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1. Introduction

The presence of multinational enterprises (MNEs) in developing countries is increasingly considered to be beneficial to host economies. The available empirical literature suggests several sources of positive influence from foreign direct investment (FDI) to the local econom

local suppliers in East Asia were supposed to produce intermediate input

Q_d (such as a radio or simple TV etc.), but does not have an adequate knowledge to produce a high-tech good Q_m (such as electronics).[1] The production of the low-tech good Q_d (the downstream industry) requires intermediates *x* (of any quality), which are produced by a single local producer of intermediates (the upstream industry). I assume that intermediate inputs are non-traded.[2] That means that if the local upstream industry is absent, the good Q_d cannot be produced locally and should be imported from abroad. The high-tech good Q_m can be either 7097 c2 0m555

3.2 Basic notation[6]

Q_d quantity of low-tech good produced by the dom

3.3 The final good (downstream) industry

The domestic producer of the final good uses x_i^d intermediate inputs to produce the low-tech good in the amount of Q_d . Index *d* refers to the domestic producer and index *i* refers to different levels of quality, $_i$, of the intermediate product. I denote by $_1$ = 1 the lowest quality of the good, which can be improved by investing effort *i* to obtain quality level $_i$. Particularly assume that $_i = \sqrt{i}$, where $i \geq 1$. Quality $_i$ is an increasing and concave function of effort *i* , since it is easier to improve a lower quality good than that of a higher quality.[7]

The production function of the local downstream producer is Cobb-Douglas and it depends on quality $_i$ of the intermediate inputs

$$Q_d = \frac{1}{\alpha} \lambda_i^{1-\alpha} (x_i^d)^\alpha \qquad \text{where } 0 < \alpha < 1 \tag{1}$$

Note that h

The first-order condition for (8) is given by

$$\frac{\partial \Pi_m}{\partial x_i^m} = P_m \lambda_i^{1-\beta} (x_i^m)^{\beta-1} - \overline{p} = 0 \qquad (9)$$

From (9) the MNE's demand for high quality intermediates can be derived as

$$x_i^m = \lambda_i \left(\frac{P_m}{\overline{p}} \right)^{\frac{1}{1-\beta}} \qquad (10)$$

3.4 The intermediate goods (upstream) producer

A single domestic producer of intermediate goods has two options in the presence of the MNE. The first one is to produce a low quality intermediate good ($\lambda_i < \overline{\lambda}$) for the local downstream producer only. The second one is to establish a linkage with the MNE, improve the quality of the good ($_i \geq \overline{\lambda}$), and supply it to both the local firm and the MNE. To improve quality the producer has to invest effort *i* which has price *f* per each unit of effort[8]. Investment costs then will be a linear function of effort: *f i* .

3.4.1 The upstream producer supplies only domestic downstream producer

Consider first that the local supplier produces for the domestic firm only. In this case he faces the demand for his product x_i^d and determines the price p_i[9].

His profit function is given by

$$\pi_d = p_i x_i^d - c x_i^d - f \cdot i = (p_i - c) x_i^d - f \cdot i \qquad (11)$$

where c is a constant marginal cost of production and *f i* is the investment cost.

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[8] ***f*** includes payments to the R&D personnel, training costs, etc. *f* will be higher for countries with low education level and42p35yc52 0ET2 tec 10.02 397.0992 102.311 T6502 0p0.02 0 0 10.02 377.35

$$\pi_d^* = \frac{1}{4f}\left((1-\alpha)\left(\frac{\alpha}{c}\right)^{\frac{\alpha}{1-\alpha}} P_d^{\frac{1}{1-\alpha}} \right)^2 \qquad (21')$$

(II) In the case of corner solution $\frac{1}{2\sqrt{i^*}}V_d - f < 0$ and $i^* = \left(\frac{V_d}{2f}\right)^2 \leq 1$

This holds when $V_d < 2f$.

In this case $\begin{cases} i^*=1, & \text{if } \pi_d^* > 0 \\ \text{No production,} & \text{if } \pi_d^* < 0 \end{cases}$;

In the former case, which corresponds to the range $V_d \in [\ f;\ \ 2f\ ]$, basic quality intermediates will be produced. In the latter, when $V_d < f$, no production will take place. The middle and bottom panels of Table 1 present these two cases.

When basic quality intermediates are produced the maximum profit is equal to

$$\pi_d^* = \sqrt{\bar{i}}\left((1-\alpha)\left(\frac{\alpha}{c}\right)^{\frac{\alpha}{1-\alpha}} P_d^{\frac{1}{1-\alpha}} \right) - f \cdot \bar{i} \qquad (22)$$

3.4.2 The upstream producer supplies both domestic downstream producer and the MNE

Now assume that the MNE establishes a linkage with the local producer of intermediates**.** The producer of intermediates needs to invest effort $\bar{i}$ to reach the required threshold quality level $\bar{\lambda}$. Assume that the transfer price for intermediates $\bar{p}$ is lower than the profit maximizing price p discriminate between the domestic final producer and the MNE. He will charge the domestic producer price p_i and the MNE price $\overline{p}$.[10]

In this case the profit function is given by

$$\pi_m = (p_i - c)x_i^d + (\overline{p} - c)x_i^m - f \cdot i \tag{23}$$

Substituting in demand functions for intermediates from (5) and (10) yields

$$\pi_m = \lambda_i (p_i - c)\left(\frac{P_d}{p_i}\right)^{\frac{1}{1-\alpha}} + \lambda_i (\overline{p} - c)\left(\frac{P_m}{\overline{p}}\right)^{\frac{1}{1-\beta}} - f \cdot i \tag{24}$$

Note that the first term on the RHS of (24) is $\lambda_i V_d$, where V_d reflects the profitability of supplying to the domestic producer. In addition, let

$$V_m = (\overline{p} - c)\left(\frac{P_m}{\overline{p}}\right)^{\frac{1}{1-\beta}} \tag{25}$$

Analogously, V_m reflects the profitability of supplying to the MNE. Now (24) can be rewritten as

$$\pi_m = \lambda_i (V_d + V_m) - f \cdot i \tag{26}$$

(26) implies that variable profits of the local supplier consists of 2 components: those earned from supplying the domestic producer and those from supplying the MNE.

Substituting in for the quality index: $_i = \sqrt{i}$, where $i \geq \bar{i}$, equation (26) becomes

$$\pi_m = \sqrt{i} \cdot (V_d + V_m) - f \cdot i \tag{27}$$

Let $V = V_d + V_m$ (28)

Then the first-order condition for optimal effort level i^{**} can be expressed as

[10] Lall (1980) describes that MNEs helped their suppliers to sell parts and components on replacement markets, where prices are significantly higher. The ability of the intermediate good supplier to discriminate is not essential. The analysis is not changed for no price discrimination case.

$$\frac{\partial \pi_m}{\partial i} = \frac{1}{2\sqrt{i^{**}}} V - f \leq 0 \qquad \text{where } i^{**} \geq \bar{i} \tag{29}$$

Consider again interior and corner solutions for effort level *i*** separately.

(I) If $\frac{1}{2\sqrt{i^{**}}} V - f = 0$, for $i \geq \bar{i}$ then $i^{**} = \left(\frac{V}{2f}\right)^2 \geq \bar{i}$ (30)

This corresponds to the internal solution and holds when $V \geq 2f\sqrt{\bar{i}}$. I will refer to this case as *innovation case* since the producer will find it profitable to improve quality beyond the required threshold level $\bar{\lambda}$. The maximum profit in this case will be given by

$$\pi_m^* = \frac{V}{2f} V - f\left(\frac{V}{2f}\right)^2 = \frac{V^2}{4f} \tag{31}$$

Substituting in for V yields expression for π_m^* in terms of the exogenous variables and the parameters of the model

$$\pi_m^* = \frac{1}{4f}\left((1-\alpha)\left(\frac{\alpha}{c}\right)^{\frac{\alpha}{1-\alpha}} P_d^{\frac{1}{1-\alpha}} + (\bar{p}-c)\left(\frac{P_m}{\bar{p}}\right)^{\frac{1}{1-\beta}}\right)^2 \tag{32}$$

The innovation cases are depicted in Table 1, column 1.

(II) For the corner solution the following should hold

If $\frac{1}{2\sqrt{i^{**}}} V - f < 0$ for $i \geq \bar{i}$ $\Rightarrow$ $i^{**} = \bar{i}$.

This holds when $V < 2f\sqrt{\bar{i}}$. I will refer to this case as the *quality improvement case* since the producer only improves quality up to the required threshold level $\bar{\lambda}$.

In this case the profit function will be:

$$\pi_m^* = V\sqrt{\bar{i}} - f \cdot \bar{i} \tag{33}$$

or substituting for V yields

$$\pi_m^* = \sqrt{\bar{i}}\left((1-\alpha)\left(\frac{\alpha}{c}\right)^{\frac{\alpha}{1-\alpha}} P_d^{\frac{1}{1-\alpha}} + (\bar{p}-c)\left(\frac{P_m}{\bar{p}}\right)^{\frac{1}{1-\beta}}\right) - f\cdot\bar{i} \qquad (34)$$

The quality improvement cases are depicted in Table1, column 2.

Consider Table 1 in more details. The rows in the table represent the quality levels of the intermediate good when the producer supplies domestic downstream firm only. While columns correspond to the cases when the producer supplies both downstream firms. For example, in Case 1 ($\lambda^* > 1,\ \lambda^{**} > \bar{\lambda}$) the supplier would produce a good of intermediate quality if he supplies only the domestic downstream firm. However, he would improve quality of the good beyond the threshold level $\bar{\lambda}$ if he supplies both downstream producers. Which option he prefers will depend on the value of the profit realized in each situation. Particularly, if $\pi_d^* > \pi_m^*$ the producer will supply the domestic downstream producer only and produce a good of intermediate quality. If $\pi_d^* < \pi_m^*$ the producer will supply both12.3>TjETEMC/Span <</MCID 18 >>2d825 of supplying the MNE. Consider first the situation when the producer decides to innovate. The following conditions should hold

$$i^{**} > \bar{i} \tag{35}$$

$$\pi_m^* > \pi_d^* \tag{36}$$

$$\pi_m^* > 0 \tag{37}$$

Condition (35) implies that it is profitable to improve quality beyond the required level $\bar{\lambda}$ by investing more effort than $\bar{i}$. Condition (36) indicates that the producer will earn higher profits by supplying to both downstream producers. And the last condition is the non-negativity constraint. Substituting in for i^{**}, π_m and π_d yields an equivalent set of conditions

$$V_d + V_m > 2f\sqrt{\bar{i}} \tag{38}$$

$$\frac{(V_d + V_m)^2}{4f} > \begin{cases} \dfrac{V_d^2}{4f} & V_d \in [\,2f;\ 2f\sqrt{\bar{i}}\,] \quad (39) \\ V_d - f & V_d \in [\,f;\ 2f\,] \quad (39') \\ 0 & \quad (40) \end{cases}$$

The solution to these inequalities corresponds to the area above the line AB in Figure 1. Therefore, in the region above the line AB the producer will improve quality beyond the threshold level $\bar{\lambda}$ by innovating. In this case it is not the quality requirements, but rather higher demand for intermediate good that triggers investment in quality improvements.

Now consider when the upstream producer will improve quality only up to threshold level $\bar{\lambda}$. The following conditions need to hold in this case

$$i^{**} \leq \bar{i} \tag{41}$$

$$\pi_m^* > \pi_d^* \tag{42}$$

$$\pi_m^* > 0 \tag{43}$$

Again substituting in for i^{**}, π_m and π_d yields an equivalent set of conditions

$$V_d + V_m \le 2f\sqrt{\bar{i}} \qquad (44)$$

$$\frac{V_d^2}{4f} \qquad V_d \in [\,2f\,;\ 2f\sqrt{\bar{i}}\,] \qquad (45)$$

$$(V_m + V_d)\sqrt{\bar{i}} - f \cdot \bar{i} \ge \quad V_d - f \qquad V_d \in [\,f\,;\ 2f\,] \qquad (45')$$

$$0 \qquad (46)$$

The solution to inequality (44) corresponds to the area below line AB in the Figure 1.

In the region OKL*f* there is no production of either Q_m or Q_d - both are imported. Q_d is not produced due to the absence of intermediate inputs (it is not profitable for the intermediate producer to launch production, because $\pi_d < 0$). In addition, the potential demand from the MNE is not large enough to make production of intermediates profitable.

Now consider how different parameter values influence the equilibrium outcome. First, the size of the regions in Figure 1 depend on investment cost parameter *f* and the required quality level $\bar{\lambda}$ (or, equivalently, the effort level $\bar{i}$ necessary to achieve $\bar{\lambda}$). Higher values of *f* will move all the boundaries proportionally in the North-East direction making 'no production' and low quality regions larger, which means higher profitability is necessary to induce the producer to invest in quality. Analogously, higher threshold quality level (higher $\bar{i}$) will move boundaries KLDB and AB in the upward direction, again increasing sizes of 'no production' and low quality regions. Other parameters influence the *position* of the outcome in the graph. Particularly, the intermediates content in domestic production, α, the price of the domestic final good, $P_{d,}$ and the marginal cost of producing intermediate good, *c*, determine the value of V_d. Therefore, they will determine the position of the firm in the 'horizontal' dimension on the graph. Analogously, the intermediates content in the MNE production, β , price of the MNE final good, $P_{m,}$ and the transfer price of intermediates, $\overline{p}$, determine the value of V_m and therefore the position of the firm in the vertical dime

$\pi_m = \lambda_i (V_d + V_m) - f \cdot i$

As can be seen higher quality λ_i generates higher profits. I simulate the behavior of the profit functions of the downstream producer, $\Pi_{d,}$ and the upstream producer, $\pi_{d,}$ along the line MM'' in Figure 1. Along that line increase in V_m makes investment in quality more attractive option. Regime switching from the basic to the required quality and to innovation case occurs along the line in the upward direction. The results are shown in Figure 2.

As can be seen in the 'basic quality' region (approximately pt.1-12) profits are constant until V_m hits the boundary between 'basic quality' and 'quality improvement' regions. At that point profits of the downstream producer jump upward due to the change in quality of intermediates, then again stay the same in the 'quality improvement' region (approximately pt.12-21) until V_m hits another boundary between 'quality improvement' and 'innovation' regions. From there on it is an increasing function of the profitability V_m since the quality of the intermediate good will be improved more. As can be seen the 'innovation case' is the most desirable outcome. The profit of the intermediate producer is linearly increasing in V_m in 'quality improvement' region and it is a convex function in 'innovation' case. Again, the most of the gain is observed in innovation region.

Analogously the MNE profit function can be expressed in terms of quality level, by substituting (10) into (7):

$$\Pi_m = \frac{1}{\beta} P_m \lambda_i^{1-\beta} \lambda_i^{\beta} \left(\frac{P_m}{\overline{p}} \right)^{\frac{\beta}{1-\beta}} - \overline{p} \lambda_i \left(\frac{P_m}{\overline{p}} \right)^{\frac{1}{1-\beta}} = \lambda_i \left(\frac{1}{\beta} - 1 \right) (\overline{p})^{-\frac{\beta}{1-\beta}} P_m^{\frac{1}{1-\beta}} \qquad (51)$$

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Table 1. Profit of the intermediate producer for different ranges of V_d and V_m

with MNE no MNE	**Innovation case** $(V_d + V_m) > 2f\sqrt{\bar{i}}$ or $\lambda^{**} > \bar{\lambda}$	**Quality improvement** $(V_d + V_m) < 2f\sqrt{\bar{i}}$ or $\lambda^{**} = \bar{\lambda}$
$2f<V_d<2f\sqrt{\bar{i}}$ $\lambda^{*} > 1$ **Intermediate quality**	Case 1 $f\,i$ π_m^* π_d^* 1 i^* i^{**} $\pi_d^* = \frac{V_d^2}{4f}$ $\pi_m^* = \frac{(V_d + V_m)^2}{4f}$	Case 2 $f\,i$ π_m^* π_d^* 1 i^* i^{**} $\pi_d^* = \frac{V_d^2}{4f}$

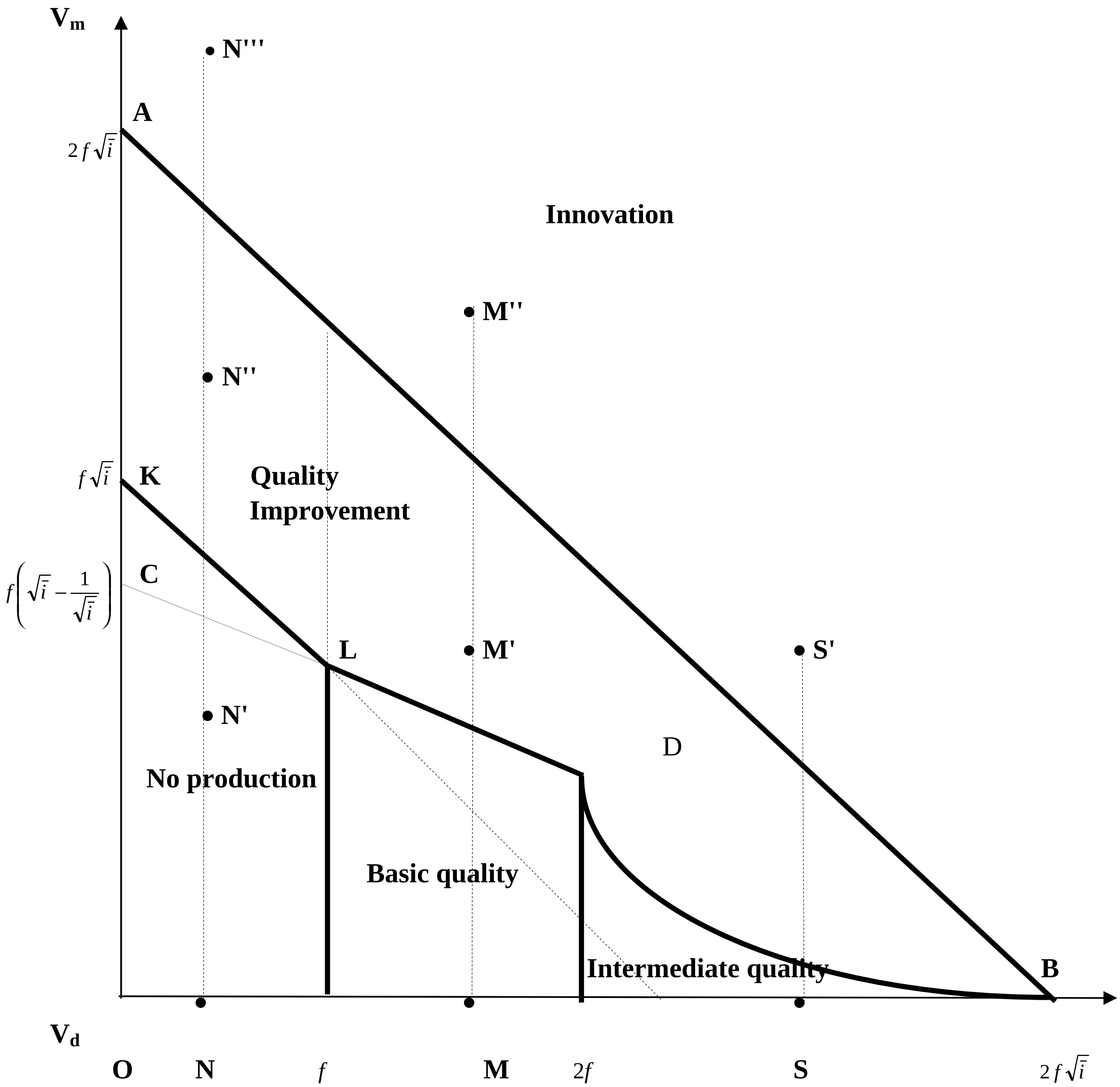
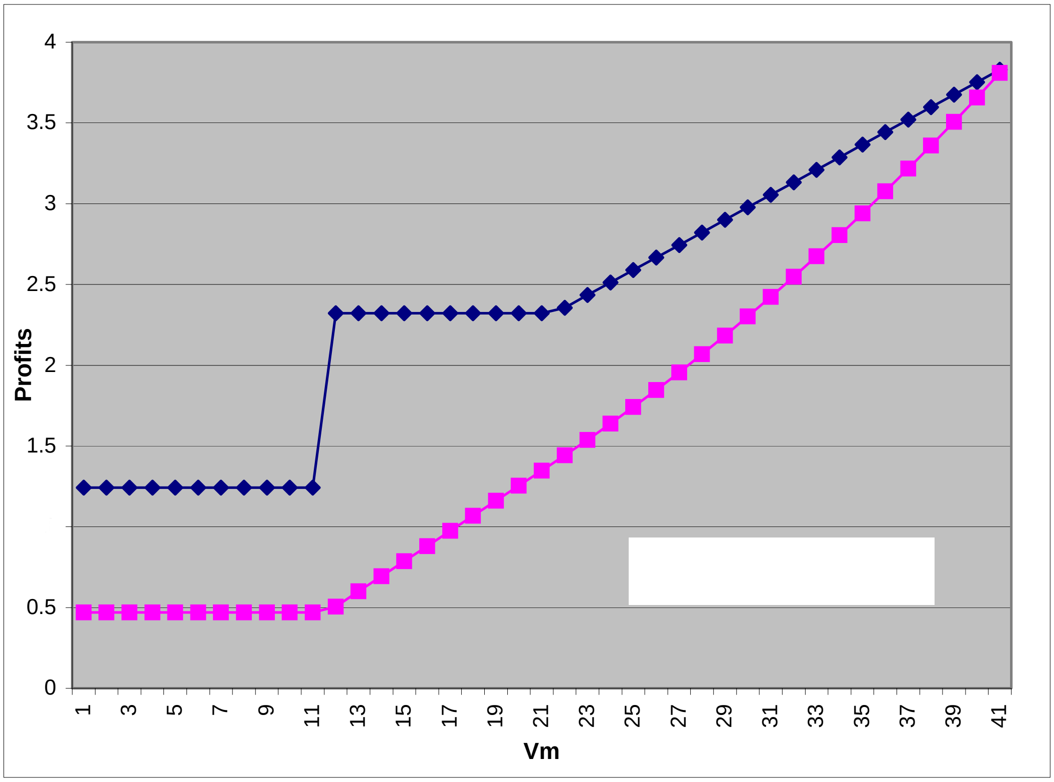


Figure 1. The decision of the local supplier to invest in quality improvements

The decision of the local supppof thpcal sup


4
3.5
3
2.5
2
1.5
0.5
0
Profits
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3
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41
Vm

Appendix A

Point D is an intersectio

Appendix B

This appendix shows comparative static exercise for the variables V_d and V_m