of transfer also increases, because K increases.
- Similarly, a smaller wage rate will lead to more technology transfer.

Trade-off between the static efficiency loss of a tariff and the dynamic gain generated by technology transfer (and its spillover effects).

Local spillover effects

- An increase in the strength of spillover effects will reduce the profit of the JV which leads to a decrease in both h^* and H^*.
- The second best amount of technology transfer also decreases.

Supplementary informations

The Costs of technology transfer

According to Teece (1977) there are four technology transfer costs:

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  1. Costs associated to pre-engeneering technological exchanges.
  2. Costs of transferring and absorption of the process or the product design.
  3. R&D costs "associated with solving unexpected problems and adapting or modifying technology".
  4. Training costs (extra supervisory personnel).